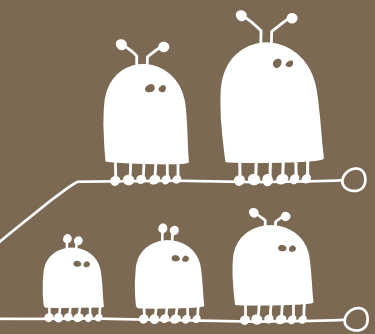
Take a giant step:

A blueprint for teaching young children in a digital age



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executive summary

Across the nation and the political spectrum, Americans are calling for dramatic improvement of public education. At the same time, the country is in an era of scarce funding for new initiatives. In this context, this report identifies a timely opportunity and challenge: By integrating emerging digital technologies into education and lifelong learning for all professionals, beginning with teachers of children aged 3 through 8, we can establish a cost-effective and productive pathway for learning in the 21st century.

This approach is timely because years of education reform efforts have established a current policy environment where the following key factors are present:

- a core of common **standards** emphasizing 21st century skills and increased curricular depth;
- legislatively enforced **accountability** for student outcomes, which provides the needed leverage for reform;
- progress in developing **improved assessments** to test higher-level skills along with fundamental knowledge;
- an increased **commitment to learning in early childhood** in the nation's policy and business sectors as a result of new infrastructure and greatly expanded investment;
- incentives for states to develop comprehensive plans that include **improved teacher preparation and professional development**; and
- evolving digital technologies and a wealth of **public media assets** that create new possibilities for transforming teaching and learning.

With the first five factors laying the foundation for substantial education improvement, rapidly developing digital technologies can bring momentum and immense new capacity to student learning, teacher preparation, and professional development.

A particularly powerful benefit of these new technologies is their capacity for deepening and personalizing learning. Up until now, teachers typically have geared most of their instruction to meet the needs of the average child and have been limited in their ability to individualize strategies and materials to meet the needs of all learners. Today, through technology they will increasingly be able to differentiate instruction, and learners themselves will be able to have greater control of the paths and pace of their own learning.

Given the growing ubiquity of digital media in most children's lives, thoughtful integration of technology in learning environments can benefit children as young as ages 3 to 8. Enhanced, modernized early learning will improve their long-term prospects for school success. Technology is most productive in young children's lives when it enhances their engagement in the rich activities of childhood — talking, interacting, manipulating, pretending, reading, constructing, exploring — as well as in children's reflections on their actions and experiences. Digital media that can contribute in these ways and that also exposes children to new knowledge and enriching vocabulary are emerging, as evident in the examples offered in this report. Teachers in the early grades and beyond can make use of such strategies to improve learning for young children and better meet individual needs.

However, in order to be effective, U.S. teachers need more robust professional preparation as well as more ongoing support than they currently receive, especially with respect to understanding children's learning and development, providing learning experiences with rich cognitive demands, and using new technologies to promote personalized learning and 21st century skills. In the enhancing of teacher education, digital tools can play significant roles — for instance in online courses, connected learning communities, and in websites and other media offering video teaching examples, curriculum plans, and materials. Leadership at the school, district, state, and national level is essential for capitalizing on opportunities made possible by technology integration in the classroom.

The challenge of improving teacher preparation and ongoing learning led to the creation of the Digital Age Teacher Preparation Council, established by the Joan Ganz Cooney Center at Sesame Workshop and the Stanford Educational Leadership Institute, with generous support from the Joyce Foundation. Beginning in January 2010, a group of 22 experts in a range of fields, including teacher education, public service media, literacy, technology, science and mathematics, and developmental science, convened to study emerging best practices, policy and program trends, as well as innovative approaches to enhancing children's learning and teacher education and support.

The Council's work is the basis for *Take a Giant Step*, which states five key goals for the nation to meet by 2020, as well as immediate and discrete step-wise actions to provide significant innovation in instruction and teacher preparation.

The first goal emphasizes creating communities of practice with a great deal more teacher collaboration and planning than is currently evident. This kind of professional environment for teachers — pervasive in high-performing countries — can exist far more widely in the United States, but first, education leaders need to restructure time and staffing so that teachers can work together and with groups of students in new ways that are supported by technology.

Beyond restructuring time and staffing in schools, we need to give American teachers significantly better preparation, professional development, and supports than they receive today. Enhancing technology infrastructure and capabilities will bring fresh potential for teachers' preparation and professional development at relatively low cost. To date, higher education, K-12 schools, and early learning programs have made only slow and scattered progress in changing their educational practices. By working together they can take a major step forward in providing

productive educational support across grades and settings by adopting shared standards for student outcomes — standards that reflect the developmental and learning sciences, national common core approaches, and the full range of learning associated with new technologies. A vision of developmentally connected learning from ages 3 to 8 can drive coordinated efforts of teachers, families, and the community. This report outlines specific recommendations for advancing this goal.

The second goal is to train early educators to integrate digital and screen media into their teaching practices in developmentally appropriate ways. The Council recommends that every accredited early childhood setting be assessed against new technology integration standards to be developed by field leaders such as the National Association for the Education of Young Children (NAEYC). The Council also concludes that a step-wise approach to introducing new professional development capacity to early education programs of diverse professional need should take place via cost-effective distance learning methods.

The third goal articulated here is to expand use of public media as a resource for teachers. The public media assets developed by highly trusted, research-based organizations for educational media distribution are a largely untapped and very low-cost resource. Moreover, they have the potential to extend and connect the learning that takes place at home and in school. New models for preparing teachers to use these assets for educational impact can be constructed efficiently without starting from scratch; emerging models for teachers to share their innovations in both the private and public sectors appear promising. This report offers a range of examples and descriptions of how public media assets may be brought into play. Further, the creation of innovative models for public-private partnership investments in public media assets to help align and strengthen the impact of teacher quality improvements is worth pursuing.

The fourth goal is to integrate technology supports into standards, curriculum, and teaching. The Council recommends that the federal government partner with states and the private sector to ensure that a technology infrastructure exists in every school and community. At the highest levels of policy, new priority must be accorded to promote better teaching and learning from the start. Government agencies at the national and state levels can help ensure that new media technologies are deployed equitably for underserved children and their teachers.

Other proposed actions at the national level include providing states with funding and accountability incentives to align the instructional system of standards, assessments, and curriculum frame-works. At present, states hoping to "race to the top" are called upon to align both expectations for contemporary technology use and models of best practices for teaching with technology resources. A useful initial step would be to organize online curriculum repositories around instructional units and use them as interactive data collection systems; states and districts could then organize professional development around these materials, and teachers could customize individual, group, and online instruction for their needs.

Finally, the report calls for creation of R&D partnerships suited to the digital age. At present, public funding of technology tools and approaches is unevenly distributed, highly fragmented, and lacking in research priorities or mechanisms to foster interagency coordination and interdisci-plinary collaboration. Better mechanisms are needed to identify the added value from integrating digital media in instructional and assessment practices, as well as to develop rigorous design and performance metrics to advance teacher effectiveness.

An important first step is to carry out a strategic inventory of current R&D initiatives to determine more precisely what is being done to modernize the field of teacher education and professional development. Investing in infrastructure that supports R&D collaboration is also critical. We need to develop faster, cheaper multimedia sharing and delivery in order for teachers to access vital digital resources and to collaborate.

Useful first steps have been taken by the current administration in outlining new commitments to high-speed broadband access in most schools with priority to reach low-income communities.

In brief, *Take a Giant Step* identifies key challenges in moving U.S. education to the level required in our global age. Because the teacher is the key to educational effectiveness, we must direct much of our effort toward teacher preparation and support. In this endeavor, emerging digital technologies can be powerful tools, but to achieve our goals we must have a blueprint and the concerted efforts of pivotal sectors, including national policymakers, states and districts, local communities, business, researchers, and public media. This report aims to provide input for such a blueprint and spur the engagement of all parties to evolve the plan and move forward together, starting now.

