Opportunities to Expand Technology-Rich Learning for Youth in Schools

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December 2005

Introduction

Significant cohorts of young people in the United States are dedicated, passionate technology users, and there is much to learn about the scope and depth of their engagement with information and communication technologies (ICT). A decade of substantial investments has allowed virtually every school (99%) to acquire Internet access (U.S. Department of Education, 2005a; Parsad & Jones, 2005). However, serious and persistent disparities exist in young people's access to new media and technologies and in the opportunities youth are offered to develop as critical, inquisitive users of those tools and resources. A recent survey conducted by the Pew Internet & American Life Project that found 87 percent of young people use the Internet also found that 3 million remain without Internet access. Many of those without access come from financially disadvantaged backgrounds, and a disproportionate number are minorities (eSchool News, 2005). A nationwide study examining the relationship between socioeconomic status and teaching practices around technology found that low-SES schools use technology for reinforcement and remediation of skills, while higher-SES schools use technology for analyzing and presenting information (Becker, 2000). These issues are of direct relevance to the future of formal K-12 education, which is urgently in need of further innovation if it is to take full advantage of ICTs to support learning, and meet its goal of providing truly equitable education to all students.

This paper seeks to contribute to the MacArthur Foundation's efforts to examine how research and development can best contribute to our understanding of young people's engagement with technology, by considering how best to connect new knowledge about young people's informal uses of ICT with the role those resources can play in the formal K-12 education system. Three premises inform this effort:

1. Because technologies are fundamental to the social, informational and communicative networks in which young people live, institutions that seek to support young people's learning and development need to leverage a range of technologies to achieve their educational objectives.

2. In order for these institutions to be prepared to serve all young people equitably, they will need to acknowledge and address current inequities in young people's access to and readiness to make use of these technologies.

3. In the U.S., the formal K-12 education system needs to be cultivated as a partner to effectively develop young people's critical thinking and problem-solving capacities and to expand their knowledge of the world around them.

From this starting point, this paper takes on two tasks. First, we describe several current, high-priority educational policy issues and identify opportunities to address those policy issues through innovative uses of technology. Second, we describe three broader categories of research and development that could build bridges between investigations of young people's informal engagement with ICT and the structures and content of formal schooling.

The Policy Context

Economic and political shifts over the past four years have significantly slowed the pace of K-12 school's adoption of classroom technologies of all stripes, as well as the public's enthusiasm for educational applications of technology in general. Sales of educational software for home computers have dropped dramatically, from $498 million in 1994 to $152 million in 2004 (The New York Times, August 23, 2005). Meeting the requirements of the No Child Left Behind Act of 2001 (NCLB) has left little time or opportunity for innovation in most classrooms, leading many teachers to abandon efforts to experiment with technology in their teaching. Federal funding for the development of innovative educational software, professional development and basic research, historically provided through the U.S. Department of Education and the National Science Foundation, has been cut significantly. Many corporations and private philanthropies that once had significant public roles to play in promoting technology as a lever for school reform have pulled

back from those initiatives, citing both cost and the difficulties of sustaining real change over time. Taken together, these forces and others have left a substantial void in efforts designed to investigate the role technologies might play in reconfiguring and improving public schooling in the U.S. At the same time, consumer technologies continue to evolve at a rapid pace, and adolescents are some of the most prominent early adopters of new hardware, software, modes of communication, and methods of consuming, creating, and sharing media, information, and ideas.

