

the power of

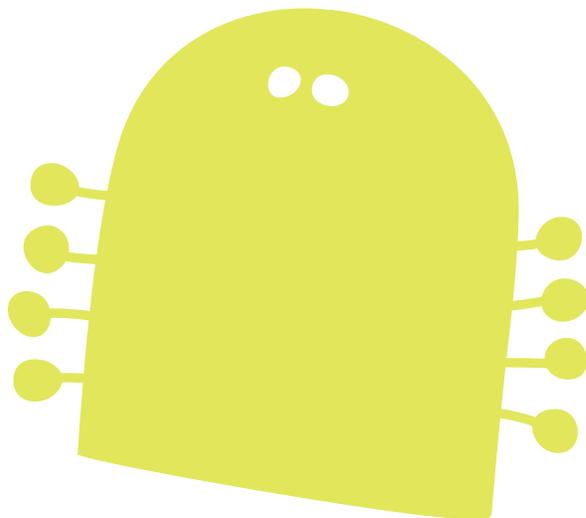
pow!

wham!

**Children, Digital Media
& Our Nation's Future**

Three Challenges for the Coming Decade

Rima Shore, Ph.D.
May 2008



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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.

For more information, visit www.joanganzcooneycenter.org.

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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preface: the power of pow! wham!

“A word about children’s programs,” Joan Ganz Cooney wrote in 1966. “Most of those commercially sponsored, seem to be inordinately noisy and mindless affairs.” She added, “Beginning at an early age, we can assume, children are conditioned to expect *pow! wham!* fast action thrillers...highly visual, slickly, and expensively produced material.” This observation led her to an important question: Would it be possible to design children’s programming that would be attractive and fun and at the same time realize serious educational aims? She concluded: “I believe the answer is an emphatic yes.”

Mrs. Cooney reached this conclusion in a landmark paper, *The Potential Uses of Television in Preschool Education*¹, which provided a rationale, initial research base, and blueprint for the Children’s Television Workshop, now known as Sesame Workshop. For the paper, she had surveyed leaders across several fields, including early childhood education and developmental psychology, about the possibility of using television broadcasts to educate young children. She envisioned children’s programming of such broad appeal that it would reach all children, especially those living in disadvantaged neighborhoods. The paper described lively, colorful, research-based content that would be aired both in homes and preschools.

Today, her creation, *Sesame Street*, has inspired children worldwide with an approach to informal learning that has left an indelible imprint on generations of children and families. Its academic effectiveness has been documented in hundreds of research studies, in business case models, and in the iconic popularity of the Muppets.

Nonetheless, “*pow! wham!* action thrillers” continue to dominate the market, but increasingly they take the form of electronic interactive games — now a multi-billion-dollar business that is shaping many school-age children’s media experiences, albeit with little explicit or intentional educational content. The context has changed dramatically, but the challenge Mrs. Cooney posed in 1966 remains relevant: How can we unleash the power of digital media to support and accelerate the learning and development of all children — including disadvantaged children — both in and out of school?

Addressing that question is the mission of the new Joan Ganz Cooney Center at Sesame Workshop. Following in Mrs. Cooney's footsteps, we have undertaken a survey of leaders in several fields, as well as an initial scan of the research literature, in order to outline an agenda for change. The stakes are as high today as they were 40 years ago. The demographic, technological, and economic trends of the past decade all demand a transformation in the way we think about the education of young children in a global, interconnected world. And given the remarkable changes, educational equity and consistently high achievement remain distant but even more urgent goals. Bold new strategies are needed to engage and inspire children, and to help them learn vital new literacy skills. Toward these ends, educators have at their disposal concepts and tools that are beyond the wildest dreams of those readers of Mrs. Cooney's 1966 report.

In contrast to *The Potential Uses of Television*, this report focuses primarily on children in the elementary school years. Digital media powerfully affect young people of all ages, but existing research and development efforts have tended to focus on younger and older kids, leaving a gap in knowledge and programming related to children ages 6 to 12, the "middle childhood" period. It is during this stretch of time that children typically take giant steps into the world that lies beyond family and home, grapple with literacy and numeracy, and continue to build the store of words and ideas that they will need to profit from reading throughout their lives. These are also the years when children develop enduring attitudes toward learning and deep convictions about their own potential.

This paper is based on interviews with 60 leaders from such fields as educational media, literacy, child development, educational and family policy, digital media production, and global knowledge and skills. Our discussions with these experts were wide-ranging, touching on subjects as diverse as reading, game design, school reform, and neuroscience. We talked about children in and out of school settings, and focused on children at risk. The interviews were done under the direction of Dr. Rima Shore, Adelaide Weismann Chair in Education at Bank Street College and a Senior Fellow at the Joan Ganz Cooney Center, with able assistance from Center staff members Dixie Ching and Ann My Thai.

We hope this paper will stimulate a new dialogue about the potential and limitations of digital media to promote learning for young children. The research and industry trends highlighted here are an intended starting point to better understand how children are growing up today. The paper poses three broad challenges that must be met if we are to unleash the educational and developmental power of digital media.

Forty years ago, Mrs. Cooney proposed having funny puppets engage with adults and children to make learning experiences more engaging and interactive. Our greatest hope is that, following in the footsteps of our founder, we will inspire leaders across sectors and disciplines to harness the enduring power of *pow! wham!* to educate and delight the next generation.

Michael Levine, Ph.D.

Executive Director

Joan Ganz Cooney Center at Sesame Workshop

executive summary

This report contains the results of an initial inquiry undertaken by the new Joan Ganz Cooney Center. It focused on the power of digital media to accelerate and deepen learning for children who spend their days and evenings immersed in new technologies. While children's involvement with digital games has drawn the most attention from researchers, journalists, and the public at large, we also considered a wide range of other digital applications and tools, such as social networking Web sites, simulations, programming tools, podcasts, digital books, and electronic toys. We have focused our inquiry on elementary school children, who have tended to receive less attention from digital learning specialists and communications industry leaders than preschoolers and adolescents.

Like every new generation, today's youngsters are both vulnerable and resilient. They are deeply affected by the experiences they have, both positive and negative, at home, in neighborhoods, and in schools. And that is why adults need to get it right — at least as right as we possibly can — when we consider the impact and potential of digital experiences.

Three broad challenges

Three interrelated challenges emerged from this inquiry. All of them must be addressed if our nation is to realize the full potential of digital learning.

1. *Build a coherent R&D effort*

From their early elementary years, millions of American children are hanging out in cyberspace. They are downloading podcasts, competing in multiplayer games, feeding virtual pets, negotiating online identities, playing out digital dreams. Digital media saturate their lives, occupying many hours of each day and shaping what and how they think. Rarely has a phenomenon affecting children been so pervasive and so powerful yet so poorly understood. We may be the Jetsons, as one interviewee observed, but when it comes to understanding the impact of digital media and harnessing their potential so they can benefit all children, we are often more like the Flintstones. Most of the important questions about the impact of interactive digital media on children's development have yet to be addressed.

Sustained research within and across diverse disciplines is needed to shed light on the potential benefits and risks of digital media for children of different ages, backgrounds, and learning profiles. We need to know more about how children choose media experiences; about the impact of adult participation or scaffolding of media experiences on benefits or risks; and about interventions that might buffer negative effects or reinforce positive ones. Given the rise of social networks and gaming communities, we need qualitative studies not only of individual youngsters but also of networks and communities of children.

Research needs to go well beyond analyses of benefits and risks. Studies of how children use digital media can help to make their learning processes more transparent — giving adults a window into how they are thinking and how they develop. Those responsible for children's learning, in and out of school, stand to benefit from these insights.

Finally, we need to know more about the unintended consequences associated with the use of digital media in and out of school. Are gains in one area of cognitive, social, or emotional development accompanied by losses in others? In the educational realm, which kinds of knowledge or activities will get less attention? Which abilities may atrophy? As children learn to create, mash up, and remix digital media, will they lose a sense of what is authentic and credible?

These questions cannot be fully addressed until important theoretical and methodological issues are resolved. As things stand, there is little consensus about how to measure the effects of digital media, which effects to measure, and how studies should be designed. It is difficult to isolate the effects of sophisticated applications that change rapidly, bridge multiple platforms, have fluid (often user-generated) content, and are typically used simultaneously with other media. Research design is especially challenging, given that digital media experiences occur in many kinds of settings and that children tend to use several kinds of media at the same time.

Important research efforts are under way in a variety of institutions, and various digital media designers are working hard to develop educational uses for new platforms. But these initiatives are scattered and fragmented: We need a coordinated national effort — one that can inform parents, educators, policy-makers, industry leaders, and the public at large.

2. *Rethink literacy and learning for the digital age*

What does it mean to be educated in today's digital, interconnected world? What should children know and be able to do by the time they enter the middle grades? How can the new literacies be strengthened and linked to traditional literacy?

The experts we consulted agreed that it remains vitally important for children to master and enjoy reading. The educational leaders we consulted stressed four key questions:

- Can digital media be used to spread or reinforce proven practices, providing support to the adults (both in and out of school) who get kids ready for a lifetime of reading?
- Can digital media motivate kids to read more?
- How can digital media help kids gain the vocabulary and background knowledge needed to make sense of texts?
- Can digital media help special learners succeed in reading?

In the 21st century, traditional literacies are crucial but not sufficient. In addition to the three Rs, today's elementary school graduate needs to be able to:

Use digital tools effectively and safely. As technologies increasingly saturate daily experience, children need to express themselves fluently using multiple media (e.g., text, video, graphic design, sound), to use those media to navigate across multiple platforms (such as desktop computers, handheld devices, cell phones, and iPods), and to adopt safe and responsible practices, especially online.

Think critically. Computers allow us to retrieve and process immense quantities of information from innumerable sources available via the Internet, but people still must discern which sources are credible or relevant. Critical thinking means taking in many perspectives, filtering out irrelevant or distracting data, and evaluating what information makes the most sense.

Understand complex systems. It is important to understand that what people think, decide, do, and create are connected across geographic, socioeconomic, and disciplinary boundaries. Proponents of digital gaming say that young gamers learn about how a dynamic set of parts interrelate to make meaning, and how people use and transform systems. As they play, they learn to follow rules and how to deal with winning and losing.

Know about other countries and cultures. We live in an interconnected world, and this fact presents challenges to an educational system that has historically downplayed the importance of international content. Experts say that educators need a broader understanding of global literacy, including world geography, world history, and one or more foreign languages. Today, almost every current issue has a global dimension, requiring students to learn innumerable facts not covered in the classroom. Thus the field is wide open for technological innovations.

Participate in collaborative learning communities. Today's children are growing up at a time when knowledge development is a team sport. Many digital activities involve participation in online communities, and to the surprise of many adults, elementary-age children are increasingly involved in such communities. Educators say that digital collaboration prepares children to participate in learning communities.

Invent, create, and design — alone and with others. As children take part in collaborative processes, they can try out many different roles: peers, novices, leaders, writers, editors, scientists, and critical friends. Among the most important identities they can experience using digital tools are those of designers, creators, and inventors. In the future, success will hinge not on how much we know, but on our ability to think and act creatively.

Find wholeness in a “remix” world. Today's children are using multiple applications and platforms, often at the same time. They are becoming adept at cutting and pasting not only texts but also ideas, images, musical compositions, literary works, video clips, and other content. Electronic networking has also led to the unbundling of institutions, bodies of knowledge, and even the concept of self. It can be challenging, in this context, for children to experience authenticity and coherence in their learning experiences. For parents and teachers, helping children recognize and meet this challenge may be the most difficult task of all.

3. Advance digital equity, reaching all children with today's most powerful learning tools

From the moment computers were introduced into schools in the 1980s, experts have worried that technology would widen the achievement gap. They worried that unequal access to computers and equipment would create a digital divide between the technology haves and have-nots. Generally speaking, their concerns about access and use of computers in schools have proven to be warranted. Children attending low-performing schools continue to have the least access to digital media. To be sure, more must be done to overcome the old digital divide. But at the same time, educational decision-makers need to focus on a new digital divide that comes from disparities in the kinds of scaffolding children receive from adults to support basic literacy and the use of new digital tools.

Circuitry and software are only part of a larger learning system enabled by new technologies. Researchers say that adult scaffolding is an indispensable element in that learning system. Many parents and teachers are surprised by children's need for adult support because they feel so strongly that in the realm of technology, kids are way ahead of them. However, research shows that children tend to overestimate their technical ability, and parents tend to overestimate their children's skills. Children need the kind of scaffolding that adults can provide. Middle-class children are more likely to get this kind of support from family members; children from lower-income households are more dependent upon scaffolding by people at supporting institutions such as schools, libraries, and community centers. Narrowing the new digital divide will take coordinated action by many players: policy-makers, schools, libraries, museums, and other community organizations.

Getting started

These three broad challenges point the way to new opportunities for research, practice, and policy-making. There is much to be done. We hope this report helps lay out the scope of work and provides a map into the unknown. Answering the questions raised by the experts we interviewed will necessitate efforts to work toward common

understandings and definitions. It will require more nuanced collection and analysis of data, such as demographic information.

Forty years ago, Joan Ganz Cooney recognized that the power of television, the most compelling medium of that era, could be brought to bear on the nation's most urgent educational challenges, and she forever changed the public's assumptions about how, where, and when learning takes place. The new Center, named in her honor, affirms that insight. In coming months and years, working with leaders in educational media and research, the Cooney Center will be pursuing the aims described in this report. It will:

1. ***Fund and disseminate research on:***
 - Media technologies and literacy development
 - Innovative models with potential to go to scale
 - Initiatives and policies to close the new digital divide
2. ***Challenge and work with industry leaders to apply knowledge about digital technology and child development in designing new products for learning***
3. ***Convene and connect leaders from across varied sectors (research, education, industry, public policy, philanthropy) to:***
 - Help identify pressing issues and priorities
 - Foster ongoing dialogue and collaboration
4. ***Advocate for innovative, research-based applications of media technologies to advance children's learning via wise investments of public and private funding***

We plan these priorities knowing the landscape will change. New media, new research, and new challenges will emerge. We are just getting started, and this is a work in progress. Please stay tuned.

introduction: getting it right



“We are the Jetsons.
Our children are growing up
in a world where their toys
obey them and their parents
converse with the family car.”

Forecasts of tomorrow's technologies have usually gotten it wrong. On the threshold of the digital revolution, many experts thought computers would get bigger and more expensive, not smaller and cheaper. In the 1950s, computer experts predicted that the technology would become so complex and costly that only the richest nations or largest institutions would be able to afford it. IBM estimated that in the future, the number of computers worldwide would reach a grand total of 10 (Fallows, 1989).

Of course, instead of getting bigger, computers have shrunk to the point where they are not only portable but wearable. And as for affordability, Mitchel Resnick of the Media Laboratory at the Massachusetts Institute of Technology (MIT) wrote that "in the years ahead, the declining cost of computation will make digital technologies accessible to nearly everyone in all parts of the world, from inner city neighborhoods in the United States to rural villages in developing nations" (Resnick, 2002, p. 32).

Scientists aren't the only ones who have gotten it wrong. In the mid-20th century, the popular press miscalculated as well. Journalists imagined Americans in the year 2000 commuting to work harnessed to personal jet propulsion devices; they failed to foresee fax machines or e-mail or the Internet.

Most of us manage without personal jet-packs. But, as Shalom Fisch told us, "We are the Jetsons."² Our children are growing up in a world where their toys obey them and their parents converse with the family car. Many of us, children and adults alike, beam ourselves to virtual worlds, instantaneously connect with people on the other side of the planet, and locate esoteric information within seconds — without giving these dazzling feats a second thought.

Electronically enabled experiences fill daily life at home, at work, and in our communities. This trend is likely to accelerate as embedded technologies become pervasive. Mobile computing is already a reality, as multiuse cell phones give users access to Internet content, including videos, games, and music.

Existing Web applications such as Google Maps are being "mashed up" with other data feeds to create previously unimaginable tools. New electronic toys combine the digital with the physical, creating learning platforms that involve movement and emotion as well as cognition.

But humans remain human. And that, history suggests, is why crystal ball-gazers have often been mistaken. Futurists have focused on what machines can do rather than on what people want and need them to do. The machines have changed. What stays the same is the most strongly felt need of the people who use them: connection with other people. Professionals who spend their days thinking about what's next continue to learn this lesson. Several of the experts interviewed for this inquiry told us that neither they nor their colleagues had anticipated the extent of children's involvement in online social networking communities.

This report is about the present: how are today's children spending their time, how well are they learning, and how do they view and use digital media? As new technologies have emerged, their world has changed, and the ways they interact with and learn about that world have changed as well. This report is also about the future: What will tomorrow's children and adults need to know and be able to do? How can they prepare to engage with vast quantities of information, communicate, and collaborate using many platforms and media, make sense of computational representations, or benefit from simulations? How can digital media strengthen and accelerate new kinds of learning?

Like every new generation, today's children are both vulnerable and resilient. They are deeply affected by the experiences they have, both positive and negative, at home, in neighborhoods, and in schools. At the same time, given sufficient support and scaffolding from caring adults, they can make the most of opportunities and thrive despite difficulties.

²Unless otherwise indicated, all quoted material is derived from interviews (see full list of interviewees on p.52.)

And that is why adults need to get it right — at least as right as we possibly can — when we consider the young people of all ages and demographic descriptions whose lives are increasingly flooded with digital experiences. How can we ensure that children’s media-saturated lives are safe and healthy? We may not know exactly what technologists have in store for our young people, but we can and must do our best to understand their changing world and the challenges it poses.

We have focused on elementary school children, who have tended to receive less attention from digital learning specialists and communications industry leaders than preschoolers and adolescents.

This report contains the results of an initial inquiry undertaken by the new Joan Ganz Cooney Center. We have focused on interactive digital media that are:

- *Physically interactive*: Allow for, and respond to, physical input from the audience, thus excluding traditional media such as print and television.
- *Informal*: Made available for purchase/consumption by any individual child or parent for use by children during their leisure time.

While children’s involvement with digital games has drawn the most attention from researchers, journalists, and the public at large, we also considered a wide range of other digital applications and tools, such as social networking Web sites, simulations, programming tools, podcasts, digital books, and electronic toys. We looked into applications that incorporate users’ contributions, such as video content Web sites and Wikis. We do not discuss television broadcasts in this paper, although we have made occasional references to Sesame Workshop’s experiences with educational programming.

And we have focused our inquiry on elementary school children, who have tended to receive less attention from digital learning specialists and communications industry leaders than preschoolers and adolescents. (A brief recap of children’s main developmental milestones appears on the opposite page.)

The digital world is moving fast. To identify key challenges for the coming decade, we interviewed more than 60 experts from diverse disciplines ranging from education to industry to policy. We asked them to share not only their experiences with digital learning and their advice about key trends, but also their hopes and concerns for the coming decade. We also consulted recent scholarship. We did not attempt an exhaustive literature review; rather, we sought to shed light on selected issues raised by interviewees. Our goal is to suggest possible directions for future work.