the digital age teacher preparation council

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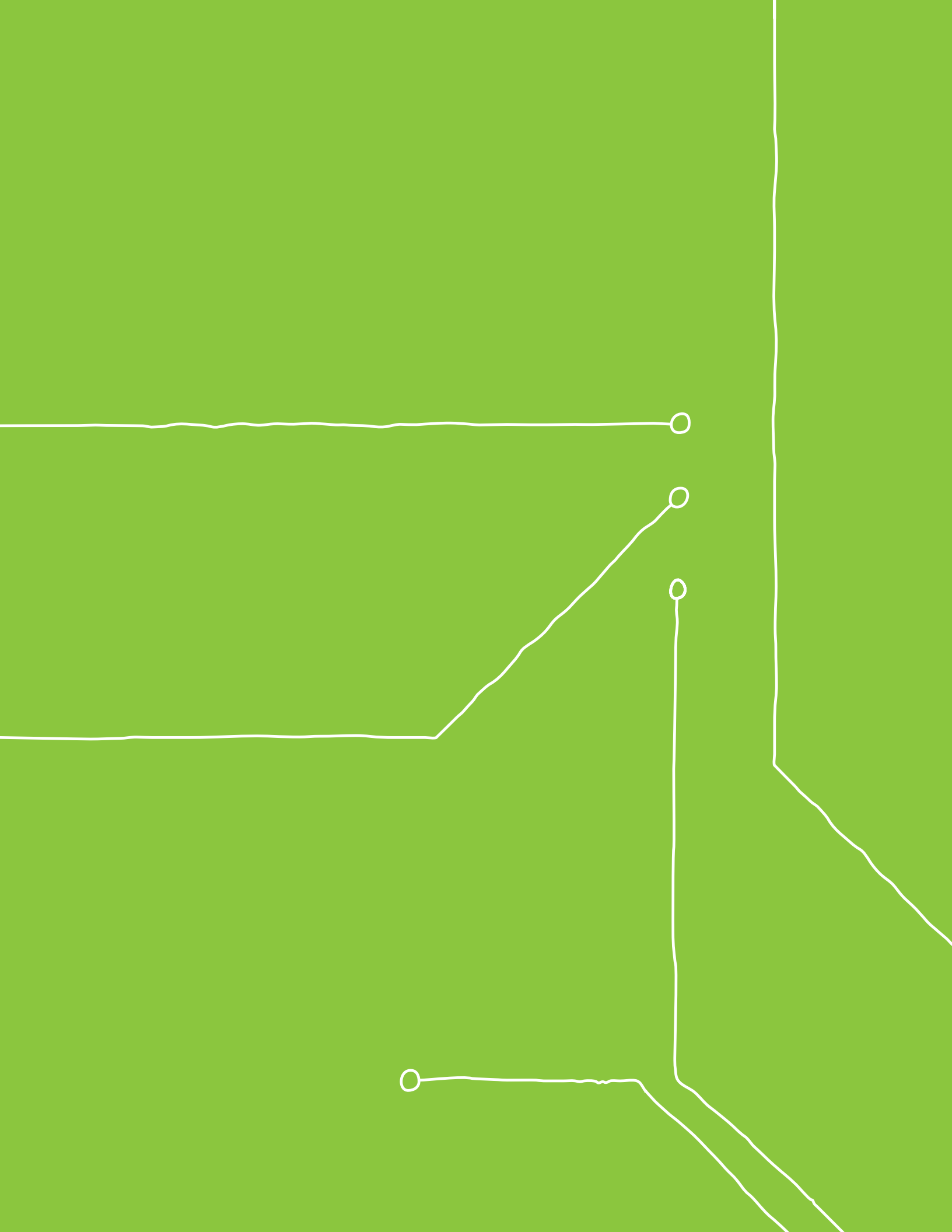
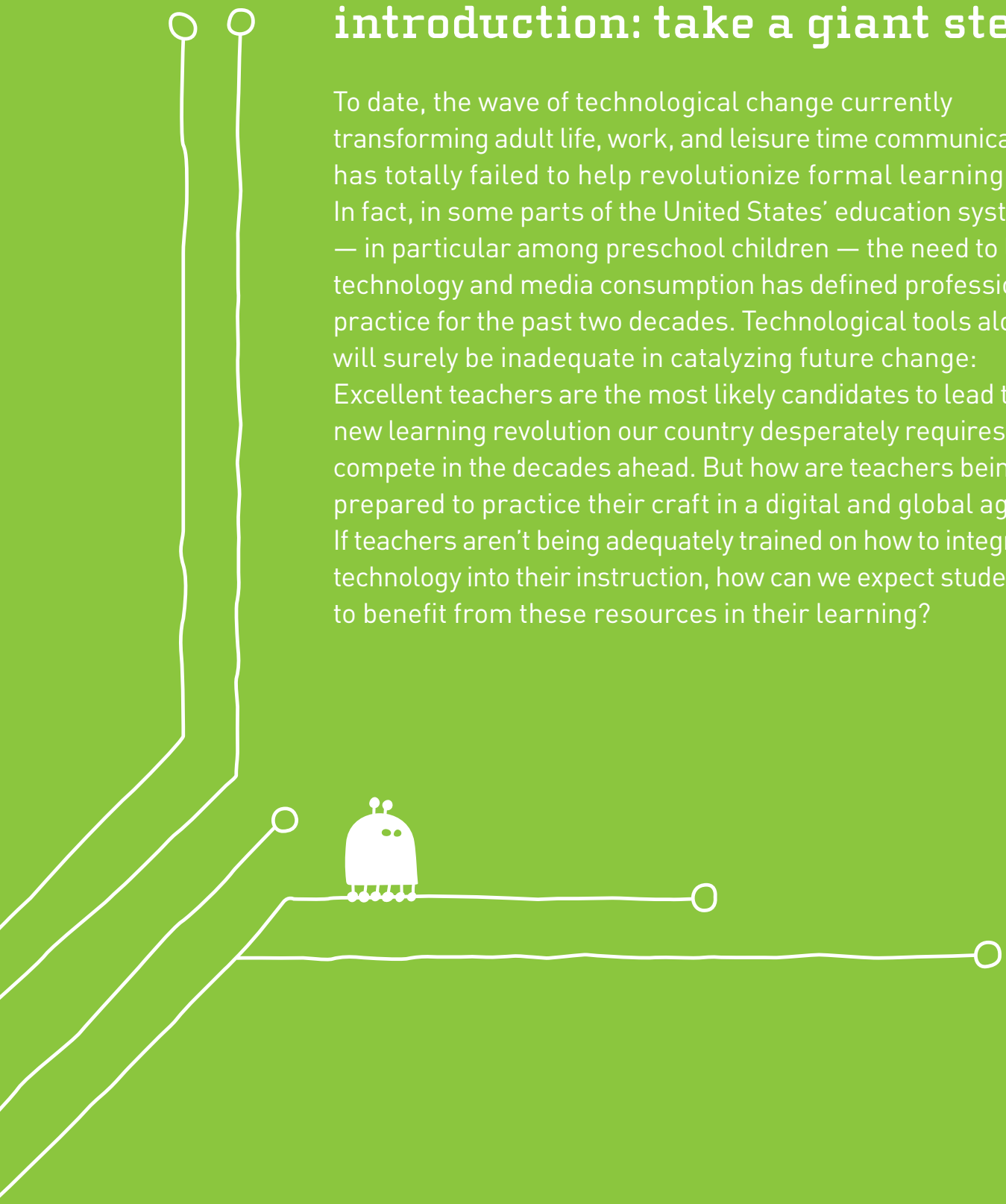


introduction: take a giant step

To date, the wave of technological change currently transforming adult life, work, and leisure time communication has totally failed to help revolutionize formal learning. In fact, in some parts of the United States' education system — in particular among preschool children — the need to limit technology and media consumption has defined professional practice for the past two decades. Technological tools alone will surely be inadequate in catalyzing future change: Excellent teachers are the most likely candidates to lead the new learning revolution our country desperately requires to compete in the decades ahead. But how are teachers being prepared to practice their craft in a digital and global age? If teachers aren't being adequately trained on how to integrate technology into their instruction, how can we expect students to benefit from these resources in their learning?



These questions led to the creation of the Digital Age Teacher Preparation Council, established by the Stanford Educational Leadership Institute and the Joan Ganz Cooney Center at Sesame Workshop, with generous support from the Joyce Foundation. In January 2010, a group of 22 experts in a range of fields including teacher education, public service media, literacy, technology, developmental and learning sciences, and mathematics, convened to study emerging best practices, policy and program trends, and innovative approaches to enhancing young children's learning as well as teacher preparation and ongoing education and support.

Charged with considering how to raise the quality of teaching in U.S. schooling through integration of technology — particularly for ages 3 through 8 — Council members reviewed recent research on professional development, technology integration, early childhood learning, and systemic education reform. Based on this analysis, the Council has formulated a blueprint for change. The blueprint urges that U.S. leaders and educators pay close attention to the significant roles digital technologies can play in building human capital and stimulating innovation, and recommends a series of action steps for key sectors to consider. Many public schools and teacher preparation institutions do not yet have the capacity for wide deployment of technology to accelerate teacher and student performance, but with a strategic action plan the nation can address these infrastructure issues. Lower relative costs, increased focus on productivity in education, and growing public demand for cutting edge tools in schools can help to move technology from the margins to a more central role in education improvement.

The blueprint is organized into four sections. First, it provides a conceptual framework that characterizes learning broadly as *life-long*, *life-wide*, and *life-deep*. This ecological framework is relevant to the learning of both the teachers and the young children that the Council's work supports. Second, it reviews the state of teacher preparation and professional development regarding technology integration into schools. Third, it presents a set of examples from the field related to teacher preparation and professional development and policy that focus on technology integration.

