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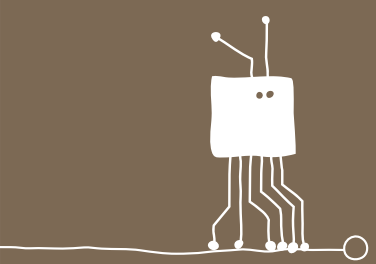
Getting over the slump:

June 2008

Innovation strategies to promote children's learning



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The Joan Ganz Cooney Center at Sesame Workshop

The mission of the Joan Ganz Cooney Center at Sesame Workshop is to harness digital media technologies to advance children's learning. The Center supports action research, encourages partnerships to connect child development experts and educators with interactive media and technology leaders, and mobilizes public and private investment in promising and proven new media technologies for children.

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The Joan Ganz Cooney Center has a deep commitment toward dissemination of useful and timely research and policy reports. Working closely with our Cooney Fellows, national advisors, media scholars, and practitioners, the Center is publishing a series of papers examining key issues in the field of digital media and learning.

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Early reading instruction will yield insufficient benefits if it does not prepare children for later content learning. Our current approach is failing too many students who experience the avoidable "fourth-grade reading slump."

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Learning content like math and science at any age must always include language learning. We must more proactively integrate approaches to teaching content, language, and literacy in the early grades.

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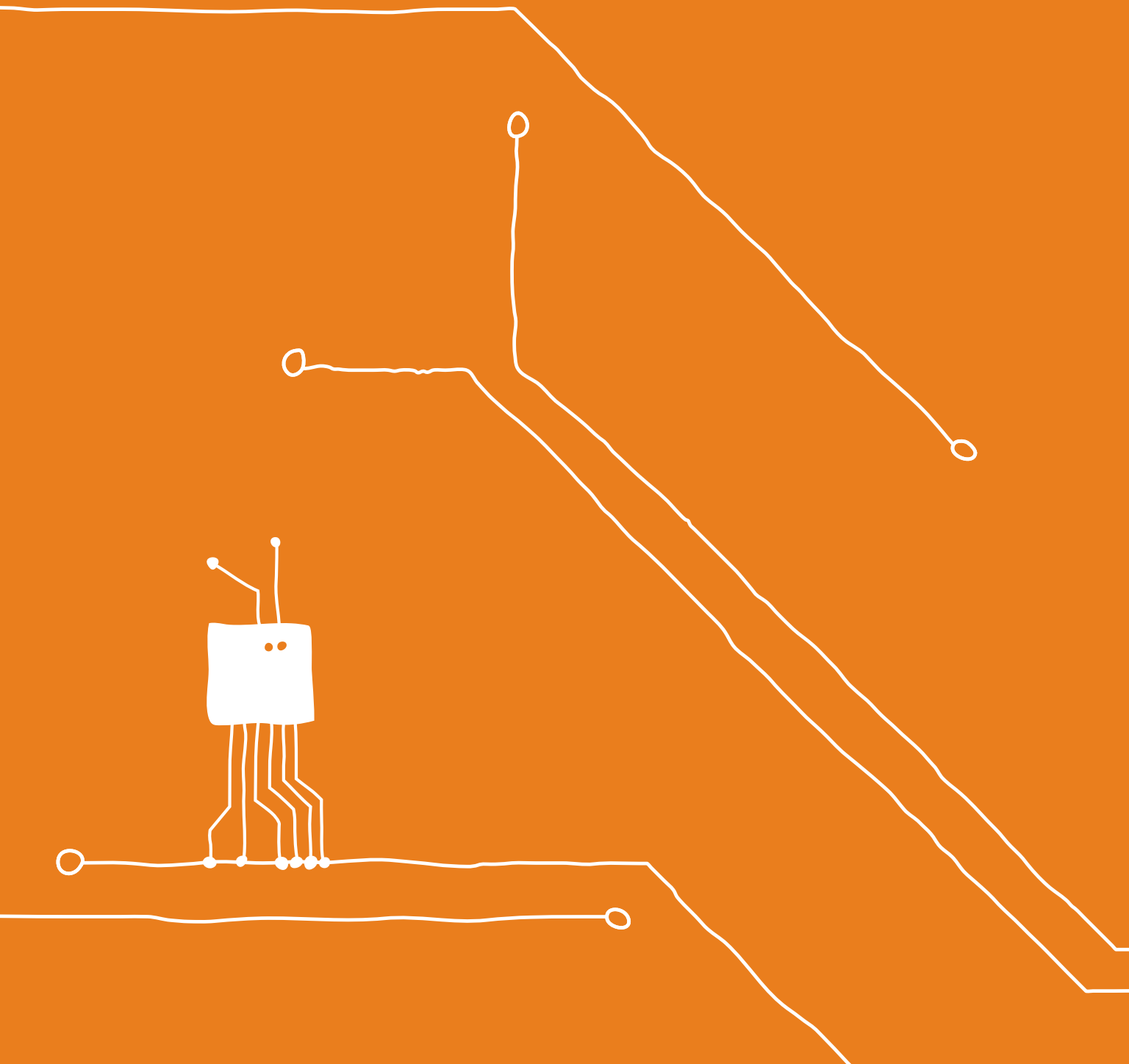
foreword:
getting over the slump



Four decades after Joan Ganz Cooney completed the landmark study that led to the creation of *Sesame Street*, a new center honoring her path breaking leadership has been established at Sesame Workshop. The Center is focusing on key new educational challenges children face today, asking the 21st-century equivalent of Mrs. Cooney's original question, "How can emerging media help children learn?" The inaugural focus of the Center is to understand how the digital media — online, video games, cell phones, and other rapidly evolving content delivery platforms — can help children develop strong literacy skills. Its focus includes the vital "foundational literacies" such as reading and writing that all children must develop as they enter school, as well as evolving competencies such as critical thinking, creativity, and intercultural skills that students now need to compete and cooperate in a global, interconnected age.

The Center's initiatives focus on research, model and partnership development, and dissemination to inform policymaking. The paper *Getting Over the Slump: Innovation Strategies to Promote Children's Learning*, by the noted learning scientist and video game expert James Paul Gee of Arizona State University, is the first in a series of policy reports to promote needed reforms to harness the potential of digital media in schools and community settings. The paper notes exciting innovations in game play that can prepare young learners to master basic and advanced literacy skills, the untapped power of interactive media to build new learning communities, and the potential of "situated learning" to transform children's educational experiences. Gee provides a fresh and urgent course of action to prevent the socially debilitating and economically disastrous "fourth-grade reading slump." He argues that by integrating naturally engaging digital media into the culture of literacy learning beginning in the primary grades, our nation can help prepare a new generation that will be more deeply knowledgeable and innovative. The paper outlines a provocative "new learning equation" and a vital action plan that all of the nation's pivotal sectors should carefully consider.

Michael Levine, Ph.D.
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executive summary

The United States is facing an educational crisis. U.S. students are doing poorly in literacy, math, and science compared with their peers in other industrialized countries. In addition, globalization is changing the demands of the workplace. American workers are now facing competition from skilled workers in many low-cost countries. Further, technology is in the process of automating all tasks reducible to rules. To stay ahead and sustain our standard of living, we must prepare our students for the 21st century with new skills — they must be capable, creative, innovative problem-solvers — along with the traditional core skills.

The foundation for all learning is basic literacy. This means more than the simple decoding of words; it also requires the ability to infer the meaning of unfamiliar words and, eventually, to infer meaning from patterns of information.

Elementary education in the United States has two urgent problems:

- The fourth-grade slump: Most fourth-graders can decode, but too many of them today cannot read to learn. They are unable to negotiate the "language of content" (e.g., the language of math, science, social studies), which is more abstract, complex, and precise than everyday oral language.
- The digital gap: Access to digital media is important, but perhaps more important is access to adult mentoring in the use of digital media. Students need adults to help them learn to leverage technological "know-how" to learn content, produce knowledge, and develop high-level expertise.

The fourth-grade slump consistently leads to educational failure. The digital gap leads to a failure to become confidently "tech-savvy," a 21st-century skill crucial for success, and even for survival. The fourth-grade slump and the digital gap interact with each other: Each makes the other worse.

The most accurate predictor of school success is the size of a child's vocabulary at age five of "book" words (words more likely to appear in written texts than in spoken language). This breadth of vocabulary is created by parents talking to children, answering their questions, reading to them, modeling their own pleasure in reading, and offering their children a wide variety of experiences in the world.

Three questions immediately arise:

- How do we help children who don't have a sufficient vocabulary in kindergarten?
- How do we help older students who cannot read to learn?
- How do we help English Language Learners?

One answer is to capitalize on the affordances of digital media to address three salient issues:

- The fourth-grade slump
- The digital gap
- The development of 21st-century skills

Kids are already attracted to digital games, digital environments, and other digital media. Many students — probably the ones already skilled at reading to learn — are learning content and becoming proficient at consulting and cooperating with others to advance their knowledge (i.e., participating in communities of practice).

Because digital media easily, perhaps uniquely, can combine action in relationship with environment, this technology can generate situated meaning — vocabulary used in actual situations, which makes meanings clear and easier to remember — in myriads of settings. Thus digital media, whether in a format custom-designed to be educational or, in some cases, in off-the-shelf products, have the potential to increase the "book" vocabulary, and the concepts attached to such words, for children whose families are unable to do so.

Digital media offer other advantages as well. They naturally elicit problem-solving behavior and attitudes in students, and they have the potential to create different modes of assessment. For example, they can be used to work on real-world problems so that students can thus demonstrate mastery. They can also be used to track how learners learn, moment by moment, so that, eventually, we can give students constant feedback based on our knowledge of various trajectories of learning.

Given the deficiencies in American education, we offer the following six policy recommendations for consideration by business leaders, policymakers, scholars, educators, citizens, and parents.

1. Fund digital research and development to invest in what works[1]

The United States spends billions of dollars every year on remedial reading, to little avail. We need to invest in finding out what works and then amplify those practices. We should examine in depth the specific educational benefits of digital media and the impact of adult scaffolding on children's digital experiences; and assess what works best for children from different backgrounds and with different learning profiles.

[1] For a discussion of research and development issues, see Shore, R. (2008). The Power of Pow! Wham!: Children, Digital Media & Our Nation's Future. Three Challenges for the Coming Decade. New York: The Joan Ganz Cooney Center at Sesame Workshop. Available at www.joanganzcooneycenter.org.

2. *Establish a Digital Teacher Corps*

A Digital Teacher Corps, modeled on Teach for America and the North Carolina Teaching Fellows, should be established to work in the lowest-performing elementary schools throughout the country. The goal should be to train teachers to help students learn to transform information for discovery and problem-solving, not leave it inert in "storage." Teachers will do this by working with digital media, in particular multiplayer games, that invite students into an environment that teaches skills, vocabulary, facts, and different ways of thinking.

3. *Design and test alternative assessments and new standards*

Besides measuring rote skills, assessments should be measuring the skills necessary for problem-solving, specifically, adaptive ability, lifelong learning habits, and the ability to adopt new technologies and ways of understanding from multiple cultural perspectives. Digital media have the potential to offer deep assessment of these skills across virtual worlds, and to help advance teaching by documenting learners' moment-by-moment progress.

4. *Create "a place in every community": New literacies technology centers*

Building on models like Intel Computer Clubhouses and Club Tech of the Boys and Girls Clubs, it is time to create a place in every community where elementary-age children can go to gain confidence in their literacy and interactive technology skills. One of the most important components of these centers would be the presence of knowledgeable adults who can help children make the most of technology.

5. *Governors' digital partnership schools*

Each state should establish at least one digital-partnership elementary school as a model and demonstration site. These schools should be laboratories for testing many different digital approaches to learning and assessment, as well as for testing different ways to break down the barriers between in- and out-of-school learning. They could become, as well, a hub for the professional development of digitally savvy teachers.

6. *Modernize public broadcasting*

Public broadcasting initiatives should expand experimentation with new formats such as games, virtual worlds, and social network communities that will engage children in both literacy and digital skills. We further recommend developing creative new business models and incentives to ensure that intellectual property is more widely distributed to schools and other learning centers. By participating in the Open Educational Resource (OER) movement, educational media companies in the U.S. could leverage the tens of millions of dollars of public investment in literacy, math, and social skills programming for children for further public benefit.

the challenges of education reform in a global economy

In the United States, economic growth in the 21st century will be driven by the ability to generate ideas and translate them into innovative products and services. Technology and economic changes have begun to level educational opportunity across the world and have created a dynamic global marketplace (Friedman, 2005). Standard skills can now be developed in many places across the world. Thanks to digital technology, many jobs requiring standard skills, whether for low- or high-status jobs, can be performed at low-cost centers in large, rapidly growing countries like China and India. Automation due to digital technology is increasingly able to turn any task reducible to rules into work that is more efficiently performed by a computer and, inescapably, overseas. Our competitors now include not just India and China, but many nations of Eastern Europe and emerging regions in South America as well. When today's U.S. students enter tomorrow's workforce they will face intense international competition for jobs at every skill level.