Our inquiry pointed to progress now taking place in homes, communities, and institutions. Across the nation, millions of families are working out new relationships with digital media. Educators are developing exciting new approaches to integrating digital learning into schools. In the realm of industry, innovators are refining today’s best offerings and inventing tomorrow’s applications. And at universities, research institutions, and foundations across the nation, researchers focusing on children’s development and learning are contributing to what we know about the benefits and impact of digital media.

Despite this activity, public discourse reflects confusion and ambivalence about children’s immersion in digital media. Polls suggest that many adults welcome the benefits of computer-based learning.³ They see young people searching the Internet to research a tremendous range of subjects; grappling with online reading material that might not hold their attention in print formats; and spending hours on simulations or games that breathe virtual life into important issues — including many issues that have not typically captivated young learners.⁴

³For example, according to a poll conducted in 2007, the great majority of parents recognize that the Internet helps their child learn skills and information needed to succeed in school (81%), learn about different cultures and ideas (74%), and express himself/herself more creatively (65%) (Cable in the Classroom & Common Sense Media, 2007).

⁴These include the development of strategies to minimize damage from natural disasters, the topic of Stop Disasters, a free online game released by the United Nations (available at: www.stopdisastersgame.org/en/).



Middle childhood

More adept than preschoolers but less savvy than tweens, the approximately 20 million American children in the age span from 6 to 11 have a set of psychological, social/emotional, moral, and environmental concerns that is all their own.

Typically, children in this age span:

Cognitive	<ul style="list-style-type: none">• Strengthen their capacity for remembering, imagining, logical reasoning, problem solving, and critical thinking.• Become more reflective — that is, better able to access, reflect upon, and talk about their own thoughts and feelings, and to describe themselves in complex ways.• Focus on activities for longer periods of time.• Communicate easily, using language effectively in a wide variety of situations.
Social/ Emotional	<ul style="list-style-type: none">• Begin to negotiate a wide range of social interactions without adult help and to establish relationships that are not extensions of their parents' networks.• Form stronger, more complex relationships, particularly with peers of the same sex, and grow in their desire to be liked and accepted by friends.• Gain the ability to play and learn in teams or groups.• Begin to create social hierarchies and a sense of "groupness."
Moral	<ul style="list-style-type: none">• Begin to form a consistent set of values that guides their behavior.• Strengthen their sense of right and wrong, understanding and adhering to social norms.
Environmental	<ul style="list-style-type: none">• Continue to be strongly influenced by their families' values and routines.• Start and finish elementary school, spending about 7 hours per weekday in a school environment.• Spend significant stretches of time immersed in media, often "multitasking."

Sources:

[Cognitive Skills Group, 1997], [Carnegie Corporation of New York, 1996], [Rideout, Roberts, & Foehr, 2005], [National Center on Birth Defects and Developmental Disabilities, 2005]

Adults nevertheless worry about the amounts and types of media children consume. Researchers say that young Americans are reading fewer books — and reading them less well. They point to competition from other media as one key factor (Iyengar & Ball, 2007). Equity is another ongoing concern: Most interviewees agreed that more needs to be done to bring the benefits of today's powerful new learning tools to all children and families.

Our experts affirmed that digital media afford all sorts of potential for powerful learning opportunities. However, they also pointed out that the digital divide may only widen as digital media and technology become more ubiquitous. We found wide consensus about the need to transform promising but dispersed research efforts into a more coherent endeavor — one that can support development of more powerful understandings and methods; industry's capacity to captivate and benefit children; schools' and communities' attempts to harness the power of digital media to prepare children for the global, innovation-based world they will inherit; and families' efforts to guide and safeguard their children.

From these interviews emerged three interrelated challenges, all of which must be addressed if our nation is to realize the full potential of digital learning.

three challenges

1. Build a coherent R&D effort

Important research efforts are under way in a variety of institutions, and various digital media designers are working hard to develop educational uses for new platforms. But these initiatives are scattered and fragmented. We need a coordinated national effort — one that can inform parents, educators, policy-makers, industry leaders, and the public at large.

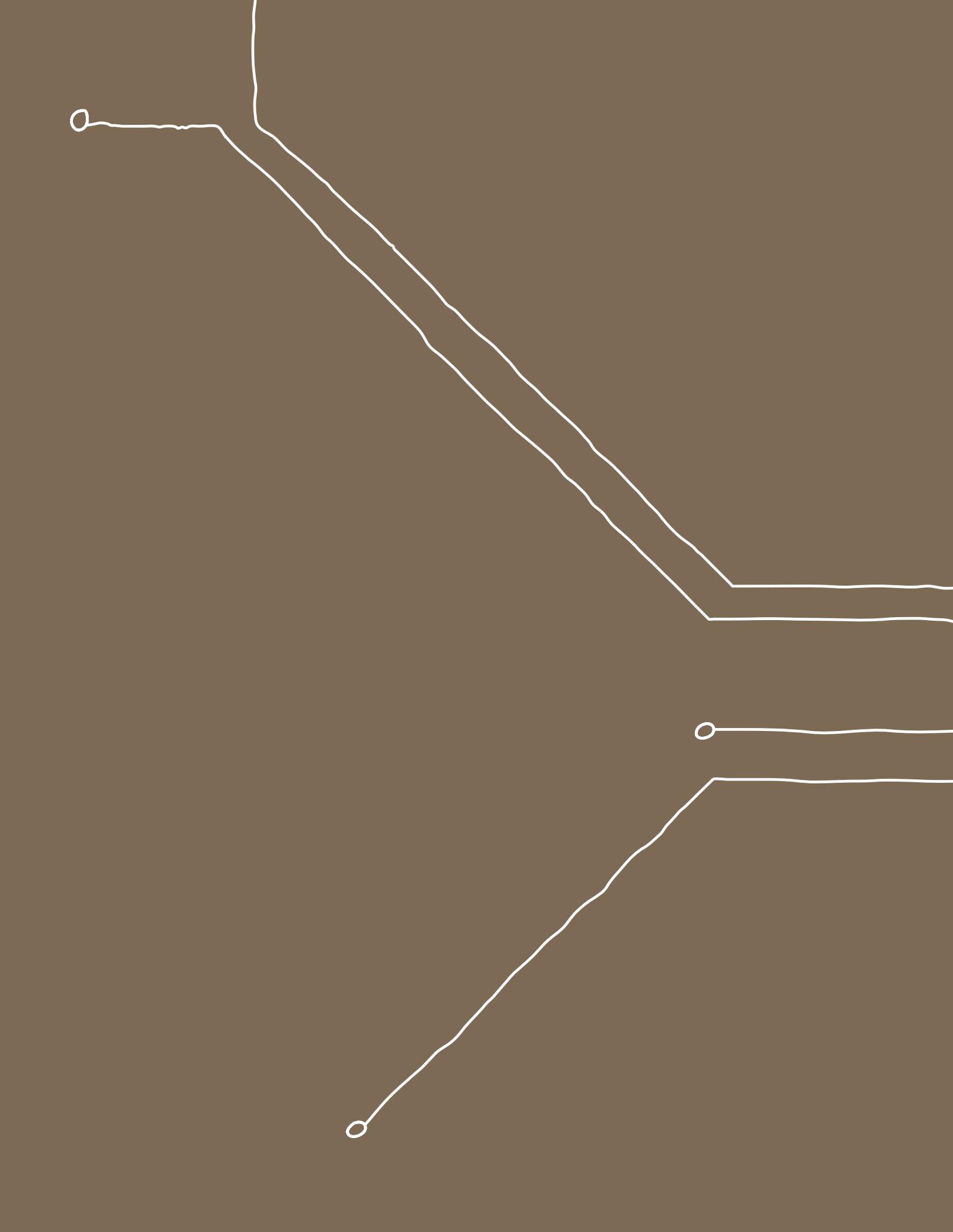
2. Rethink literacy and learning for the digital age

Reading continues to be a crucial skill, but our reading enterprise needs to be retooled and linked with other competencies — such as critical thinking, media literacy, inter-cultural awareness, and second language proficiency — that are increasingly important in an innovation-based, interconnected global age.

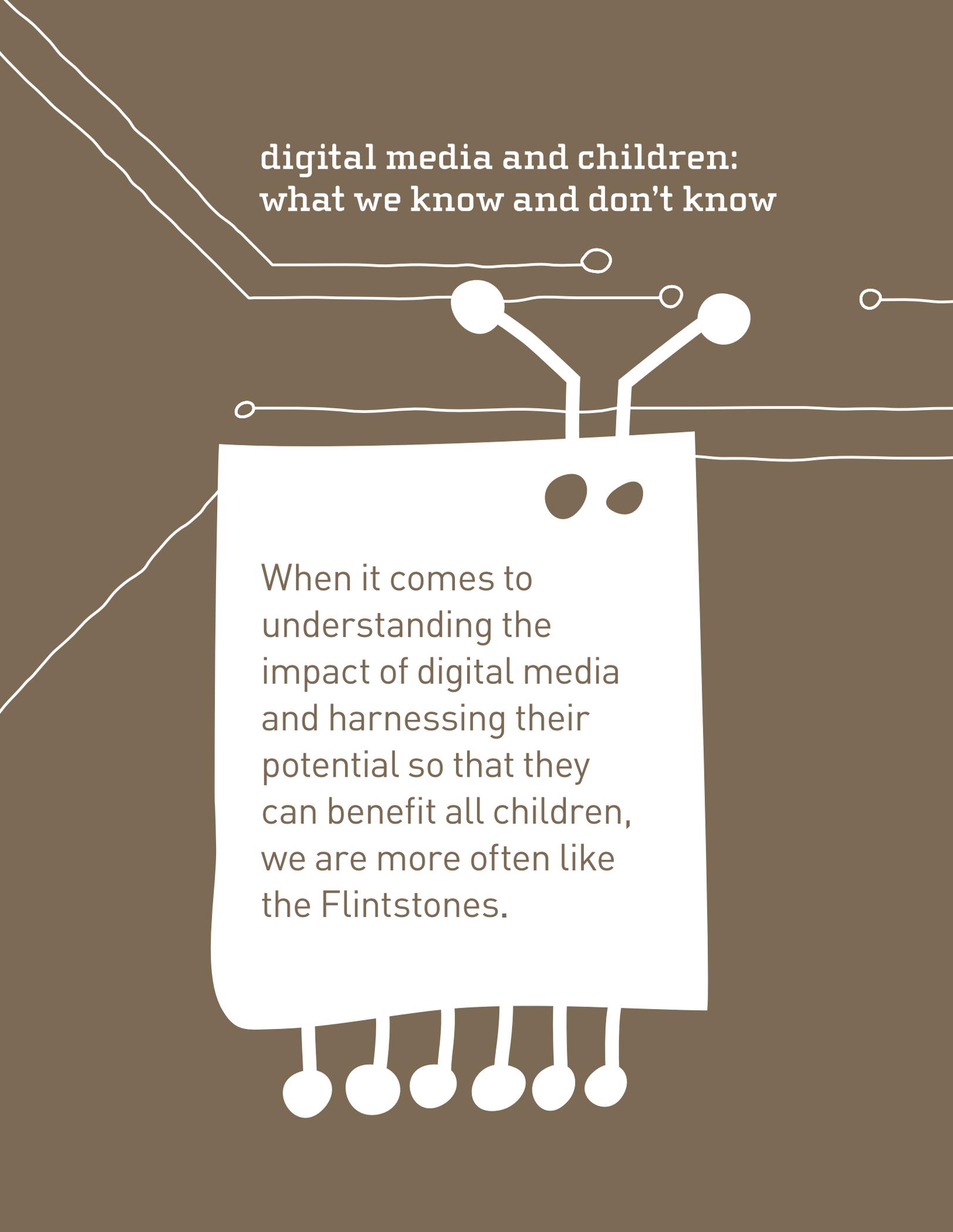
3. Advance digital equity, reaching all children with today's most powerful learning tools

Digital media have the potential to enhance all children's learning, but equity is now more critical than ever. We must focus not only on overcoming the old digital divide — the one related to access to technology and networks — but also the new digital divide, which relates to adults' capacity to support children's digital learning experiences.

For each challenge, this report issues a call to action, highlighting important lines of work that need to be advanced and coordinated.



digital media and children: what we know and don't know



When it comes to understanding the impact of digital media and harnessing their potential so that they can benefit all children, we are more often like the Flintstones.

From their early elementary years, millions of American children are hanging out in cyberspace. They are downloading podcasts, competing in multiplayer games, feeding virtual pets, negotiating online identities, playing out digital dreams. Digital media saturate their lives, occupying many hours of each day and shaping what and how they think. Rarely has a phenomenon affecting children been so pervasive and so powerful yet so poorly understood. We may be the Jetsons, as one interviewee observed, but when it comes to understanding the impact of digital media and harnessing their potential so that they can benefit all children, we are often more like the Flintstones.

Many educational researchers hypothesize that digital learning has the potential to strengthen the foundational and new literacies that are needed for success in the 21st century, but they readily acknowledge that most of the important questions about the impact of interactive digital media on children's development have yet to be addressed. For example:

- How do experiences with digital media shape children's ways of knowing about the world?
- What are the benefits and risks of digital media experiences for subgroups of children (such as girls, elementary school children, special learners, and English Language Learners)?
- How is children's development influenced by such digital-age phenomena as media multitasking, social networking, or YouTube-style opportunities for creative expression?

Several of the experts we interviewed urged better understanding of digital gaming and other media use as cultural practice: What are game-playing experiences like? As they play, what are children actually doing — and with whom?

To be sure, significant efforts are now under way to study how immersion in electronic activities may be affecting children and how digital media can be harnessed to strengthen and accelerate learning. Researchers at many universities are addressing these questions, and large foundations such as the William and Flora Hewlett Foundation,

Kaiser Family Foundation, and the John D. and Catherine T. MacArthur Foundation are bringing their prestige and resources to bear on issues related to children and digital media. Evaluations of federal and state technology initiatives have added to the research base. These initiatives are shedding light on the usage, impact, and potential of digital media, but the most promising efforts remain in the early stages.

Researcher Daniel Anderson of the University of Massachusetts at Amherst has written, "Over the past 50 years, few researchers have had consistent programs of research on children and media. ...The reasons lie in the insularity of academic disciplines and the lack of sustained sources of research funding. But nevertheless, the media explosion in children's lives is happening, releasing forces with unknown consequences" (Anderson, 2006, p. 11).⁵

Anderson's insight points to a larger set of concerns our respondents detailed. The evolving field of children's media research would benefit from better coordination, more sustained funding, and greater methodological clarity. The walls that separate sectors are often steep and are seldom scaled. Interactions are few and far between among those who have an interest in, and insights into, digital learning, such as researchers, industry leaders, parent groups, media designers, legislators, health providers, and child advocates. Research and development efforts suffer as a result.

According to Douglas Hartman of the University of Connecticut, "The [digital] gaming world has immense potential for education, but a lot of resources will be wasted. Game designers seem to understand little about the culture of classrooms. And educators have little understanding of what game designers are up to." Henry Jenkins of MIT put it this way: "In gaming, we have an industry that isn't historically interested in schooling. And then there are the educational organizations that don't understand games." Jenkins stressed that educators often try to make standard lessons palatable by turning them into games. "It's like a spinach sundae," he said.

⁵Anderson concluded: "Because so few people have active research programs concerned with children and media, many methodologies remain to be exploited."

Educational media specialists tend to be remote from researchers as well. As Linda Simensky of PBS KIDS told us, “University centers do all this research.... No one who is creating digital applications sees it or is able to think about how to apply the findings.... That’s a missing link.”

If these fields and sectors work together more frequently and effectively, children stand to benefit. As James Paul Gee of Arizona State University has argued, bringing together today’s most effective literacy strategies, interactive technologies, and appealing content can result in a new learning equation for children in the primary grades (Gee, 2007). The competencies young children gain through games, online collaboration, and multimedia communication can create a strong foundation for later learning.

The bottom line: Our nation urgently needs a coordinated research and development plan for digital media that focuses squarely on children’s well-being, development, and learning.

Keeping up with the kids

In the realm of digital media, researchers (like most other adults) are hard pressed to keep up with children. They follow along somewhat breathlessly as kids make seemingly effortless leaps to new platforms. As children explore the possibilities of Web 2.0 applications, cell phone programs, and podcasts, researchers are debating the impact of decade-old digital games. University of Wisconsin professor Kurt Squire has written, “SimCity is more than a decade old. A generation of youth has grown up with edutainment. Yet, we know very little about what they are learning playing these games (if anything)” (Squire, 2002, p. 4).

Opportunities and risks

This much is clear: Digital media permeate children’s lives. Games geared to a variety of platforms (such as computers, televisions, handheld devices, and cell phones) constitute a huge and growing market, dominated by

products for teens and adults. At the same time, consumer groups report a marked proliferation of digital games designed specifically for young children and “tweens” (those approaching the teen years). Hundreds of such games are now commercially available. Many call themselves

Most of the important questions about the impact of interactive digital media on children’s development have yet to be addressed.

educational, but it is often difficult for parents or teachers to gauge which are effective learning tools and how they should best be used.

Video game industry analyst Anita Frazier of the NPD Group told the online gaming industry magazine *Game Daily Biz*, “When kids get to the six- to eight-year-old age range is when we see them turn into more serious gamers. Not only does the amount of time they spend playing games increase the most dramatically, but they migrate from using ‘kid’ systems to using more portable and console systems as well.” Frazier added, “This appears to be a critical age at which to capture the future gamers of the world” (Brightman, 2007).

As adults struggle to monitor and guide children’s gaming behaviors, other digital activities are quickly emerging. For example, virtual world Web sites designed for young elementary school children are registering huge increases in traffic.⁶ Over the last year, the number of visitors to the virtual world Web site Club Penguin more than doubled from 1.9 million to 4.7 million, and the number of visitors to Webkinz exploded from less than 1 million to 6 million, according to comScore Media Metrix (as cited in Navarro, 2007).

As children move through the elementary grades, media consumption appears to rise and they become habitual multitaskers. As they play video games or visit new virtual worlds, elementary school children may also be sending text messages

⁶It is not clear, however, whether this represents a shift in Web site preferences or an overall surge in online activity among elementary-age children.

on their cell phones, listening to iPods, and keeping an eye on the TV screen (see “Media use by kids ages 8-10” at right).⁷

The big doses of digital media that children consume daily are cause for a great deal of public concern. Many parents worry about the quality and quantity of kids’ media experiences and have precious few findings on which to base decisions such as how much time to let kids use media, which products to purchase, or which Internet sites to allow. Many teachers are hard pressed to make choices about how much time to invest in digital technologies without clear guidance about the outcomes they can expect.