Finally, the blueprint offers educators and policymakers a set of recommendations regarding how to promote effective teaching and deep learning with the support of new technologies in classrooms across the U.S. If this blueprint sparks professional and policy action, the nation's early learning system will take a giant step forward.

A time ripe for action

Digital technologies offer a remarkable capability for accessing information and connecting schools, teachers, students, and families within neighborhoods, around the nation and around the world. These tools are altering everyday communication and transforming opportunities for learning. Blogging, social networking, podcasting, instant messaging, posting to newsgroups or boards, and the Internet itself have brought new ways to connect, collaborate, and share, transforming the way we live and work.

Together, these advances have led to the emergence of what has been called a new "participatory culture" (Jenkins, 2006). This culture simultaneously requires a host of new literacy skills and affords a dramatic re-envisioning of learning environments for both children and teachers. Even young children are able to not only access but produce content that can be shared and reacted to by a community beyond the classroom. Current technologies also offer possibilities for augmenting traditional approaches to instruction and for the development of mixed models that blend in-school and out-of-school learning. Importantly for education purposes, individuals can use such technologies at their own pace and in their own ways. This capacity for individualization for both students and teachers has the potential to enhance teaching and learning.

The promise of technological innovation to deliver change to our current education system — especially for our youngest students — is the focus of this report. In the past, education reform has been slow and scattered across the decentralized patchwork quilt of the nation's 50 states and more than 16,000 school districts. Yet today there are strong reasons to be optimistic

that, given a firm commitment, the U.S. can realize a wide and swift transformation in its schools. This potential exists because of rapidly developing technologies and because, after decades of education reform efforts, a number of other factors critical for change are now in place:

- Common Core[1] standards will enable the nation to move from the morass of state standards to greater curricular depth, **coherence and emphasis on 21st century skills**;
- Legislatively enforced **accountability** for student outcomes provides the needed leverage for reform, and progress is being made in developing **assessments** to test higher-level skills along with fundamental knowledge;
- The nation's policy and business sectors have expressed an increased **commitment to learning in early childhood** with new infrastructure in place in many states and expanded investment that will likely grow in the decade ahead;
- New incentives are motivating the states to develop comprehensive plans that include crucial elements such as **teacher support and professional development**; and
- A wealth of **public media assets** is creating new possibilities for transforming teaching and learning. High-quality video segments designed to teach many concepts and skills can be used in new interactive formats and contexts in and out of the classroom. The range of platforms (e.g., games, websites, mobile devices) over which these media assets can be viewed today offers new modalities to enhance learning.

Technology's potency in facilitating reform depends on the presence of these factors. Although some teachers are taking on the challenge of learning how to incorporate technology into the classroom on their own initiative, they are in the minority and typically have access to a strong social network of support. Leadership at the school, district, state, and national level is essential for envisioning and realizing opportunities, and this message has been communicated regularly by organizations such as the International Society for Technology & Education (ISTE), the Consortium of School Networks (CoSN), and the George Lucas Educational Foundation.

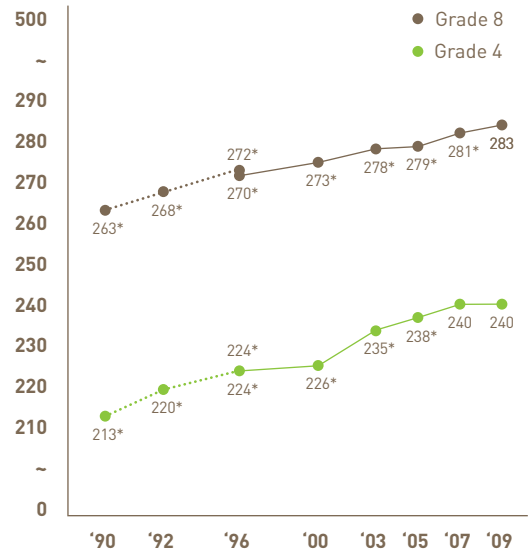
We see the task of capitalizing on the opportunities in front of us as an interdisciplinary challenge that requires expertise from social scientists, educators, policy makers, and designers of new media technologies.

Other national education organizations express hope that technology can play an important role in improving the quality of teaching and learning in U.S. schools. Table 1 provides a subset of the recommendations expressed in recent position statements by these organizations.

Critical learning gaps — new and old

Despite decades of reform efforts and some modest gains in the U.S., educational progress has been slow and appears to be stagnant. As reported in the National Assessment of Educational Progress in 2009, student scores on fourth grade reading and math have plateaued (see Figures 1 and 2 on pp. 10 and 13 respectively).

Figure 1: Trend in fourth and eighth grade NAEP mathematics average scores



* Significantly different ($p < .05$) from 2009.

Source: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), various years, 1990–2009 Mathematics Assessments.

[1] The Common Core Standards in English Language Arts and Mathematics Education were established in 2010 and mark a movement towards a national set of standards. At the time of this printing, 44 states and U.S. territories have adopted the Common Core.

Table 1: Excerpts from policy statements and position papers authored by educational organizations

International Reading Association 2009	Internet, multimedia and other information and communication technologies (ICTs) need to be considered and integrated in literacy education. "Providing adequate education and staff development will ensure that each teacher is prepared to effectively integrate new literacies into the curriculum." (p. 2) "Teacher education programs can play a critical role in preparing teachers to use new technologies for instruction." (p. 2) "Creative initiatives to increase access, provide professional development, and enhance teacher education should be supported by professional literacy organizations." (p. 2) "An intensive program of research on literacy and technology will enable us to better understand the rapid changes taking place in the nature of literacy and literacy instruction." (p. 2) "We must pay particular attention to the critical literacies that new technologies demand." (p. 2)
National Staff Development Council: Professional Learning in the Learning Profession Darling-Hammond, Wei, Andree, Richardson, & Orphanos, 2009	Teachers include among their top four priorities for further professional development "using technology in the classroom" (along with learning more about the content they teach, classroom management, and teaching students with special needs). The United States is "far behind" in offering extended learning opportunities for teachers. Nations that outperform the U.S. educationally build ongoing, sustained professional development into teachers' work hours. "Effective professional development is intensive, ongoing and connected to practice. Sustained and intensive professional development is related to student gains." (pp. 5-6) "Collaborative approaches to professional learning can promote school change that extends beyond individual classrooms." (pp. 5-6) *Table continues on p.12*

High school graduation rates are alarmingly low, and students who do graduate often lack even the rudimentary skills and knowledge necessary to cope with the demands of the workplace and postsecondary education. On virtually every academic proficiency indicator on which they compete with students in other developed nations, U.S. high school students' performance varies from mediocre to poor (NAEP, 2009). The achievement of ethnic minority, high-poverty, and immigrant children and youth lags even more, and our public schools largely fail to mitigate the barriers that these groups face.

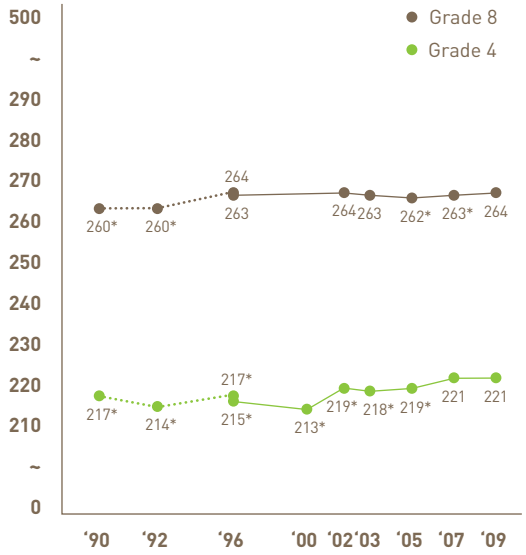
In fact, many other countries do a significantly better job of educating immigrant and high-poverty populations that are proportionately larger than those in the United States.

In part, other developed nations' superior education outcomes stem from the fact that they invest substantially more than does the United States in early care and education, child health, and family leave. These countries see such investment as critical for an educated populace, thriving economy, and stable society. Nearly all children participate in this voluntary,

Table 1: Excerpts from policy statements and position papers authored by educational organizations (cont.)