According to *Tough Choices or Tough Times*, the report by the New Commission on the Skills of the American Workforce:

> *Over the past 30 years, one country after another has surpassed us in the proportion of their entering workforce with the equivalent of a high school diploma, and many more are on the verge of doing so. Thirty years ago, the United States could lay claim to having 30 percent of the world's population of college students. Today that proportion has fallen to 14 percent and is continuing to fall (National Center on Education and the Economy, 2007, p. 4).*

Our students are not learning the skills they need for tomorrow's world in today's schools. According to *A Stagnant Nation: Why American Students Are Still at Risk*, "One in four high school seniors cannot glean basic information about subway fares by reading a Metrorail guide. . . . America's 15-year-olds perform below average in math, science, and problem-solving. Even our best students can no longer compete. In math, America has a below average proportion of top performers; our best math students rank 24th when compared with top performers in 29 other countries" (Strong American Schools, 2008).

Not only are we failing to educate millions of young people in basic literacy and numeracy, but we are also failing to educate them in important 21st-century skills. "21st-century skills" (Jenkins, Clinton, Purushotma, Robison, & Weigel, 2006) include the following abilities:

- To use technical information and digital technologies to solve problems and make discoveries
- To construct and interpret models of real-world processes and complex systems
- To collaborate with others to pool knowledge and to produce knowledge that no one person could produce alone
- To access, assess, and synthesize different information sources for reliability and credibility
- To follow and integrate the flow of information across multiple media
- To deal productively with diverse perspectives linguistically, socially, and culturally

These 21st-century skills require students to become "tech-savvy," in the sense of being undeterred by technical processes or information and able to use new technologies not just for consuming knowledge, but for producing it as well. Unfortunately, while other countries are racing ahead, the U.S. is falling behind in all of these areas, especially where these require technical and technological tools for problem-solving and innovation (National Press Club, 2007; PISA, 2006; Romer, 2007; Schleicher, 2007). But instead of facing the enlarged needs of the future, our nation has turned many of our schools into test-prep academies focused on assessing standardized skill sets in a world that demands higher-level skills and the ability to innovate. We need a new educational approach.

How should our nation respond to this urgent need for educational change? What can we do to prepare children to be innovative, entrepreneurial citizens in the new global economy? Which practices and policies will produce the highest payoff in the decade ahead? Finally, in a high-tech, digital age, how can U.S. leaders provide its students with a solid foundation for lifetime learning, inside and outside schools, with the best tools available?

The fourth-grade slump

All the skills needed to thrive in the 21st century build on a foundation of basic literacy. In this, U.S. schools have failed abysmally for some time. According to the National Assessment of Educational Progress, most low-income children in the U.S. are below grade level in reading by fourth grade (NAEP, 2007). Letting children fall behind in reading is a serious long-term problem. Children who are behind in reading in the early grades (kindergarten through third grade) tend to stay behind as they move into the upper grades (Clay, 1991; Strickland, 1990).[2] If children cannot read well, they can hardly master new digital tools to innovate in knowledge domains — tools that often entail quite technical language.

[2] The probability that a poor first-grade reader will be a poor reader in the fourth grade is 0.88, and children who are behind in reading in the first grade have only a one-in-eight chance of ever catching up (Juel, 1988; Juel, Griffith, & Gough, 1986). A report from the Civil Rights Project at Harvard (Lee, 2006) notes that if current trends continue, the proficiency gap between advantaged white and disadvantaged minority students will not appreciably close. By 2014, less than 25 percent of poor black students will achieve NAEP proficiency in reading, and less than 50 percent will achieve proficiency in math.

While the U.S. has strongly emphasized the need for all children to learn to decode print in the early grades, it has not dealt sufficiently with the well-known phenomenon of the "fourth-grade slump" (American Educator, 2003; Chall, Jacobs, & Baldwin, 1990; Chall & Jacobs, 2003; Hirsch, 2003). U.S. schools resemble a football team that keeps losing because it plays poorly in the second quarter. In educational terms this lapse is called the "fourth-grade slump." Many students who appear to be learning to read well in the early years of school cannot read to learn by the fourth grade. Thereafter they are always playing catch up in middle school and high school and later. By "read to learn," we mean using written texts to master content in areas such as science, mathematics, social studies, and literature. (But, as we have argued above, even such mastery is now no longer enough. We need to add the ability "to read to discover and innovate," not just to settle for the ability "to read to learn" school content as a body of inert information.)

Drawing on the work of human capital experts, cognitive psychologists, literacy experts, and education practitioners, this paper proposes some new possibilities for teaching children during "the years of promise" (Carnegie Corporation, 1996). Stated simply, if we don't create a different approach to literacy in the primary grades, millions of children will never overcome the "slump" that prevents them from becoming fully productive citizens. Our current approach, locked in a time warp, is unintentionally limiting our nation from harvesting its potential for innovation and creative enterprise. The new path we propose — building out from work that has already assembled a rich and balanced research base for early literacy development among struggling readers (Snow, Burns, & Griffin, 1998) — involves tightly integrating traditional literacy, content learning, and digital media.

Academic language

What leads to the fourth-grade slump? It is not caused just by poor early decoding instruction, since many children who can decode adequately still fall victim to it. Probably the most important cause of the slump is language, or mastery of vocabulary. As school progresses, the language of learning (the language of content areas like math, science, and social studies) becomes more and more complex (that is, more abstract and more precise) and specialised and less and less like everyday conversational language. What gives students a good running head start to engage this complex language is a wide-ranging, sturdy vocabulary of complex words in the early years (before age five). Unfortunately, we don't teach early literacy in a way that provides most students with that vocabulary if they don't already have it (Gee, 2004, 2007; Snow et al., 2002).

The complex language associated with school success is often called "academic language." Different academic subject areas and disciplines use different varieties of academic language, and academic language itself is just one type of specialist language. Specialist varieties of language are used in many workplaces, institutions, and public-sphere domains such as law, medicine, and government. Academic language encompasses not just a specialist vocabulary, but also a good number of more formal words that occur across many academic, specialist, and public-sphere domains and in a wide variety of written texts, words like "process," "state," "account," "probable," "occurrence," "maintain," "benevolent," and so forth. Such words do not occur regularly in everyday conversation. (These have been called "Tier 2 words" — Tier 1 words are basic everyday words; Tier 3 are specialist words; see Beck, McKeown, & Kucan, 2002.) There are also many seemingly everyday words like "work," "heat," and "temperature" that do not mean in science what they mean in everyday life.

Consider the difference between "Hornworms sure vary a lot in how they grow" and "Hornworm growth exhibits a significant amount of variation" (Gee, 2004, 2005). The first sentence is vernacular English. The second is academic language. The second sentence is not simply a variant of the first; rather, it expresses a way of looking at the world that scientists have created for specific knowledge-building goals (Gee, 2004, 2007). The academic language ties judgments about the hornworms' growth to disciplinary agreements and tests ("significant amount of variation" is determined by tests a scientific community has

validated). In everyday language, such judgments are expressed as opinion and observation. The academic language is integrally tied to the procedures, values, and practices of a "knowledge-building community" — in this case, biologists. Understanding the language of an academic area, understanding its concepts, and understanding its tools for problem-solving and discovery are integrally linked.

Content in school is more and more couched in academic language as school proceeds. This means that in areas like physics or social studies, for instance, the problems students are asked to solve, the discussions they are asked to engage in, and the arguments they are asked to make become contingent on their control of academic language. But, let's pause a moment to consider what we really mean by "content" in school learning, because this, too, is changing in the 21st century.

In school "content" often means "facts and information" connected (sometimes loosely) to academic disciplines. But "content" in any academic domain really means more than this. It means being able to use such facts and information, as well as various technologies and practices, to solve problems. Learning content in this sense — learning physics or social studies, for example — means coming to see the world, because one now has new forms of language and new tools with which to operate on the world.

Furthermore, in the 21st century, academic knowledge is applied more and more to complex systems (where multiple variables interact in complex ways), systems such as the environment, the economy, interactions of cultures and civilizations, or the interactions of politics, technology, the economy, and the environment in an area like global warming. In the future, more and more learning of "content" will come to mean being able to work with others collaboratively to pool disciplinary knowledge and tools to deal with complexity.

If we are to teach literacy in ways that prevent the fourth-grade slump and that make all children adept at academic language and school content in the expanded sense above, then the middle childhood period — the ages 6 to 11 — is absolutely crucial. It is during this time that children are making the transition from learning to read to reading to learn and, we now hope, reading to discover. It is during this time — and the critical preschool period, when children's background knowledge and vocabulary development are set in motion — that the foundations are laid for meeting the demands of comprehending and using academic language connected to content. If these foundations are not well set, young people cannot successfully navigate secondary school, let alone graduate from college.

One key reason that some children — often, but not always more privileged children — are successful in school with academic language is their early home-based preparation. Many successful students enter kindergarten with a large and varied vocabulary acquired through regular dialogue with parents or grandparents, being read to frequently, and exposure to a wide variety of experiences in the world. Such interactions are crucial (see the classic study by Hart & Risley, 1995, that shows that lots of talk between child and adult is the single most effective early preparation for school). Beyond such practices, Kevin Crowley has insightfully studied quite young children developing what he calls "islands of expertise." Crowley and Jacobs (2002) define an island of expertise as "any topic in which children happen to become interested and in which they develop relatively deep and rich knowledge" (p. 333). One example is a boy who develops relatively deep content knowledge and a "sophisticated conversational space" (p. 335) about trains and related topics after he is given a *Thomas the Tank Engine* book. Such islands also turn out to be efficacious for later school success.

Crowley describes a mother looking at replicas of a dinosaur and dinosaur egg with her four-year-old son, who has an island of expertise around dinosaurs (pp. 343–344). The mother has a small information card about the replicas. The boy says the egg "looks like an egg." *Mother:* "That's exactly what it is! How did you know?" *Child:* "Because it looks like it." *Mother:* "That's what it says, see, look 'egg,' 'egg' … replica of a dinosaur 'egg.' 'From the oviraptor.'" Here the mother leads the child

to reflect on the basis of his claim, shows that print is a privileged way to establish claims, and uses specialist language ("replica," "dinosaur," "oviraptor"). She continues this type of talk with the child for some time.

Many students today, especially from low-income families, do not get the sorts of early language-based preparation for schooling that we have just discussed. Although billions of dollars have been spent developing and administering reading intervention programs, these have failed to significantly improve reading skills, especially the skills that lead to being able to master school-based content. We need to supply such children, within their families and in programs beyond the family, the early school-based language development that more privileged children are getting. This would most certainly include one-on-one talk and reading with adults. This kind of intense in-person support, however, has sometimes proven difficult to sustain in the preschool period among lower-income families. This is why we need programs beyond the family and why schools must learn to play "catch-up" with children once they enter kindergarten. But such "catch-up" interventions, which immerse children in school-based language as it applies to the world and to problem-solving, must continue from kindergarten through middle school to be effective (Adams, 1990; Zigler & Styfco, 2001). It is here, too, that digital media have an important contribution to make.

Two gaps

If we do not get the transition from early schooling to later schooling right so that all young people have a solid foundation for learning language and content, we will continue to face, as we do now, two educational gaps, both detrimental to our success as a leading nation. One is the old reading gap between richer and poorer children and the consequent disparity in school success between white children and children from some minority groups (Snow, Burns, & Griffin, 1998). This inability to read well, first seen in early school literacy, eventually stunts children's use of language and their later ability to learn content in school. Our response thus far has been to impose standards and testing, which has led many schools to focus on the basics, skill-and-drill, test preparation, and standardized skills, often at the expense of teaching students complex language and thinking skills, let alone the ability to use these skills to innovate and produce knowledge.

The other gap is a newer emerging one, connected to 21st-century skills in our rapidly changing world. It is a digital gap, between those students who can leverage technical skills and technological "know-how" to learn content, produce knowledge, and develop high-level expertise, and those who cannot (Neuman & Celano, 2006; Warschauer, 2004, 2006). This digital gap is not just a matter of who has access to technology. More important, it is about who has access (and who does not) to well-designed learning systems and mentorship built around new digital technologies. Mastery of digital media for learning and the production of knowledge constitute a new family of "digital literacies," since such media (like print before them) are tools for the production of meaning.

Our old reading gap and our new digital one interact with each other. The old reading gap can only worsen as the high-tech digital world makes larger and more complex demands on literacy and content learning. At the same time, the old reading gap prevents certain children from meeting these demands. Indeed, the Internet requires a good deal of technical reading for a student to fully leverage its possibilities for learning and knowledge production, or even to access, assess, and modify the plethora of information it makes available (Packard, 2007). These skills don't just happen; they require mentoring and teaching, especially for children who do not come from families able to provide that mentoring and teaching at home. These skills also require mastery of traditional print literacy and, quite often, specialist forms of language.
So we face two gaps, an old one and a new one. We face them at a time when we need not only to increase young people's skills, but to increase them in a way that also increases their ability to innovate. We can do all this well only if we make full and creative use of our new digital learning tools and environments.