The gap between adolescents' expectations of the role of technology in daily life and the realities of technology use in the daily life of K-12 schools has never been wider. Current federal education policy makes superficial links between young people's engagement with technology and the life of schools, but there is little, if any, programmatic support offered to advance this connection. The Bush administration recently laid out its vision for technology in K-12 education in its recent National Education Technology Plan (U.S. Department of Education, 2005b). While this plan features images of young people as technology enthusiasts, the plan's substance primarily emphasizes, as Andrew Trotter recently summarized in *Technology Counts 2005*, technology as a tool to help teachers and administrators "connect the dots" among different portions of their efforts to respond to the NCLB mandates (Trotter, 2005). For example, the administration is funding, through block grants to states, the development of commercial tools to support the aggregation and dis-aggregation of testing data. It is also funding the development and delivery of electronic curricular resources that are tightly aligned to the standards and tests used in various states. While these strategies are critical to building a technical foundation that can help schools and states meet NCLB requirements, it is equally important to invest in strategies that will support the effective use of data and instructional resources to improve student learning in the classroom. The next section of this paper delves into three related topics: *Creating stronger links between accountability and instruction*; *Integrating multiple institutional structures into traditional school districts*; and *Maintaining the global competitiveness of the United States*. The final section of the paper will consider other agendas that could be pursued by other funders to leverage, work around, or influence these federal agendas.

Priority 1: Creating stronger links between accountability and instruction. While NCLB has greatly expanded accountability mechanisms, it has focused almost exclusively on students' standardized test scores as an outcome measure. This approach embodies a vision of comprehensive, high-stakes testing as a primary driver of educational improvement. However, translating testing pressures into improvements in instruction and learning is not without its challenges (Chester, 2005, 2005a; Desimone, Smith, Hayes, & Frisvold, 2005a, 2005b; Ferrara, 2005). For example, testing pressure at the local level can lead to an excessive narrowing of the curriculum or of instructional practices. This narrowing of instruction is a serious consequence of NCLB mandates, one that is playing out in classrooms and school district offices across the country where accountability pressures lead teachers to "teach to the test" (Dwyer, 2005; Porter, 2005). This narrowing of students' school experience is a prominent topic at local school board meetings, state education departments, and in the media (Baker, 2005; Gipps, 2005; Ladson-Billings, 2005). In addition to this narrowing of teaching practice, the enormous investments states and districts have made in accountability systems over the last four years are producing vast amounts of information that is of little value to teachers— the people who are actually in a position to improve student learning. It is now common for teachers to have access to testing results, but unusual for them to have any tools or supports available to help pose questions or draw meaningful conclusions from that mass of data. Teachers are urgently in need of resources and tools to help them make sense of testing data and apply it toward the development of more effective instructional strategies.

While school districts and state departments of education are building the technical and human infrastructure to track, coordinate, and disaggregate the testing data being generated in response to NCLB requirements, the decision-making capacity to query and examine testing data to drive decisions about grouping and instruction at the classroom level is in a much earlier stages of development. However, even when it is made available to them in a usable format, recent research suggests that teachers have few opportunities, and are poorly prepared, to make good use of the data (Love, 2002,

2004; Confrey & Makar, 2005). An acute need exists for tools and training to help building-level administrators and classroom teachers.

Both our political leadership and the education policy community have made it clear that accountability measures are here to stay. If teachers are to be prepared adequately to make use of testing data, we need to identify how the data-management, visualization, tracking, and representational capacities of ICTs can be used to meet this need, build the resources that will help teachers do this kind of systematic exploration of data, and train teachers to use them effectively in the context of their own practice.

Technology Opportunities. Researchers have been investigating ways to tie accountability practices, and the data they produce, into a tighter feedback loop, in which testing data informs, but does not define, teachers' instructional practices (Carnoy, 2005; Porter, Linn, & Trimble, 2005; Snow & Mandinach, 1991). Early research in this area suggests the challenges involved in doing this well. The high level of focus on standardized test scores that currently dominates discussion of K-12 education runs contrary to most teachers' assessment practices. Teachers are wary of using any single data source, such as high-stakes test data, to make decisions about their students' strengths and weaknesses. Their preference is to engage multiple sources of data—homework assignments, in-class tests, classroom performances, as well as impressionistic, anecdotal, and experiential information—to inform their thinking about student learning (Honey, Brunner, Light, Kim, McDermott, Heinze, Mandinach, & Bereiter, 2002; Light, Wexler, & Heinze, 2004). While this approach to data yields a richer profile of individual student performance, it also has a downside. Our research and that of others (Confrey & Makar, 2002, 2005; Hammerman, & Rubin, 2002, 2003) suggests that teachers are more inclined to examine factors that contribute to individual patterns of behavior and to think on a case-by-case basis, and are unlikely to look for patterns in data at different levels of aggregation, such as classroom-wide patterns, or to draw valid conclusions from them even when they do find them. As a result, teachers' decision-making strategies often lack systematicity, from student-to-student, class-to-class, and year-to-year, are unintentionally tinged with personal bias, and ignore key statistical concepts like distribution, variation, and reliability.