Concerned adults can easily find books and articles that associate immersion in digital media with adverse effects on social behavior (less cooperation, more aggression); cognition (less reading, more attention difficulties); and overall health and well-being (less exercise, more addictive reliance on media). They can also locate, without difficulty, books and articles reporting positive effects in the same areas. These sources say that digital media can support social growth (more peer interaction around common interests; more collaborative projects); cognition (greater motivation to read, more opportunities for problem-solving); and health (through simulations and games, better understanding of the importance of healthy behaviors).⁸

Daniel Anderson has proposed a more tempered approach, offering an analogy to nutrition. He points out that we do not ask whether food is good or bad for children; rather, we try to determine the best mix of foods, keeping in mind what we think kids like and need, as well as our own past experiences and cultural preferences. “As with food,” Anderson suggests, “the overall quantity ingested is important, but equally important are quality and balance. Thus, for example, children may benefit from information, educational programming and, most likely, entertainment, as well — although the research base for developing precise guidelines as to the recommended levels or proportions of each is insufficient” (National



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%), using graphics programs (9%), or visiting chat rooms (8%).

(Rideout, Roberts, & Foehr, 2005)

Research Council, 2006, p. 5). Of course, children need food, whereas they can live without media. But given the almost overwhelming pressure to consume media, Anderson believes the analogy is apt.

Before researchers can make firm recommendations for a beneficial media diet, they need to shed light on many issues. Studies conducted over the last two decades offer some guidance, as the following pages will suggest. Some have been conducted by educational researchers; others come from various branches of psychology (cognitive, social, and developmental); still others come from neuroscience. In all of these fields, however, for every question that has been answered, many more remain.

⁷This chapter focuses on the effects of computer use and gaming; the important issue of how television viewing affects children has been covered in great detail elsewhere (see Fisch, 2001).

⁸Literature reviews focusing on the effects of digital media on children’s development and learning may cite hundreds or even thousands of numbers, but as Lucy Bernholz (2006) has pointed out, the vast majority cannot be considered empirical based on their methodological characteristics. (See Appendix A on p.57 for a list of reviews of the literature on children and interactive media.)

Cognitive development

Research on the effects of literacy-oriented television shows such as *Sesame Street*, *Electric Company*, and *Between the Lions* demonstrate that educational media can indeed help children acquire literacy skills and can strengthen overall school readiness, especially when adults watch with children and reinforce their learning. Elementary school children who regularly watched educational programs such as *Sesame Street* during their preschool years have been shown to spend more time on reading and other educational activities, to have stronger letter-word knowledge and math skills, to have larger vocabularies, and to be better prepared to succeed in school than their non- or low-viewing classmates. Research also demonstrates that these positive effects can be long-lasting (Fisch, in press).

The experts we consulted believe that interactive media may intensify these effects because they afford interactivity and more personalized programming, and thus facilitate presenting meaningful content to their audience. After all, a television broadcast is, literally, cast broadly. As WGBH producer Bill Shribman stressed, “We can be most effective when we are able to key the content more closely to particular groups of children. When we have some understanding of their families’ cultures or literacy backgrounds, we can personalize and customize their experience. When we assess users’ abilities on the fly — as our online games often do with smart code running behind the scenes — we can calibrate a game to nudge users up to, and just beyond, their skill level.”

A growing body of research suggests that interactive media have the potential to support reading readiness, literacy skills, and content-area learning in mathematics, science, and social studies. At the same time, researchers stress that exploiting this potential is a complex educational challenge. As Shalom Fisch has written, “The impact of a given piece of interactive media may not be the same for all users under all circumstances. Even if the interactive activity is sufficiently well designed to produce significant outcomes, these outcomes may be moderated by features of both the educational content

(e.g., difficulty) and the preexisting skills and knowledge that the user brings to the screen” (Fisch, in press). Results hinge, in part, on the match between the on-screen material and the desired outcomes. How to achieve that match may not be evident, since different concepts or learning processes lend themselves to different forms of representation (such as video, animation, graph, or narrative), and different learners may benefit from different media or narrative strategies.

Cognitive basics

Faced with such complexities, researchers looking at the impact of digital media are getting back to cognitive basics. That is, they are trying to integrate new insights into the utility and impact of digital media with today’s best understandings of how children develop and learn. Some are looking at how experiences with digital media promote key competencies or strategies highlighted in the “new science of learning” as set forth in *How People Learn*, the influential National Research Council publication (1999). Sandra Calvert of Georgetown University and colleagues, for example, have looked at the capacity of digital media to support active learning, metacognition, and verbal memory. They report that digital experiences allow children to take active control of their own learning, adjusting the pace and the level of difficulty of the material (Huffaker & Calvert, 2003). Studies suggest that when elementary school children engage in educational games that allow them to control their own learning, they spend more time on the activities and therefore learn more than they do from traditional drill activities.⁹ Digital media experiences encourage *metacognitive strategies* by providing the feedback children need to gauge their own progress and recognize which learning strategies work best for them (Huffaker & Calvert, 2003). They promote *verbal memory* by giving children an additional mode of representation that helps them remember the names of unfamiliar objects. Researchers suggest that the visual element is especially important for young children, who often think in iconic, visual forms, as well as for poor readers who rely more on visual modes of thought to scaffold verbal memory skills (Huffaker & Calvert, 2003).

Other researchers have zeroed in on how digital media experiences affect specific cognitive skills. A number of studies have documented high levels of attention and concentration among children engaged in playing computer games (Rosas et al., 2003). However, most of the evidence concerns a specific type of attention known as *visual attention*. This is the capacity to select some items for further processing while ignoring others. Gamers learn to divide and shift attention and to pay attention simultaneously to a great number of objects (Green & Bavelier, 2007). Youngsters who play digital games exhibit faster reaction times, increased eye-hand coordination, and improved manual dexterity. Video-game play has also been shown to enhance such spatial skills as mental rotation, spatial visualization, and the ability to mentally work in three dimensions (Green & Bavelier, 2007). One study showed that children improved their scores on the Mental Rotations Test after training on video games, and that fifth-graders, given video game experience, outperformed ninth-graders who lacked this experience (Green & Bavelier, 2007).

These findings raise important questions:

- To what extent do the documented skills transfer to real-world settings?
- How does visual attention relate to the skills that allow children to sustain attention to challenging tasks, or to focus on unfamiliar information or ideas in classrooms or out-of-school settings?
- What are the educational implications of gamers' greater capacity to divide and shift visual attention?

On the important question of how video games affect children with attention deficit/hyperactivity disorders, the 2007 review of the literature by the American Medical Association report noted the ongoing controversy, "with some research pointing to video game usage as a risk factor, and other research suggesting video games as a useful treatment" (American Medical Association, 2007, p. 5).

Processing information

Studies have shown that digital media experiences affect the way children process information, but here again, the research raises more questions than it answers. For example, some researchers have associated children's digital media experiences with a heightened ability to process information in a parallel rather than linear fashions. That is, digital media users are better able to access information randomly rather than relying on a step-by-step presentation. As Begoña Gros has written, "The digital generation has an ever increasing capacity for parallel processing which involves a more diversified form of concentration — probably less intense, and less centered on a single aspect" (Gros, 2003). Researchers have also associated digital media use with a tendency to focus on graphics first and text second as children take in new information. The text illustrates the image — not the other way around (Gros, 2003). But these findings raise questions: How do these learning characteristics affect children's classroom learning? Are "random accessers" more or less likely than other children to be good readers, logical thinkers, or critical consumers of information? We need to know more about the implications of these findings for children's overall learning and school success.

Other cognitive issues

There is some evidence that digital media experiences can raise verbal and performance IQ scores, but once again, questions remain. Some of the findings come from studies of computer-assisted cognitive rehabilitation (CACR) showing that computer-based therapies (often games) can improve not only the memories but also the attentional, visual-spatial, and problem-solving abilities of people who have sustained traumatic brain injury or other impairments. Other studies have found that computer-based training regimens for the elderly have led to sustained improvement in cognitive performance (Gunther, Schafer, Holzner, & Kemmler, 2003).¹⁰ These results led researchers to examine whether similar interventions, using digital games, could improve children's cognitive functioning, but to date such studies have been small and inconclusive (see, for example, Bracy et al., 1999).

¹⁰The researchers found that after participating in the cognitive training program, participants showed significant improvements in primary working memory as well as secondary working memory (for verbal and visual stimuli). Participants also showed improvements on parameters of information processing speed and learning and interference tendency, and improvements in these cognitive parameters were maintained five months after completion of the training program. The study concluded that "computerized cognitive training programs can be used in older people to achieve long-term improvements in some important aspects of fluid intelligence" (Gunther, Schafer, Holzner, & Kemmler, 2003, p. 1).

Finally, we need more evidence about the impact of digital media on children's capacity for complex thinking. As University of Wisconsin professor Kurt Squire has written, "Games such as SimCity depict social bodies as complex dynamic systems and embody concepts like positive feedback loops that are central to systems thinking. Are students developing intuitions about systems as a result of playing these games?" (Squire, 2002, p. 4). Some researchers caution that by simplifying real-world problems, digital games and simulations may distort perceptions of reality or lead to naive thinking. Others have wondered whether gamers playing SimCity will come to believe, for example, that mayors control everything, that raising taxes always incites riots, or that politics, ethnicity, and race play negligible roles in urban planning (Oppenheimer, 1997).¹¹ As interviewee Rosemary Chalk of the National Research Council put it, no matter how colorful they may be, "Digital media focus on things that lend themselves to black and white concepts."

Digital media, particularly computer games and the kinds of skills they appear to foster, also raise important questions about student engagement and motivation to learn. "In really good classroom environments, there is a slowing down of learning, and students are given the opportunity to dig deeper," said Margaret Honey of Wireless Generation. "This kind of learning tends to foster genuine engagement on the part of students. It's a very different technique than that found in the rapid-fire decision-making of video games." These are the interactions that foster complex thinking, communication, and creativity. Other researchers are less concerned about pace, arguing that what matters most are the talk and activities that surround the digital media experience. We need more evidence to make sense of this debate.

In the future, brain scan technology is likely to generate new insights into the cognitive effects of children's media-saturated lives. It is now well established that from childhood, the architecture of the human brain changes in response to an individual's environment and experiences (Shonkoff & Phillips, 2000). A number of studies have used brain scans to assess changes in brain

function as children and adults play digital games. One recent study used Positron Emission Tomography (PET) scans to study the brains of adults and children playing the same video game and found that children and adults were utilizing different neural circuits, suggesting that digital experience may affect users differently at different ages and developmental stages (Nagamitsu, Nagano, Yamashita, Takashima, & Matsuishi, 2006). While the sample was relatively small and the scientists were circumspect in their discussion of the implications, this study nonetheless suggests a line of research that is likely to expand in coming years, illuminating the processes and impacts of digital experiences.

While scientists have a number of technologies at their disposal for studying the living brain, many research problems must be resolved before they can make strides. As a National Research Council publication concluded, "A far more detailed understanding of how the brain responds to media stimuli, as well as how cognition and behavior are affected in turn, would be possible if a stronger taxonomy to classify media technologies based on their design features was available" (National Research Council, 2006, p. 13).

Social and emotional development

Do digital media foster closer relationships among peers, engaging them in shared activities and providing a common language and culture? Have they forged new kinds of relationships by involving children in virtual communities? Or, as many adults fear, do digital media tend to isolate children from friends and family? More tightly controlled studies are needed before these questions can be answered.

Research suggests that the social impact of digital media hinges not on the technology but on the circumstances and context in which they are used. For example, a 2000 study found that "virtual and real interactions reflexively construct each other" and that participation in multi-user games can draw shy or withdrawn children into closer contact with peers. The study found that

¹¹Oppenheimer wrote: "There is no good evidence that most uses of computers significantly improve teaching and learning, yet school districts are cutting programs — music, art, physical education — that enrich children's lives to make room for this dubious nostrum...." (Oppenheimer, 1997, p. 1).

the use of computers per se does not make children more reclusive, socially introverted, or otherwise atypical in their social development (Orleans & Laney, 2000).¹² Others say that game playing can foster peer cooperation and verbal interaction. UCLA researcher Yasmin Kafai observed that youngsters who enter the virtual world Whyville, which has more than two million registered users, gain social status by sharing “secret” information with peers (Fields & Kafai, 2007). Kurt Squire has observed that researchers have not yet taken fully into account the social communities that gather around particular games or applications or the interactions related to fan fiction sites and cheat code sites (Squire, 2002, p. 5).

Interactive media may also play a role in emotional development — including children’s capacity to name and understand the feelings they have. Many electronic games, simulations, and other activities involve storylines that challenge young people to assume a variety of roles (Gros, 2003). Players are challenged, moreover, to think about how, in these roles, they might feel or respond to different kinds of situations. In the process, children may gain insight into their own feelings and those of others — the kind of reflection that can lead to empathy.

Some adults wonder whether digital media companies are using marketing techniques to manipulate children’s emotions and parents’ spending. Even digital play that appears to foster empathy and caring, such as commercial sites that let children take care of virtual pets, generates skepticism when children beg parents to lay out real money for virtual supplies needed to keep the online pets from suffering (Navarro, 2007). Some worry about the impact of so much point-and-click experience. And what about the un-virtual experiences they displace? As one parent recently told a *New York Times* reporter, “It seems they’re getting so far away from things that are hands-on” (Navarro, 2007).

Children’s health and safety

Public concern about children’s immersion in digital media, especially action games, tends to focus more on their social-emotional development and overall well-being than on their cognitive growth. “The question we have to ask ourselves,” said Donald Shifrin, co-chair of the American Academy of Pediatrics’ Council on Communications and Media, is “Are kids too wired, too often, for too long?” Shifrin is concerned that risks associated with young children’s unmonitored Internet use, including sexuality, predators, violence, cyber bullying, and gambling, can adversely affect their health (American Academy of Pediatrics, 2007). The American Academy of Pediatrics also suggests limiting the time children spend with digital media.

Many adults are impressed by the power of digital media to grab and hold the attention of children who are otherwise hard to engage. They are eager to take advantage of technologies that motivate children to read large chunks of instructional or narrative text, think through complex strategies, and sustain effort despite obstacles. But where is the line between intense engagement and overstimulation or addiction? Such concerns are hardly limited to the United States. In November 2007, a front-page *New York Times* article featured South Korean “boot camp” programs for youngsters addicted to digital media (Fackler, 2007).

Data can be found that justify as well as alleviate public concern. In 1998, *Nature* published a widely discussed study that found that playing video games, like taking cocaine, is associated with sharp spikes in the levels of dopamine (Koepp et al., 1998). In 2007, the American Medical Association (AMA) issued a report on the effects of video games (defining them as fast-action electronic games using a wide variety of platforms) and expressed concern about their overuse. The AMA report stated that “dependence-like behaviors are more likely in children who start playing video games at younger ages.”

¹²See also Wartella & Jennings (2000), Livingstone (2003), and Subrahmanyam, Greenfield, Kraut, & Gross (2001).

The report cited research estimating that in the United States, “anywhere from a small minority to as much as 10% to 15% of players [of all ages] may be affected” (AMA 2007, p. 4). Ultimately, the AMA resisted pressure to call heavy gaming an addictive behavior, concluding that “there is currently insufficient research to definitively conclude that video game overuse is an addiction” (AMA, 2007, p. 4). This call for more research was a response to contradictions among existing studies of the impact of video games.

The AMA report also pointed to potential benefits of video and virtual-reality games, reporting that digital learning games, when used effectively, can play a role in helping children manage diabetes and asthma and alleviating some phobias. Game designer Noah Falstein cited a study of young cancer patients who spent time playing a game called Re-Mission. Players “enter” a cancer patient’s bloodstream to see what is going on and blast cancer cells with drugs.

A study of 375 young cancer patients found that, compared with a control group, those who spent time playing the game were more likely to adhere to treatment regimens and therefore had, on average, higher levels of the prescribed drugs in their systems (Beale, Kato, Marin-Bowling, Guthrie, & Cole, 2007).

challenge #1: build a coherent r&d effort

What we need to know

This chapter has raised questions about the potential and impact of digital media, and subsequent chapters will broach many more. Sustained research within and across diverse disciplines is needed to shed light on the potential benefits and risks of digital media for children of different ages, backgrounds, and learning profiles. We need to know more about how children choose media experiences; about the impact of adult participation or scaffolding of media experiences on benefits or risks; and about interventions that might buffer negative effects or reinforce positive ones. Given the rise of social networks and gaming communities, we need qualitative studies not only of individual youngsters but also of networks and communities of children.

Research needs to go well beyond analyses of benefits and risks. Studies of how children use digital media can help to make their learning processes more transparent, giving adults a window into how they are thinking and how they develop and use new understandings and misunderstandings. Those responsible for children’s learning, in and out of school, stand to benefit from these insights.

Finally, we need to know more about the unintended consequences associated with the use of digital media in and out of school. Are gains in one area of cognitive, social, or emotional development accompanied by losses in others (Green & Bavelier, 2007)? In the educational realm, which kinds of knowledge or activities will get less attention? Which abilities may atrophy? As children learn to create, mash up, and remix digital media, will they lose a sense of what is authentic and credible (Bernholz, 2006, p. 10)?

However, these questions cannot be fully addressed until important theoretical and methodological issues are resolved. As Ellen Wartella of University of California at Riverside has observed, there is little consensus about how to measure the effects of media, which effects to measure, and how studies should be designed (National Research Council, 2006). It is difficult to isolate the effects of sophisticated applications that change rapidly, bridge multiple platforms, have fluid (often user-generated) content, and are typically used simultaneously with other media.

Research design is especially challenging, given that digital media experiences occur in many kinds of settings and that children tend to use several kinds of media at the same time. Can findings about a Nintendo game apply to the impact of a turn-based strategy computer game like Civilization, a preteen online virtual world such as Whyville, or a third-person shooter game for cancer patients like Re-Mission? Until we have better definitions of key learning and design features, research on the effects of digital media will have limited use.

Wartella, Calvert, the Federation of American Scientists, and other researchers have been active in developing strategies for a new national research infrastructure intended to further understand the impact of media on children's healthy growth and development. Since the field of digital media research is relatively new and those who study digital media's effects have no clear disciplinary home, there has been a paucity of funding opportunities. Further, because digital media research studies tend to be isolated from other fields, assembling teams attracting funding for sustained efforts is often difficult. A bipartisan group of members of Congress has introduced national legislation to expand our knowledge base.

The Children and Media Research Advancement (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. In addition, Congress has recently passed legislation to

establish a National Center for Learning Science (also known as the Digital Promise Act). The Center would be fashioned after the National Science Foundation and National Institutes of Health and provide valuable financing for R&D to demonstrate how advanced information technologies can transform education and professional development.

Call to action:

Establish the state of the art

Map major research and development efforts currently supported by federal agencies, states, foundations, universities, independent research institutions, and industry groups. Look at funding gaps and how to fill them (for example, through proposed legislation such as the Children and Media Research Advancement Act and the Digital Promise Act).

Convene the nation's leading experts

Seek consensus among diverse sectors and disciplines on key research questions, priorities, and strategies for advancing knowledge development.