The NAEYC and Fred Rogers Center Joint Position Statement on Technology in Early Childhood Programs Serving Children from Birth through Age 8 Forthcoming, 2011	"Educators grounded in child development theory and developmentally appropriate practices, and who are technologically and media literate have the knowledge, skills, and experience to select and use technology and digital media that are appropriate for the ages and developmental levels of the children in their care, and they know whether, how, and when to integrate technology into the program effectively." "Educators need positive examples of how to successfully adapt and integrate technology into the classroom to enhance children's learning." "Educators need guidelines for the informed, intentional, appropriate, and integrated selection, use, and evaluation of technology tools with young children." "In the digital age, educators need pre-service and professional development opportunities to test new technology tools, learn about appropriate use of technology, and gain the knowledge and skills to implement them effectively."
Foundation for Child Development: Core Knowledge for PK-3 Teaching Sadowski, 2006	Professional collaboration and development is key when it comes to utilizing new technologies in the classroom. "...simply knowing what resources are available is not enough; the best teachers know how to use resources to help them achieve their learning goals for their students." (p. 5) The organization of learning environments, including "incorporation of both small group and individual activities along with full-class instruction, and the integration of play with learning activities" (p. 4) is the foundation of proper implementation.

Figure 2: Trend in fourth and eighth grade NAEP reading average scores



* Significantly different ($p < .05$) from 2009.

Source: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), various years, 1992–2009 Reading Assessments.

universally available, quality early care and education, which is seen to promote both early learning and social integration across economic and other divides. Thus most children in these nations enter the primary grades well prepared for the learning ahead (Kamerman, 2006).

By contrast, in the United States, the students most in need of good teachers are the least likely to get them. Children living in poverty tend to experience the poorest quality early care and education environments. For example, in state-funded preschools, which serve many students from low-income families, studies have found that only 15% of classrooms are of "high quality," with 18% rated as "low quality" (Early, Barbarin, Bryant, et al., 2005; Mashburn, Pianta, Hamre, et al., 2008). A fairly large proportion of the classrooms were observed to have a "positive emotional climate." Far less frequent were instances of teachers intentionally promoting student learning and providing the high levels of instructional support that predict student outcomes (Pianta, Belsky, Houts, & Morrison 2007; Pianta, La Paro, & Hamre 2008).

Another difference between the U.S. and higher-achieving nations has emerged in recent years: Numerous countries outside the U.S. have successfully made the transition to teaching 21st century skills — critical thinking and problem solving, collaboration, accessing information, oral and written communication, and information and media literacy skills (Partnership for 21st Century Skills, 2008). However, in the United States, focus on such skills is not yet common. To promote students' acquisition of higher-order thinking, we must begin to test and teach quite differently. Essential levers for such change certainly include relevant standards and assessments, but enhanced and transformed teaching capacity is also needed. In this respect, technology can also play a number of key roles that we will examine in the section of this report on the preparation and professional development of teachers (See "Wanted: Effective 21st century teachers," p. 18).

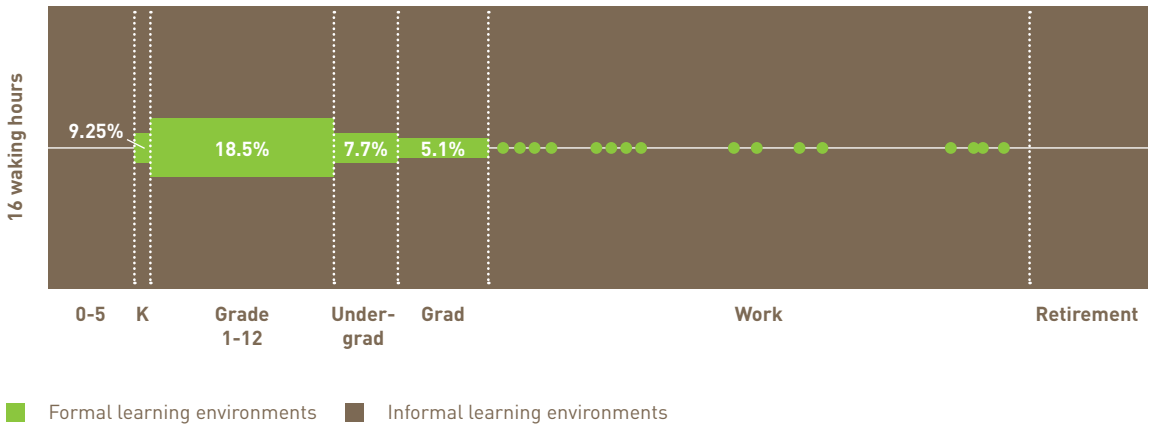
Conceptual framework: Life-long, life-wide, and life deep learning

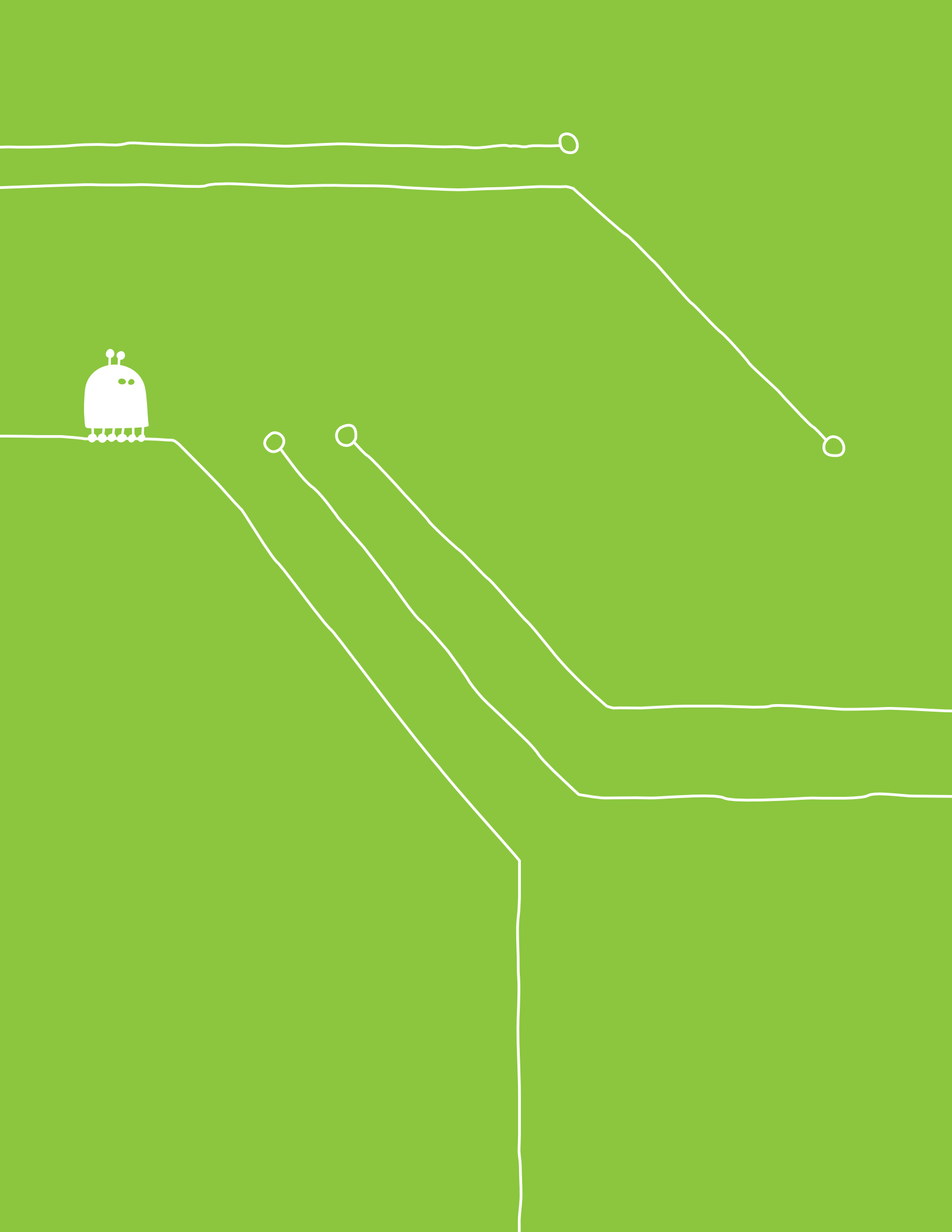
The authors of this report and the Council endorse what has been termed the life-long, life-wide, and life-deep perspective on learning, developed by the Learning in Informal and Formal Environments (LIFE) Center and offered in the National Education Technology Plan (Office of Educational Technology, U.S. Department of Education, 2010). This perspective takes into account the broader ecology of learning, including what children and adolescents experience in the home, in education and in care settings, their communities, and in their interaction with an increasingly broad array of media (Banks, Au, Ball, et al., 2007; Barron, 2006; Bell, Lewenstein, Shouse, & Feder, 2009; Bronfenbrenner, 1979; Lee, 2008; Bransford, Barron, Pea, et al., 2006). Figure 3 conceptually depicts how much time is spent in more and less formal learning environments across a child's life span (Banks et al., 2007). More than two thirds of all preschoolers now spend time outside of the home during the day

— a major shift from past generations. This is due largely to the rise of women's employment since 1970 and the desire of many families to provide socialization and different learning experiences to children before formal schooling begins. Although great variation exists across individuals, a significant amount of learning clearly takes place outside of school. Further, such learning is becoming easier all the time due to networked technologies.