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New statistical visualization tools have the potential to not only support cognitive decision-making practices, but also deepen and systematize these practices into more rigorous and methodologically sound investigations of the relationships between instructional strategies and student performance. These tools make it possible to interrogate data flexibly by visualizing the relationships among different combinations of variables (Confrey & Makar, 2002, 2005; Konold, 2002; Konold & Higgins, 2003; Konold, Pollatsek, Well, & Gagnon, 1997; Hammerman & Rubin, 2004).

Cliff Konold of the University of Massachusetts at Amherst created a software tool called TinkerPlots (http://www.umass.edu/srri/serg/projects/tp/tpmain.html) originally to support students' investigation of data interrelationships, but this software also shows promise as a tool for teachers to use in their own investigations of test scores and other associated data (Konold & Miller, 2001). Tinkerplots, unlike other data analysis applications, is a flexible tool that allows users to include all sorts of soft data (Konold, 2002, 2005). With other tools, once the data are set, it is difficult or impossible to include additional attributes or variables. Tinkerplots, in contrast, allows for iteration and flexibility, enabling users to interact with data in ways that they could not imagine without the tool, and therefore ask questions they otherwise might not consider. For example, deciding if an apparent difference is a real difference or just due to chance is only available to users in statistical packages such as SPSS or SAS by examining a p-value. There are, however, other visual ways to estimate whether or not a difference is significant when you have graphs that can be flexibly manipulated. At the data level, users can add new attributes at will, enabling flexible manipulation of data sets and emphasizes organizing and collecting skills. At the level of information, Tinkerplots affords visualization to enable easy summarizing and analyzing. At the level of usable knowledge, synthesis and decisions occur through visualization and representations. Users can view different outcomes and justify their decisions based on the application's representations.

Visualization tools, such at Tinkerplots, are not the only technology-based applications with the potential to enable educators to interrogate and manipulate data in effective and understandable ways. Some promising tools and professional development programs are already being used in schools, though work remains to be done in this area.

Examples of emerging and promising approaches include the Grow Network, a division of McGraw-Hill that provides districts with a teacher-level interface to student test data, and provides teachers with an array of links to various instructional strategies that can be used to respond to student misconceptions or weaknesses identified through examination of the data. EDC/CCT conducted a study of an early implementation of the Grow Network in New York City that discusses some of the promising and challenging issues that arise for teachers trying to make sense of testing data in the classroom (Honey, Brunner, Light, Kim, McDermott, Heinze, Breiter, & Mandinach, 2002). Other data interrogation applications, such as diagnostic assessments delivered on handheld computers and data warehouses containing a myriad of data ranging from demographics to student achievement data, provide promising technology solutions that enable a diversity of users to access valuable information (Mandinach, Honey, Light, Heinze, & Rivas, 2005). In October 2005, a Wingspread Conference called "Improving Achievement through Linking Data and Learning" was held on this topic—a compilations of the papers presented there is forthcoming (Honey & Mandinach, forthcoming).

Priority 2: Integrating multiple institutional structures into traditional school districts. The cultivation of voucher programs and charter schools continues to be a high national priority. In practice, these alternative structures are most commonly taking root in large school districts where administrators are increasingly willing to support multiple forms of school organization within a single district, particularly charters run by a variety of entities, small schools and, to a lesser extent, limited voucher programs. Districts such as Philadelphia and New York City are investing in a range of school types and waiting to see which are sustainable, meet student needs, and can function within existing district-level administrative structures.