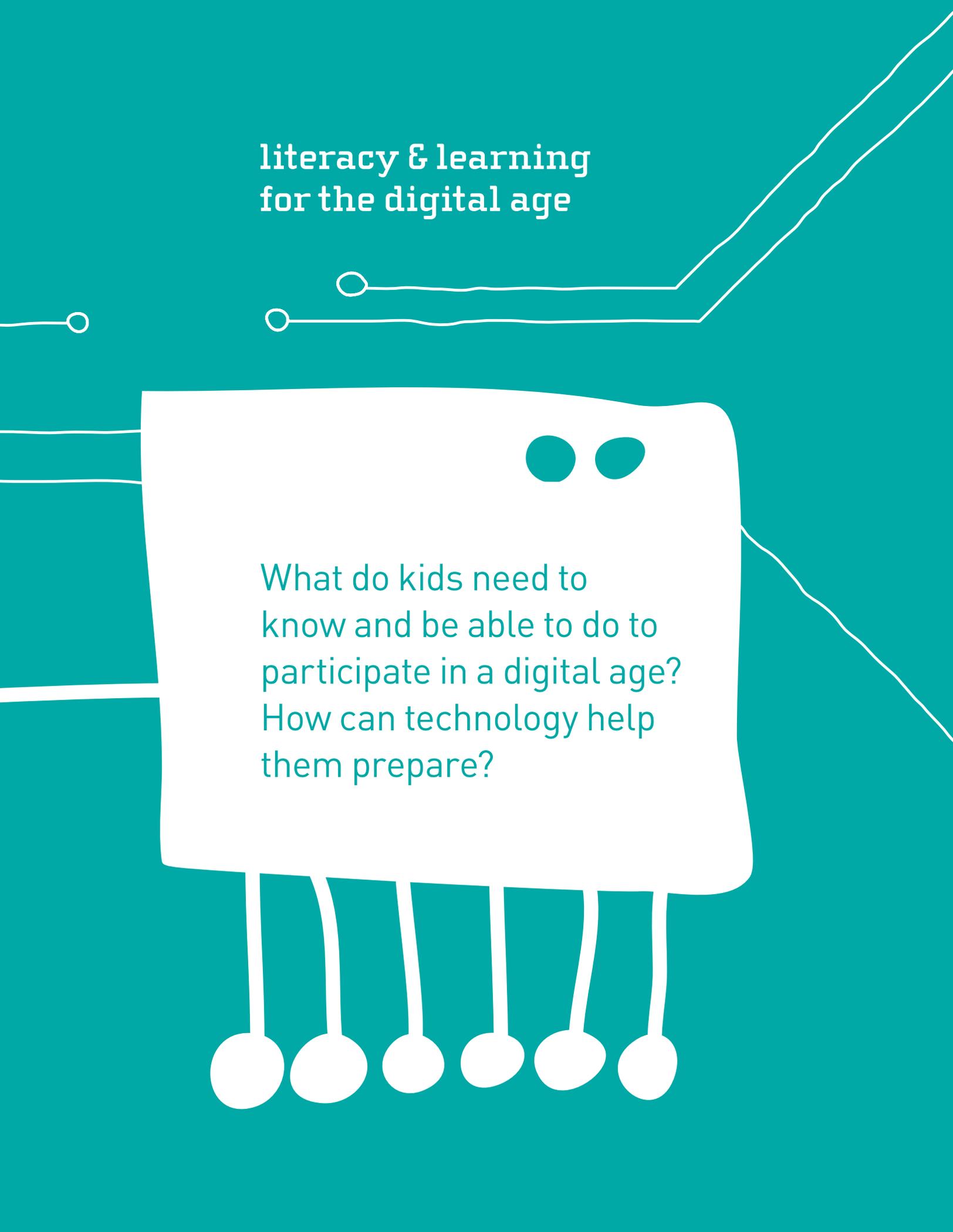
Coordinate and fund basic and applied research

New priority should be placed by the nation's research agencies, including the National Science Foundation, the National Institutes of Health, the U.S. Department of Education, and the private sector on key issues raised in this report.

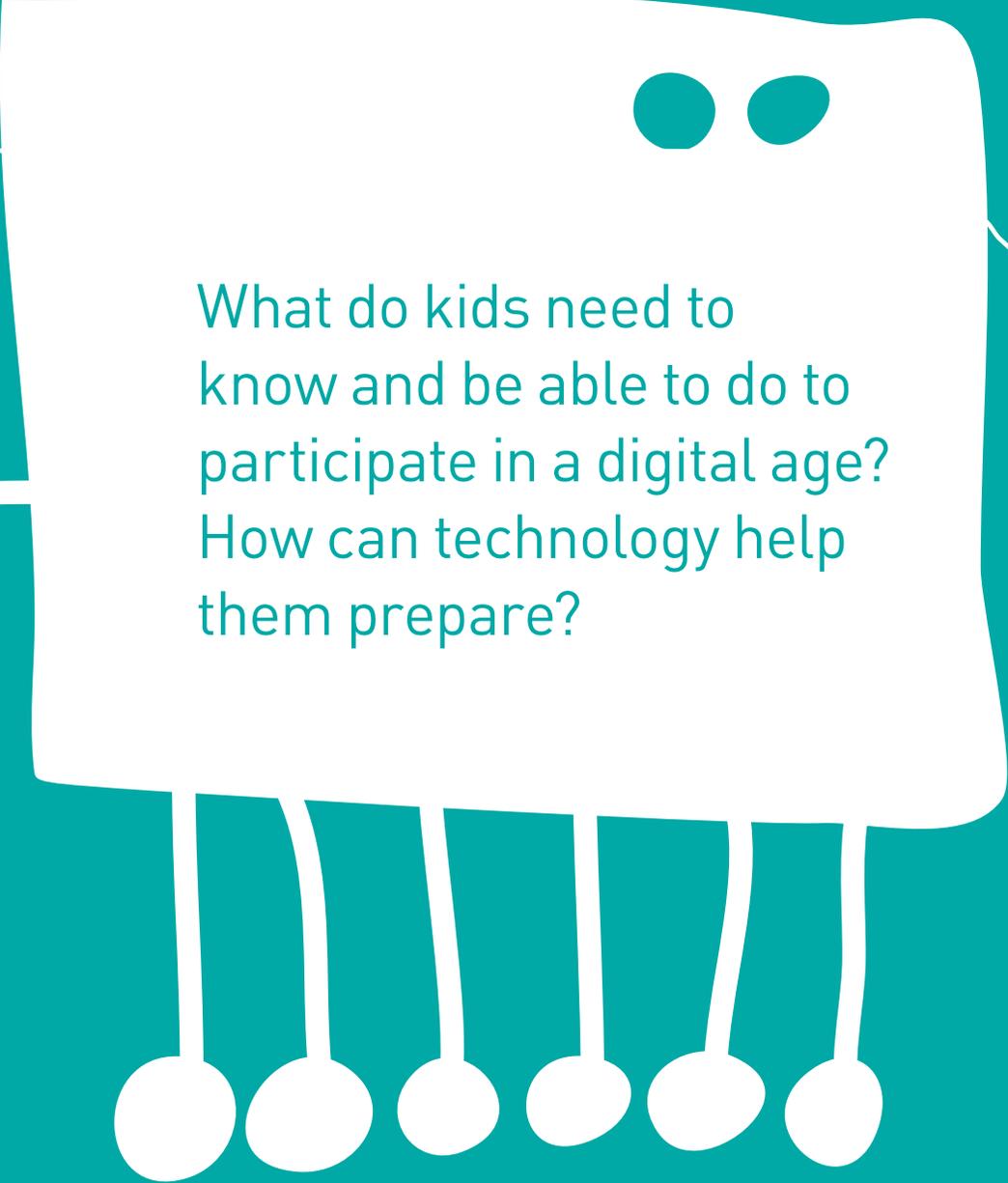
Engage and inform concerned adults

As new research findings emerge, inform policy-makers, parents, and teachers about the effects and potential of digital media and what they can do to safeguard children and support learning.

literacy & learning for the digital age



What do kids need to
know and be able to do to
participate in a digital age?
How can technology help
them prepare?



Foundational literacy

In the global, interconnected world children inhabit, they must come to terms with many ideas and master many new competencies. And yet, it remains vitally important to become literate in the traditional sense of being “lettered” — able to decipher and make meaning from written texts.

The experts interviewed for this study expressed diverse views on most issues, but all agreed on the primacy of learning to read. Literacy experts such as Catherine Snow of the Harvard Graduate School of Education emphasized how important it is for children to master the alphabetic principle, learn to sound out words, and begin recognizing sight words early in their elementary school years. So did the most passionate proponents of the educational potential of video games such as James Paul Gee. In a paper that argues for expanded notions of literacy, Gee begins with this assertion: “...if children do not learn to decode early and well, a long-term and hard-to-solve literacy problem is created” (Gee, 2007).

Despite wide agreement on the fundamental importance of literacy and significant investment in the teaching of reading, substantial proportions (one-third) of U.S. fourth-graders are reading below the basic level. Results from the National Assessment of Educational Progress (NAEP) show that fourth-grade reading achievement has improved only marginally (Nation’s Report Card: Reading 2007). As Amanda Avallone, an English teacher and member of NAEP’s governing board stated: “The NAEP data for 2007 — and indeed over the past 15 years — suggest that substantial improvement in reading achievement is eluding us as a nation.”

We asked educational leaders: Can digital media transform our nation’s approach to teaching children to read? Some questioned the premise. There is room for improvement, to be sure, they told us, but the nation’s knowledge base for teaching children to read is sound. In particular,

they believe that reading researchers have, in recent decades, identified effective practices for getting children ready to read and teaching them to crack the alphabetic code. Marshall Smith, former Undersecretary of the U.S. Department of Education and currently a Hewlett Foundation executive, put it this way: “We’ve spent tens of millions on reading research. We know how to teach foundational literacy skills. We just haven’t been doing it very well for the last 40 years.”

The National Research Council’s authoritative publication *Preventing Reading Difficulties in Young Children* indicates that the key ingredients of a successful reading program are proven strategies, knowledgeable, well-prepared teachers, and motivated children — no matter what demographic group the children belong to or how much education their parents achieved. It states: “There is little evidence that children experiencing difficulties learning to read, even those with identifiable learning disabilities, need radically different sorts of supports than children at low risk, although they may need much more intensive support” (Snow, Burns, & Griffin, 1998, p.3).



2007 National Report Card on Fourth-Grade Reading

- Nationwide, one-third of fourth-graders are reading at the proficient level.
- One-third of fourth-graders are reading below the basic level.
- Black and Hispanic students lag significantly behind other fourth-graders, as do those in special education and those who qualify for subsidized meals.

(NAEP, 2007)

The National Research Council specified the types of strategies that work, both for teaching children to sound out texts and for helping them grapple with content: “Beginning in the earliest grades, instruction should promote comprehension by actively building linguistic and conceptual knowledge in a rich variety of domains, as well as through direct instruction about comprehension strategies such as summarizing the main idea, predicting events and outcomes of upcoming text, drawing inferences and monitoring for coherence and misunderstandings. This instruction can take place while adults read to students or when students read themselves” (Snow, Burns, & Griffin, 1998, p. 7).

We asked education experts: Knowing the essential elements of reading success, how can we do a better job? What role can digital media play? Our interviewees turned the spotlight on these key questions:

- Can digital media be used to spread proven practices, providing support to the adults (both in and out of school) who get kids ready for a lifetime of reading?
- Can digital media motivate kids to read more?
- How can digital media help kids gain the vocabulary and background knowledge needed to make sense of texts?
- Can digital media help special learners succeed in reading?

Enhancing proven practices

No expert we spoke with supported a radically different approach to teaching children to decode (sound out) texts. Rather, they stressed that digital media can be used to disseminate and enhance proven practices. Many schools are investing in technologies (e.g., interactive white boards) that give groups of children access to appealing content in interactive formats. Researchers Robert Slavin, Bette Chambers, and Nancy Madden have used embedded video segments to enhance reading instruction in the Success for All network of more than 1,000 schools in the U.S. and U.K., and have presented evidence from two large, randomized experiments that embedded media do indeed enhance the impact of classroom instruction (Chambers,

Cheung, Madden, Slavin, & Gifford, 2006; Chambers et al., in press). While these researchers feel it crucial to consider the strengths of the digital media as well as the strengths of the teacher, they have shown that engaging video content can reinforce teachers’ lessons on letter sounds and sound blending as well as support sight-word recognition and vocabulary building.

Allison Druin, who directs the Human-Computer Interaction Lab at University of Maryland and the International Children’s Digital Library, a repository of books representing 40 countries, believes that digital learning will increasingly be available on mobile technologies, such as hand-held devices that personalize learning experiences and free young children from their chairs. “Young children need to move,” she said. She foresees fun digital activities that help children get ready to read while exploring their environments, in homes and classrooms, and out-of-doors. As mobile technologies evolve, children’s movements may well become part of the learning activity.

1 The PBS next generation media initiative

Computers and handheld devices have joined televisions, not replaced them. Children continue to watch educational TV programs with explicit literacy curricula, such as *Sesame Street* and *Between the Lions*, while new entries such as *Super Why!* and *WordGirl* are winning new viewers. Through PBS’s Next Generation Media initiative, efforts will intensify in coming years to extend the reach of these programs by making them more interactive through the addition of compelling games and other multimedia activities. The PBS KIDS Web site (pbskids.org) features interactive games, stories, and virtual adventures that complement the overall PBS KIDS curriculum.

Whatever the platform, the experts agree that digital content must be delivered at the appropriate content or skill level. It must be integrated at the appropriate time. And it must be interactive: Kids need to practice new skills — rhyming words or using new vocabulary — and they need active engagement with the content.

Teachers need curricula and professional development to make good use of digital media. Educational technologists can:

- Design curricula that align with proven strategies for reading instruction.
- Help professionals access the resources and support they need, in school, online, and at professional conferences.
- Infuse into teacher preparation programs coursework and field experiences that allow future teachers to make strategic use of digital media.

Motivating children to read more

Reading takes practice, so teachers are always trying to increase the amount of time children spend practicing skills and grappling with texts. Here, digital media can be powerful motivators.

Children who are learning to read often crave repetition, wanting to repeat the same games or hear the same story read over and over. There is a good reason for this. Neuroscientists say that repetition helps to reinforce the neuronal connections associated with learning. And repetition is something machines are better at than humans. Game developer Noah Falstein recalled watching his daughter practice literacy skills: “The computer would show her words and say them as many times as she wished, with more patience and repetition than I — or a teacher — would have been able to manage.”

Digital media offer high production values, with exciting images, color, and movement that captivate kids. Visual appeal is even more important than many educators have realized. “Kids care a lot about the physical world — about the way things look,” Allison Druin told us. “When we developed a digital library for kids, we found that kids search for books by the color of the cover.

Adults don’t understand this, but kids are like, well, duh...” Eye-catching visual appeal — some called it the “coolness factor” — is certainly part of the motivating power of digital media.

Digital media inspire beginning readers to exert effort in other ways as well. They structure opportunities for kids to be active learners. They provide immediate feedback. And they give kids exciting shared experiences to talk about. It is the talk that surrounds digital learning that most powerfully keeps kids motivated and focused, some experts say.

Finally, children appear to be motivated to read independently when text is embedded in online explorations or digital games. “An interesting [recent] finding,” said Donald Leu, who codirects the New Literacies Lab at the University of Connecticut, “is how much kids are reading online...much more than we thought.” In addition, Joshua Lawrence, a Boston University doctoral candidate working with Catherine Snow, has found that middle school boys spend more time reading cheat codes than chapter books.

There are plenty of kids today who are reading off the Internet before reading a book.

Most studies of online reading look at secondary school students. Funding for research on early reading and online experiences has been sparse, and some interviewees say that this needs to change. According to Leu, “The sooner you get to young kids, especially from challenging environments, the better opportunity they have to succeed. We lose a generation of kids by thinking that first you learn book reading and then you go online...there are plenty of kids today who are reading off the Internet before reading a book. If you take a stage developmental perspective, you deny opportunities to kids who need our help the most.”

Leu said teachers need a better understanding of what online reading entails. Until recently, educators have tended to assume that children who can read paper texts will have no problem with online content. Leu cited several studies that suggest otherwise. One 2007 study of sixth graders proficient at using the Internet found that online reading comprehension requires a more complex and somewhat different set of skills and strategies (Coiro & Dobler, 2007). Another reached the same conclusion after finding no statistically significant correlation between scores on a state reading comprehension assessment and online reading comprehension (Leu et al., 2007). Further research will be needed to guide teacher preparation programs and professional development planners in helping teachers prepare children for our networked world. As the RAND Reading Study Group has stated, “Accessing the Internet makes large demands on individuals’ literacy skills; in some cases, this new technology requires readers to have novel literacy skills, and little is known about how to analyze or teach those skills” (RAND Reading Study Group, 2002, p. 4).

Even the most fluent decoders will hit a wall at about the fourth grade if they lack the contextual knowledge needed to make sense of the texts they have sounded out. This has been called the “fourth-grade slump.”

Gaining the background knowledge needed to grasp content

For children in the primary grades, decoding is crucial, but schools cannot afford to overlook other foundational learning as they teach children to sound out texts. To become good readers, children also need exposure to a wide variety of experiences and wide-ranging conversations with adults, and that exposure cannot wait until they have mastered phonics. Even the most fluent decoders will hit a wall at about the fourth grade if they lack the contextual knowledge needed to make sense of the texts they have sounded out.

Literacy expert Jeanne Chall has called this the “fourth-grade slump” (Chall & Jacobs, 2003). For most children, fourth grade marks a shift from “learning to read” (decoding) to “reading to learn” (reading for understanding and information). Texts become more demanding, presenting words and ideas that reach beyond children’s everyday experiences. In order to read, understand, and learn from these texts, young readers need to know not only more words but also more about the world (Chall & Jacobs, 2003).

According to Catherine Snow, the people who write for elementary school audiences — whether in print or other media — tend to assume that readers have somehow absorbed a storehouse of words and understandings that may not be part of any formal curriculum. “Struggling readers just need to know stuff,” said Snow. More often than not, she adds, “the basics of knowledge that you think they’ve absorbed, somehow they haven’t.” Snow is talking about the kind of contextual information that used to be thought of as “enrichment” but now is seen as basic to reading and school achievement. This storehouse of words and understandings comes with exposure to diverse people, places, institutions, and ideas.

Vocabulary is part of the challenge. Children whose parents take them to the supermarket or local fruit stand may know a peach from a papaya — if adults take time to chat with the kids about what they are seeing. A youngster who is taken to school by her grandmother may be able to name some of the interesting sights along the way (whether nuthatches or hatchbacks, ball fields or bodegas), if grandma has the patience to point them out. Naming objects is only the beginning. Children also need exposure to a wide range of conversations and experiences, in and out of their homes, that help them make sense of nonintuitive expressions (Jell-O mold, queen of clubs, right of way), cultural references (apartheid, Ramadan, siesta), or abstractions (justice, insurance, fate).