Digital media have potential to transform literacy instruction

Project iREAD
iREAD, an acronym for I Record Educational Audio Digitally, entails a group of pilot teachers in Escondido Union School District who are exploring the use of iPods, GarageBand, and iTunes to improve student reading. Using the iPod's voice memo and a Belkin recorder, students can record and then hear themselves reading, which improves motivation and helps them work on fluency and comprehension. Teachers can also import student recordings into their iTunes library and create time-stamped digital portfolios (via playlists) that they can use to track progress over time. Kathy Shirley, an Apple Distinguished Educator, has been collecting data on fluency rates for a small classroom of fourth graders and has found that using iPods to practice fluency resulted in more rapid improvement rates, compared with a control classroom. (See www.eusd4kids.org/edtech/iRead.html.)

Multimedia Reading Environment with Adaptive Delivery (mREAD)
Sesame Workshop and Wireless Generation are collaborating on a research project to develop a highly personalized, media-based literacy intervention system that targets the instructional needs of each individual student. Each student's DIBELS scores (along with developmental patterns in assessment responses detected by Wireless Generation's mCLASS:DIBELS software) are used to develop an individualized intervention for that student, drawing on classic video footage and computer games from Sesame Workshop's award-winning series *The Electric Company*. The effectiveness of this prototype system will be evaluated in a large-scale study in four cities in the fall of 2008. Students will use mREAD on the computer during school hours, and some students will also use iPods to view supplementary mREAD videos in school and/or after school. This project is funded under the U.S. Department of Education's Ready To Learn initiative through the Corporation for Public Broadcasting and PBS.

JUMP into reading for meaning (JUMP) program
The JUMP program focuses on the development, delivery, and evaluation of a supplemental vocabulary instructional game for the Nintendo DS Lite. The curriculum targets low-performing fourth-grade students enrolled in supplemental educational services programs. The JUMP game is a hybrid vocabulary instructional program and role-playing adventure game designed to teach and assess word-learning strategies and to increase the student's vocabulary by several hundred words through an innovative mix of teaching methods, storytelling, and game play. The game involves exploring 10 diverse environments, overcoming robot challenges, completing engaging quests, and solving thought-provoking puzzles. This project is funded by a five-year Star Schools grant from the U.S. Department of Education. (See www.prel.org/programs/care/jump.aspx.)

What exactly is the connection between digital media, on the one hand, and literacy, content learning, and complex academic language, on the other? The argument put most simply is this: Digital media — video games, simulations, modeling tools, handheld devices, media production tools — can allow students to do two things. First, they can see how complex language and other symbol systems attach to the world. We can put kids into virtual worlds and let them engage in goal-based actions and interactions that clearly associate words in a domain not just with other words and texts, but with images, actions, and dialogue with others. For example, consider the video game Dimenxion (and more generally the world DimensionM) from Tabula Digita (see www.dimensionm.com), in which children use an algebraic Cartesian coordinate system to allow their avatar to navigate the landscape and eventually construct such

coordinate systems to map their environment and solve other algebraic problems in the virtual world. They have to algebratize the world to play the game, and the game world gives them constant feedback and mentoring. They now have vivid images and actions associated with algebraic symbols — images and actions that give these symbols (technical and in some respects arbitrary) "situated meanings," that is, meanings tied to experiences they can remember and call up when they need to use coordinate systems for further problem-solving or even remember how they are defined.

Second, young people can use digital media to produce knowledge and to display, argue for, and demonstrate their learning. This can transform our traditional notions of assessment. We can imagine the day in which learners enter a virtual world and work collaboratively to apply calculus to real-world-type problems such as building roller coasters or landing a spaceship. When they have reached mastery, perhaps this will be considered passing their advanced calculus placement test without any formal paper and pencil test at all. Digital media can also combine assessment more intimately with teaching. When the media are used to track what learners do moment by moment, we can begin to study different trajectories toward mastery, give students constant feedback based on this knowledge, and then assess learners in terms of trajectories across time and not just in terms of a one-off test.

Of course, in the best school learning, kids have always learned in the world and not just out of books, but digital media greatly expand the possibilities and the practicalities available. Today, young people can read books and textbooks, but they can also step into those books and textbooks — in the guise of virtual worlds and 3D models — to interact directly with the worlds that complex words are about and to act with others to learn and produce knowledge.

Digital technology

During the past decade we have made giant leaps in children's and educators' access to digital technologies. Data from national studies conducted by the Kaiser Family Foundation (Roberts, Foehr, & Rideout, 2005) indicate that families, across income and demographic categories, now have access to the Internet, cell phones, and video game platforms (see box "Media use by kids ages 8–10") and that the amount of time spent on digital media for elementary-age children out of school has accelerated dramatically. The group lagging furthest behind in digital media access is Hispanics. They have lower levels of education and English proficiency as well.

It is important to understand that the core issue is not just "time spent" using technology of any sort. The most important issues are how this time is spent, how the technology is or is not built into a good learning system, whether good mentors are involved, and how the technology is being related to other technologies and other areas of learning. We know too little, for instance, about how these parameters vary regarding young

Media use by kids ages 8–10

- On average per day children spend 37 minutes using computers, 65 minutes playing video games, 59 minutes listening to music, and 197 minutes watching TV.
- Computer time is spent mostly playing games (20 minutes) or visiting Web sites (8 minutes).
- Compared with older kids and teens, 8-to 10-year-olds spend more time playing video games and watching TV and less time using computers or listening to music.
- Children often experience two or more media at the same time.
- White children spend less time playing video games than Hispanic or African American children.
- Forty-two percent of children reported that they had engaged in computer activities the previous day; 18% had used the computer for more than an hour.
- Most reported playing games (37%) or visiting Web sites (21%). Smaller percentages reported using e-mail (11%), instant messaging (10%), graphics programs (9%), or visiting chat rooms (8%)

(Rideout, Foehr, & Roberts, 2005)

people from different social and economic groups playing video games, for example. Obviously playing a game like *Civilization* and modifying it with other young people to reflect aspects of cultures beyond those already in the game is different from playing first-person shooter games with no desire to further one's technological skills (Squire 2006; Squire, DeVane, & Durga, in press).

School connectivity to the Internet has grown enormously in the past decade, due to policy and financing efforts such as E-Rate, which spent approximately $16.48 billion to wire schools and libraries between 1998 and 2005 (Universal Service Administrative Company Web site, 2008). Teens reported use of the Internet in school grew by 45 percent between 2000 and 2005 (Pew Internet & American Life memo, 2005).

Pro-Ams: amateur experts outside of school

Today young people are using the Internet and other digital media outside of school to learn and even become experts in a variety of domains. Like books, digital tools and digital environments can allow young people — and indeed everyone — to learn 24/7 not just in schools, but at home, in community sites, and in workplaces. But unlike books, they are interactive, and much of digital learning does not involve traditional school-based content. Crucial questions arise as to how we can recruit this pervasive out-of-school learning to enhance school learning, while arming young people with 21st-century technological skills.

At an informal level, digital worlds and tools are already being used to massively enhance learning at earlier and earlier ages. We live in the age of "Pro-Ams," or amateurs who have become experts at whatever they have developed a passion for (Anderson, 2006; Leadbeater & Miller, 2004). Many of these are young people who use the Internet, communication media, digital tools, and membership in often virtual, sometimes real, communities of practice to develop technical expertise in a plethora of different areas. These include video games, digital storytelling, machinima, fan fiction, history and civilization simulations, music, graphic art, political commentary, robotics, anime, fashion design (e.g., for Sims in *The Sims*; see box "Example of a young Pro-Am in the making"), and nearly every other endeavor the human mind can think of.

! Example of a young Pro-Am in the making

A young girl is in a program, unaffiliated with school, which encourages girls' interests in technology (Hayes, in press). In the program she has learned that she can use Photoshop to turn real clothes into fashions for her Sims in the game *The Sims*, though this is something of a technical feat. Eventually she designs virtual clothes for her friends and then discovers she can upload her clothes on the Internet so that people across the world can see them and use them. Currently hundreds of people are using her designs. Asked how this experience has made her think differently about her future, she says, not that she wants to become a clothes designer, but, rather, to "work with computers," because she has seen they are source of "power." But note that she sees working with computers, too, as a source of innovation and creation.

These Pro-Ams have passion and go deep rather than wide. In fact, it seems that in any field developing such a passion is a sine qua non of deep learning that leads to expertise. At the same time, Pro-Ams are often adept at pooling their skills and knowledge with other Pro-Ams to bring off bigger tasks or to solve larger problems. These are people who don't necessarily know what everyone else knows, but do know how to collaborate with other Pro-Ams to put knowledge to work to fulfill their intellectual and social passions.

We do not know how pervasive this Pro-Am phenomenon is among less privileged young people, though many community programs are seeking to offer less privileged kids the opportunity to engage with digital communities of practice (see, for example, many of the projects funded by the MacArthur Foundation's New Digital Media and Learning initiative: www.digitallearning.macfound.org). What we do know is that this is

a promising space where we can work to involve more and more young people in ways that will enhance school-based learning and lead to 21st-century skills (see box "The young girl becomes a 'prosumer'").

The young girl becomes a "prosumer"

This girl originally did not sell her clothes, but gave them away. Recently she has opened a shop in Second Life, which she constructed herself, and sells her clothes there. She has become a classic example of what the Tofflers (Toffler & Toffler, 2006) call a "prosumer," a consumer who produces and transforms, not just passively consumes, for off-market status and as part of a community of like-minded experts. As the Tofflers point out, such prosumer activity often eventually impacts on markets when people like this little girl eventually sell their goods or services. In fact, the Tofflers believe such activity, though unmeasured by economists, is a big part of the global economy and will be a yet bigger part in the future.

So some of our children are already using digital environments and tools to join learning communities and become experts. Their process of learning, collaboration, and transforming passion into knowledge is exactly what we need to see in schools today. Surely we can leverage this power to speak to our literacy gaps, our international skills problems, and our innovation crisis. We don't need to solve all of our problems in schools alone. We educators can build, in and out of school, Pro-Am communities and opportunities that build skills in language and problem-solving that we value both in school and in workplaces.

Getting traditional literacy and digital literacy to work together

However, as we move to recruit digital technologies for learning — and in the act, speak to the new digital gap — we dare not ignore our old reading gap. The key to dealing with our old reading gap, the new digital gap, and our emerging innovation crisis together is to use the connections among literacy, content learning, and digital technologies in new ways. How? Digital technologies allow us to build worlds full of the sorts of content we have associated with books, but allow young people to enter these worlds and experience directly the connections between words and other symbols and the world. They can see how these connections can be used for problem-solving. Learning can move from just relating texts to other texts and words to other words, as so often happens in school, to relating words to actual situations of use for problem-solving. In the act, young people can build up an arsenal of "situated meanings" for words that will allow deeper and better learning from texts, which they will now be able to understand in a deeper way.

There is, of course, much that we need to learn in regard to recruiting digital technologies for integrating content and literacy in a 21st-century-skills framework. But progress is already beginning. Consider David Shaffer's work on "epistemic games" (Shaffer, 2004, 2005, 2007; www.epistemicgames.org). What Shaffer proposes is: Take a profession — say architecture, journalism, engineering, or urban planning — and consider the following. First, professions in these fields know how to use school-based skills to solve real problems. Second, they know how to innovate. And, third, they know very well how to educate — to apprentice — their new members. Each profession owns and operates a tool kit of knowledge, skills, and values, what Shaffer calls its "epistemic frame," to look at and act on the world in a quite distinctive way. To look at and act on the world in that way, one must master the tool kit.

If we could just entice kids to role-play such professions we would get school-based skills, learning for innovation, and a recipe for a new pedagogy. But what would entice them? Shaffer's answer: Let them, beginning at an early age, play the game of one or more of these professions. Let them take on the identity or the role. Let them produce the products professionals produce. And we can now get this to happen, thanks to the sorts of technologies Shaffer leverages: In Urban Science they use a city simulation to become urban planners; in Digital Zoo they use

Research in the learning sciences illuminates the nature of situated meaning

Both embodied experience and the ability to build mental simulations are crucial for deep understanding and learning. For example, a study by Glenberg, Gutierrez, Levin, Japuntich, & Kaschak (2004), describes an experiment where children entering second grade read a passage and manipulate plastic figures in order to physically portray the actions and relationships in the passage. By manipulating the figures, the children get a structured embodied experience. After some practice doing this, the children are asked simply to imagine manipulating the figures. This is a request to engage in simulation in their heads. As a post-test, the children read a final passage without any prompting.