Learning can also be said to be life-deep, reflecting values, beliefs, and interests that are linked to broader cultural patterns. Conceptualizing learning broadly as life-long, life-wide, and life-deep can help stakeholders address the challenges and capitalize on the opportunities offered by rapid advances in information and communication technologies (Banks et al., 2007). Council members are convinced that activities engaging children in problem solving and creating their own expressions and products via technology help to prepare them for the future. For designers, teacher educators, and policymakers, it will be helpful to consider how teachers and young children learn both within specific settings and across the multiple settings where they spend their time.

Figure 3: Life-long and life-wide learning

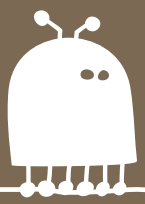




technology integration in the early childhood classroom: a review of programs and research

Technology and young children

Younger and younger children are becoming immersed in the consumption of media and the early adoption of technology in their homes. According to studies conducted by the Kaiser Family Foundation (Rideout, Foehr, & Roberts, 2010), Sesame Workshop, and others recently synthesized in the Cooney Center's report *Always Connected: The New Digital Media Habits of Young Children* preschool and primary grades children typically consume between 4 (for preschoolers) and 7.5 hours (for 8-year-olds) of media on a typical day. More than half of all children under 5 use some type of electronic learning toy, and watch an average of 3.5 hours of television in an average day. By the time they are 8, more than 70% of all children play video games on an average day, and 67% use the Internet on a daily basis. (Gutnick, Robb, Takeuchi, & Kotler, 2011)



Besides examining the environments in which young children live — including connected involvement with media and digital technologies — the task of thoughtfully integrating technology in and out of education settings requires careful consideration of what is known about childhood development and learning.

To learn and develop well cognitively, emotionally, physically, and socially, young children need to do a wide variety of things. Every day they should be interacting with one another and with adults, moving and exploring, manipulating objects, constructing, reading and creating representations, listening to (and then reading) books, engaging in pretend play, conversing, and forming relationships. This information about children's needs is the basic reason that early childhood teachers often believe that computers and "screen time" have little place in the early childhood setting; they are correct that technology should not replace these vital experiences of childhood. Rather, technology is most productive in young children's lives when it enhances children's engagement in these activities, as well as their reflections about their actions and experiences.

Integrating technology in early childhood education can take many forms. One is the approach used in the acclaimed Reggio Emilia schools in Italy, which have inspired U.S. practitioners. A fundamental premise of the approach dictates that children acquire and deepen their conceptual understanding by representing ideas and actions using different media, similar to the learning and usage of new languages (Edwards, Gandini, & Forman, 1998). Photography, videos, and computers also enable them to revisit prior experiences they seek to represent and understand. In the process of creating representations (with the support of teachers), children not only demonstrate what they know but become more aware of problems and possibilities and can deeply reflect on them.

Various education approaches and programs capitalize on the capacity of digital media to extend children's thinking and learning. For instance, children advance in spatial and mathematical understanding when they use digital media to manipulate objects and shapes in space, as in the well-researched Building Blocks curriculum. Evidence suggests that well-conceived digital media do in fact enable young children to gain greater awareness and more control over their own thinking and actions (Sarama & Clements, 2004). When a child clicks on a computer icon to rotate a shape on the screen, they are not performing an unconscious or intuitive manipulation as they might when physically putting together a puzzle or building with blocks; use of the icon tends to make the student more aware of rotation and thus "mathematizes" the experience.

In a project created by the Elliot Pearson Children's School at Tufts University that focused on the Boston Marathon, kindergartners created a storyboard and eventually made their own movie about the parts of the marathon that they found most interesting. Students assigned roles such as camera crew, directors, writers, and editors; considered the sequence of the scenes; and addressed a variety of real-world problems while shooting the video. All of the kindergarten children were able to become active, thoughtful participants in the experience (Mardell, 2009). A video documenting this curriculum titled "Learning is a Team Sport" is used in Massachusetts Charter Public School Association and NAEYC professional development workshops as a paradigm of the use of technology with young children to support the social nature of learning.

Another simple but powerful way of extending children's experiences through technology is through the viewing of video clips and the execution of "virtual field trips." Knowledge of the world undergirds children's learning in science, social studies, the arts, and other domains, and increases the richness of the dramatic play so fundamental to their development of self-regulation and other abilities. Moreover, children must have considerable background knowledge to comprehend what they read. Children from low income and immigrant families particularly need growth in background knowledge because their stock of experiences often doesn't match the content and language they encounter in books and other learning materials. Through digital media, children from urban areas can easily visit places like a dairy farm or orchard, and rural

students can explore a world-class museum or experience a ride on a subway. Students can even take a virtual trip to another galaxy or a distant environment like a rainforest, follow a team of explorers through each step of their journey, and often have extensive opportunities to interact with the environment.

Technologies such as educational video games, handheld devices, and media production tools may also enable children to broaden their experiences and observe how language and other symbol systems link in the world. Websites connected to public media including PBS KIDS and SesameStreet.org also have the potential to increase vocabulary and concept learning — especially the vocabulary and concepts of books and school materials — for children who need an extra boost to get ready for school. It has also been suggested that integration of highly engaging technology may help to prevent the loss of interest that contributes to the prevalent fourth grade reading slump[2] as students are introduced to more and more complex interactive software that engages them and continues to build their critical thinking, problem solving, and content knowledge (Gee, 2008).

Wanted: Effective 21st century teachers

The goal of transforming U.S. education so that all children can perform to higher standards and master 21st century skills has major implications for teacher pre-service and in-service education, and especially for the underdeveloped system of professional supports for teachers of young children. Teachers need to gain facility in using technology for a variety of purposes, and this challenge is just part of the broader undertaking: Becoming skilled in teaching methods that differ markedly from those generally used in the U.S today. These approaches include more personalized formats and methods such as project-based learning that engages students in actively thinking, creating, and collaborating on authentic[3] problems.

While these student-centered approaches are not novel (they appear in most teaching methods texts, and teachers generally see them as effective and appealing), relatively few American teachers regularly use them. Rather, whole-group instruction and seatwork fill most of the day in the majority of K-12 classrooms (National Institute of Child Health and Human Development (NICHD) Early Child Care Research Network, 2005). Similarly, in many pre-K classrooms, too few intentional teaching interactions take place, meaning that many early childhood teachers spend a good deal of time on transitions or create a situation lacking in concentrated, scaffolded learning time (Early et al., 2005). So, what stands in the way of widespread use of teaching methods that develop 21st century skills? Getting beyond standards and assessments that emphasize only facts and basic skills is part of the answer; however, dramatic changes in teaching also need to occur. Promoting deep conceptual understanding and higher-order thinking among students requires different classroom organization and management skills, curriculum, and pedagogy. Teachers must simultaneously engage with content, classroom management, and the ongoing monitoring of student progress. They need to be knowledgeable about children's learning paths, embrace a broad range of content and be prepared to make in-the-moment decisions as learning activities unfold. Finally, they need to be comfortable with new technologies and knowledgeable about how best to use them.

If a transformation in classroom practice is to occur, administrators and policymakers must not underestimate the challenge of enabling teachers to make this change. Teachers need far more robust training and support than they receive today, especially with regard to providing learning experiences, as the cognitive development of children that must be taken into account, as well as the classroom organization and management necessary to make such learning possible.

Effective teachers look to other teachers for inspiration, guidance, and support. Collaboration among teachers is common in high-performing countries such as Finland, New Zealand, and South Korea, and in U.S. schools that attain excellent student outcomes (Schleicher, 2008). In these settings teachers routinely work with their colleagues to conceive and refine lessons.

[2] Jeanne Chall first defined the fourth grade reading slump as the time when students fall behind in reading. The hypothesis is that the slump occurs because starting around the fourth grade, reading shifts from "learning to read" to "reading to learn" (Chall, 1983).

[3] Authentic learning refers to a type of learning and problem solving in which activities and tasks are situated in real world contexts (see Lombardi, 2007).

They observe each other's teaching; participate in formal, informal, and virtual communities of practice[4]; and jointly conduct research. In fact, teachers in countries including Japan, Taiwan, and South Korea teach only 35 to 60% of the time they are in school. Their remaining time is dedicated to working with colleagues, planning and assessing, and participating in a variety of professional growth experiences (Paine & Ma, 1993; Schmidt, McKnight, & Raizen, 1996).