Of course, children can also learn new words and concepts by reading. Context clues in the text (or a handy print or online dictionary) can point young children toward word meaning.

In the primary grades, when the texts have very limited vocabularies, that works well. But as children move into the upper elementary grades, the number of words, expressions, and concepts they are expected to understand suddenly explodes, and neither context clues nor dictionaries suffice. What arises, in short, is an experience gap, and many literacy experts believe that digital media can help to narrow this gap.



Digital Media & English Language Learners

According to Kenji Hakuta of Stanford University, English Language Learners can shine in the primary grades, when decoding is the focus of reading. Research shows that they can outperform other children in reading — until they hit a wall at about the fourth grade. They have difficulty with comprehension and meaning, and their achievement drops off. For these students, narrowing the knowledge gap is especially important. Hakuta also stressed the importance of curricula that combine verbal and visual cues to language. A well-known psychological phenomenon called the McGurk effect refers to how the mind automatically integrates speech sounds with visual cues from facial and lip movements [McGurk & MacDonald, 1976]

Others say that multimedia formats do not simply sharpen visual acuity or skills. “Kids use pictures to consolidate concepts that would otherwise [elude them]...,” Susan Neuman of the University of Michigan said. “Multiple media can be used to teach kids vocabulary words in taxonomic categories that enable them to understand not just words but also concepts, and then to infer concepts beyond those we are teaching.” Neuman cites the work of Allan Paivio, whose dual-coding theory posited that learners are far more likely to understand concrete (nonabstract) words when they are accompanied by referent pictures than when paired only with their pronunciations (Paivio, 1986). “When you have multiple media, then you have experiences coming in multiple channels,” she observed.

“When you use multiple media to bootstrap children’s learning, you see gains.”

Digital game players can encounter historical eras (as in *Pirates!*), investigate complex systems like Earth’s chemical and life cycles (*SimEarth*), govern island nations (*Tropico*), manage complex industrial empires (*Railroad Tycoon*), or, indeed, run an entire civilization (*Civilization series*). They can travel in time to Ancient Greece (*Caesar I, II, and III*), Rome (*Age of Empires I and II*), or colonial America (*Colonization*), or manage an ant colony, farm, hospital, skyscraper, theme park, zoo, airport, or fast-food chain.

Stanford professor Kenji Hakuta believes that such digital experiences can help many students, including English Language Learners, who, in the primary grades, can outperform native English-speaking beginning readers but then hit a wall around grade four when comprehension and cultural knowledge become increasingly necessary for reading success. Many experts we consulted made the point that digital adventures do not replace the real-life experiences that children share with their families and friends, real experiences crucial to children’s development. But digital adventures can certainly supplement the learning that happens in the real world, and for children who rarely leave their neighborhoods, digital experiences can help narrow what Milton Chen calls the “exposure gap” and Susan Neuman calls the “knowledge gap.” Whatever the terminology, the key idea is that children need a wide range of experiences scaffolded by caring adults.

Supporting special learners

The potential of digital media to build the basic understandings that ground successful reading has particular import for special educators, according to James Wendorf, Executive Director of the National Center for Learning Disabilities. He points out that close to three million children in the nation’s public schools have learning disabilities; 80% of these learning disabilities are language-based and thus tend to surface as children are learning to read. Other children have reading difficulties that have not been classified as learning disabilities. “In high-poverty areas,”

according to Wendorf, “well over half of children in K–3 settings are considered to lag behind in their reading development.”

To be sure, special educators encounter many other challenges. “I wouldn’t want to downplay other literacies; they’re very important,” Wendorf said. “But for a significant percentage of children, it is the core literacy development that absolutely must be front and center.” Because the supplemental support children receive often takes place outside of the classroom setting, interactive technologies have a huge role to play. Interactive technology can help kids learn how to decode, comprehend more effectively, and build vocabulary. Digital-based materials, when designed well, may also be particularly well-suited to providing more opportunities for engagement and understanding (see “CAST: Universal design for learning” below). Said Margaret Honey of Wireless Generation,

“Digital media can be incredibly powerful, precisely because they support different pathways of engagement for different types of learners. Kids can enter into a media-rich experience and take away from it what is particularly compelling to them.” Wendorf predicts that products geared to helping struggling readers will proliferate because of policy changes related to eligibility for special education services.

Technology-related professional development is especially crucial for teachers who are responsible for meeting learners’ special needs.¹³ Researchers say that multimedia projects can powerfully motivate students with disabilities — if classroom teachers are clear and intentional about what they are trying to achieve and how digital media can help them meet their goals (White & Fredrickson, 1998; Hasselbring & Williams Glaser, 2000).



CAST: Universal design for learning

The mission of the Center for Applied Special Technology (CAST) is to expand educational opportunities for all learners, especially those with special needs, through Universal Design for Learning (UDL). A UDL-designed product uses the inherent versatility of digital media to reach all learners by offering multiple means of representation to give students various ways of acquiring information; multiple means of expression to give students many ways to demonstrate what they know; and multiple means of engagement to leverage students’ self-motivation to learn. This is often achieved by employing digital media.

One result of CAST’s research is the Thinking Reader®, an award-winning reading program for upper elementary and middle school students that exemplifies the principles of UDL. This software program enables struggling readers to read the same texts as their peers, while employing prompts, hints, exemplary answers, and immediate feedback to provide differentiated instruction and individualized support. CAST is also the developer of the first universally designed literacy program, WiggleWorks®, and of Bobby, one of the first Web site accessibility assessment tools. CAST is currently partnering with Google to develop universal learning editions for literacy.

For more information about CAST and UDL, visit: www.cast.org.

¹³Technological advances are also enabling educators to use an expanding range of assistive technologies in their work with students who have physical or other disabilities. As with other educational technologies, funding is often a steep barrier. These assistive technologies fall outside the scope of this paper.

The new literacies

“Everything is literacy now!” one of our interviewees told us with a mix of exhilaration and exasperation as we discussed the range of understandings that children must now master: computer literacy, global literacy, visual literacy, scientific literacy, and others. To be sure, the capacity to make sense of text differs in important ways from other competencies that may now be thought of as “new literacies,” such as gathering, sorting, and analyzing information or negotiating cultural differences. The key point is that in an interconnected world, children must become fluent in the use of many symbolic systems and communication tools, particularly visual means of expression. They must come to terms with a much wider range of ideas and understandings, including knowledge of other countries and cultures.

The demands of 21st-century workplaces have been discussed in depth by many experts and institutions across the nation, and several institutions have begun to identify and advocate for a new formulation of school standards (see “New standards for a new age” on p.34). Virtually all of their reports stress the need to prepare young learners to make meaning from masses of information, take part in collaborative problem-solving, and move beyond the bounds of conventional thinking.

Reports from other parts of the world strengthen the economic case for new approaches to learning. In a 2006 *Financial Times* feature, Andreas Schleicher, author of a recent Organisation for Economic Co-operation and Development (OECD) report comparing education in many nations, predicted that “tomorrow’s high-skilled jobs in innovation and R&D will be relocated in Asia unless the E.U. and U.S. make significant progress.” America’s leadership in many spheres resulted from the massive investments in education made after World War II. That may change, says Schleicher, because today, “You see that more and more countries reach and surpass U.S. qualification levels.” In particular, he said, American educators need to focus on “high-level thinking and reasoning skills...using insight and reflection to solve problems, and being able to

formulate and communicate arguments and explanation.” In these areas, we lag behind many other nations (“Ask the expert,” 2006).

The general public agrees with the experts on the need to redefine education for the new century. According to a recent survey by the Partnership for 21st Century Skills, two-thirds of U.S. voters said that students need more than just reading, writing, and arithmetic. The vast majority (88%) believe students are ill-equipped in critical thinking, problem solving, and communication skills. The Partnership’s report concluded: “Voters generally are not happy with the direction our schools are headed with respect to ensuring we have the skills to compete” (Partnership for 21st Century Skills, 2007).

challenge #2: rethink literacy & learning for the digital age

What does it mean to be educated in today’s digital, interconnected world? What should children know and be able to do by the time they enter the middle grades? How can the new literacies be strengthened and linked to traditional literacy?

The heart of the second Cooney Challenge is located in the overlap between the span of digital experiences that saturate children’s lives and the wide range of competencies they will need as engaged citizens of the interconnected 21st-century world. Our scan of the field indicates that in addition to the three Rs, today’s elementary school graduate needs to be able to:

- Use digital tools effectively and safely
- Think critically
- Understand complex systems
- Know about other countries and cultures
- Participate in collaborative learning communities
- Invent, create, and design — alone and with others
- Find wholeness in a “remix” world.



New standards for a new age

Several experts and institutions have begun to identify and advocate for a new formulation of school standards that better reflect the demands of 21st-century workplaces. Below are summaries of four such efforts:

The executive committee of the **National Council of Teachers of English** recently announced their definition of 21st-Century Literacies. The committee stated, "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." They went on to enumerate the skills that readers and writers need, which include the ability 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; and attend to the ethical responsibilities required by these complex environments. Visit <http://www.ncte.org/announce/129117.htm> for more information.

The Partnership for 21st-Century Skills, a research and advocacy organization comprising members of the business community, education leaders, and policy-makers, has developed "21st-century standards," to increase workforce-readiness in youth. Beyond mastery of core subject matter, the Partnership recommends that students develop skills in: learning and innovation, media and technology, and life and career. These skills include creativity, critical thinking, literacy in information and communications technology and media, cross-cultural skills, and leadership (Partnership for 21st Skills, 2006). Visit www.21stcenturyskills.org for more information.

The **International Society for Technology in Education (ISTE)**, a nonprofit organization that seeks to improve teaching and learning through the effective use of technology, released an updated version of its National Educational Technology Standards for Students (NETS•S) in 2007. According to ISTE, what students need to know in order to "learn effectively and live productively in an increasingly digital world" requires more than just technical competency and knowledge of isolated computer applications. The new standards include the development of "higher-order thinking skills" such as analyzing, critiquing, and creating, and view the technological environment as providing the tools to do that. Accordingly, the new NETS standards address students' aptitudes for creativity and innovation; communication and collaboration; research and information fluency; as well as critical thinking, problem-solving, and decision making (ISTE, 2007). Visit www.iste.org/inhouse/nets/cnets/index.html for more information.

Henry Jenkins, Director of MIT's Comparative Media Studies Program, argues that the skills needed to participate in today's online communities amount to a "hidden curriculum [that shapes] which youth will succeed and which will be left behind as they enter the school and the workplace." He posits three main deficiencies to consider in preparing children to participate fully and competently in contemporary digital culture:

- children may lack the skills to fully interact and share with their peers (The Participation Gap);
- children may be unaware of the way media shapes perceptions (The Transparency Problem);
- the ability to use Web 2.0 tools to broadcast thoughts widely and easily requires knowledge of certain social protocols (The Ethics Challenge).

Jenkins urges educators to provide experiences around the following skills: play, performance, simulation, appropriation, multitasking, distributed cognition, collective intelligence, judgment, transmedia navigation, networking, and negotiation (Jenkins et al., 2006).

Use digital tools effectively and safely

Safe, effective use goes well beyond the basic computer skills needed to navigate the Internet and make good use of search engines (see box, right). As technologies increasingly saturate daily experience, children need to be able to express themselves fluently using multiple media (e.g., text, video, graphic design, sound), to use those media as they navigate across multiple platforms (such as desktop computers, handheld devices, cell phones, and iPods), and to adopt safe and responsible practices, especially online.

Children are already using a variety of digital tools to master complex communication skills, and these tools will become more important over time. Our interviewees brought different perspectives to their forecasts of tomorrow's world, but all agree on this point: Machines will take care of almost all routine cognitive tasks, but complex communication, along with innovation, will remain the realm of humans. As Mitchel Resnick of the Media Laboratory at MIT observed, literacy means being able to express meaning to oneself and others. New technologies give kids the capacity to communicate in new ways — including ways that do not entail words. According to Resnick, “Words will not vanish from the literacy domain — but literacy will increasingly be words-with-other-things.” Others pointed to elementary schoolers’ activities on Club Penguin and “iCarly” (a television show with a user-generated-content-focused Web site) as evidence of a new movement in multimedia self-expression.

Game industry consultant Ben Sawyer noted that in recent years, digital media have obscured computer programming and moved coding out of the schools. That is a mistake, he says. Fluency with digital media means seeing YouTube “not just as what appears on the screen, but also seeing the programming and coding and procedural computation that went behind it.” New programming tools such as Scratch capitalize on kids’ fascination with modular construction kits like Legos.



Helping kids become careful, critical media consumers

Like all of the settings where children play and learn, today’s electronic playgrounds pose potential hazards that kids and adults need to recognize. To be sure, policy-makers have put safeguards in place.

Policy initiatives like these are important but they cannot take the place of the guidance parents and other caring adults can offer. As they use digital media, children need to know:

- 1. How to stay safe.** Age-appropriate rules are available from many online sources, including:
 - The American Academy of Pediatrics (<http://safetynet.aap.org/internet.pdf>)
 - FBI Kids (www.fbi.gov/kids/k5th/safety2.htm)
 - The American Library Association (www.ala.org)
 - Some of the many parent-oriented child safety Web sites, such as www.getnetwise.org, www.netmom.com, www.safekids.com.
- 2. How to stay healthy.** Intensive Internet use can affect children’s activity levels and cause repetitive stress injuries. For children with specific health issues, such as seizure disorders, there may be additional risks. The American Academy of Pediatrics (AAP) has called upon pediatricians to discuss children’s media usage with families as part of routine well-child visits (AAP, 1999).
- 3. How to be critical consumers.** Media education can help children recognize inappropriate content as well as marketing strategies and scams aimed at kids in their age-group.

(American Academy of Pediatrics, 1999). See also: The Children’s Internet Protection Act (www.ifea.net/cipa.html) and FCC regulations implementing CIPA (FCC 01-120) (www.fcc.gov/Bureaus/Common_Carrier/Orders/2001/fcc01120.doc)

Think critically

Years ago, the *New York Times* errata section contained this message to readers: “The photo that appeared yesterday on page forty-one, labeled as the sun, was the moon” (as cited in Gould, 1988). Even the most trusted media sources have inevitably made mistakes, so deciding what to believe has always been a challenge for consumers of information. But in the past, the number of sources encountered on any given day was limited. Today, computers allow us to retrieve and process immense quantities of information from innumerable sources available via the Internet, but people still must discern which sources are credible or relevant. Sometimes this means making judgment calls based on previous knowledge; other times, it means resisting the impulse to settle on a convenient assumption and spend more time in order to gain more insight or consider other perspectives.

In short, children (and adults) must learn to be able researchers and critical thinkers. As Eric Klopfer, director of the Teacher Education Program at MIT, observed, children “have to be able to judge the validity of information coming in, decipher context, determine the source, and separate opinion from fact. They also have to be able to contextualize the message within their lives.” Critical thinking means not only taking in many perspectives but also filtering out irrelevant or distracting data, and evaluating what information makes the most sense.

As Ellen Meier of Columbia University’s Teachers College stressed, children must be able to pose essential questions: What matters most? Which step comes first? How much is enough? They need to be able to think through and solve problems by drawing on powers of judgment and a framework of well-articulated values. They need to be able to consider (and sometimes invent) novel solutions or contrarian views, and to anticipate probable as well as unintended consequences.

Catherine Snow suggests that daily debate can engage elementary school children and develop critical thinking. “Get kids to debate 15 minutes a day,” she said. “Have them think about global



Beyond the three Rs...

What every fifth-grader should know and be able to do:

1. Use digital tools, especially complex communication tools, effectively and safely
2. Think critically
3. Understand key principles about how complex systems work
4. Know about other countries and cultures
5. Participate in collaborative learning communities
6. Invent, design, and create — alone and with others
7. Find wholeness in a “remix” world

warming. Who is responsible? What can be done? Or school uniforms... It’s the most fun kids have all day.” These young users can also go online to sites such as Imbee to explore and debate issues, expressing themselves in many modalities.

Thinking critically also means understanding intentions (one’s own and those of others) and working through ethical considerations by considering the consequences of their actions.

Can children learn these skills without benefit of digital media? Certainly. People have done so since time immemorial. However, many game designers and technology researchers we talked to emphasized the particular power of digital simulations and games to engage kids in decision-making and help them understand the impact of various choices. Designers make sure that digital games have their own extrinsic rewards (such as getting to the next level and receiving a multimedia fanfare for any achievement). There is another kind of emotional payoff as well: Games often satisfy youngsters’ desire to be in control and experience a powerful sense of their own efficacy. “Video games are worlds that kids can seek to master and control, and this makes them feel efficacious and powerful,” said Margaret Honey of Wireless Generation.

Understand complex systems

“Gaming literacy is not just about games,” said Eric Zimmerman of Gamelab. Games, he says, are at least useful as conveyers of information. Games are more essentially about having the player engage with processes and systems. In an interconnected world, it is important to understand how the things that people think, decide, do, and create are connected and how they affect each other, across geographic, socio-economic, and across disciplinary boundaries.



PANWAPA... and other global opportunities for kids.

Panwapa (www.panwapa.com) is a multimedia, multilingual project designed to inspire and empower children ages four to seven to become responsible global citizens. Launched in October 2007, the site was developed by Sesame Workshop in partnership with Merrill Lynch.

Panwapa, which means “here on this Earth” in Tshiluba, a language spoken in the Democratic Republic of the Congo, is the name of an imaginary island that kids can inhabit and explore. With a simple series of mouse clicks, children create online avatars called Panwapa Kids. Through them, children explore this virtual space and interact with other Panwapa Kids, learning about other cultures in the process. Offline, children can reinforce their experiences via DVD and print materials. All components are available in English, Japanese, Mandarin, Spanish, and Arabic.

Within five months of launch, more than 50,000 children from many countries signed up. In collaboration with the United Nations Association’s Global Classrooms project, a Panwapa Ambassador’s program was also developed, allowing teens to extend their Model UN experience by working with young kids on a variety of Panwapa projects. In addition, Asia Society and the Apple Learning Interchange are working with educators to create a Panwapa curriculum and bring this informal learning tool into the classroom.

How do decisions about water resources in California affect people living in Utah? How are economic policies likely to influence educational outcomes? How do the religious beliefs of Muslims affect Judeo-Christian thought?

According to Zimmerman, “Games are bona fide systems with parts that interact with each other. They exist in a digital context where a lot of systemic elements become magnified and accentuated.” Young gamers come to learn how rules structure experience. Proponents of digital gaming say that the benefits are both cognitive and social: Gamers learn about how a dynamic set of parts interrelate to make meaning, and how people use and transform systems. As they play, they learn to follow rules and how to deal with winning and losing.