Children who completed the sequence of embodied experience followed by simulation were better at remembering and drawing inferences about the new passage compared with children who received no training. They were also better compared with children who were instructed only to imagine the passage. And, most interesting, they were better compared with children who manipulated the figures without the next stage of imagining manipulation. Encouraging simulation through the initial use of physical enactment helped the children learn a new reading comprehension strategy, namely, calling on their experiences in the world to build simulations for understanding a text in specific ways.

Sodaconstructor to design wire-frame character prototypes for an upcoming animated file and in the act become biomechanical engineers; in Science.net they become reporters working for an online newsmagazine engaged in science journalism, using new digital editing and media production tools.

But Shaffer's "games" are special. They are not just virtual worlds — for instance, kids using a game-like simulation to rezone their town. Shaffer's games are "augmented by reality." Kids go back and forth between the virtual world and the real world. They walk the streets of their town in both real space and virtual SimCity–like space. They report their results and defend them to real urban planners. They play by virtual and real rules. They walk the walk and talk the talk and, in the process, master the tool kit, coming to see the real world in a new way.

But the tool kit is replete with school-based knowledge and skills, with tools for innovation, and, in almost every case today, replete with technical and technological devices. And, just as good, you can't play these professional games without using, over and over again, lots of basic skills, facts, and information ("content"). These things, which are in the foreground at school, come for free, that is, develop naturally as the learner solves problems and achieves goals, when the focus is solidly placed on solving problems by using the tool kit of a professional role that you think is "cool" and definitely worth inhabiting, perhaps because you want your shot at replanning your downtown, facing an emergency like Katrina, or straightening people out on the science behind cloning. Shaffer's research (Shaffer, 2007) shows clearly that young people playing epistemic games make great progress in academic language, as well as showing conceptual growth in their complex thinking abilities. But the two are connected: The language growth and the conceptual growth fuel each other as the young people learn a new language within which to argue about, discuss, report on, and solve problems in a professional domain.

For another example, consider Quest Atlantis at University of Indiana, a project headed by Sasha Barab (www.atlantis.crlt.indiana.edu). Quest Atlantis puts children into a 3D virtual multiuser environment where they use scientific information and tools to solve science problems collaboratively. For example, one unit for fourth-graders takes place in an aquatic park with serious ecological problems, including the pollution of fish habitats. The students are invited to assume the role of field investigators: They gather information from virtual characters, report on how different users might relate to the fish problem, develop theories about causation, and propose an informed solution.

In carrying out quests like these in various units, students see how problems arise in the world. They can interview virtual characters, real people in the virtual world with them, and real people in the actual world about the problems and possible solutions. The world offers them mentoring and tools with which to engage productively with the problems they are discovering. They deal with ethical questions surrounding science and technology as well. Quests can be accomplished in the game or through research in and engagement with the real world. Learners' progress can be tracked moment by moment and in great detail in the digital world. Teachers can, thus, access their trajectories of learning across time and not just in terms of one-shot tests.

Researchers working on Quest Atlantis have found that the students learn both the science behind the game world, as well as the linguistic and symbolic ways of dealing with this science. They have also found transfer to standardized tests (Barab, Zuiker, Warren, Hickey, Ingram-Goble, Kwon, Kouper, & Herring, 2007).

Solving the fourth-grade slump demands sustained interventions from early childhood — including before school — right through middle school. Shaffer's epistemic games have been used successfully with middle school children and can be adapted for elementary school children; Quest Atlantis is often used with fourth-graders.

But such approaches need to be sustained and deepened as the child progresses through school. Earlier work needs to prepare the child for later work. Even games for quite young children — like Pajama Sam in No Need to Hide When It's Dark Outside — involve children in sophisticated problem-solving in virtual worlds, problem-solving that is ideal for joint interaction, collaboration, and talk with an adult that can lead to vocabulary growth and meta-level thinking about problem-solving. Such games could be adapted to be more educational and, further, to stress early preparation for school-based learning and school content.

Literacy, content, academic language, and digital media

For most people, "literacy" means children learning to read early in life. Subsequently, "literacy" per se is subordinate to learning "content," e.g., science and math. This view is dangerously limited. The literacy skills now necessary to succeed in the 21st century must go beyond decoding and literal meaning to the ability to draw inferences from complex academic texts and use such texts as resources to solve problems,

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Toward a definition of 21st-century literacies, adopted by the NCTE executive committee February 15, 2008

Literacy has always been a collection of cultural and communicative practices shared among members of particular groups. As society and technology change, so does literacy. Because technology has increased the intensity and complexity of literate environments, the 21st century demands that a literate person possess a wide range of abilities and competencies, many literacies. These literacies — from reading online newspapers to participating in virtual classrooms — are multiple, dynamic, and malleable. As in the past, they are inextricably linked with particular histories, life possibilities, and social trajectories of individuals and groups.

Twenty-first-century readers and writers need to:

- Develop proficiency with the tools of technology.
- Build relationships with others to pose and solve problems collaboratively and cross-culturally.
- Design and share information for global communities to meet a variety of purposes.
- Manage, analyze, and synthesize multiple streams of simultaneous information.
- Create, critique, analyze, and evaluate multimedia texts.
- Attend to the ethical responsibilities required by these complex environments.

(Source: www.ncte.org/announce/129117.htm)

engage in discussion, argue for a point of view, and even innovate in a domain — something kids are already doing in Shaffer's epistemic games and Indiana University's Quest Atlantis.

In accord with the idea that literacy is a constantly expanding construct and that it is inextricably linked to content, the United States must address three major issues in the early grades to prepare our children to meet the challenges of a globalized, automated, increasingly complex 21st-century world.

- First, traditional early-reading instruction will continue to stall if it does not prepare children for later content learning. We must address the current trajectory of content failure, whose first indicator is the fourth-grade slump. A new approach to pedagogy that advances "situated meaning" and a new appreciation of "informal" learning facilitated by digital tools will pay large benefits.
- Second, at any age, learning content such as math and science is always a form of language and literacy learning (Halliday, 2006; Halliday & Martin, 1993; Martin, 1990), since learners must learn the "language of the domain" to be able to interact with and within it. We must more proactively integrate language, literacy, and content learning in the early grades and, indeed, later on, as well.
- Third, new digital media hold transformational potential to integrate literacy learning and content learning if we invest in the right practice and policy reforms (diSessa, 2000; Gee, 2003, 2007).

challenge #1:

Early reading instruction will yield insufficient benefits if it does not prepare children for later content learning. Our current approach is failing too many students who experience the avoidable "fourth-grade reading slump."

As we have argued above, long-term success in school requires the acquisition of "academic language" (Gee, 2004; Schleppegrell, 2002, 2004; Zwiers, 2005). By high school, much of the school curriculum is conducted not in "everyday language" but in the complex forms of language (and other symbol systems) academics and specialists use to produce, transform, and transmit technical and specialist knowledge.

The most accurate predictor of a child's long-term school success is his or her vocabulary at age five of "school-based" or "book" words (Dickinson & Neuman, 2006; Senechal, Ouellette, & Rodney, 2006), the sorts of words that show up in academic language and other "public sphere" uses of language. A varied early vocabulary is a good indicator of a solid early home-based preparation for academic varieties of language ("school language") (Crowley & Jacobs, 2002).

Three questions immediately arise:

1. How do we ensure that all children, not just those from highly educated homes, get good early preparation not just for reading but for academic language as well?
2. What do we do for young people who have gotten past the early years of schooling — and are on a tragic path to academic failure — without good and solid preparation for academic language, either at home or at school?
3. With the enormous growth in English Language Learners in the United States, how do we teach English academic language in the larger context of English language and multilingual language development?

We have suggested above and will discuss further below that using new digital media for learning can address all these questions at once. Such media allow learners — young and old, behind or ahead in school, first- or second-language speakers of English — to visualize and experience the meanings of words, rather than just associate words with other words as happens when children are simply given definitions or engage in highly text-based learning. This can lead to better preparation for future learning (through texts or otherwise), as well as to deeper learning that enhances problem-solving and not just passing paper-and-pencil tests (Bransford & Schwartz, 1999).

challenge #2:

Learning content like math and science at any age must always include language learning. We must more proactively integrate approaches to teaching content, language, and literacy in the early grades.

Many people think that learning something like science has nothing to do with language or literacy and everything to do with "concepts" or even just "facts." However, these subjects are accessible only through the language and other symbol systems they use to represent their concepts, content, and practices (Gee, 2004; Halliday, 2006; Halliday & Martin, 1993; Martin, 1990). But science is not unique — this dependence on language is true of all academic domains and, indeed, most professional domains. Furthermore, different academic domains develop different forms of language and use different sorts of symbols. By the time a student is in high school or college — not to mention a high-tech workplace — the ability to handle complex forms of language and other symbol systems is crucial. It is the necessary entry ticket into the forms of thinking, problem-solving, and knowledge production that are the essence of higher-order skills today.

What are the barriers to understanding complex forms of language? Why can't kids move from "everyday language" to academic language? We suggest that the barrier to academic language in school, especially for underprivileged kids, is the overreliance on texts and words to teach new language, texts that they cannot fully understand. One solution — in fact, the one taken by popular culture practices that recruit complex language — is to tie language more to images, actions, goals, experiences, and dialogue as a way to teach deep comprehension of texts.

The complex forms of language in which much of mathematics, biology, the social sciences, or other content areas are conducted are a barrier for learners who are not well prepared for such demands. Since a good deal of modern work in our high-tech global world is conducted in complex, specialist language and symbols, these, too, will be barriers for workers not prepared for such demands and not adept at learning new technical "ways with words" and symbols.

While many learners from lower socioeconomic backgrounds do not do well in school — because of both poor reading and poor content knowledge — the evidence indicates that more advantaged learners have a problem as well (Bransford, Brown, & Cocking, 2000; Chi, Feltovich, & Glaser, 1988; Gardner, 1991). More-advantaged learners in our schools often cannot apply the knowledge they can write down on paper-and-pencil tests to real problem-solving in areas like history and physics.

One key reason for this failure is linguistic. In school, words often take on meaning only in terms of yet other words. Words are associated with other words in terms of definitions and networks of verbal meanings encountered across complex talk and texts. A word such as "work" in physics simply has a verbal definition and relationships with other words in many texts. It is not understood as a tool for problem-solving.

Students may know how the words "work," "heat," and "temperature" are used in physics, but they are often unable to use these understandings to solve physics problems in specific situations. Indeed, they may not even know why these

words are used as they are in physics and why these meanings are different from their everyday meanings, if they even realize that the meanings are different.

In everyday life, words do not have just verbal-textualized meanings, that is, definitions in terms of other words. They have what we call "situated meanings" (Gee, 2004, 2005), meanings that are associated with images, actions, and dialogue that are relevant to the specific context or problem situation in which the word is being used.

Consider these three sentences (Clark, 1989):

- "The coffee spilled, go get a mop."
- "The coffee spilled, go get a broom."
- "The coffee spilled, go stack it again."

To understand the meaning of the word "coffee" in these cases, you associate it with images and actions. Ultimately these actions and images can be represented by words, but there is good evidence that the brain stores meaning in terms of images, actions, and goals, not just words (Barsalou, 1999a, b; Glenberg, 1997; Glenberg et al., 2004; Glenberg & Robertson, 1999).

In everyday life, the ability to situate the meanings of words and sentences in specific contexts of action is the basis of real understanding. The same thing is true of words and sentences in the more specialized and technical languages of school content and academic domains. Once you can situate the meanings of words in a variety of specific situations, you can engage in fruitful reading to learn more.

In school we often value words more than images and action. We often want to put a good deal of reading ahead of a learner's opportunity to get images and actions ("read first, do later" or "competence before performance"). But it is images, actions, and the back-and-forth use of words in dialogue with a helpful adult that give situated, contextual, useful meanings to words. We sometimes must "do first, read later" and have "performance before competence" — as happens so often in learning out of school. Images, actions, and dialogue must sometimes come first for learners who cannot keep up with the complex school-based networks of words and texts. They must sometimes come first for all learners if we want learners who can apply their knowledge and not just write it down on paper-and-pencil tests. They most certainly must sometimes come first if we want to foster creativity and innovation, which entail the ability to situate meanings in new and novel situations and not just in routine ones.

So how does a learner develop the ability to situate meaning in a particular domain? Learners need experiences in situations where a word applies, so they can build up the images and actions that tie the word to actual activity. They need interactions with more-capable others, including masters, so that they can build up experience with the sorts of dialogues and social interactions in which words occur across different situations. They need to experience models of how more-capable others situate meaning and reflect on meaning in different situations in order to talk, read, write, interact, argue, and solve problems. These are just fundamental principles of language development, whether for infants learning language or for people acquiring new varieties of language for new purposes (Barsalou, 1999a, b; Bransford, Brown, & Cocking, 2000; Pellegrino, Chudowsky, & Glaser, 2001; diSessa, 2000; Glenberg & Robertson, 1999). And these are all strategies that digital environments and tools can greatly accelerate and facilitate.