One of the attractions of this kind of school diversification for large school districts is that it increases the district's capacity to offer a wider range of specialized and thematic educational programs to families. Small schools and charter schools frequently are designed for specific populations of students, or offer thematically grounded curricula. A major challenge, though, is creating a curricular and instructional program

that lives up to the promise of the school design and the thematic or conceptual framework laid out for its educational program. The school reform literature makes it clear that establishing and maintaining truly innovative school designs is difficult, and that multiple forces push schools consistently toward a middle ground of traditional instruction and well-trodden curricular pathways. But at the same time, alternative school structures, such as charters and newly-created small schools, provide valuable opportunities to start from scratch and design programs that can begin from a point of innovation and creativity, instead of trying to impose these qualities within well-established programs. Accomplishing this, however, requires access to professional development and curricular resources that can match up with the particular designs or themes of these widely varying new schools.

Technology Opportunities. Curriculum development is an enormous and labor-intensive undertaking, and teachers in alternative schools are in need of mechanisms to help them locate, review, and assemble rich and diverse content into coherent curricular units. Of course, access to the Internet has transformed the range of content available to these teachers. Any number of ready-made curricular resources, as well as raw sets of data, images, and other primary sources, exist online and can be used to expand or extend curricula. What has not been adequately addressed is teachers' need for access to content that is rich, deep, and complex, but also vetted, organized in a meaningful fashion, and accessible to non-specialists. In addition to a vast array of content, the web can also support the delivery of professional development experiences designed to help teachers hone their skills in using curricula grounded in these types of material.

Museums, libraries and organizations with access to rich archives of primary source documents are already creating exemplary curriculum development and professional development sites for teachers. Examples of rich curriculum resources include:

- WGBH's Teachers' Domain organizes a subset of PBS' vast programming archive, making video and audio clips, documents and images available in a searchable format within subject areas and connecting these resources to standards, sample lesson plans, and additional explanatory text. http://www.teachersdomain.org/

- The American Memory collection at the Library of Congress provides educators

with structured access to millions of historical documents and multiple thematic threads, original source material and lesson plans that chart various pathways through the collections. http://memory.loc.gov/ammem/

- Discovery Channel Schools' Curriculum Center ties ideas for both extended and short-term projects and lessons to digital video, images and text drawn from the channel's extensive archive of natural science content. http://school.discovery.com/curriculumcenter/

Each of these sites has assembled resources and created scaffolding that helps educators more easily investigate and synthesize rich media resources. By using raw material taken from the Internet or other digital and non-digital archives and organizing them into information units that align with both the structure and content of schooling, - these sites expand the range of thematically-relevant content available in the classroom and deepen the kinds of inquiry into that content that students can pursue.

Even after these scaffolds are created and embedded in high-quality content, considerable obstacles must be overcome to make these resources useful to teachers. First, teachers need to be prepared to help students make the connection between seeking out rich digital resources and putting those resources to work to support the process of building new knowledge. Second, teachers need to understand how to teach effectively with these resources—not only discuss the content but also prepare students to use multiple forms of media and information to guide, structure, and inform their investigations and explorations of new content and ideas. Third, schools need to find balance between the desire to provide students with rich resources because they can be instructionally productive and the desire to constrain available resources available because the diversity and novelty of these materials can disrupt the uniformity and pace of schooling.

Both the structural features of traditional American schooling and young people's need for instructional support in the use of these tools impede the tools' potential to support kinds of learning that correspond with contemporary forms of communication, exploration, and community-building occurring outside of school. This is why these kinds of resources need to be tied to professional development programs, and often are. Exemplars in this area include the American Museum of Natural History, which offers a

range of online courses coordinated with its online collection, Resources for Learning. These seminars are led by research scientists and engage teachers with current research literature and digital resources available at the website, and help them plan for and practice in-class implementations of new lessons and activities. PBS TeacherLine offers an enormous range of online courses for teachers, all drawing on PBS digital archives as content resources.