Know about other countries and cultures

An obvious but often overlooked feature of the world today is that it is global, and this fact presents challenges to an educational system that has historically downplayed the importance of international content. In recent years, many organizations, led by Asia Society, National Geographic Society, and the Committee for Economic Development, have called upon U.S. policy-makers and educators to respond to this deficiency. Asia Society and National Geographic have undertaken complementary research showing that our high school and college students are ignorant of the most basic facts of world geography and politics. Only a small minority can name the world’s largest democracy (India); many failed to identify the Pacific Ocean as the body of water separating North America from Asia (Steinemann, Fiske, & Sackett, 2001; Fiske, 2005; National Geographic-Roper Public Affairs, 2006). These groups have made substantial progress in recent years in enlarging the definition of education to include knowledge of other world regions, languages, and cultures.

Vivien Stewart, Asia Society’s vice president of education, made this case forcefully. She pointed out that global literacy has generally been seen as an issue for the high school curriculum, while prejudices solidify much earlier, and therefore learning about other cultures (at home and abroad)

is just as important in the elementary years. Stewart stressed the potential of digital media to accelerate progress in this sphere. “We have effective practices for teaching reading and math,” she said. “We just don’t use them consistently or well enough. That’s not true in the realm of global literacy. That’s where I see the greatest potential for digital media. That’s where their intrinsic strengths — universality, connectivity, powerful visual imagery — can really pay off.”

For this to happen, Stewart says, educators need a broader understanding of global literacy. Traditional global literacy includes world geography, world history, and sometimes one or more foreign languages. But today, almost every current issue has a global dimension, and to grasp such issues fully requires students to learn innumerable facts not covered in the classroom. Thus the field is wide open for technological solutions. Stewart envisions applications that use many modalities. “Games and Internet-based exchanges can be effective,” she says, “but they need to be tailored to meet each need and each audience.” She suggests that elementary school children’s natural interest in cultural stories and family traditions may be advanced through strong literacy experiences, perhaps facilitated with digital technologies.

Children need to know *how* and they need to know *what*. But in an interconnected world, they also need to be able to know *with*. Today’s children are growing up at a time when knowledge development is a team sport.

In the realm of foreign language learning, digital technology offers important tools. Today, only half of our nation’s high school students study a foreign language. The vast majority of those who do (70%) study Spanish, but most stop after the introductory course. Interest in Chinese and Arabic is increasing, but few K–12 schools can

find (or afford) teachers qualified to teach these languages. For all of these reasons, digital media are important tools for foreign-language learning. Some designers have created multimedia, immersive language-learning environments that motivate students by giving them roles in an unfolding story and letting them move through authentically depicted settings such as Moscow or Paris (Murray, 1997).

Participate in collaborative learning communities

Today children need to know *how* and they need to know *what*. But in an interconnected world, they also need to be able to know *with*. Participatory knowledge development is at the heart of the online world known as Web 2.0, where user-generated Web sites and content dominate. In this setting, children need to master not only the tools that allow collaborative exploration or invention but also the social and communication skills needed to respond to and improve on others’ ideas, designs, or creations. They need the cultural sensitivity to share insights with people who come from other backgrounds and experiences. And, as they engage with others in group interpretation, they need to negotiate shared understandings and problem-solving strategies.

Today’s elementary school children are growing up at a time when knowledge development is a team sport. The process is increasingly participatory, democratic, and resistant to external control. For participants, this can be both empowering and confusing. Participatory knowledge tools tap the experience of countless people with many kinds of experience, factoring their insights and beliefs into the process and the result. They allow participants to engage in real-time collaboration and to co-construct solutions to problems. At the same time, they compound the problems of credibility that can already be overwhelming in an interconnected world. The anonymity of online collaboration can also create problems of safety and security.

The tools that facilitate participation are fast-proliferating. Learners can take part in threaded discussions, contributing ideas or taking the conversation off in a new direction at any time.

They can visit multiuser virtual environments that let people explore virtual worlds together and collaboratively create new understandings based on their experiences. Children can contribute to a Wiki, a collaborative Web site, perpetually in process, that combines the work of many authors and allows users to edit, delete, or modify content provided by previous contributors. Learners can also share their online explorations with others using social bookmarking — an online mechanism that allows users to save links to Web pages that they want to remember or share.¹⁴

To the surprise of many adults, elementary-age children are increasingly involved in building online communities themselves. On popular Web sites, such as those hosted by PBS KIDS, Disney, and Nickelodeon, children are playing online games starring their favorite television characters. They are also immersing themselves in complex virtual worlds such as Whyville, Webkinz, and Club Penguin. The trend appears to have great momentum, and adults interested in children's healthy development and learning should be working to make online experiences safe and meaningful for children.

Many educators say that digital collaboration prepares children to participate in learning communities. In the adult world, they are known as communities of practice, meaning groups of individuals who share a common way of knowing and way of being with respect to a set of similar (often shared) problems, purposes, and values (Shaffer, 2005, p. 21). Together they develop not only shared understandings but also shared values. The group members may share a profession (educational reformers, architects, or constitutional lawyers), but the participants share more than membership cards from the same professional associations or a predilection for scouring the same Web sites. They share an epistemic frame: that is, ideas about the kinds of problems that are worth solving, the kind of knowledge that matters most, and the kinds of processes that are likely to yield desired results. They share assumptions about what counts as evidence.

Educators today often talk about the importance of teaching children to “think like” scientists or “think like” artists. This does not mean training elementary school children for these careers; rather, they want children to experience being part of a community of practice, to know that different communities of practice may have different ideas about what constitutes an important question or a good answer.

Educators also believe that “thinking with” provides a meaningful approach to multiculturalism. By thinking about how individuals and groups know what they know, children can gain deeper insights into cultural diversity. They explore and gain insight into how cultural assumptions, frames of reference, perspectives, and biases influence how knowledge is constructed within a discipline (Shaffer, 2005, p. 30).

Invent, create, and design — alone and with others

As children take part in collaborative processes, they can try out many different roles: peers, novices, leaders, writers, editors, scientists, and critical friends. Many of the experts we interviewed say that the most important identities they can experience using digital tools are those of designers, creators, and inventors. As Margaret Honey observed, “America’s future lies in abilities that are neither ‘offshorable’ nor the realm of the machine: inventing and creating.” As journalist Thomas Friedman has stressed, ingenuity has long been a key to our nation’s prosperity. We have been the world’s “dream factory” (Friedman, 2005). Our creative successes have depended, in part, on individual thinkers’ flashes of brilliance; but those flashes would have soon dimmed if we had not built collaborative structures that allow groups of people to refine and build on those insights or inventions. Mitchel Resnick wants to replace the term “Knowledge Society,” coined in the 1990s to highlight the transformative power of drawing meaning from information, with the “Creative Society.” Resnick believes that “success in the future will be based not on how much we know but on our ability to think and act creatively” (Resnick, 2002, p. 36).

¹⁴Del.icio.us is the best-known example.

How does a society teach its children to dream? How do we prepare them to invent together? Some experts believe that in our efforts to define learning standards and assure accountability, we are neglecting children's imaginative lives. Gee and Shaffer have written of a coming crisis in education: "Young people in the United States today are being prepared — in school and at home — for "commodity jobs" in a world that will, very soon, only reward people who can do "innovative work" and punish those who can't" (Shaffer & Gee, 2005).

Others believe that the kids are way ahead of the adults who design their educational experiences. As Ellen Wartella of the University of California at Riverside remarked, "The social network explosion is an entrée into creating. Right now we don't understand it — we're just observing the phenomenon." According to Ellen Meier, "Kids are doing inventive things with technology and media all the time. And in schools we say: Turn it off, put it away, and don't do it here."

To be sure, in schools across the nation, many children and teachers are experimenting with digital media. Some are taking advantage of digital media to imagine, invent, or develop what-if scenarios. Learning from students, some teachers are encouraging multimedia authoring projects, but in a teacher survey published in 2005, only one-fifth said that they considered multimedia authoring programs to be essential for teaching in their classrooms (National Center for Education Statistics, 2005).

"Kids are doing inventive things with technology and media all the time. And in schools we say: Turn it off, put it away, and don't do it here."

Those teachers who do encourage students to invent together meet steep obstacles. These include technological challenges (inadequate equipment and technical support); organizational

issues (few opportunities for teachers to become more fluent with digital media); and pedagogical impediments (standards and assessments that undervalue invention and leave little class time for experimentation).

Find wholeness in a "remix" world

Today's children are using multiple applications and platforms, often at the same time. They are becoming adept at cutting and pasting not only texts but also ideas, images, musical compositions, literary works, video clips, and other content. Many are learning the art of mash-up — a hip-hop music term that describes the process of mixing data from two or more sources into an integrated experience. With digital tools, users take things apart and put them together in new, ever more ingenious ways. Web 2.0 applications encourage them to alter encyclopedia entries, remix stories or novels into new multimedia forms, and reassemble elements of other people's designs into new creations.

In the new century, children must be able to follow a line of reasoning or a storyline across multiple media or platforms. But the challenges extend well beyond making sense of remixed content. Electronic networking has also led to the unbundling of institutions, bodies of knowledge, and even the concept of self. Children are prompted to try out multiple identities, sometimes anonymously.

It can be challenging, in this context, for children to experience authenticity and coherence in their learning experiences. For parents and teachers, helping children recognize and meet this challenge may be the most difficult task of all. A number of experts pointed the way toward narrative as a way of knowing that helps children organize disparate experiences and data, giving them a sense of coherence. As Ellen Meier put it, "Kids are drawn by striking visual images, color, and action — they certainly are part of the appeal of digital media. But what kids are always trying to do is make meaning of the action. Kids are always looking for a storyline. The most compelling digital media are built around stories."

Stories provide a sense of direction. Most often, they have a beginning, middle, and end. Of course, the advent of hypertext has exploded assumptions about sequencing, but even when there are multiple pathways through a story, narrative asks children to grapple with notions of ordering that can help them organize their thinking. Stories also bring focus to remixed or seemingly chaotic productions by grounding them in emotion. They help students find wholeness in a remix world. As Jerome Bruner has written, narrative is “an organizing principle by which people organize their experience in, knowledge about, and transactions with the social world” (Bruner, 1990, p. 35).

Game designers understand this principle, and the most popular online games and simulations are built around compelling storylines. Narrative is often the secret behind what digital learning experts call “stealth learning.” Kids playing digital games or exploring virtual worlds gain competence and knowledge as a by-product of their involvement in the storyline. In this sense, game designers may have a great deal to offer other curriculum designers. According to Bruner, schools traditionally favor logical, scientific thinking, and treat the narrative arts (song, drama, fiction, and theater) as decoration, not necessity. And yet, as Bruner points out, “It is only in the narrative mode that one can construct an identity and find a place in one’s culture. Schools must cultivate it, nurture it, and cease taking it for granted” (Bruner, 1996, p. 2).

Call to action:

Retool the nation’s reading enterprise

Ensure that today’s most effective reading strategies are disseminated and supported by digital media experiences. Identify digital media strategies that hold promise for helping all children (including English Language Learners and children in special education) become able readers. Train and support educators to realize the potential for integrating digital media to accelerate literacy learning.

Address the fourth-grade slump

Seek solutions for the fourth-grade “reading slump,” including a sharp focus on strategies for narrowing the knowledge gap that opens up between “learning to read” and “reading to learn.”

Engage leaders across sectors in efforts to reconceptualize literacy

Convene leaders from various sectors and disciplines to work together to identify the competencies children need, rethinking literacy for a new era and providing guidance to parents, educators, out-of-school program planners, industry leaders, policy-makers, and the public at large.

Update learning standards and assessments

Ensure that policy-makers align learning standards and assessments with this new vision of literacy as well as with the realities of children’s lives in and out of school.

Investigate how digital media contribute to real-world literacy learning

Examine whether the skills children learn from digital games or social Web sites are transferable to the real world. In addition, examine whether they learn facts of history, literature, or science that they can use to support an argument.

Support and spread promising ideas

Identify and replicate promising program models, including in-school and out-of-school initiatives.

advancing equity

Children learn wherever they are. These days, they are also likely to experience digital media wherever they are. Educators and parents need to know more about how children learn in different settings, and they need effective strategies for bridging the learning that takes place in classrooms, after-school programs, libraries, and homes.

In school

Over the last two decades, most school districts have made significant investments in computer hardware and software. Today's public schools are better equipped and better connected than ever before. Between 1994 and 2002, the percentage of schools with Internet access rose from 35% to 99% (U.S. Department of Education, 2002). Many classrooms have several desktop computers, laptop carts have become more common, and many schools have broadband and/or wireless Internet connections.

This represents significant change, but we know more about the presence of the machines than about whether or how they are used. According to the U.S. Department of Education, "Despite regular reports of increasing school-level access to computers and technology, little national-level data is available on teacher opinions regarding the availability and usefulness of the technology in their classrooms" (National Center for Education Statistics, 2005, p. 1). A survey of more than 4,000 public and charter school teachers reported by the National Center for Education Statistics in 2005 found that 58% of pre-K and elementary teachers agreed that computers and other technology were sufficiently available in their classrooms. The findings raised a number of questions about teachers' attitudes toward and readiness to take advantage of computer-based technologies. The survey found, for example, that 39% of teachers who had no computers in their classrooms for students to use agreed with the statement that classroom technology was "sufficiently available" (National Center for Education Statistics, 2005, p. 3).

Given the demonstrated power of digital media to engage children and expand their horizons, why would so many teachers be satisfied with few or no computers in their classrooms? The reasons are complex, educational leaders say. A key factor is public schools' focus on meeting learning standards and demonstrating progress in doing so. The more engaging tools and programs are not currently aligned with these standards.

In addition, educational technologists say that it has been especially difficult to integrate technology into elementary school classrooms, despite the availability of good applications and tools for younger children. The problem lies elsewhere: Middle and high school students often use digital media in computer labs or technology centers; in the primary grades, children generally stay in one room. "In a really good elementary classroom," said Jim Pollard of Intel's Education Group, "the teacher is continually adjusting activities to kids' emerging interests and needs. There's an organic flow. Technology can be disruptive in that environment. You have to stop and turn on the machine, and in elementary schools that's almost always problematic. The network may be slow, or you need to reboot." Pollard predicts that the movement toward one-on-one computing (a computer for each child) could change the paradigm. "The computer would no longer be an event," he said. "It could be much better integrated."

Out of school

Today, three quarters of American homes have Internet access (Rideout et. al., 2005), and as we have seen, from their early years, children from all socioeconomic strata spend a great deal of time with digital media. Shadowing kids in and out of school can be an eye-opening experience for researchers, said Douglas Hartman of the University of Connecticut. "In school, even though the kids I studied could read, they chose not to. Out of school and online, they were voracious readers and writers."

Online or in their bedrooms, kids are involved in games that revolve around multifaceted narratives and involve complex rules. These games can be very challenging — what one educator has called "hard fun" (as cited in Fisch, in press, p. 32). A number of experts have observed that, at times in the realm of reading and math, pop culture demands more of our children than schools do. One often-used example is the Japanese video game Pokémon. To succeed at Pokémon (and many digital games), Noah Falstein said, "You need to know your chances of winning when you're up against a particular character.

Kids can master this concept long before probability is introduced into the school curriculum.” In addition, mastering the Pokémon trading card system also means mastering a sophisticated vocabulary, including such terms as holographic, evolution, whirlpool, swagger, magnetic, and so forth. “Pokémon cards are more challenging than many fourth-grade textbooks, though no one is taking this seriously,” said Henry Jenkins of MIT.

Pop culture demands more of our children than schools do. Pokémon cards are more challenging than many fourth-grade textbooks.

In contrast with the activities children most often encounter in school, these out-of-school pursuits generally take the form of play. And from this standpoint, it may not be surprising that they can be more challenging than in-school activities. Psychologists have long observed that in the context of play, children typically engage in more complex activities and use more complex grammatical structures than they do in other parts of their lives (Vygotsky, 1978; Bruner, 1986).

What we call fun can be seen as humans’ emotional response to learning.

And as Eric Zimmerman of Gamelab emphasized, children’s attraction to games may be hardwired into our species. “Play is the way all mammals practice and perfect adult skills,” he said. “You can watch puppies playing and see that clearly.” In this view, play can be seen as an evolutionary imperative — nature’s way of ensuring that the young of a species learn survival skills. And what we call fun, Zimmerman added, can be seen as humans’ emotional response to learning.

1

Elmo on the go

Not every family in the U.S. owns a computer, but a great majority has at least one cell phone. Are phones a good way to get literacy tips to parents and appealing content to children? In 2006, Sesame Workshop studied this very question and asked independent evaluators to analyze the results. Eighty families from a variety of locations in California and representing a variety of income levels participated. The families received on their cell phones parent-directed literacy tips presented by *Sesame Street*’s Maria, followed by Elmo introducing the Letter of the Day and a clip from the *Sesame Street* archives. Three to four times a week, over the eight weeks of the study, parents were asked to watch the literacy tip and then stream the new letter video for their preschoolers to watch.

The results indicated that cell phones are a promising educational platform for literacy content. Parents said that after participating in the study, they were more likely to initiate literacy activities with their kids. The children were, for the most part, eager and excited to view the clips. One parent recounted that whenever the phone rang, her children came running, hoping the call was from Elmo.

(Horowitz et al., 2006)

Toward a 360-degree vision of learning

As we interviewed leaders across a number of fields — including reading, special education, educational technology, neuroscience, game design, the communications industry, and government — two different approaches to digital learning emerged. One focused on the informal learning that occurs in homes and communities, seeing change as coming primarily from outside of schools. Proponents were excited by the boundless possibilities presented by interactive, mobile devices, as well as by technologies embedded in the many settings where children live and learn (see “Elmo on the go,” above).

They saw today's school-based computer labs and technology resources as limited and transient, and called for new ways of thinking about learning and teaching.

The other approach focused on the formal learning that takes place inside schools. These leaders urgently sought strategies for building schools' capacities to support struggling learners. They wanted to see powerful content, with high production values, for the technologies that schools already own or will soon own, along with efforts to strengthen professional development for teachers. They understood that outside of school, many children encounter more sophisticated technologies and challenging applications than they find in their classrooms, but out of concern for equity, believed that schools should be the locus of efforts to accelerate learning with digital media. Sharon Lynn Kagan of Columbia University's Teachers College put it this way: "Obviously, rich learning can take place outside of school, but until we get it right within schools, we won't have equality of opportunity. If we focus primarily on spreading opportunities outside of schools, we will advantage the advantaged, and they will be the ones who will continue to produce and consume in our society. So there is a strong equity rationale for working through schooling."

What will it take to create a vision of digital learning that encompasses both in-school and out-of-school settings? A logical starting place may be the bringing together of policy-makers and researchers from diverse fields who are deeply interested in children and share the hope that digital media can accelerate learning but approach this goal from markedly different standpoints.