Language development (oral and written) and learning content are tightly married, because all languages are learned in situ. Further, learning to situate the meanings of the sorts of words that appear more and more frequently as school moves on — the words of the content areas — needs to be a core task of early schooling (remember the importance of early vocabulary). It surely needs to be a core task for English Language Learners if we want them to learn English (or their native language, for that matter) for content learning and not just everyday social interactions. The task of learning to situate the meanings of such words remains core to learning throughout all schooling and life, if we seek real understanding and the ability to innovate.

Learning in situ is not a call for "pure immersion" or justification for "anything goes." Learning to situate meanings requires that learners have well-structured, well-supported, well-mentored experiences in the area of interest. While experts and more expert learners can and do learn from books and lectures, novices need experiences (diSessa, 2000) to marry to words to give them concrete meanings. This will start them on the path to more general meanings as they have more experiences and find patterns within them (including, of course, experiences with texts). Such experiences must show students at least two modes of learning: 1) how, through goal-based activity and interaction with others (peers and masters), to marry words to images, actions, and dialogue for problem-solving; and 2) how to develop, critique, and defend arguments. Research in the learning sciences shows that goals need to be clear; problems well ordered; models and worked examples need to be available; copious feedback must be offered; direct instruction is often important as well, but is most effective when it is "just in time" (when learners are able to apply it) and "on demand" (when learners know they need it and want it). Such active instruction helps learners eventually rise above specific experiences to find more general patterns and to transfer what they are learning to new problems and areas (diSessa, 2000; Gee, 2004; Kolodner, 1993, 2006; Lave, 1996; Lehrer & Schauble, 2006; Shaffer, 2007).

But how can we grant all learners — rich and poor, English as a First Language, English as a Second Language students — access to such richly mentored, lucidly structured, experiential curricula? How can we do this not just later in school, when academic language is at its peak, but early enough to prepare all learners for future content learning?

Today's new digital media hold out great potential to enhance literacy and content learning and, most important, to enhance them simultaneously such that each richly supports the other. They hold out the potential, as well, for new sorts of 24/7 learning fit for our modern, high-tech-driven world.

challenge #3:

New digital tools hold the potential to transform learning and innovation in a global age if they are wisely and equitably deployed.

It is becoming apparent that simple access to digital media for learning does not narrow achievement gaps. What is crucial for learning is not just access to books or digital tools, but access to support and structured mentorship as well.

In a recent study of high-end computers and reputable learning software placed into libraries in economically diverse communities, it was found that well-off parents accompanied their children to the library and mentored them to read at or above their reading levels, to challenge themselves, and to sustain their engagement with particular learning activities, and to do so in reflective and strategic ways (Neuman & Celano, 2006). Less-well-off families engaged much less in such mentoring, and consequently, their children gain less school-based knowledge from digital media and print literacy, read less well, are more passive in their activities, have less of a foundation to build on, and, thus, fall further and further behind. In contrast, the more-well-off students progressively build on their achievements. In this way, digital media — much like print literacy — can make "the rich richer and the poor poorer."

These findings do not mean that parents are the only effective source of mentoring. Good digital media made for learning build in important mentoring devices such as well-ordered problems and worked examples, as well as artificial (virtual) or real tutors. However, they can only be useful if parents, teachers, and more advanced peers help children seek out good learning media and fruitfully draw on their internal design features for learning.

At the same time, evidence is growing that many children, poor and rich, encounter complex specialist language and demanding problem-solving in some of their popular culture activities

(Gee, 2003, 2004, 2007; Jenkins et al., 2006). In video games such as Civilization or Age of Mythology or card games like Yu-Gi-Oh — and many other such activities — children as young as seven encounter language that is as complicated as anything they see in school. These games further demand that players engage in complex, strategic, systems thinking and problem-solving.

Young people's engagement with the complex language of popular culture raises many questions. For example:

- What do players learn from these activities, and is their learning, if any, transferable to the real world?
- Is their learning enhanced by the adult and peer mentorship they receive, including the quality of the Internet communities to which they belong, and if so, what kind of learning is enhanced and to what extent?
- Which young people do or do not use these popular culture activities to enhance their emerging expertise as tech-savvy producers and consumers of media and knowledge?

The crucial issues here are how to address new digital literacies — that is, expertise with digital media as a form of communication and knowledge production — without forgetting traditional literacy. We want to close both the reading gap and the digital gap at one and the same time. And it is crucial that we close these gaps in ways that create learners who are able to innovate and produce knowledge, not just recapitulate standard answers on tests.

Digital media hold out the potential to enhance the new skills necessary for success in our globalized world. They hold out the potential to make all learners "tech-savvy," that is, unafraid of technical learning, adept at technology, and able to use it in productive and innovative ways. They hold out the potential to enhance the learning of traditional print literacy and to enhance situated understandings in the content areas (Gee, 2003, 2007; Shaffer, 2007). And they hold out the potential to do all these things in an integrated way that allows young learners to accumulate a store of knowledge that cuts across home, community, and school settings.

Beyond the three Rs...

Consider the technical and logical language in the following definition written on an Internet board discussing Yu-Gi-Oh. Yu-Gi-Oh is a card game played via video games or face-to-face and depicted on Web sites and in books, movies, and television shows. The site answers players' questions about the game:

Amplify (Onslaught) — Amplify X means "When this creature card is summoned, reveal X creatures of the summoned creature's creature type(s). If you do, put X times N +1/+1 counters on that creature (X = Amplify X. N = Number of revealed creatures).

[www.pojo.biz/board/showthread.php?t=15266]

This is "algebra talk."

Such integration is important both for practical reasons and conceptual ones, since digital media can help give situated meanings to complex language and, thus, enhance content learning and text-based learning wherever it occurs.

Digital media's main source of promise lies in its ability to situate meaning, to show people what words and symbols mean in ways that make them usable for problem-solving. An excellent example of how this works is the out-of-school popular card game Yu-Gi-Oh, a game played by children as young as seven as well as by older children and young adults. Each card (there are 10,000 of them) in this popular cultural practice displays a complex and technical written description that tells the player its precise role in the game relative to specific situations. In addition, players can look up rules and settle disputes by going to Web sites that present very complex language and thinking.

Each word and phrase on the cards and Web sites is associated with the player's explicit actions; with cultural images the player is familiar with from games, books, television shows, and movies; and with rich dialogue the player hears and reads

in the game's "community of practice." The Yu-Gi-Oh communities of practice, which grow on various Internet sites, allow players of all different skill levels, including mentors and masters, to interact with each other. Yu-Gi-Oh is a classic example of what Henry Jenkins (2006) calls "media convergence" (diverse media supporting the same content). Complex language is rendered completely lucid when it is so clearly tied to action, interaction, images, and dialogue, as well as to many different types of texts. It is tied, as well, to communities of practice where players argue and debate at a meta-level about game rules, strategies, and innovations they advocate.

Yu-Gi-Oh is not special or atypical, nor does it or should it replace content learning. However, Yu-Gi-Oh works the way all good language development works in terms of acquiring new varieties of language for new goals and purposes. Language grows out of specific experiences of action and interaction and then generalizes to patterns that come to help organize experience and apply to new situations. Yu-Gi-Oh and other popular culture practices — as well as the phenomenon of Pro-Ams discussed earlier — simply illustrate effective ways to organize learning and knowledge-building communities. But, of course, we have to build them in areas we value.

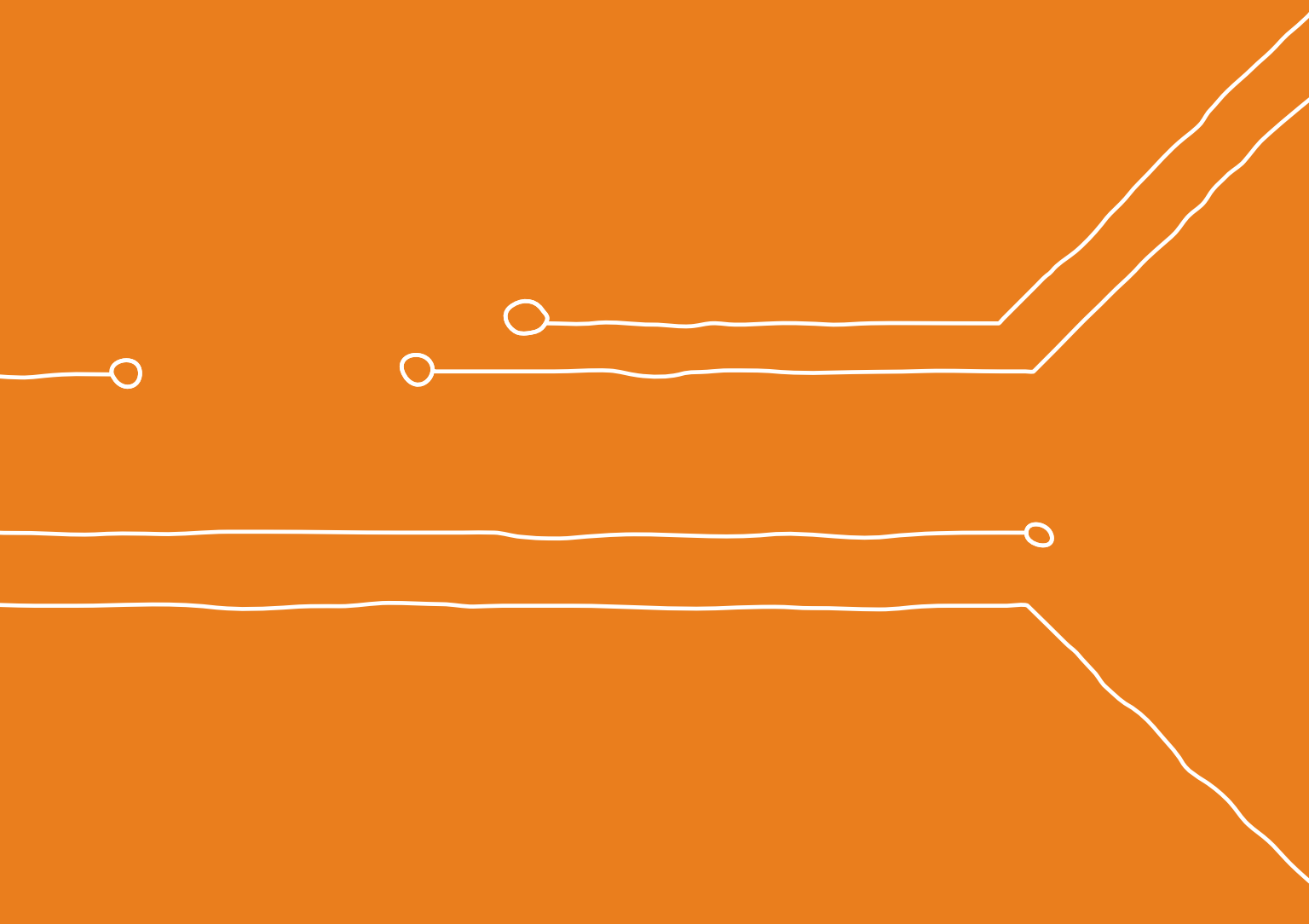
Research in the learning sciences suggests that learners need experiences germane to what they need to understand in texts (note that while Yu-Gi-Oh texts are fantasy, players experience how its language ties to action and to the rules of the game through actual interactions). They also need to learn to use these experiences to build up simulations in their minds. Such simulations become the basis for situated understandings of texts they will see later; simulations become a way for learners to continuously bring their experiences to bear on understanding words and texts. And, of course, as in other fields, learners can and must learn to use their experiences to build novel simulations, by combining elements of experience in new ways to go beyond the specifics of their own experiences in the world. In sum, digital media offer an extraordinary range of potential learning enhancement. They can integrate oral and written language and real-world interactions as well as provide an enormous source of images, actions, and dialogue, all of which help users learn to situate meanings in a great variety of domains, including school subjects such as algebra, science, social studies, art, and literature. They can help level the playing field for learners whose families have not introduced them to a wealth of images, actions, dialogue, interactions, and experiences connected to these academic domains.

At the same time, for the modern world, being "tech-savvy" is crucial for success, and even for survival. Becoming tech-savvy, learning language, learning literacy, and learning content are elements of the modern-day equation for learning to innovate. Indeed, if we continue to separate these things, we will create new gaps and waste enormous amounts of human potential.

policy recommendations

The digital promise: an agenda to build literacy and learning in the 21st century

Current early literacy practices and policies have cost taxpayers tens of billions of dollars over the past decade but have not seriously assessed or integrated the digital tools and new teaching practices that have the potential to promote the types of skills and knowledge demanded by universities and employers in the 21st century.