Developing this kind of professional environment for teachers poses real challenges. For example, the issue of time: when in the day can schools find the release time for such collaboration? Technology can help, though only as part of broader efforts that restructure use of teacher and student time and foster new learning approaches. Well planned changes to technology infrastructure will enable teachers to more easily collaborate not only with colleagues in their building but those across town and around the country. Importantly, teachers can more readily communicate with those teaching in the preceding and subsequent grade levels, sharing information about children and working to increase the continuity and coherence of learning across age levels. Moreover, as students spend more time in highly interactive and personalized learning experiences aided by technology, teachers' time may be reconfigured to allow for more team work as well.

Building and maintaining high-quality websites, wikis, and digital resources to support teacher development is not a trivial challenge, but work is underway that offers promise for getting tools and resources into teachers' hands. For example, a variety of tools and web resources for teachers of children across the age spectrum are available on sites such as Reading Rockets, an initiative of WETA (which produces for PBS; http://www.readingrockets.org/), WGBH's Teachers' Domain (http://www.teachersdomain.org/), PBS's Teacher and Parent sites (http://www.pbs.org/teachers/ and http://www.pbs.org/parents/), and The Literacy Web at the University of Connecticut (http://www.literacy.uconn.edu/). Such sites offer professional development resources for teachers, as well as links and resources that their students can use.

Transforming professional development in early childhood education

In recent years, the states have expanded their early childhood presence with more funding of public prekindergarten, for which bachelor's level credentials are typically required. Also, Head Start, which employs over 50,000 teachers, has significantly raised teacher qualification requirements. Together these changes have created demand for a much larger pool of formally qualified early childhood educators.

In providing professional development for those working with children under age five, the challenges differ significantly from those for K-12 teachers. The pre-K teaching force is more diverse both in educational background and in the array of settings where individuals work. Among these settings are private and parochial preschools, child care centers, Head Start, state prekindergarten in the schools, family child care homes, and many other combinations and variations on these. Only 24% of the early childhood workforce are based in centers; the majority work in licensed (28%) or unregulated (48%) home-based settings (Burton, Whitebook, Young et al., 2002). As a result, providing more effective professional development and support in the early childhood world will require using a more complicated array of venues and strategies than in the K-12 sphere.

With respect to education level, about half of all teachers of 3- and 4-year-olds have a bachelor's degree. This figure differs widely by setting, however with close to 90% of college-educated teachers in public school prekindergarten programs and less than 40% in for-profit child care settings (Saluja, Early & Clifford, 2002). Separately, family child care providers, who serve large percentages of low-income children, have less formal education and access to training opportunities than their counterparts in center-based settings.

To compound the difficulties of producing a stable, well-qualified workforce in the U.S., present capacity to prepare people for positions in early care and education is low. Fewer than 30% of the higher education institutions offering two-year and four-year degrees even have early childhood

[4] Communities of Practice (CoP) refer to groups of people who come together to share knowledge regarding an interest, craft, or profession. CoPs can exist in physical settings and/or through virtual interactions (Wenger, 1998).

programs (Early & Winton, 2001). Moreover, a shortage exists in the pipeline of early childhood researchers and faculty at institutions of higher education, and few sources of funding assistance are available for individuals seeking to gain qualifications in the field.

In a comprehensive report, the Committee on Early Childhood Pedagogy concluded:

> There is a serious mismatch between the preparation (and compensation) of the average early childhood professional and the growing expectations of parents and policy makers. Teachers of young children are being asked to promote high levels of achievement among all children, respond sensitively and appropriately to a wide array of diverse student needs, implement complex pedagogy, have a deep understanding of subject-matter disciplines, engage in serious reflection about their practices, and work collaboratively with colleagues and families (National Research Council, 2001, p. 261).

Many teachers working with young children (indeed with any age group), have inadequate knowledge of development and learning. Teacher preparation programs often have insufficient coursework in child and adolescent development despite the fact that developmentally focused approaches to learning reliably produce gains in student achievement of over ten percentile points (National Council for Accreditation of Teacher Education, 2010). As such, the nation faces the significant challenge of ensuring that early childhood teachers have knowledge of child development and learning, plan and implement a valid curriculum that includes all developmental areas and subject areas, use intentional teaching strategies, assess children's progress, and communicate with families (NAEYC 2008; NCATE 2010).

Given the disparity between the preparedness of the early childhood workforce and the level of effective practice needed to achieve desired outcomes, new technological possibilities in professional development bring real opportunities and, at the same time, present special challenges. Providing online professional development and other forms of distance learning is a viable and rapidly growing sector of the field, especially at the community college level where a large proportion of early childhood teacher education takes place. Use of online learning and other digital media for purposes of staff development is also growing in Head Start, child care in the military, and for-profit child care — three significant sectors of the early childhood universe (Donohue & Neugebauer, 2004; Bright Horizons, 2011).

To be effective, professional development through digital technologies must reflect adult learning principles, particularly when learners have concerns about using technology — an issue more common among early childhood educators than among teachers in general (PBS & Grunwald, 2011). In discussions of the usage of technology however, there is wide agreement amongst early childhood professionals that distance education should facilitate interaction among members of a group, connecting them with others and helping them develop relationships (Bates, 2005).

Even well-conceived distance learning programs face barriers in attracting teachers' participation. Challenges exist relating to the program's perceived credibility and participants' discomfort or anxiety about using the technology involved in distance learning. As a remedy, programs and courses can boost their credibility by associating with a university program, ensuring that courses are credit-bearing (both at the pre-service and in-service levels), and providing clear guidelines on how courses can fit into a larger career plan. Useful too is offering technical support to teachers even before online courses start so that individuals are more comfortable participating.

Taking on the challenges of in-service education

Providing in-service education in the early childhood field tends to be even more difficult than providing pre-service education. One issue is the venue for training. Participants typically work in widely scattered locations and have less release time and compensation for time spent in professional development than do

their counterparts in K-12. If staff can participate in these experiences at or near their workplace, their involvement is facilitated. For example, ease of access to training was one of the positive features of the model used in HeadsUp! Reading, a 30-hour literacy course that reached approximately 10,000 teaching staff working with children from birth to age 5 over a four-year period (Jackson, Lazerlere, St Clair et al., 2006). In this program, over the course of a semester, groups of participants observed live satellite TV broadcasts featuring literacy experts, videotapes of excellent practice, and participated in call-in opportunities. A trained on-site facilitator mediated the learning experience, and web-based support was also offered. Although HeadsUp! Reading is no longer broadcast live, many community college faculty continue to use its archived programs because of its powerful video images of good practices.

Two online professional development courses from PBS target early childhood teachers: *Raising Readers: Preparing Preschoolers for Success, and Raising Readers: Ready to Read and Write with Digital Media*. PBS Teacherline develops, distributes, and facilitates these courses, which focus on how early childhood educators can promote children's reading and writing skills. In an evaluation of these two courses, preschool teachers were found to learn more about early literacy, have more positive attitudes about several literacy-related areas, and spend more time engaged in literacy activities in the classroom when compared with a control group. The second course also instructs teachers on how to use Ready to Learn digital resources. The teacher participants reported that they did intend to use these resources in the classroom following the course (Goldenberg, Strother, Meade et al., 2010).

A group of early childhood educators frequently neglected in professional development is home-based caregivers (including family child care providers and family members, friends, and neighbors) — especially in rural populations. The Better Kid Care Program at Pennsylvania State University targets these groups by providing videos, workbooks, and assignment questions as part of professional development courses, which can be done through the mail or online.

Publicly available teacher professional development resources for early childhood educators

The Better Kid Care Program: Provides professional development opportunities and educational information on caring for children at http://betterkidcare.psu.edu/

HeadsUp! Reading: HeadsUp! Reading is no longer broadcast live, but is still available through Ready to Learn Providence at http://www.r2lp.org/matriarch/MultiPiecePage.asp_Q_PageID_E_61_A_PageName_E_WhatInvestingHeadsUpReading

PBS Teacherline: Offers standards-based graduate-level courses for teachers. Sign up at http://www.pbs.org/teacherline/

Raising Readers: Lessons, articles, and curricula available at http://pbskids.org/island/teachers/

Tools of the Mind: A research-based early childhood program that builds success in preschool and kindergarten children by promoting their intentional and self-regulated learning. Learn more at http://www.mscd.edu/extendedcampus/toolsofthemind/

Observing good teaching practices in action is a key ingredient in a number of the programs and approaches described above and in various other online courses, websites, and professional development venues. An exciting new spin on using video examples of teaching in professional development practice is the practice of bringing these resources directly to the teacher in the field via an iPad. With this technology, when a teacher wants to better understand a certain kind of scaffolding, for example, they can see classroom examples immediately, at the very moment when they are seeking to understand the strategy or principle. A Vygotsky-based approach called Tools of the Mind, which is used in preschool and kindergarten classrooms around the country and promotes children's self-regulation and cognition, is currently exploring this use of the iPad with very favorable response from teachers and coaches (D. Leong, personal communication, March 2, 2011).