Priority 3: Maintaining the global competitiveness of the United States. Leaders in the business community, high-end research and development institutions, and this administration often identify K-12 education as both the key, and the main threat, to American competitiveness in the global marketplace. As former Education Secretary Rod Paige explained to a group of high school students who were visiting Washington, D.C., "Too many of our students leave school without the skills to compete in a global economy" (Paige, October 8, 2003). Education Secretary Margaret Spellings (Spellings, 2005) and former Secretary of State Colin Powell (Kagan & Stewart, 2004) have also signaled that today's students are not prepared to compete internationally. These grave statements, part of an American tradition of tying economic health to K-12 education, typically focus on test scores, most recently international comparisons drawn from the TIMMS and PISA results, and often lead to calls for broad, generalized reforms ranging from improving the teacher corps to lengthening the school day.

Recently, though, the business, policy, and education research sectors have begun talking about education's role in shaping the place of America's students in the world (Bertelsmann Foundation & AOL Time Warner Foundation, 2002; CEO Forum, 2001; Partnership for 21st Century Skills, 2003). This approach focuses on the need to prepare students to participate in the global marketplace and take part in the kind of border-crossing, globetrotting work that multinational companies increasingly depend upon. The goal is to develop students who not only compete globally, but also collaborate effectively across very different cultural arenas. While mastery of core subjects, particularly math and science, and the ability to innovate and think creatively are still prized, this newer globally-focused model of education reform privileges first and foremost meta-cognitive and interpersonal skills, often described as 21st century skills or ICT literacy. For example, the ability to communicate complex ideas to an audience

effectively, to gather and critically assess diverse forms of evidence, to respond to rapid, multiple changes in the composition or structure of a task, and to collaborate productively are skills that are central to success in an interconnected, rapidly changing, technology- and media-rich world. To develop these 21st century skills, these organizations suggest that students need settings that involve significant engagement with digital content, analytic tools, and multimedia forms of communication as well as authentic, complex, and collaborative learning tasks (Roschelle, Pea, Hoadley, Gordin & Means, 2000). Schools hoping to teach these skills must give students the opportunity to use the relevant technologies with frequency and depth. And, perhaps, more importantly, schools must find define and measure not just technology use but its application toward the acquisition and application of these 21st century learning and critical thinking skills (Kay & Honey, in press; Partnership for 21st Century Skills, 2005).

NCLB legislation, which requires states to demonstrate that "every student is technologically literate by the time the student finishes the eighth grade, regardless of the student's race, ethnicity, gender, family income, geographic location, or disability" (U.S. Department of Education, 2001), provides a timeline for the development of an eighth-grade assessment of ICT literacy. This presents a compelling opportunity to define and assess ICT literacy in a way that moves well beyond traditional notions of "computer literacy" to investigate the development of students' 21st century skills. However, there has been little movement on the federal level to address this need or begin developing assessments that measure these skills in authentic, 21st century contexts (Kay & Honey, in press). While a lack of appropriate assessments threatens the long-term viability of ICT literacy, testing pressures represent a more immediate challenge to the teaching and assessment of these skills. As teachers respond to testing demands by narrowing their curriculum and their style of instruction, these kinds of skills are most likely being de-emphasized in the day-to-day use of technology in schools. At precisely the moment when functional definitions of "achievement" need to expand, they are systematically being narrowed (Apple Computer, 2003).

A range of organizations are beginning to develop ICT literacy assessments, with a goal of producing a rigorous method for revealing and tracking students' acquisition of cognitive skills in conjunction with their use of technology (Partnership for 21st Century

Skills, 2005); however, much of this work is taking place internationally. A handful of active projects, largely based in the United Kingdom, have managed to combine the educational vision, funding, and appropriate political will necessary to craft broadly applicable assessments that capture students' application of higher-order thinking in problems requiring the use of ICT skills. A particularly promising project is the innovative new *Key Stage 3* (age 14) *ICT Literacy Assessment* created by the British government's Qualifications and Curriculum Authority (QCA).