Of course, this is a new area. Studies are under way, evidence is coming in. Although more research is needed, there is enough evidence that digital media can have an enormous impact on the field of education to act on this premise (Gee, 2007; Jenkins, 2006; Squire, 2006, 2007; Shaffer, 2007; Barab, Hay, Barnett, & Squire, 2001). Digital media are here to stay, and children develop literacy and numeracy skills playing games that they do not exhibit in schoolwork. We need to capitalize on these advantages now. Therefore we recommend the following as a national agenda to business leaders, policy makers, scholars, educators, citizens, and parents:

1. Fund digital research and development to invest in what works

This paper has examined the potential impact of digital media as young children begin their literacy development and make the crucial transition from learning key reading skills to reading to learn content. Sustained research within and across diverse disciplines is needed to shed light on the specific benefits of digital media, and to assess what works best for children from different backgrounds and with different learning profiles.[3] The recent phenomena of reading and writing online, literacy learning through electronic game play, or engagement in various other forms of creative expression through digital play noted in this paper have not been adequately studied.

We need to know more about how children choose media experiences; about the impact of adult participation or scaffolding of these experiences; and about interventions that might buffer potential negative effects or reinforce positive ones. Given the rise of social networks and gaming communities, we need studies not only of individual youngsters but also of networks and communities of children.

The creation of a coordinated system of nationally significant research priorities in basic and applied research on digital media could focus on key literacy and learning issues such as:

- The underlying theories of literacy learning in digital media
- The promise of educational games
- The use of new technologies to reach struggling readers
- The deployment of new forms of media to accelerate second-language learning
- The benchmarking of literacy learning approaches in other nations
- How to establish a new "what works" standard for children's literacy development that incorporates educational technologies

Two promising pieces of national legislation to advance knowledge in this area are the Children and Media Research Advancement (CAMRA) Act and the National Center for Learning Science and Technology Trust Fund. The currently pending CAMRA Act would authorize long-term funding to establish a coherent research program on the many forms of electronic media and the myriad ways they affect children, from their developing brains to their developing bodies. The National Center, recently passed by the House and fashioned after the National Science Foundation, would also provide valuable financing for R&D to demonstrate how advanced information technologies can transform education and professional development. The Center will focus on the convergence between traditional learning and the new 21st-century skills that promote innovation and are rooted in early childhood.

2. Establish a digital teacher corps

Teachers cannot teach what they do not know. Unfortunately, the skills — especially the digital skills — needed to modernize early literacy teaching are not being transmitted in teacher education programs in the United States. We need to radically transform the preparation and professional development opportunities available to teachers in the primary grades. The goal should be to create teachers who help young people learn to transform information for discovery and problem-solving. Three areas that need particular attention are:

- Primary-grade teachers need to master content knowledge in areas such as math, science, literature, and technology.

[3] For a fuller discussion of research and development issues, see Shore (2008). Available at www.joanganzcooneycenter.org.

- They need to become digital experts and experts at using digital tools to learn content.
- They need to learn to collaborate with other educators and children to become mentors and guides of others' learning, not mere conduits of information or "storage."

We propose the establishment of a new Digital Teachers Corps of some 6,000 21st-century literacy leaders, that is, two new teachers for each of the 3,000 lowest-performing elementary schools in the United States. Modeled after other programs such as the North Carolina Teaching Fellows, which has successfully recruited strong new teachers from underserved minority groups, and Teach for America, which has a track record of attracting the "best and brightest" young minds committed to national service, the Digital Teachers Corps would recruit prospective members from leading universities, community organizations, and technology-oriented businesses.

Digital media hold out great promise to enhance the development of teachers. Multiplayer worlds can eventually be developed so that teachers can interact with young people to learn alongside them and to mentor them. Such games can be used to teach and introduce rich content in areas young children have a natural affinity with, such as environmental issues and civic participation, as well as to develop 21st-century skills in media, technology, knowledge construction, and innovation. Massive multiplayer spaces like Second Life and simulation games like Civilization and SimCity are already used for a wide variety of learning purposes,[4] and we can build richer and deeper worlds that allow young people and teachers to build communities of learners in and out of school. Thus, as part of the Digital Teachers Corps, we would encourage the development of such worlds for the production and development of digitally savvy teachers, as well as for building interactions between teachers and their students.

3. Design and test alternative assessments and new standards

One way to institutionalize needed reforms to accelerate literacy practice is to redesign and internationalize benchmark standards and to align assessments. As schools and other learning institutions change their teaching to address the fourth-grade slump, leaders should support the expanded definition of "literacy" with new standards and assessments.

Currently, in the United States, each state has its own standards, curricula, and assessments, and most of them measure textbook knowledge. What they should be measuring are the adaptive skills, lifelong learning habits, and ability to adopt new technologies and ways of understanding from multiple cultural perspectives that are critical to solving problems and that are primed in the early grades.

Here, again, digital media themselves hold out great promise for the work of assessment. We can imagine the day where learners enter a virtual world and use academic tools from science, mathematics, the social sciences, and the arts to solve problems and make discoveries. Their problem-solving in the digital world would itself be a deep assessment of skills, including collaboration and the applications of these skills across other virtual worlds, and the real world would be a test of transfer.

Furthermore, when learners learn in a digital world, all their moment-by-moment actions and interactions can be copiously documented. We can use this information to track each learner's progress in an area across time; to discover different trajectories to mastery across thousands of learners; and to inform learners of which trajectory they are on and how to enhance it or move to a better one. Assessment would no longer be a one-time sample taken out of context.

[4] A *USA Today* article reports on the educational uses of Second Life at more than 300 universities, including Harvard and Duke. Some educators conduct entire distance-learning courses there; others supplement classes (Sussman, 2007). In addition, Kurt Squire has done extensive research and demonstration programs using Civilization III as the basis for a unit on world history in urban learning environments. He examined how the game engages players, the social interactions that occur, how understandings emerge, and what role game play serves in mediating students' understandings (http://website.education.wisc.edu/kdsquire/dissertation.html). And finally, in Erving, Massachusetts, a team of fifth- and sixth-grade teachers used the Sim City 2000 computer simulation software as the core of a two-month multidisciplinary study of cities (http://www.fi.edu/fellows/fellow3/apr99/simcity2000/why.htm).

The moment-by-moment data we use to evaluate learners could often be the same data they use to resource and develop their own learning. If we care about more informative assessments, we need to build more and better virtual worlds for learning and use digitally augmented experiential learning in the real world with, for example, mobile and handheld devices (e.g., of the sort we saw in the discussion of epistemic games or Quest Atlantis).

To make sure that elementary school children are learning what they will need to compete in the 21st century, we need alternative assessment tools. We need to document not only basic competencies in "gateway" proficiency areas such as reading, but also to assess critical thinking, problem-solving, innovation, global awareness, media literacies, and situated, proactive understanding of content. Organizations across the country have already begun to develop alternative assessments, notably at the Partnership for 21st Century Skills, the New Media Literacies Project at MIT, and the MacArthur Foundation's 21st Century Assessment Project.

4. Create "a place in every community": 21st-century literacies technology centers

Many elementary school children are gamers and emerging tech-savvy "digital natives." They crave engaging experiences with new technologies, and today they want to learn socially and collaboratively, using digital tools that allow them to participate in learning communities (see the discussion of Pro-Ams earlier) and to produce media and knowledge (Gee, 2004; Hawisher & Selfe, 2007; Jenkins, 2006). Their evident skills usually outstrip those of adults around them, but they still need teaching applicable to the digital world. They often need help with how to evaluate information available online and how to put their tech skills to the most productive uses. Kids' enthusiasm for digital activities presents a great "hook" for teaching, but if schools ignore the digital world, that world becomes reserved for home and the resources only more privileged families can marshal.

Despite billions of dollars invested in programs such as E-Rate and school district wiring, as well as multiple community after-school experiments, most low-income and minority children have limited access to rich in-school or out-of-school learning through the best technology opportunities available today. This means not only access to the technology, but also appropriate guidance and attention from grownups on how best to use and leverage the technology. Low-income and minority children are the ones who can benefit most from this form of learning.

Building on important models developed by corporations such as Intel (Computer Clubhouses) and national informal education leaders such as the Boys and Girls Clubs (Club Tech), it is time to create a place in every community where elementary-age children can go to gain confidence in their literacy and interactive technology skills. These centers[5] should expose children to high-quality, engaging digital worlds, and tools that integrate language and literacy development with content learning that emphasizes situated understanding, innovation, and collaboration. The knowledge tools would include simulations, models, games, mobile and handheld devices, and media production tools. One of the most important elements of these centers would be the presence of knowledgeable adults who can help children make the most of technology.

The emphasis in these centers would be to support literacy and content learning using virtual worlds, augmented reality games, and other digital tools to solve problems, often collaboratively as part of an emerging Pro-Am community, while allowing all children to become tech-savvy. There should also be an emphasis on speakers of other languages learning English and native speakers learning a second language to promote cultural communication, international understanding, and the skills necessary to live, participate, and prosper in a global world.

[5] Current centers are financed by both the federally funded network of "21st-Century Learning Centers" and state and local after-school programs such as LA's Best and New York City's Afterschool Corporation, and through the "supplemental service" funding that has largely been used for "test prep" organizations attempting to help struggling readers pass annual state reading assessments.

A key goal of these centers would be to help "at-risk" kids transfer to school what they learn in an informal digitally enhanced environment with good mentoring. Another goal would be to allow all students to gain a "passion" that leads to expertise and skills they can apply in life — to allow them to become "Pro-Ams." In this way, all children could gain the technological sophistication for knowledge production that many privileged kids are getting at home.

5. *Governors' digital partnership schools*

In the past two decades, governors, philanthropies, and business leaders have created special demonstration schools on key themes ranging from science and math to arts and culture to international education with some notable successes. Secondary school models such as High Tech (www.hightechhigh.org) and New Tech High Schools (www.newtechhigh.org) as well as Microsoft's "School of the Future" in Philadelphia offer helpful lessons for the creation of elementary schools that would demonstrate how to teach essential literacy skills in a digital age.

States and school districts should establish digital-partnership elementary schools as model demonstration sites. These schools would be laboratories for testing many different digital approaches to learning and assessment, as well as for testing different ways to break down the barriers between in- and out-of-school learning. They could become a hub for the professional development of digitally savvy teachers. The model schools could also link to state innovations such as virtual high schools to deliver strong instruction in key areas that most children have no access to, such as high-quality second-language instruction, which is associated with higher levels of performance on native language skills in the early grades (Curtain & Dahlberg, 2003).

Finally, these schools could become a fulcrum for demonstrating how businesses could get involved, by donating mentors, training teachers, or funding model initiatives. These partnerships could serve as a force for a true innovation in promoting learning in and out of school.

6. *Modernize public broadcasting*

Educational television media for young children, stimulated by *Sesame Street*'s pioneering work, have accumulated a four-decade track record indicating that under the right conditions, basic reading, math, and social and problem-solving skills can be enhanced for all children, especially those from underserved communities (Anderson, 2003, 2004; Anderson & Evans, 2003; Gladwell, 2000). It is now time for these television-based efforts to be modernized to accommodate the needs and interests of children living in a digital age.

Young people, including 6-to-11-year-olds, today are spending many hours on digital media in addition to their continued attention to traditional educational media such as books and television. In a "media convergence" world (Jenkins, 2006), young people most often engage in activities — like Yu-Gi-Oh — that combine and integrate books, games, television and movies, Web sites, and activities like face-to-face card games, art, and fan fiction writing.

We have the opportunity now to capitalize on the tastes and preferences of this age group and possibly shape learning habits for a lifetime. A first step would be to support ongoing efforts to reinvent the current "Ready-to-Learn" program financed by Congress and the U.S. Department of Education. The program now reaches millions of low-income children in preschool and the primary grades with quality television broadcast fare, but has only recently paid attention to extending literacy learning on new platforms, and to wider distribution in schools and community settings.

Shows like *Sesame Street* and *Blue's Clues* have shown that television can teach and does so in ways that encourage adults to be involved with children's learning as an interactive experience between parent and child. The digital media and games engendered by such shows have been used in homes to accelerate children's cognitive growth, language development, preparation for school, and affiliation with school learning in the sense of making children comfortable with the practices, values, and even the language of schooling.