Furthermore, before we can develop 360-degree digital learning, we need to know more about the children doing the learning. Said Margaret Honey of Wireless Generation, "We tend to paint divergent portraits of the children we're trying to educate. On the one hand, we talk about tech-savvy, digital natives, and, on the other, schools struggle to address the achievement gap and educate all students to higher standards. We need to develop a much more articulated understanding of the

relationship between digital competencies and foundational skills, and carefully examine how these skills relate to a child's socioeconomic background."

The assumption is that one set of kids is tech-savvy. They are the 10-year-olds who love YouTube, Webkinz, and Wikipedia, and, when it comes to digital tools, leave most adults in the dust. When we think about these children, the challenge is about making our classrooms places where kids can use the same kinds of tools they are routinely using in the rest of their lives. The other set of kids includes the children of No Child Left Behind — the ones whose scores must rise for schools to reach their Annual Yearly Progress targets. We have myths about these children too. We assume that they do not read outside of school, that they need to spend every moment practicing basic skills, and that they can ill afford to spend time with technology. We need a much better understanding of their interests and needs as well.

To be sure, there are more and less tech-savvy children; there are kids with stronger and weaker reading skills and academic records. But the reality is that most of these children are immersed in digital media. They are playing games or spending hours online. The great majority are in schools that are connected to the Internet. The old digital divide remains, while a new digital divide is gradually coming into focus.

The old digital divide

From the moment computers were introduced into schools in the 1980s, many individuals and groups have worried that technology would widen the achievement gap. They worried that unequal access to computers and equipment would create a digital divide between the technology haves and have-nots.

Generally speaking, their concerns about access and use of computers in schools have proven to be warranted. A number of the leaders we interviewed stressed that children attending low-performing schools continue to have the

least access to digital media. “Where I live,” one interviewee told us, “the schools have difficulty getting books into classrooms. So saying that technology will dramatically shift how learning takes place — that won’t happen soon in this city.” Schools have certainly made progress in acquiring and linking educational technologies, but the likelihood that children will benefit from digital media continues to depend a great deal on their ZIP code.

Teachers in all kinds of schools and communities need better access to technology as well as the professional development needed to use it well, but barriers to equity are not only about access. “The digital divide didn’t pan out quite as expected,” James Paul Gee of Arizona State University told us. Access is just one barrier — and not necessarily the steepest. Another is competing priorities. In low-performing schools where the pressure to improve scores is most intense, decision-makers and teachers are less likely to invest in technology. Further, as the International Society for Technology in Education (ISTE) stressed in its 2007 report (National Educational Technology Standards for Students, 2007) on digital equity, even when computers are available, teachers are less likely to value technology as an instructional tool since the activities it makes possible are not generally aligned with the kinds of mastery that high-stakes tests assess. Moreover, in a policy framework that emphasizes standards and accountability and places a premium on improved test scores, funding for technology is often hard to come by.

Today, the old digital divide is also seen to apply to computer access and use in the home. Compared with schools, homes are very well equipped: Today, 74% of American homes have Internet access and 60% have instant messaging software (Vandewater & Lee, 2006). However, as Delia Pompa of the National Council of La Raza emphasized, children in low-income communities remain less likely than their better-off peers to have computers and Internet access at home. The disparities run along both economic and racial lines. Furthermore, compared with white children, African-American and Hispanic children spend less time on the computer and more time

playing video games and watching television (Rideout, Roberts, & Foehr, 2005). Schools can sometimes help to fill the gap by making computers available in their libraries or after-school programs, but in many cases principals eager to protect the school’s investment lock up the computers during nonschool hours, when students have the most free time to use them.

For all of these reasons, more must be done to overcome the old digital divide — the one that is mostly about access and use of computers in schools. But at the same time, educational decision-makers need to focus on a new digital divide that comes from disparities in the kinds of scaffolding children receive from adults to support basic literacy and the use of new digital tools.

The new digital divide

Circuitry and software are only part of a larger learning system enabled by new technologies. That learning system includes the people whose conversation and advice support digital learning as well as the machines that make it possible (Ba, Tally, & Tsikalas, 2002). Researchers say that adult scaffolding is an indispensable element in that learning system.

Many parents and teachers are surprised by children’s need for adult support because they feel so strongly that in the realm of technology, kids are way ahead of them. Experts in educational technology may have unintentionally promoted this idea by popularizing the distinction between digital natives (kids who have grown up with digital media and feel at home using them) and digital immigrants (the adults who can acquire fluency using digital media but generally do so more slowly and with greater effort) (Prensky, 2001).

Intergenerational learning

“Kids can do amazing things with technology,” Mitchel Resnick of the Media Laboratory at MIT said. “They can explore and experiment in more sophisticated ways than adults would expect. But it is also true that kids left on their own will run into barriers. Many adults think they need to just get out of the way. They are wrong. Kids can

browse and click and find comic book sites, but they can't make interactive animated books on their own. So there is a big role for scaffolding if kids are to make full use of technology and really learn how to express themselves."

Many adults think they just need to get out of the way. They are wrong.

Like the Molière character who is delighted to discover he has been speaking prose all his life, many adults may be surprised to learn that their daily interactions with children have a name: scaffolding. This term was popularized by researcher Barbara Rogoff, who wrote about

children's apprenticeship in thinking and drew attention to the kinds of cognitive and social guidance adults provide (Rogoff, 1990). In practice, scaffolding encompasses all of the things adults do to support and encourage children as they dive into new experiences. It includes conveying high expectations, keeping children company, keeping them safe, asking children to explain what they are thinking and doing, challenging them to go further, giving them the confidence to take imaginative leaps, listening to their dilemmas, and suggesting sources of assistance when they get stuck. In the context of digital learning, it certainly means more than helping children resolve technical difficulties — which some adults can do and others cannot. By doing these things, parents do more than provide hints and help.



The crucial role of adult scaffolding

Susan Neuman of the University of Michigan offers evidence of a "scaffolding gap" in her six-year study of technology use by children in public libraries located in low- and middle-income neighborhoods. In the middle-class neighborhoods, children typically were brought to the library by parents who helped them get settled and actively supported their digital activities; in lower-income neighborhoods, kids typically arrived alone or were dropped off and then used digital learning tools on their own.

"When we looked at what kids were doing, the contrast was startling," Neuman adds. "In middle-income neighborhoods, kids in libraries were using computers to go to print sites. But in low-income neighborhoods, they looked at pictures — there was no print on the screen. We calculated the words per minute each group is exposed to on the Internet — and the difference comes to millions of words.

Neuman linked her studies' implications to the landmark research by Hart and Risley, which found that very young children in low-income homes are exposed to a significantly smaller store of words than children in more affluent households.

She said, "What Hart and Risley saw with respect to vocabulary used during home interactions, we've seen with print on computer screens." Middle- and upper-income parents are more likely to expose children to new experiences and to surround those experiences with talk. Over time, children in low-income households have more limited vocabularies and less of the background knowledge that helps children become good readers and successful students.

In theory, digital media would seem to be a remedy, taking children on virtual adventures and familiarizing them with a wider range of words, ideas, and experiences, but in reality, this does not happen unless adult scaffolding is part of the equation. As Neuman has shown, children who lack scaffolding benefit less from digital learning tools than those who have the support of tech-savvy adults

The bottom line: In the absence of adult scaffolding, digital media may actually widen the achievement gap rather than narrowing it. (Neuman and Celano, 2006)

As James Paul Gee and David Shaffer have written, “They build and expand their children’s interests by engaging with them in ways of talking, thinking, and working that are technical, specialized, and ‘academic.’ They prepare their children for later learning, and help them feel that ‘people like us’ are good at learning complex, technical, and specialized things” (Shaffer & Gee, 2005, p. 8).

The vast majority of parents are eager to support their children, but some have more of the resources — such as educational or work experience, disposable time, good health and physical stamina, or confidence — needed to do so. Researchers say that middle- and upper-income parents are much more likely than lower-income parents to build a mentoring scaffold around new technologies (see “The crucial role of adult scaffolding” p.47). This scaffolding gap is widening the divide between groups of children in low-income communities and their peers in more affluent neighborhoods.

As Peter Lyman of the University of California at Berkeley has observed, “Research shows that all children tend to overestimate their technical ability, and parents tend to overestimate their children’s skills, thus kids require access to learning resources in order to scaffold mastery of new technical skills. This kind of knowledge capital resides in the peer groups and family members (siblings as well as parents) of middle-class kids, making them seem to be independent learners, while disadvantaged kids are much more dependent upon scaffolding by people at supporting institutions such as schools and community centers” (Lyman et al., 2004, p. 6).

challenge #3: advance digital equity, reaching all children with today’s most powerful learning tools

Narrowing the new digital divide will take coordinated action by many players: policy-makers, schools, libraries, museums, and other community organizations. It is important not to blame parents when they cannot provide sufficient support. The goal is to support parents while broadening responsibility for scaffolding children’s learning. Decision-makers need to consider parents’ educational roles as they plan family support programs and shape employment policies. At the same time, they need to ensure that the professionals who staff schools and out-of-school programs are prepared to offer the supports children need to benefit from digital media. Industry has a key role to play as well. Software developers and game designers also can ensure that the scaffolding embedded in their applications is sturdy, culturally relevant, and grounded in a clear understanding of diverse learners’ preferences and capacities. Developers, designers, or research institutes can also prepare supplemental educational guides for parents and educators so that adults can make use of digital learning opportunities to support children’s learning.

Schools need to provide enrichment when home support is unavailable. By the same token, when parents are able to nurture digital learning, schools need to learn to support and sustain those efforts. As Shaffer has written, “Some kids go to schools that build on this ‘home work’ and sustain it.... All too often, however, our public

schools are doing no such thing. Worse still, many children don't get these kinds of rich learning opportunities at home or at school. Modern technologies and popular culture are creating a new set of 'haves' and 'have-nots' when it comes to learning, and the difference between the two groups is only compounded by many of today's technologically impoverished schools" (Shaffer, 2005, p. 5).

Call to action:

Articulate a vision of 360-degree learning linked to the full span of 21st-century competencies, for all children

Align the expectations that underlie in-school and out-of-school learning, and provide the resources needed to support digital learning in schools, homes, and community-based settings.

Sustain attention to the "old" digital divide, ensuring that all children have access to digital resources

Ensure equity in children's access to technology, focusing not only on whether computers and Internet connections are available, but also on whether and how they are used.

Address the "new" digital divide, focusing on intergenerational supports

Provide children in traditionally underserved communities with the adult support they need to benefit fully from digital learning experiences.

Create digital learning resource centers in every community

Ensure that parents, educators, librarians, after-school program staff, and other adults have the supports they need to effectively scaffold children's learning.

conclusion: getting started

This inquiry has surfaced three broad challenges in the realm of children and digital media, pointing the way to new opportunities for research, practice, and policy-making. There is much to be done. We hope this report helps lay out the scope of work and provides a map into the unknown.

Answering the questions raised by the experts we interviewed will require addressing vital methodological issues. How, for example, can the educational effects of particular digital media be documented accurately when children are habitually multitasking? It will necessitate efforts to work toward common understandings and definitions. What exactly does educational mean in a digital age? It will require more nuanced collection and analysis of data, such as demographic information. Which individuals and groups constitute the audience for specific digital experiences?

Forty years ago, Joan Ganz Cooney recognized that the power of television, the most compelling medium of that era, could be brought to bear on solving urgent educational challenges, and she forever changed the public's assumptions about how, where, and when learning takes place. The new Center, named in her honor, affirms that insight. In coming months and years, working with leaders in educational media and research, the Cooney Center will be pursuing the aims described in this report.

It will:

1. Fund and disseminate research on:

- Media technologies and literacy development for elementary-age children
- Innovative models with potential to go to scale
- Initiatives and policies to close the new digital divide.

2. Challenge and work with industry leaders to apply knowledge about digital technology and child development in designing new products for learning.

3. Convene and connect leaders from across varied sectors (research, education, industry, public policy, philanthropy)

- To help identify pressing issues and priorities
- To foster ongoing dialogue and collaboration.

4. Advocate for innovative, research-based applications of media technologies to advance children's learning via wise investments of public and private funding.

We plan these priorities knowing the landscape will change. New media, new research, and new challenges will emerge. As we move forward, we will be making recommendations to those in pivotal sectors such as industry, government, and education. We are just getting started, and this is a work in progress. Please stay tuned.

list of interviewees

Literacy

- Rosemary Chalk, Director, Board on Children, Youth and Families, National Research Council and the Institute of Medicine, The National Academies
- Kenji Hakuta, Lee J. Jacks Professor of Education, Stanford University
- Ellen Meier, Co-Director, Center for Technology and School Change; Professor of Practice in the Communication, Computing and Technology Program, Teachers College at Columbia University
- Susan B. Neuman, Professor in Educational Studies, University of Michigan
- Bob Slavin, Co-Director, Center for Research on the Education of Students Placed at Risk, Johns Hopkins University; Chairman, Success for All
- Catherine E. Snow, Henry Lee Shattuck Professor of Education, Harvard Graduate School of Education
- Paula Tallal, Board of Governors Professor of Neuroscience and Co-Director of the Center for Molecular and Behavioral Neuroscience, Rutgers University; Co-Founder and a Director of Scientific Learning Corporation
- James H. Wendorf, Executive Director, National Center for Learning Disabilities

Children and family policy

- James A. Griffin, Director, Early Learning and School Readiness Program, Child Development and Behavior Branch, National Institute of Child Health and Human Development
- Andrés Henríquez, Program Officer, Education Division, Carnegie Corporation of New York
- Sharon Lynn Kagan, Virginia and Leonard Marx Professor of Early Childhood and Family Policy, Teachers College, Columbia University
- Peggy McCardle, Chief, Child Development and Behavior Branch, National Institute of Child Health and Human Development
- Patti Miller, Vice President and Director, Children and the Media, Children Now
- Kathryn Montgomery, Project Director, Youth, Media and Democracy Project, Center for Social Media; Professor, Public Communication, School of Communication, American University
- Delia Pompa, Vice President, Education, National Council of La Raza
- David Rejeski, Director, Foresight and Governance Project, Woodrow Wilson International Center for Scholars
- Vicky Rideout, Vice President and Director, Program for the Study of Entertainment Media and Health, Kaiser Family Foundation
- Marshall (Mike) S. Smith, Director, Education Program, The William and Flora Hewlett Foundation
- Constance M. Yowell, Director of Education, Human and Community Development, The John D. and Catherine T. MacArthur Foundation
- Susan Tave Zelman, Superintendent of Public Instruction, Ohio Department of Education

Global knowledge and skills

- Donna Christian, President, Center for Applied Linguistics
- Ken Kay, Principal and Chairman, Infotech Strategies, Inc.; President, Partnership for 21st Century Skills
- Vivien Stewart, Vice President, Education, Asia Society

Digital media (academic)

- Daniel R. Anderson, Professor, Department of Psychology, University of Massachusetts, Amherst
- Sandra L. Calvert, Director, Children's Digital Media Center; Chair and Professor, Department of Psychology, Georgetown University
- Milton Chen, Executive Director, The George Lucas Educational Foundation
- Julie L. Coiro, Assistant Professor, Education, University of Rhode Island
- Christopher Dede, Timothy E. Wirth Professor in Learning Technologies, Technology, Innovation and Education, Harvard Graduate School of Education
- Allison Druin, Director, Human-Computer Interaction Lab; Associate Professor, College of Information Studies and Institute for Advanced Computer Studies, University of Maryland
- Javier Elizondo, Director, Jump Into Reading for Meaning project, Pacific Resources for Education and Learning
- Shalom M. Fisch, President, MediaKidz Research and Consulting
- Tracy Fullerton, Co-Director, Electronic Arts Game Innovation Lab
- James Paul Gee, Mary Lou Fulton Presidential Professor of Literacy Studies, Arizona State University
- Douglas K. Hartman, Professor, Literacy, Language and Culture; Co-Director and Research Scientist, New Literacies Research Lab, University of Connecticut
- Henry Jenkins, Director, Comparative Media Studies Program and Peter de Florez Professor of Humanities, Massachusetts Institute of Technology (MIT)
- Yasmin Kafai, Associate Professor of Learning and Instruction, Graduate School of Education and Information Studies, University of California at Los Angeles
- Eric Klopfer, Director, MIT Teacher Education Program; Scheller Career Development Professor, Science Education and Educational Technology Department, MIT
- Donald J. Leu, John and Maria Neag Endowed Chair in Literacy and Technology, University of Connecticut; Co-Director, New Literacies Research Lab, University of Connecticut
- Roy D. Pea, Professor, Education and the Learning Sciences, Stanford University; Co-Director, Stanford Center for Innovations in Learning
- Nichole Pinkard, Senior Research Associate, Chief Technology Officer and Director of the Information Infrastructure System project, Center for Urban School Improvement, University of Chicago
- Mitchel Resnick, Director, Lifelong Kindergarten research group, Media Laboratory, MIT; Co-Founder, Computer Clubhouse project
- Linda G. Roberts, Former Director, Office of Educational Technology, U.S. Department of Education and Board Trustee, Sesame Workshop
- David Rose, Founder and Chief Education Officer, CAST
- Katie Salen, Acting Director, Design and Technology Department, Parsons New School; Executive Director, Institute of Play
- Ellen Ann Wartella, Professor, Executive Vice Chancellor and Provost, University of California, Riverside

list of interviewees (cont.)