The role of leadership and communities of practice

Successes in technology integration within rich professional development experiences, such as those noted above, require strong and dedicated leadership. In higher education, pre-K, and K-12 schools alike, leaders need to support a new culture of learning that includes implementing technology. Schools vary in how readily teachers are able to get technology support from school leaders, colleagues, and support staff. Informal support and peer encouragement for adoption have been shown to correlate with the diffusion of technology integration in schools.

Research in 16 elementary schools found that although teachers' own comfort level accounted for the most variance in their adoption of technologies, the access they had to expertise and help, as well as social pressure for innovating within a community of practice were also significant indicators of technology use. Frank, Zhao, and Borman (2004) argue that principals, superintendents, curriculum specialists and other school leaders can nurture such a community. For example, these leaders can designate professional development time to informal sharing. Additionally, they can identify and encourage individual teachers to become experts in particular innovations and then share their knowledge, using the Technology Coordinator Model of professional development (described in Table 2 on p.24) on a smaller scale. School leaders can also explicitly assess the network of relationships in their schools and strategically nurture new relationships that foster knowledge exchange. Finally, when a stronger sense of community exists, resources are more likely to flow through the organization. Thus, while we tend to focus on teachers as the primary change agents, it is clear that school leaders have opportunities to support the ongoing professional development that helps all school personnel establish and maintain a vision.

Building teacher expertise in integrating new technology

Teachers' positive attitudes toward and actual use of digital technologies in instruction are on the rise. A recent survey found that 62% of K-12 teachers frequently use digital media in classroom instruction. Pre-K teachers too are seeing the benefits of age-appropriate content and technology, with 82% reporting that they make use of digital content (PBS & Grunwald, 2009). Technical transformations include pervasive low-cost computing, broadband and Wi-Fi networking, ubiquitous low-cost HD video, open standards and open source components for building large scale platforms, multimedia-capable mobile devices (especially tablets), free, robust, and scalable audio/videoconferencing (such as Skype), and a variety of recommendation services (e.g., Amazon, Netflix, iTunes, Hunch). The Open Educational Resources movement has encouraged colleges, universities, faculty and K-12 education to use open resources and online courses freely offered for wide usage under a creative commons license to share, use, remix, improve, and redistribute content. These courses incorporate online learning resources — videos, books, lesson plans, games, simulations — and open source software tools to enable creation, delivery, use and improvement of open learning content (Atkins, Brown & Hammond, 2007; Smith, 2009). Individually these technical and social changes may be viewed as incremental; collectively, they can be integrated to huge advantage.

Another boon to teacher development and technology expertise is the work of pioneering states and local districts which have introduced eLearning networks. These networks reach students with "blended learning models" (part direct classroom instruction and part online learning) for anytime, anywhere instruction. For example, the Florida Virtual School, which is now the largest state-supported virtual learning operation in the United States (reaching nearly 100 thousand children with courses in Florida alone), is now expanding into the primary grades. These new publicly supported online resources provide a promising way for highly effective teachers to reach students in any neighborhood

where there are huge demands on families, from a variety of convenient locations. The growing capacity of blended learning may soon prime new partnerships with Head Start and preschool programs, afterschool providers (such as Ys and Boys and Girls Clubs), and other community professionals who can help young students and their families learn.

Professional development for integrating educational technology needs to occur for three groups: teacher education faculty, pre-service teachers, and in-service teachers. Successful technology integration depends on how a given technology is actually used in the specific learning context (Cradler, Freeman, Cradler & McNabb, 2002). A number of promising approaches for professional development (PD) in technology integration emerged in the Digital Age Teacher Preparation Council's review of PD programs. Table 2 summarizes four main types: the Community with a Common Approach Model, the Technology Coordinator Model, the Ongoing Research Partnership Model, and the Distributed Expertise Model.

Each of these models relies on new collaborative relationships to support innovation. For example, many schools have re-envisioned the role of the librarian, broadening the title to include responsibilities as a technology coordinator or a media specialist. Library media specialists help teachers find digital media assets and can play a lead role in helping to envision ways to use networked resources to enhance learning. The American Association of School Librarians (AASL) (http://www.ala.org/ala/mgrps/divs/aasl/index.cfm) describes a range of roles including curriculum designer, resource finder, and important facilitator of students' information literacy. A number of schools of education are also developing programs that provide training for this new breed of librarian.

Momentum for education innovation is resulting from the convergence of technological and social transformations; they bring rich new potential for life-wide learning to many adults, including teachers. The challenges of preparing teachers to integrate new technologies into their teaching may be partially addressed by leveraging the capabilities of Web 2.0, which allows users to interact and collaborate with each other through social media[5] as consumers of user-generated content[6]—indeed to operate as a virtual community.

Technical glossary

Low-cost computing: Inspired by the One Laptop Per Child initiative (OLPC), low-cost computers are now more readily available to schools. Low-cost laptops typically cost under $350.

Broadband and Wi-Fi networking: High speed network access in schools provides students connection to the Internet at speeds acceptable for video, audio, and conferencing, resources that are difficult to use at dial-up speeds.

Open standards and open source components: An open standard is a published standard that is possessed by no one and may be used without a fee. Open source indicates that there is free reference material available for users.

Multimedia-capable mobile devices: Smart phones (e.g., iPhones and Android phones) and tablets (e.g., iPads) are small mobile devices that provide access to the Internet and often have audio and video recording capabilities.

Open Educational Resources (OER): OER are resources such as videos, lesson plans, and other educational materials offered freely and openly for educators, students, and the public to use for teaching, learning, and research.

[5] http://en.wikipedia.org/wiki/Social_media
[6] http://en.wikipedia.org/wiki/User-generated_content

Table 2: Promising professional development approaches

Community with a Common Approach Model This model is consistent with current understanding of quality professional development in general and involves establishing a community that is intentionally designed around common beliefs of the community members.	**Example:** As part of a PT3 grant[7], one university had graduate students attend teacher education courses to share how to use technology to teach a concept. However, faculty did not learn how to use the technology or integrate it for themselves, and felt like it was being forced upon them. The program worked together to develop a new model based on an agreed-upon set of beliefs for how technology can be helpful for communication, evaluation, and for other areas of teaching and learning. Within this new community, some faculty were more willing to experiment with integrating technology and to try again if their first attempt did not result in a better learning experience (Otero, Peressini, Meymaris et al., 2005).
Ongoing Research Partnership Model We found several examples of ongoing partnerships between universities and schools that were mutually beneficial. Within these, teachers had access to ongoing direct support from faculty and graduate students, access to technological resources, and opportunities to co-develop learning activities. The faculty and graduate students in turn benefited from access to classrooms where they could develop ideas about learning, and in some cases collect data.	**Example 1:** As part of a PT3 grant, one university experimented with a faculty-graduate student distributed expertise model. Graduate students were paired with faculty based on subject interests as course collaborators (rather than just course assistants). The graduate students offered their technology expertise and the faculty members brought their content expertise to the course planning meetings, and together they worked to "determine how technology could be used to enhance the instructional practices and learning" in their courses (Otero et al., 2005, p 11). The graduate students started by helping several faculty in a common area and gradually reduced the amount of assistance. **Example 2:** The U.S. Department of Education's Ready to Learn initiative has produced educational media, research, and outreach materials for underserved 2-8-year-olds. A 10-week media rich early literacy curriculum and corresponding professional development program was implemented in preschool classrooms with teachers representing a broad range of preparation experiences. Participating centers received teacher guides with daily scripts, detailed activity guides, and manipulatives. In addition to these materials, teachers participated in a two-hour orientation led by a coach that familiarized them with the materials. Coaches then provided on-site support that included examples of good teaching practice, as well as observation and assistance, with implementation. Each visit was two hours long on average and occurred during eight of the ten weeks. Between visits, coaches provided support via email or telephone.

[7] PT3 (Preparing Tomorrow's Teachers to use Technology) was a grant program run by the U.S. Department of Education from 1999 to 2003 to address the challenges of preparing teachers to be more comfortable using technology in the classroom.

Table 2: Promising professional development approaches (cont.)