The assessment, administered online, is an ambitious attempt to assess higher-order thinking in conjunction with ICT use. The test assesses students' ICT skills, and their ability to use those skills to solve a set of complex problems involving research, communication, information management, and presentation. Most importantly, the QCA's responsive assessment engine tracks and responds to the test-taker's performance on both technical and problem-solving tasks throughout the course of the assessment. Student scores are based on their performance in these areas as well as their demonstrated level of technical skill, and the test engine's final output includes not only a numerical score (useful for national ranking purposes), but a detailed profile of the test-taker's performance and areas for potential improvement– making the test useful not only for ranking students, but for providing them with targeted instruction in the future.

In the United States, only the Educational Testing Service's new ICT Literacy Assessment approaches the work being developed in Great Britain. The ETS assessment employs "scenario-based assignments" – tasks such as selecting the best database for an information need -- to evaluate test-takers' abilities to use ICT to think critically and solve problems. This evaluation is currently targeted only to college-age students, though it may eventually have implications at high school level.[1]

<u>Opportunities to influence student-driven use of technology in schools</u>
Creating schools that are able to keep pace with their students' enthusiastic accommodation of ICT into their daily lives requires, first and foremost, using ICT to professionalize the daily lives of their teachers. Bringing technology to bear on the policy priorities discussed above could help to create a professional environment in which teachers are able to create innovative, timely curricula; put testing data to work as one

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[1] For a complete review of current efforts in this area, see Partnership for 21st Century Skills, 2005.

among many streams of diagnostic information driving instruction; and assess their students' work deeply, appropriately and productively. But such an effort would also transform teachers' working lives by placing them in an environment in which they would use technology to track rapidly changing information, communicate with networks of colleagues, explore complex information and represent their evolving understanding of it, and pose questions and seek out answers to them. In short, they must begin using technology in many of the same ways that their students are already accustomed to. Only once the professional work of being a teacher is a fundamentally technology-integrated job can teachers really be expected to invest universally and deeply in creating technology-rich teaching and learning environments in schools. The following sections describe how further effort in three areas could directly influence and improve how technology is used to support learning in formal educational environments.

Each of these recommendations begins from a premise that we must continue to invest in schools and educators, to help them create learning environments in which technology-rich, cognitively sophisticated student learning can take root and develop over time. It is not enough for students simply to use technology more frequently in school, or even for technology to become a ubiquitous tool in schools. Further investment in training, infrastructure, and curricular resources will only be justified if school environments allow for the implementation of technology-rich curriculum and instruction that are tightly yoked to well-defined student learning goals that focus on the development of sophisticated interpretive, communicative, and analytic abilities.

1. Create data tools for teachers and research their influence on instruction. As researchers at the UCLA Center for Research on Evaluation, Standards, and Student Testing (CRESST) note, "Data-based decision-making and use of data for continuous improvement are the operating concepts of the day. These new expectations, that schools monitor their efforts to enable all students to achieve, assume that school leaders and teachers are ready and able to use data to understand where students are academically and why, and to establish improvement plans that are targeted, responsive, and flexible" (Mitchell, Lee, & Herman, 2000, p. 22). However, despite encouragement at the policy level, there is growing consensus that teachers are not typically trained or asked to think

critically about the relationships between instructional practices and student outcomes (Confrey & Makar, 2005; Hammerman & Rubin, 2002).

Lacking techniques for making sense of assessment data, too many teachers, if they have access to testing data at all, draw only the most superficial conclusions from the data available, missing opportunities to learn about the strengths and weaknesses of their practices. For those resources to become meaningful to educators, they need to be transformed into usable or actionable knowledge (Mandinach, Honey, Light, Heinze, & Rivas, 2005). The emerging research in this area suggests that what is needed is a comprehensive and purposeful approach to the use of data that not only informs the practices of individual teachers, but is supported as an essential and strategic part of school-wide improvement strategies.

Addressing this issue will eventually require investments in the development of more tools and resources for teachers, but a whole range of preliminary research remains to be done to help us understand some of the most basic questions about what data is actually relevant at the classroom level, whether and how teachers can and do go about making use of data, and the depth and sustainability of its impact on their practice, or eventual student outcomes. Given the current overwhelming presence of high-stakes testing on the national, state and local educational agenda, this is a topic that urgently needs to be addressed and that will require technology-rich solutions in order to manage and guide teachers' explorations of data.