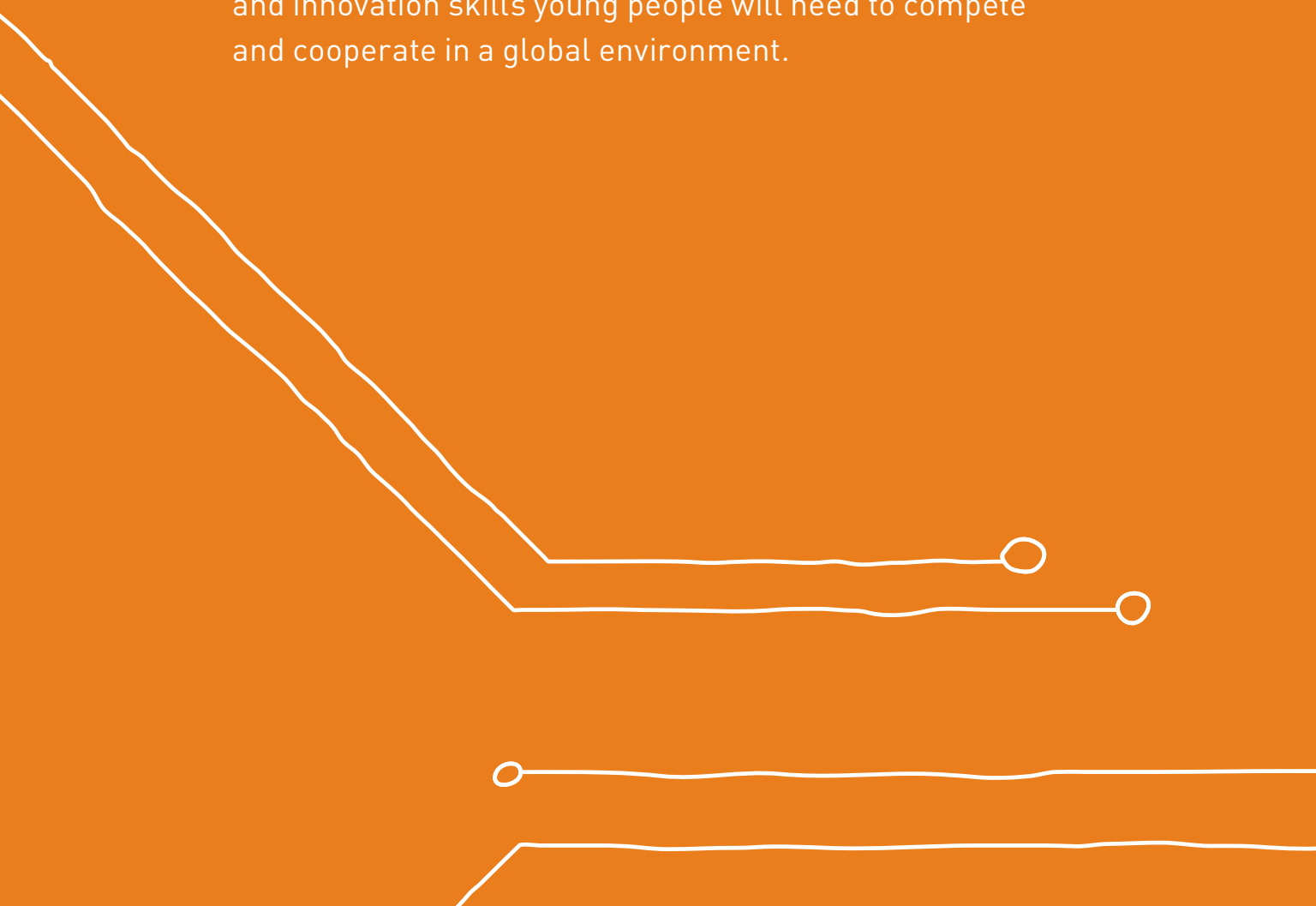
Digital media offer the promise of 24/7 learning, and may provide opportunities for the intense exposure needed to accelerate struggling students that educational television programs have not delivered in the past.

To reframe the public interest in public broadcasting initiatives in a digital age, we recommend adding significant resources to the recently initiated PBS Kids Next Generation Media Initiative so that a new framework for production will expand to include wider experimentation with formats such as games, virtual worlds, and social network communities that will engage children in both traditional and newer literacy skills. We recommend, as well, the development of creative business models and incentives to ensure that intellectual property is more open, available for modification by children (in the ways in which gamers, for example, "mod" games), and more widely distributed to schools and other learning centers. By becoming part of the Open Educational Resource (OER) movement, which has built vital infrastructure to democratize access to high-quality content for older learners throughout the world (Atkins, Brown, & Hammond, 2007), educational media companies in the U.S. can leverage the tens of millions of dollars of public investment in educational programming for children. A tremendous archive of materials developed by broadcasters should now be used for further public benefit.

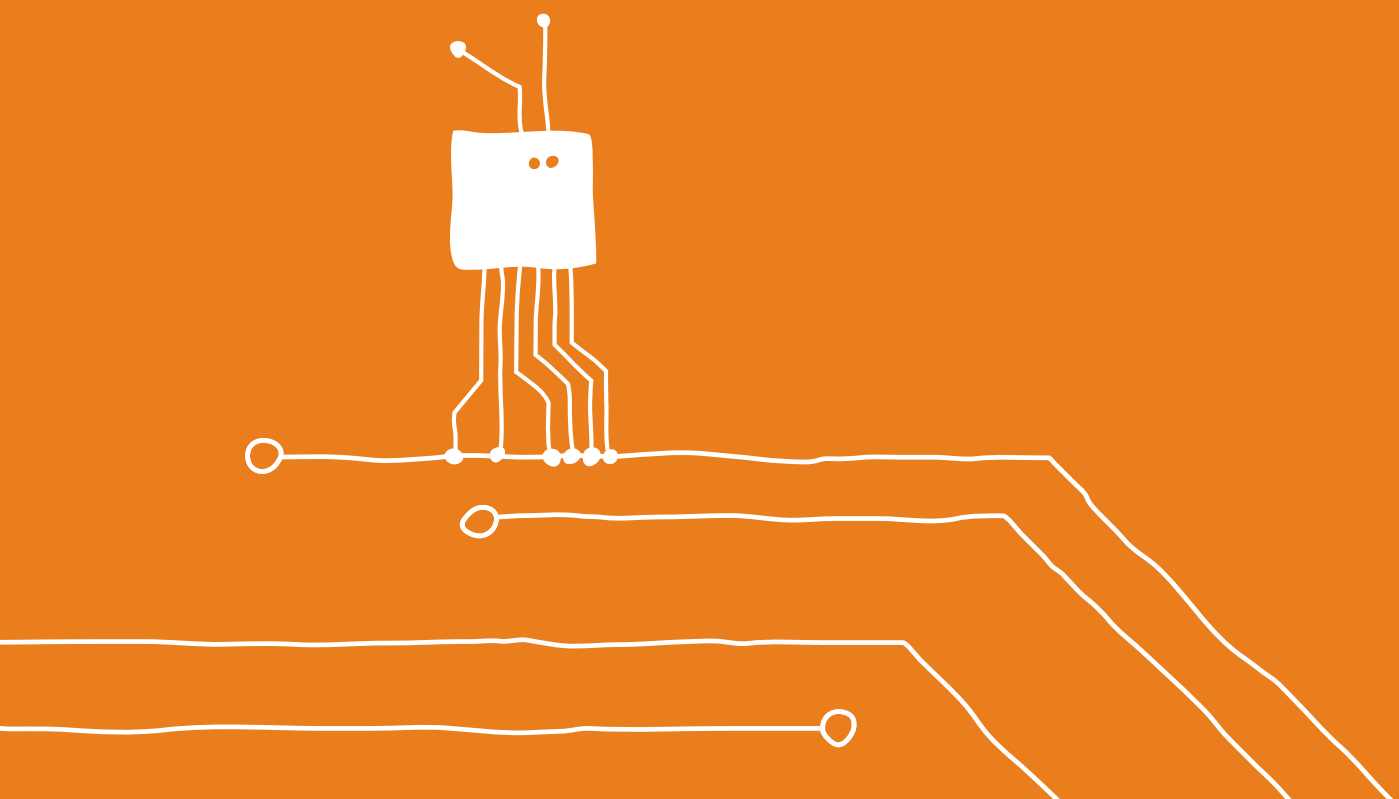
Informal communications leaders such as Sesame Workshop, WNET, WGBH, National Geographic, Family Communications, Discovery, and Scholastic as well as the Corporation for Public Broadcasting and PBS should expand new literacy and 21st-century skills initiatives for classroom and informal applications, featuring teacher training materials and classroom links to exciting multimedia presentations that feature research-based ways to teach reading, math, science, intercultural skills, and world languages. These activities will proliferate if CPB and PBS make a "Next Generation" (Barna, 1997) commitment in all of their programming.

conclusion

Five decades ago, the threat to our nation's security posed by the Soviet launch of Sputnik galvanized an education reform movement that invested wisely in basic research, higher education, and area studies. The United States catapulted to dominant leadership in math, science, and technology. Today, the threat is to America's economy and comes from the inexorable but less visible movement of globalization. American leadership in the new economy can be assured only if students are prepared from the early grades to read widely and deeply for effective content learning and if we promote the types of knowledge, creativity, communication, and innovation skills young people will need to compete and cooperate in a global environment.



As the next generation of Americans move from school into commerce, education, government, health care, the arts, and other fields, they will need to know and be able to do different things than previous generations. Their success will depend on a capacity to comprehend how the United States interacts with other countries and cultures; to function in a complex and ever-changing global environment; to understand and intervene in risky, complex systems; and to interact with people whose backgrounds, assumptions, and perspectives bear little resemblance to their own. A national commitment to a new approach to learning and literacy will play a pivotal role in ensuring a brighter future for all of our children.



glosssary

Avatars: Textual, two-dimensional, or three-dimensional graphical representations of the computer user's self found in virtual worlds.

Digital storytelling: The use of editing and graphic design software to manipulate video and audio to construct narratives.

Community of practice: Learning as a group process occurring when individuals with a common interest collaborate over time to share consensus ideas and create new ideas.

Fan fiction (alternately referred to as fanfiction, fanfic, FF, or fic): Stories about characters or settings written by fans of the original work, rather than by the creators. The term usually applies to works that are uncommissioned and unauthorized by the creators and publishers of the original, and usually works that are not professionally published.

Machinima: The rendering of computer-generated imagery using low-end 3D video game engines. Also refers to the genre of films created this way.

Massively multiplayer online game (MMO or MMOG): A video game, played on the Internet, that is capable of supporting hundreds or thousands of players simultaneously. Most of the newer game consoles (Xbox 360, PSP, PS3, Wii, etc.) can access the Internet, and thus can have MMO genre games.

Media convergence (from Jenkins, 2006): Refers to a trend in media consumption due to the proliferation of channels and the increasingly ubiquitous nature of computing and communications. Jenkins believes that, due to the fact that media will be everywhere, and that media will be used in relation to one another, this will require the development of new skills for managing information, new structures for transmitting information across channels, and new creative genres that exploit the potentials of those emerging information structures.

Meta-level: Discussion about the thinking on a particular subject rather than about the subject itself.

Mod (short for modding or modifying): The act of modifying a piece of hardware or software to perform a function not originally conceived or intended by the designer. Often used within the Open Source software movement and within the computer game community, particularly in regard to creating new or altered content and sharing that via the Web. Modifications can include the creation of new items, weapons, characters, enemies, models, modes, textures, levels, story lines, music, and game modes.

Rich: Including information from multiple perspectives and in a variety of forms.

Social network community: A group of people that primarily interact via communication media such as the Internet rather than face-to-face, for social, professional, educational, or other purposes. Virtual and online communities have become a supplemental form of communication between people who know each other primarily in real life.

Simulation: A representation of a real world phenomenon by a computer program that imitates a physical process or object by causing a computer to respond mathematically to data and changing conditions as though it were the process or object itself.

Virtual world: A computer-based simulated environment intended for its users to inhabit and interact via avatars.

references

Adams, M. J. (1990). *Beginning to read: Thinking and learning about print*. Cambridge, MA: MIT Press.

American Educator. (2003). Research round-up (September).

Anderson, C. (2006). *The long tail: Why the future of business is selling less of more*. New York: Hyperion.

Anderson, D. R. (2003). The Children's Television Act: A public policy that benefits children (Commentary). *Journal of Applied Developmental Psychology*, 24(3), 337–340.

Anderson, D. R. (2004). Watching children watch television and the creation of *Blue's Clues*. In H. Hendershot (Ed.), *Nickelodeon nation: The history, politics, and economics of America's only TV channel for kids* (pp. 241–268). New York: New York University Press.

Anderson, D .R., & Evans, M. K. (2003). The impact of the Internet on children: Lessons from television. In J. Turow & A. Kavanaugh (Eds.). *The wired homestead* (pp.73–92). Cambridge, MA: MIT Press.

Atkins, D. E., Brown, J. S., & Hammond, A. L. (2007). A review of the open educational resources (OER) movement: Achievements, challenges, and new opportunities. Accessed March 28, 2008, at http://www.hewlett.org/NR/rdonlyres/5D2E3386-3974-4314-8F675C2F22EC4F9B/0/AReviewoftheOpenEducationalResourcesOERMovement_BlogLink.pdf

Baker, E. L. (2007). 2007 Presidential address: The end(s) of testing. *Educational Researcher*, 36(6), 309–317.

Barab, S. A., Hay, K. E., Barnett, M., & Squire, K. (2001). Constructing virtual worlds: Tracking the historical development of learner practices. *Cognition and Instruction, 19*(1), 47–94.