Digital media (industry)

- Karen Cator, Director, Education Leadership and Advocacy, Apple Inc.
- David Dockterman, Vice President and Chief Academic Officer, Tom Snyder Productions
- Noah Falstein, President, The Inspiracy
- Alan Gershenfeld, Co-Founder and Managing Partner, E-Line Ventures
- Jon Goldman, Chairman and CEO, Foundation 9 Entertainment
- Nathon Gunn, CEO, Bitcasters
- Margaret Honey, Senior Vice President, Strategic Initiatives and Research, Wireless Generation
- Nancy Knowlton, Co-Founder and CEO, Smart Technologies
- Robert M. Lippincott, Senior Vice President, Education, Public Broadcasting Service (PBS)
- Dan Norton, Co-Founder, Filament Games
- Jim Pollard, Interactive Content Manager, Intel Education Group
- Lesli Rotenberg, Senior Vice President, Brand Management and Promotion, PBS;
Senior Vice President, PBS KIDS Next Generation Media initiative
- Ben Sawyer, Co-Director, Games for Health project, Serious Games Initiative; President,
DigitalMill, Inc.
- Bill Shribman, Executive Producer of Kids' Projects, WGBH-Boston
- Linda Simensky, Senior Director, Programming, PBS KIDS
- Bernie Trilling, Senior Director, Educational Strategy and Partnerships, Oracle Education Foundation
- Dan White, Co-Founder, Filament Games
- Eric Zimmerman, Co-Founder and CEO, Gamelab

appendix a: selected reviews of the literature on children and interactive media

- Bernholz, L. (2006). *Pedagogy, playstations, and the public interest*. San Francisco: Blueprint Research & Design, Inc.
- Cuban, L. (2001). *Oversold and underused: Computers in the classroom*. Cambridge, MA.: Harvard University Press.
- Gee, J.P. (2003). *What video games have to teach us about learning and literacy*. New York: Palgrave, Macmillan.
- Gros, B. (2003). The impact of digital games in education. *First Monday*. Available at www.firstmonday.org/issues/issue8_7/xyzgros/index.html
- Horowitz, Sosenko, Hoffman, Ziobrowski, Tafoya, & Haagenson, et al. (2006).
- Jackson, S., Low, J., Gee, S., Butler, C., & Hollings, J. (2007). *Children's media use and responses: A review of the literature*. Auckland, NZ: New Zealand Broadcasting Standards Authority.
- Johnson, S. (2005). *Everything bad is good for you: How today's popular culture is actually making us smarter*. New York: Riverhead Books.
- Livingstone, S. (2002). *Children's use of the Internet: A literature review*. London: Report to the National Children's Bureau.
- Lyman, P., with Billings, A., Ellinger, S., Finn, M., & Perkel, D. (2004). *Literature Review: Kids' informal learning and digital-mediated experiences*. Berkeley, CA: University of California. Available at http://www.exploratorium.edu/research/digitalkids/Lyman_DigitalKids.pdf
- Millwood Hargave, A., & Livingstone, S. (2006). *Harm and offence in media content: A review of the evidence*. Bristol, U.K.: Intellect Press.
- Mitchell, A., & Savill-Smith, C. (2004). *The use of computer and video games for learning: A review of the literature*. London: Learning and Skills Development Agency.
- O'Neil, H.F., Wainess, R., & Baker, E.L. (2005). Classification of learning outcomes: Evidence from the computer games literature. *The Curriculum Journal*, 16(4), 455–74.
- Prensky, M. (2001). *Digital game-based learning*. New York: McGraw-Hill.
- Provenzo, E.F. (1992). What do video games teach? *Education Digest*, 58(4), 56–58.
- Sefton-Green, J. (2004). Literature review in informal learning with technology outside school. Bristol, U.K.: NESTA Futurelab. Available at http://www.futurelab.org.uk/resources/documents/lit_reviews/Informal_Learning_Review.pdf.
- Shaffer, D.W., Squire, K.R., Halverson, R., & Gee, J.P. (2005). *Video games and the future of learning* (WCER Working Paper No. 2005-4). Madison: Wisconsin Center for Education Research, University of Wisconsin – Madison.
- Squire, K. (2001). *Video games in education*. Cambridge, MA: MIT Media Lab. Available at <http://educationarcade.org/gtt/pubs/IJIS.doc>
- Wartella, E., O'Keefe, B., & Scantlin, R. (2000). *Children and interactive media: A compendium of current research and directions for the future*. Menlo Park, CA: Markle Foundation.
- Wartella, E., Lee, G.H., & Caplovitz, A.G. (2002). *Children and interactive media: An updated research compendium*. Menlo Park, CA: Markle Foundation.

references

- American Academy of Pediatrics. (1999). Committee on Public Education Policy Statement on Media Education. *Pediatrics*, 104(2), 341–43.
- American Academy of Pediatrics. (2007, October 23). Tech-savvy kids present pediatricians with new challenges. *Newswise*. Retrieved November 1, 2007, from <http://www.newswise.com/articles/view/534547/>
- American Association of Colleges and Universities. (2007). *College learning for the new global century*. Washington, DC: Author.
- American Medical Association. (2007). *Emotional and behavioral effects of video games and Internet overuse*. Chicago, IL: Author.
- Anderson, D.R. (2006, March). *Children, media, methodology*. Presented at a workshop of the National Research Council, Washington, DC.
- Ask the Expert: Global education (Andreas Schleicher). (2006, October 17). *Financial Times*. Retrieved online November 27, 2007, at <http://www.ft.com/cms/s/2/e2d7f070-5d2c-11db-9d15-0000779e2340.html>
- Avallone, A. P. (2007, September). Statement on results from The Nation's Report Card: Reading 2007. National Assessment Governing Board. Available at <http://www.nagb.org/release/avallone-statement.doc>
- Ba, H., Tally, W., Tsikalas, K. (2002). Investigating children's emerging digital literacies. *The Journal of Technology, Learning, and Assessment*, 1 (4). Available from <http://www.jtla.org>
- Beale, I., Kato, P., Marin-Bowling, V., Guthrie, N., & Cole, S. (2007). Improvement in cancer-related knowledge following use of a psychoeducational video game for adolescents and young adults with cancer. *Journal of Adolescent Health*, 41(3), 263–70.
- Bernholz, L. (2006). *Pedagogy, playstations, and the public interest*. San Francisco: Blueprint Research & Design.
- Bracy, O.L., Oakes, A.L., Cooper, R.S., Watkins, D., Watkins, M., Brown, D.E., et al. (1999). Rehabilitation therapy techniques for enhancing the cognitive intellectual functioning of seventh- and eighth-grade children. *International Journal of Cognitive Technology*, 4(1), 19–27.
- Brightman, J. (2007, October 16). Video game playing on the rise among kids, PC dominates — NPD. *Game Daily Biz*. Retrieved December 22, 2007, from <http://www.gamedaily.com/articles/features/video-game-playing-on-the-rise-among-kids-pc-dominates-npd/71051/?biz=1>
- Bruner, J. (1986). *Actual minds, possible worlds*. Cambridge, MA: Harvard University Press.
- Bruner, J. (1990). *Acts of meaning*. Cambridge, MA: Harvard University Press.
- Bruner, J. (1996). *The culture of education*. Cambridge, MA: Harvard University Press.
- Cable in the Classroom & Common Sense Media. (2007). *Parenting moves online: Parents' Internet actions and attitudes, 2007*. Available at <http://i.ciconline.org/poll/Parenting%20Online%20Data1.pdf>
- Carnegie Corporation of New York. (1996). *Years of Promise; A Comprehensive Learning Strategy for America's Children*. New York: Author.
- Chall, J.S., & Jacobs, V.A. (2003). Poor children's fourth-grade slump. *American Educator*, 27(1), 14–15.
- Chambers, B., Cheung, A., Madden, N., Slavin, R.E., & Gifford, R. (2006). Achievement effects of embedded multimedia in a Success for All reading program. *Journal of Educational Psychology*, 98(1), 232–37.
- Chambers, B., Slavin, R.E., Madden, N.A., Abrami, P.C., Tucker, B.J., Cheung, A., et al. (in press). Technology infusion in Success for All: Reading outcomes for first graders. *Elementary School Journal*.

- Children Now. (2007). *The effects of interactive media on preschoolers' learning*. Oakland, CA: Author. Available at http://publications.childrennow.org/publications/media/prek_interactive_media_2007.cfm
- Cognitive Skills Group. (1997). *Development Overview*. Harvard Project Zero. Presented on T-543 Web site at Harvard Graduate School of Education.
- Coiro, J., & Dobler, E. (2007). Exploring the online reading comprehension strategies used by sixth-grade skilled readers to search for and locate information on the Internet. *Reading Research Quarterly*, 42(2), 214–57.
- Educational Testing Service. (2002). *Digital transformation: A framework for ICT literacy*. Princeton, NJ: Author.
- Fackler, M. (2007, November 18). South Korea opens boot camp to confront cyberspace addiction. *New York Times*, p. A1.
- Fallows, J. (1989). *More like us: Making America great again*. Boston: Houghton Mifflin.
- Fields, D.A., & Kafai, Y.B. (2007). *Tracing insider knowledge across time and spaces: A connective ethnography in a teen online game world*. Los Angeles: University of California at Los Angeles. Retrieved August 15, 2007, from http://66.102.1.104/scholar?hl=en&lr=&q=cache:siZ_gSmz-JEJ:www.gseis.ucla.edu/faculty/kafai/paper/whyville_pdfs/CSCLO7_fields_kafai.pdf+kafai+whyville+insider
- Fisch, S.M. (in press). Educational television and interactive media for children: Effects on academic knowledge, skills, and attitudes. In J. Bryant & M.B. Oliver (Eds.), *Media Effects* (3rd ed.). Mahwah, NJ: Lawrence Erlbaum Associates.
- Fisch, S.M., & Truglio, R.T. (Eds.). (2001). *"G" is for growing: Thirty years of research on children and Sesame Street*. Mahwah, NJ: Lawrence Erlbaum Associates.
- Fiske, E.B. (2005). *States Prepare for the Global Age*. New York: Asia Society. Available at <http://www.internationale.org/statespreparefortheGLOBALAGE.pdf>
- Friedman, T.L. (2005). *The world is flat: A brief history of the twenty-first century*. New York: Farrar, Straus & Giroux.
- Gee, J.P. (2007). *Literacy, technology, and content: Married*. Unpublished manuscript, Program in Language and Literacy, College of Education, Arizona State University.
- Gould, S.J. (1988, August 18). The streak of streaks. *New York Review of Books*, 35(13).
- Green, C.S., & Bavelier, D. (2007). The cognitive neuroscience of video games. In P. Messaris & L. Humphreys (Eds.), *Digital media: Transformations in human communication*. New York: Peter Lang Publishing Group.
- Gros, B. (2003, July). The impact of digital games in education. *First Monday*. Retrieved December 22, 2007, from www.firstmonday.org/issues/issue8_7/xyzgros/index.html
- Gunther, V.K., Schafer, P., Holzner, B.J., & Kemmler, G.W. (2003). Long-term improvements in cognitive performance through computer-assisted cognitive training: A pilot study in a residential home for older people. *Aging & Mental Health*, 7, 200–06.
- Hasselbring, T.S., & Williams Glaser, C.H. (2000). Use of computer technology to help students with special needs. *The Future of Children: Children and Computer Technology*, 10(2), 102–22.
- Horowitz, J., Sosenko, L., Hoffman, J., Ziobrowski, J., Tafoya, A., Haagenson, A., et al. (2006, August). Evaluation of the PBS Ready to Learn cell phone study: Learning letters with Elmo. Los Alamitos, CA: WestEd. Available at http://www-tc.pbs.org/readytolearn/research/PBS_CPS_Report.pdf
- Huffaker, D.A., & Calvert, S.L. (2003). The new science of learning: Active learning, metacognition, and transfer of knowledge in e-learning applications. *Journal of Educational Computing Research*, 29, 325–34.
- International Society for Technology in Education. (2007). National Educational Technology Standards for Students (NETS•S) in 2007. Accessed January 11, 2008, at http://www.iste.org/Content/NavigationMenu/NETS/For_Students/NETS_S.htm

references (cont.)

- Iyengar, S., & Ball, D. (2007). *To read or not to read*. Washington, DC: National Endowment for the Arts.
- 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: John D. and Catherine T MacArthur Foundation. Available at <http://digitallearning.macfound.org/site/pp.aspx?c=enJLKQNLFiG&b=2029291>
- Koepp, M.J., Gunn, R.N., Lawrence, A.D., Cunningham, V.J., Dagher, A., Jones, T., et al. (1998). Evidence of striatal dopamine release during a video game. *Nature*, 393(6682), 266–68.
- Leitch Review of Skills. (2006). *Prosperity for all in the global economy — World-class skills*. London: Her Majesty's Treasury.
- Leu, D.J., Reinking, D.P., Carter, A.R., Castek, J.M., Coiro, J.L., Henry, L.A., et al. (2007, April). *Defining online reading comprehension: Using think-aloud verbal protocols to refine a preliminary model of Internet reading comprehension processes*. Presented at the meeting of the American Educational Research Association, Chicago.
- Livingstone, S. (2003). Children's use of the Internet: Reflection on the emerging research agenda. *New Media & Society*, 5(2), 147–66.
- Lyman, P., with Billings, A., Ellinger, S., Finn, M., & Perkel, D. (2004). *Literature Review: Kids' informal learning and digital-mediated experiences*. Berkeley, CA: University of California. Available at http://www.exploratorium.edu/research/digitalkids/Lyman_DigitalKids.pdf
- McGurk, H., & MacDonald, J. (1976). Hearing lips and seeing voices. *Nature*, 264, 746–48.
- Murray, J.H. (1997). *Hamlet on the holodeck: The future of narrative in cyberspace*. Cambridge, MA: MIT Press.
- Nagamitsu, S., Nagano, M., Yamashita, Y., Takashima, S., & Matsuishi, T. (2006). Prefrontal cerebral blood volume patterns while playing video games — A near-infrared spectroscopy study. *Brain & Development*, 28, 315–21.
- National Assessment of Educational Progress (NAEP). (2007, September). Available at http://nces.ed.gov/nationsreportcard/pdf/main2007/2007496_2.pdf
- National Center on Birth Defects and Developmental Disabilities. (2005). *Middle childhood (6 to 8 years old) and middle childhood (9–11 years old)*. Available at <http://www.cdc.gov/ncbddd/child/default.htm>.
- National Center for Educational Statistics. (2005, March). *Computer technology in the public school classroom: Teacher perspectives*. (Issue brief). Washington, DC: U.S. Department of Education. Available at <http://nces.ed.gov/pubs2005/2005083.pdf>
- National Geographic–Roper Public Affairs. (2006). *2006 Geographic Literacy Study*. Washington, DC: National Geographic Education Society. Retrieved on November 27, 2007, from <http://www.nationalgeographic.com/roper2006/pdf/FINALReport2006GeogLitsurvey.pdf>
- National Research Council. (1999). *How people learn: Brain, mind, experience, and school*. Washington, DC: The National Academies Press.
- National Research Council. (2006). *Studying media effects on children and youth: Improving methods and measures*. (Workshop summary). Washington, DC: The National Academies Press.
- Navarro, M. (2007, October 28). Pay up, kid, or your igloo melts. *New York Times*. Retrieved December 14, 2007, from http://www.nytimes.com/2007/10/28/fashion/28virtual.html?_r=1&oref=slogin
- Neuman, S. (2002). *The Role of School Libraries in Elementary and Secondary Education*. *Knowledge Quest*, 31(Suppl. 1), 13–16.

- 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*, April–June 2006, 41 2, 176–201.
- North Central Regional Educational Laboratory & The Metiri Group. (2003). *enGauge 21st century skills: Literacy in the digital age*. Naperville, IL: Author.
- Oppenheimer, T. (1997, July). The computer delusion. *The Atlantic Monthly*, 280(1), 45–62.
- Orleans, M., & Laney, M.C. (2000). Children's computer use in the home: Isolation or sociation? *Social Science of Computer Review*, 18, 56–72.
- Paivio, A. (1986). *Mental representations: A dual-coding approach*. New York: Oxford University Press.
- Partnership for 21st Century Skills. (2007). Beyond the Three Rs: Voter Attitudes toward 21st Century Skills. Retrieved November 15, 2007, from http://www.21stcenturyskills.org/documents/P21_pollreport_singlepg.pdf
- Prensky, M. (2001). Digital natives, digital immigrants. *On the Horizon*, 9(5). Retrieved August 8, 2007, from <http://www.marcprensky.com/writing/Prensky - Digital Natives, Digital Immigrants - Part1.pdf>
- RAND Reading Study Group. (2002). *Reading for understanding: Toward an R&D program in reading comprehension*. Santa Monica, CA: RAND Corporation.
- Resnick, M. (2002). Rethinking learning in the digital age. In G. Kirkman (Ed.), *The Global information technology report: Readiness for the networked world* (32–37). New York: Oxford University Press. Available at <http://llk.media.mit.edu/papers/mres-wef.pdf>
- Rideout, V., Roberts, D.F., & Foehr, U.G. (2005). *Generation M: Media in the lives of 8–18-year-olds*. Menlo Park, CA: The Henry J. Kaiser Family Foundation.
- Rogoff, B. (1990). *Apprenticeship in thinking: Cognitive development in social context*. New York: Oxford University Press.
- Rosas, R., Nussbaum, M., Cumsille, P., Marianov, V., Correa, M., Flores, P., et al. (2003). Beyond Nintendo: Design and assessment of educational video games for first- and second-grade students. *Computers & Education*, 40(1), 71–94.
- Shaffer, D.W., (2005). *Multiculturalism: Computers and the end of progressive education* (Working Paper No. 2005-5). Madison: Wisconsin Center for Education Research. Available at http://72.14.205.104/search?q=cache:A3DXE1iQbQJ:https://www.wcer.wisc.edu/publications/workingPapers/Working_Paper_No_2005_5.pdf+Shaffer+%22Epistemic+frames+are+a+form+of+knowing%22&hl=en&ct=clnk&cd=4&gl=us
- Shaffer, D.W., & Gee, J.P. (2005). *Before every child is left behind: How epistemic games can solve the coming crisis in education*, WCER Working Paper 2005-7. Madison: Wisconsin Center for Education Research.
- Shonkoff, J., & Phillips, D. (2000). *From neurons to neighborhoods: The science of early childhood development*. Washington, DC: National Academy Press.
- Shuler, C. (2007) *D is for Digital: An analysis of the children's interactive media environment with a focus on mass-marketed products that promote learning*. New York: The Joan Ganz Cooney Center at Sesame Workshop.
- Snow, C.E., Burns, M.S., & Griffin, P. (Eds.). (1998). *Preventing reading difficulties in young children*. Washington, DC: The National Academies Press.
- Squire, K. (2002). Cultural framing of computer/video. *Game Studies: The International Journal of Computer Game Research*, 2(1). Retrieved August 8, 2007, from <http://www.gamestudies.org/0102/squire/>
- Steinemann, N.K., Fiske, E.B., & Sackett, V. (2000). *Asia in the Schools: Preparing young Americans for today's interconnected world*. A Report of the National Commission on Asia in the Schools. New York: Asia Society.
- Subrahmanyam, K., Greenfield, P., Kraut, R., & Gross, E. (2001). The impact of computer use on children's and adolescents' development. *Journal of Applied Developmental Psychology*, 22, 7–30.

references (cont.)

- Tallal, P. (2000). The science of literacy: From the laboratory to the classroom. *Proceedings of the National Academy of Science*, 97(6), 2402–04.
- U.S. Department of Education. (2002). *Digest of education statistics 2002*. Washington, DC: Author.
- Vandewater, E., & Lee, S-J. (2006, March). *Measuring children's media use in the digital age: Issues and challenges*. Background paper prepared for the Workshop on Media Research Methods and Measures. National Academies of Science, Washington, DC. Available at <http://www.bocycf.org/o3o2o6.html>.
- Vygotsky, L.S. (1978). *Mind in society*. Cambridge, MA: Harvard University Press.
- Wartella, E.A., & Jennings, N. (2000.) Children and computers: New technology — old concerns. *The Future of Children: Children and Computer Technology*, 10(2), 31–43.
- White, B.Y., & Fredrickson, J.R. (1998). Inquiry, modeling, and metacognition: Making science accessible to all students. *Cognition and Instruction*, 16, 3–117.

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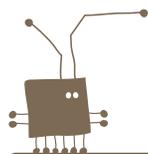


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