2. Fund innovation in the development and delivery of rich, scaffolded content for teachers and associated professional development. The Internet has given teachers the opportunity to think differently about the role of information and imagery in their teaching. Via the web, teachers have access to a universe of information that was completely out of their reach only ten years ago. However, both teachers and content providers have quickly learned that in order for this diverse universe of content to reach the classroom and to influence how and what students learn, teachers need not only access to such content, but:

- Organizational frameworks for making sense of a given set of resources

- Tools to scaffold their own investigation of the content matter and understanding of the concept presented

- Aid in envisioning how to translate a mass of imagery or data into the building blocks of an activity, lesson or unit.

Further, while each of these supports can be provided within a content website, they also need to be supported more extensively through full-blown professional development opportunities.

Designing these multiple forms of support and training is a resource-intensive process and requires multiple forms of expertise that are unlikely to reside within every museum, media company, or other organization that wants to make its resources useful to educators. Few funding sources currently exist to support the design and development of these kinds of resources. Librarians, curators, and other educators and resource experts working outside of the educational system have much to offer to K-12 education. Significant investments need to be made to support individual development projects, as well as to build up a knowledge base regarding best known practices, support the development of new approaches to exploiting the capacities of the web to provide the richest possible online experiences for teachers, evaluate the relative effectiveness and utility of various kinds of resource and professional development sites, build relationships across institutions supporting this kind of work, and promote the value and importance of these resources within the K-12 community.

3. Invest in assessments of 21st century skills. Many recent research and policy reports have called on schools to acknowledge and respond to the technological sophistication of today's pre-adolescents and adolescents. They argue that by accommodating this cohort's habits of multitasking and intensive small-network communication (Ito, 2004), schools will be able to increase student engagement and achievement (Apple Computer, 2003; Lenhart, Rainie, & Lewis, 2001). Most prominently, the national educational technology plan places a strong emphasis on millennial children's fluency with technology, and puts young people's enthusiasm for technology at the center of their vision of technology's role in K-12 education (U.S. Department of Education, 2005).

We argue, though, that enthusiasm is not enough to change schools, and that technology will not become a meaningful part of young people's in-school learning experiences until a clear paradigm of the relation of technology use to learning, and to the

development of specific metacognitive skills, is modeled and broadly promoted. Investment in assessments of 21st century skills is, in part, a strategic move to accomplish this, since assessments are well known to drive instruction. Assessing students' 21st century skills will make explicit a particular vision of how ICTs can and should be facilitating young people's learning.

Putting in place such an assessment would likely be a critical step in establishing clearer expectations about how American youth should be using technology in schools to develop their ability to explore complex topics, assess critically the information and media they encounter, and put their own experience and expertise in conversation with images and ideas from different perspectives and cultures. Such a shift would also bring schools into the network of influences shaping youth engagement with technology in positive ways. For example, in a recent study conducted at EDC/CCT, we found that young people who had opportunities at school to use technology in support of substantive, creative project work were much more likely to be creative, enthusiastic users of technology in other informal environments than their peers who used technology at school for trivial or routine tasks (Gersick, Nudell, Ba, Tally and Culp, 2004). While some youth will always be willing and able to seek out and develop these abilities on their own, networks of institutional supports, knowledgeable adults and savvy peers will always play a central role in spreading these skills, and schools are too ubiquitous and play too large a role in young people's lives to be left out of this process.

Implications for research on youth in informal settings. Achieving each of these goals requires that researchers and educators articulate clear visions of how specific modes of technology use can inform and support *learning*. To date, far too much in-school use of technology has relied on notions of increasing motivation or building technical skill to justify and drive students' use of technology. Too little attention has been paid to learning about how students *do* use technology to learn. As described above, a range of efforts to define and promote the importance of 21st Century Skills are underway, but this body of work has much to gain from studies of youth practices and skills as they are expressed in informal activity. These studies can shed light on whether and how deep and flexible engagement with technology is not only motivating youth and expanding the scope and depth of the environment in which they function, but actually

influencing what and how they learn and the development of their capacities for critical and analytical thinking. Teasing out these issues in studies of informal technology use will be crucial to making this line of research relevant to research, policy, or practice related to the reform of traditional schools.