Barab, S., Zuiker, S., Warren, S., Hickey, D., Ingram-Goble, A., Kwon, E-J., Kouper, I., & Herring, S. C. (2007). Situationally embodied curriculum: Relating formalisms and contexts. *Science Education*, 91(5), 750–782.

Barna, G. (1997). *Generation Next: What you need to know about today's youth*. Ventura, CA: Regal Books.

Barsalou, L. W. (1999a). Language comprehension: Archival memory or preparation for situated action. *Discourse Processes* 28(1), 61–80.

Barsalou, L. W. (1999b). Perceptual symbol systems. *Behavioral and Brain Sciences, 22*(4), 577–660.

Beck, I. L., McKeown, M. G., & Kucan, L. (2002). *Bringing words to life: Robust vocabulary instruction*. New York: Guilford Press.

Biemiller, A. (2003). Oral comprehension sets the ceiling on reading comprehension. *American Educator, 27*(1), 23, 44.

Bransford, J., Brown, A. L., and Cocking, R. R. (2000). *How people learn: Brain, mind, experience, and school*. Expanded Edition. Washington, D.C.: National Academy Press.

Bransford, J. D., & Schwartz, D. L. (1999). Rethinking transfer: A simple proposal with multiple implications. In A. Iran-Nejad and P. D. Pearson (Eds.). *Review of research in education*, Vol. 24 (pp. 61–100). Washington, D.C.: American Educational Research Association.

Carnegie Corporation. (1996). *Years of Promise: A Comprehensive Learning Strategy for America's Children*. New York: Carnegie Corporation.

Chall, J. S., Jacobs, V. A., & Baldwin, L. E. (1990). *The reading crisis: Why poor children fall behind*. Cambridge, MA: Harvard University Press.

Chall, J. S., & Jacobs, V. A. (2003). Poor children's fourth-grade slump. *American Educator* 27(1), 14.

Chi, M., Feltovich, P., & Glaser, R. (1981). Categorization and representation of physics problems by experts and novices. *Cognitive Science* 5(2), 121–152.

Clark, A. (1989). *Microcognition: Philosophy, cognitive science, and parallel distributed processing*. Cambridge, MA: MIT Press.

references (cont.)

Clay, M. M. (1991). *Becoming literate: The construction of inner control*. Auckland, NZ: Heinemann Educational Books.

Crowley, K., & Jacobs, M. (2002). Islands of expertise and the development of family scientific literacy. In G. Leinhardt, K. Crowley, & K. Knutson (Eds.). *Learning conversations in museums* (pp. 333–356). Mahwah, NJ: Lawrence Erlbaum.

Curtain, H., & Dahlberg, C. A. (2003). *Languages and children — Making the match: New languages for your learners, Grades K–8* (3rd Ed.). Columbus, OH: Allyn and Bacon.

Dickinson, D. K., & Neuman, S. B., Eds. (2006). *Handbook of early literacy research,* Vol. 2. New York: Guilford Press.

DiSessa, A. A. (2000). *Changing minds: Computers, learning, and literacy*. Cambridge, MA: MIT Press.

Finn, C., & Ravitch, D. (2007). Not by geeks alone. Accessed Jan. 25, 2008, at http://www.philipwaring.us/on_education/2007/08/not-by-geeks-al.html

Friedman, T. (2005). *The world is flat: A brief history of the twenty-first century*. New York: Farrar, Straus, and Giroux.

Gardner, H. (1991). *The unschooled mind: How children think and how schools should teach*. New York: Basic Books.

Gee, J. P. (2003). *What video games have to teach us about learning and literacy*. New York: Palgrave/Macmillan (2nd ed., 2007).

Gee, J. P. (2004). *Situated language and learning: A critique of traditional schooling*. London: Routledge.

Gee, J. P. (2005). *An introduction to discourse analysis: Theory and method*. London: Routledge.

Gee, J. P. (2007). *Good video games and good learning: Collected essays on video games, learning, and literacy*. New York: Peter Lang.

Gladwell, M. (2000). *The tipping point: How little things can make a big difference*. Boston: Little, Brown.

Glenberg, A. M. (1997). What is memory for. *Behavioral and Brain Sciences, 20*(1), 1–55.

Glenberg, A. M., Gutierrez, T., Levin, J. R., Japuntich, S., & Kaschak, M. P. (2004). Activity and imagined activity can enhance young children's reading comprehension. *Journal of Educational Psychology, 96*(3), 424–436.

Glenberg, A. M., & Robertson, D. A. (1999). Indexical understanding of instructions. *Discourse Processes, 28*(1), 1–26.

Halliday, M. A. K. (2006). *The language of science*. London: Continuum International Publishing Group.

Halliday, M. A. K., & Martin, J. R. (1993). *Writing science: Literacy and discursive power*. Pittsburgh: University of Pittsburgh Press.

Hart, B. M. & Risley, T. R. (1995). Meaningful differences in the everyday experience of young American children. Baltimore: Paul H. Brookes.

Hawisher, G. E., & Selfe, C. L. (2007). *Gaming lives in the twenty-first century: Literate connections*. New York: Palgrave/Macmillan.

Hayes, E. (in press). Girls, gaming, and trajectories of technological expertise. In Y. B. Kafai, C. Heeter, J. Denner, & J. Sun (Eds.). *Beyond Barbie and Mortal Kombat: New perspectives on gender, games, and computing*. Cambridge, MA: MIT Press.

Hirsch, E. D. (2003). Reading comprehension requires knowledge—of words and the world: Scientific insights into the fourth-grade slump and the nation's stagnant comprehension scores. *American Educator, 27*(1), 10–29, 44.

Jenkins, H. (2006). *Convergence culture: Where old and new media collide*. New York: NYU Press.

Jenkins, H. with Clinton, K., Purushotma, R., Robison, A. J., & Weigel, M. (2006). *Confronting the challenges of participatory culture: Media education for the 21st century*. Chicago: MacArthur Foundation.

Juel, C. (1988). Learning to read and write: A longitudinal study of 54 children from first to fourth grades. *Journal of Educational Psychology, 80*(4), 437–447.

Juel, C., Griffith, P., & Gough, P. B. (1986). Acquisition of literacy: A longitudinal study of children in first and second grade. *Journal of Educational Psychology 78*. 243–255.

Kolodner, J. L. (1993). *Case-based reasoning*. San Mateo, CA: Morgan Kaufmann.

Kolodner, J. L. (2006). Case-based reasoning. In R. K. Sawyer (Ed.), *The Cambridge handbook of the learning sciences* (pp. 225–242). Cambridge, England: Cambridge University Press.

Lave, J. (1996). Teaching, as learning, in practice. *Mind, Culture, and Activity 3*(3), 149–164.

Leadbeater, C., & Miller, P. (2004). *The Pro-Am revolution: How enthusiasts are changing our society and economy*. London: Demos.

Lee, J. (2006). *Tracking achievement gaps and assessing the impact of NCLB on the gaps: An in-depth look into national and state reading and math outcome trends*. Cambridge, MA: The Civil Rights Project at Harvard University.

Lehrer, R., & Schauble, L. (2006). Cultivating model-based reasoning in science education. In R. K. Sawyer (Ed.), *The Cambridge handbook of the learning sciences* (pp. 371–387). Cambridge, England: Cambridge University Press.

Martin, J. R. (1990). Literacy in science: Learning to handle text as technology. In F. Christe (Ed.), *Literacy for a changing world* (pp. 79–117). Melbourne: Australian Council for Educational Research.

National Press Club. (2007, December 4). Losing our edge: Are American students unprepared for the global economy? Washington, D.C. Accessed January 25, 2008, at http://www.all4ed.org/events/losingedge

Neuman, S. B., & Celano, D. (2006). The knowledge gap: Implications of leveling the playing field for low-income and middle-income children. *Reading Research Quarterly, 41*(2), 176–201.

Neuman, S. B., & Dickinson, D. K. (Eds.). (2001). *Handbook of early literacy research*. New York: Guilford Press.

New Commission on the Skills of the American Workforce. (2007). *Tough Choices or Tough Times*. Washington, D.C.: National Center on Education and the Economy.

Packard, E. (2007). Children and the Internet: It's fun, but does it make you smarter? Researchers find a relationship between children's Internet use and academic performance. *Monitor on Psychology, 38*(10), 44.

Pellegrino, J., Chudowsky, N., & Glaser, R. (Eds.). (2001). *Knowing what students know: The science and design of educational assessment*. Committee on the Foundations of Assessment. Board on Testing and Assessment, Center for Education. Division of Behavioral and Social Sciences and Education. Washington, D.C.: National Academy Press.

Pew Internet & American Life memo. (2005). Accessed March 28, 2008, at: http://www.pewinternet.org/pdfs/PIP_Internet_and_schools_05.pdf

PISA (2006). *Science competencies for tomorrow's world*: Volume 1: *Analysis*. Paris: OECD Publishing.

Roberts D. F., Foehr, U. G., & Rideout, V. (2005). *Generation M: Media in the lives of 8–18 year-olds*. Menlo Park, CA: Kaiser Family Foundation.

Romer, R. (2007, December 4). Dropping below the middle…Bad news for America's schools.

Roy's blog on schools. Accessed January 25, 2008, at http://www.edino8.com/BlogEntry.aspx?id=2766

Schleicher, A. (2007, June 7). Universities must face the Chinese challenge. *The (London) Independent*. Accessed January 25, 2008, at http://news.independent.co.uk/education/higher/article2619392.ece

Schleppegrell, M. (2002). Linguistic features of the language of schooling. *Linguistics and Education*, 12(4), 431–459.

Schleppegrell, M. (2004). *Language of schooling: A functional linguistics perspective*. Mahwah, NJ: Lawrence Erlbaum.

references (cont.)

Senechal, M., Ouellette, G., & Rodney D. (2006). The misunderstood giant: Predictive role of early vocabulary to future reading. In D. K. Dickinson & S. B. Neuman (Eds.). *Handbook of early literacy research*, Volume 2 (pp. 173–182). New York: Guilford Press.

Shaffer, D. (2007). *How Computer Games Help Children Learn*. New York: Palgrave/Macmillan.

Shaffer, D. W. (2004). Pedagogical praxis: The professions as models for post-industrial education. *Teachers College Record, 10*(7), 1401–1421.

Shaffer, D. W. (2005). Epistemic games. Innovate 1.6. Accessed February 22, 2008, at http://www.innovateonline.info/index.php?view=article&id=81

Shore, R. (2008). *The Power of Pow! Wham!: Children, Digital Media & Our Nation's Future*. Three Challenges for the Coming Decade. New York: The Joan Ganz Cooney Center at Sesame Workshop.

Snow, C., et al. (2002). *Reading for understanding: Toward an R&D program in reading comprehension*. Santa Monica, CA: The Rand Corporation.

Snow, C. E., Burns, M. S., & Griffin, P. (Eds.). (1998). *Preventing reading difficulties in young children*. Washington, D.C.: National Academy Press.

Squire, K. D. (2006). From content to context: Video games as designed experience. *Educational Researcher, 35*(8), 19–29.

Squire, K. D. (2007). Games, learning, and society: Building a field. *Educational Technology, 4*(5), 51–54.

Squire, K. D., DeVane, B., & Durga, S. (in press). Designing centers of expertise for academic learning through video games. To appear in *Theory Into Practice*.

Sternberg, R. (2008). Applying psychological theories to educational practice. *American Educational Research Journal, 45(1), 150–165*.

Strickland, D. S. (1990). Emergent literacy: How young children learn to read and write. *Educational Leadership, 47*(6), 18–23.

Strong American Schools. (2008, April). *A Stagnant Nation: Why American Students Are Still at Risk*. Washington, D.C.: Author. Accessed on April 28, 2008, at http://www.edin08.com/uploaded Files/Issues/Issues_Pages/EDin08_Stagnant_Nation.pdf

Sussman, B. (2007). Teachers, college students lead a second life. USA TODAY. Accessed on March 27, 2008, at http://www.usatoday.com/news/education/2007-08-01-second-life_N.htm

Toffler, A., & Toffler, H. (2006). *Revolutionary wealth: How it will be created and how it will change our lives*. New York: Knopf.

Universal Service Administrative Company Web site. (2008). Accessed March 27, 2008, at http://www.usac.org/about/universal-service/fund-facts/fund-facts.aspx

Warschauer, M. (2004). *Technology and social inclusion: Rethinking the digital divide*. Cambridge, MA: MIT Press.

Warschauer, M. (2006). *Laptops and literacy: Learning in the wireless classroom*. New York: Teachers College Press.

Zigler, E., & Styfco, S. J. (2001). Extended childhood intervention prepared children for school and beyond. *The Journal of the American Medical Association, 285*(18), 2378–2380.

Zwiers, J. (2005). The third language of academic English. *Educational Leadership* 62(4), 60–63.

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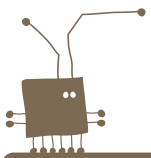

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