Studies of young people's informal engagement with technology also need to identify more systematically the specific networks of influences that support and impede young people's acquisition of particular abilities relative to the technologies they use. It is particularly important to move beyond descriptive studies and to begin pursuing analytic studies focused on young people who are accomplished and enthusiastic adopters of ICTs—the bellwethers of the near future for their peers. We know that these young people possess some extraordinary skills and knowledge, but we also know that their skills are often limited in ways that directly influence their ability to use ICTs to support learning. Their skills are often constrained by their own literacy levels, their ages and associated developmental capacities and limits, the models of technology use they are exposed to, the logistical realities of their access to technology and relevant content, and the social context in which their use of these technologies play out. There is much to learn about all of these issues and about the interactions among them. This knowledge is crucial to moving the field beyond simply valorizing these youth and toward learning from both their successes and their limitations.

<u>Conclusion</u>

ICT-rich educational environments need to be created and sustained and educators need to be properly supported, so that all young people can use ICT tools and resources to develop the critical and analytic skills they will need to be successful in the world. For young people, building the critical thinking and communication skills necessary to succeed in a 21st century world requires opportunities to build on technology-related expertise and enthusiasms they may cultivate on their own. The challenge facing these young people that formal educational systems can help with is learning how to put those skills and interests to work in the service of activities such as tackling complex and novel problems, building knowledge in new domains, interpreting and analyzing extensive, quickly-changing bodies of information, and communicating complex ideas to diverse audiences.

Making the connections that will allow educators working in formal settings to tap into young people's existing knowledge and leverage it effectively in the service of further learning will require expanding our understanding of the full range of young people's experiences as learners and explorers in a technology-saturated environment. In this work, we will need to pay paying attention to what young people do well, and also to what they have not yet had the opportunity to learn to do and what they are not yet developmentally ready to do. Then we can begin to build the resources and develop the human supports they need, and their teachers need, so they can be prepared to participate in, and lead, the adult world of the near future.

Answering these questions will require working across multiple sectors, conducting more research with young people and with educators in formal and informal educational environments, and conducting policy research to identify what resources could and should be brought to bear on the school- and teacher-level issues that now impede the easy flow of student-centered technology use in and out of the schoolhouse.

Doing this work will also require that researchers rethink their assumptions about how to engage productively with schools, so that innovative ideas and practices can connect with the existing priorities and constraints schools face. Building these kinds of learning environments will require intensive collaboration among researchers, educators and industry. Experience has taught us that doing this successfully that is, in a way that leads to deep, sustained changes in educational practice, will require significant changes in how researchers and industry professionals connect with schools. Schools have undergone dramatic changes in their technology infrastructure over the past ten years, but both long-standing traditions and more recent policy pressures have created a daunting atmosphere for any educator who might attempt to find a place for student-driven, resource-rich, innovative technology applications in her classroom. In this context, other funders must step in to influence the agenda and provide the resources and support these educators need to establish these environments.

Formal schooling provides an indispensable environment for balancing the challenges of supporting human development, facilitating children's learning of content and thinking skills necessary to holding a productive role in future societies, and creating an environment in which formal, adult-sponsored structures can live in productive tension

with youth-driven social practices and organizing structures. But formal schools are too often isolated and parochial in their vision and their practices, and they must begin to work in closer collaboration with out-of-school and informal learning environments, complementing them as those organizations can complement the school. In this belief, we are building in part on the work of the Carnegie Corporation (Carnegie Corporation, 1995). This report argued strongly that for adolescents to thrive and build the knowledge they need to become productive adults, they will need to access to multiple, mutually reinforcing learning environments, and that no single environment can or should provide all possible forms of support, stimulation or reinforcement.

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