Distributed Expertise Model This model describes a variety of individuals with different expertise working together to create effective instruction. In the case of technology integration, one person might know several technologies while another individual might know the course content. Working together, both individuals develop stronger knowledge of both the content and technology and find ways to effectively integrate technology into the course to highlight the content.	**Example 1:** At the Childhood Development Center at the University of Michigan, Dearborn (where a Reggio Emilia inspired early childhood education program is run in partnership with teacher preparation) technology was found to be an effective tool for furthering the goals of the Reggio approach. Through technology tools, children could represent and organize ideas in different media, facilitating long-term projects that build on their interests. Software helped students create higher-level representations of students' ideas, as well as visually represent and connect them. The technology also strengthened the communication of ideas and collaboration among members of a specific learning community. Digital photography and video made it possible for teachers to see and reflect on their, their colleagues', and the children's behavior, and also allowed for extension and communication of consolidated learning to the broader community (in the form of images and information online that parents could interact with) (Hong & Trepanier-Street, 2004). **Example 2:** A program partnering a preschool with the University of Southern Carolina, Charleston used a constructivist, learner-centered approach to allow children to actively delve into a meaningful topic (in this case, dinosaurs and paleontology). According to the NAEYC account of the model, it embodied the principles of integrating technology along with other "analog" tools to allow for extensive student inquiry, equity in the classroom, and forging connections with parents and community. For example, the classroom incorporated digital microscopes, magnifying glasses, document cameras, Internet and an interactive whiteboard to investigate and document items students dug up from a sand pit in a paleontology lab. The interactive whiteboard facilitated teacher-guided Internet searching that led the children to more information on the species, dictation of emails to experts and electronic drawing. Children created visual representations by printing photographs, hand-drawing or using KidPix drawing software. Children collaboratively wrote and created books choosing multimedia tools, traditional drawing or a combination thereof. In the context of the university-school partnership, two graduate students aided the two teachers, strengthening the ability to support children's use of classroom tools, including technology (NAEYC, 2008). *Table continues on p.26*

Understanding the role of technology in teaching and learning

The Council's review of programs and research on technology integration revealed major disconnects between the potential of the technology and what actually happens in most classrooms (McMillan Culp, Honey, & Mandinach, 2003; Groff & Mouza, 2008). Recent scholarship suggests that one of the reasons for this disconnect is the pervasive "technocentric" (Papert, 1980) approach to helping teachers learn about new technologies (Harris, Mishra, & Koehler, 2009). Professional development tends to focus on specific software, hardware, or helping teachers develop their own technological fluency. In reaction to this state of affairs, Mishra and Koehler (2006) propose that we build on decades of work that views professional teaching knowledge as consisting of the integration of subject matter understanding and the pedagogy that advances learning of the subject matter, spearheaded by Shulman (1986). The framework they introduce is called Technological Pedagogical Content Knowledge (TPCK), and it refers to the domain of teacher knowledge that lies at the intersection of three major components of learning environments: content, pedagogy, and technology.

Developing the knowledge needed for skilled, meaningful integration of technology in teaching requires teachers to unpack the characteristics of media, software, and other technologies, identify their specific potentials, and consider how to incorporate them into learning experiences. Through this process, teachers must take into account two facets of interactivity: the interactivity inherent in the technology and the interactivity among students, teachers, and technology.

Table 2: Promising professional development approaches (cont.)

Technology Coordinator Model This model establishes a technology corps that can work with teachers or faculty individually to help them incorporate technology into their courses and lessons. Professional development focuses on helping faculty and teachers analyze when and how to use electronic resources and on linking the use of technology with curricular goals, which is often accomplished with the help of mentors (Cradler et al., 2002; Strudler & Wetzel, 1999). This level of insight requires trainers who can work with faculty in understanding both their needs and the curriculum (Strudler & Wetzel, 1999).	**Example:** At the early childhood level, a researcher worked with a teacher to choose mathematics activities from the school's software that would fit with planned lessons (Kerawalla, O'Connor, Underwood et al. 2007). The researchers loaded resources on tablet PCs that children could take home. These included activities, information for parents on the goals of the activities, and a history of math topics and keywords students had learned in school. The tablets were sent home with 29 students between 5 and 6 years old for four weeks. This homework system allowed "teachers to develop and deliver individualized learning plans and homework, including digital resources (e.g., multimedia games, video clips and digital worksheets), to each child or group of children to both in class and at home" (p. 294). Aside from helping the teacher foster a connection between home and school using technology, parents said they felt they could offer their children more support because they knew what their children were doing and what concepts they should understand. Parents also reported that students chose to spend more time on their homework than before and increased their levels of independence in numeracy.

Features of Interactivity

Feedback involves responses that help users know if their actions are correct or need to be changed.

- Control refers to users' ability to change elements of the technological experience, such as the rate or sequence of actions, the action itself, or the outcome.
- Creativity involves elements which allow users to make something or contribute to the experience.
- Adaptivity is the ability of the technology to adjust the level of difficulty to suit the users' needs.
- Communications are opportunities provided to meet and talk with others or share ideas.
- Productivity is less relevant outside of business suite applications.

(Shedroff, 1994)

Any digital environment can be analyzed with respect to several dimensions of technology interactivity, including feedback, learner control, creativity, productivity, adaptivity, and communications (see sidebar *Features of Interactivity*; Shedroff, 1994). Teachers also need to understand what particular technologies offer in terms of representational possibilities for displaying and engaging with core concepts in particular subject areas. In the early teaching of mathematics for instance, technologies can be potent because they afford the opportunity to go beyond symbolic representations to simulate quantitative phenomena, and can do so in varying ways. For instance, watching an episode of the TV program *Math Monsters* allows students to see how a math concept applies in real-life situations, while playing a game in the Building Blocks curriculum software allows students to interact with a concept and receive feedback on their performance. Table 3 provides examples of these and other applications and media environments that range in level and type of interactivity. The products in the table exemplify the range of approaches designers of digital media have taken toward interactivity. For each product, strengths and weaknesses are indicated, highlighting what teachers have to consider when assessing tools for the classroom.

Teachers also need to consider the kinds of interpersonal interactions, the kinds of feedback, and the opportunities for creative production that are made possible by particular digitally mediated environments. Sometimes a single child might productively interact with a computer or a mobile device — as is the case with the Storymat or KidPix, as described in Table 3 — because the technology is high in interactivity (especially in creativity and control, or in feedback and adaptivity).

Other activities may invite *joint media engagement* (Media and Learning Group at SRI, 2010) among small groups of peers, adult child pairs, or between teachers and their students in a whole class setting, such as watching and discussing an episode of *The Electric Company*, *Math Monsters*, or *Between the Lions*. This type of structure is especially helpful if the technology itself is not high in interactivity. Joint media engagement can be synchronous when learners simultaneously engage in media viewing and responding, or asynchronous when learners interact with media individually but then engage in discussion on a digitally mediated networked thread. For teachers, the ease of imagining the possibilities is greatly enhanced when innovations have been well-documented and ideas can be shared, ideally in the form of video records as well as curriculum and planning documents.

Table 3: Examples of applications and media environments and their levels of interactivity

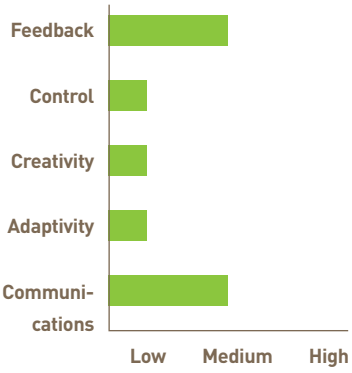
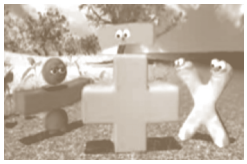
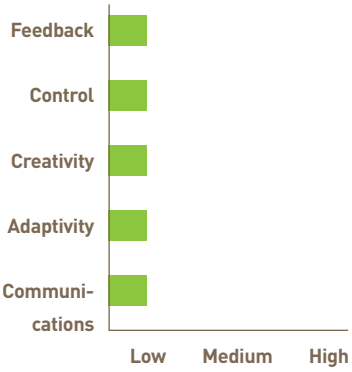
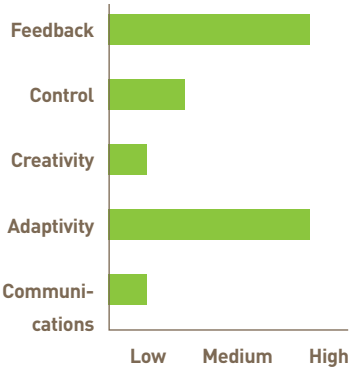
Grade	Technology application	Continuum of interactivity
Pre-K – 1	**Blue's Clues** (television show)  **Blue's Clues** is an example of an early childhood program which attempts to both encourage and anticipate children's responses to questions posed on the show, and then reacts to those anticipated answers. Children receive slightly more feedback in this format than they would with traditional shows.	
Pre-K – 2	**Math Monsters** (television show)  Catherine Fosnot and Maarten Dolk helped transform the television show **Math Monsters** — an animated series focusing on big ideas in math — into a video series with pause points for teacher discussion and pre- and post-viewing activities (Slim Goodbody Corp., 2003). While the medium itself does not encourage interactivity, teachers can increase communication and feedback aspects by using the pause points.	
Pre-K – 2	**Building Blocks** (software)  The **Building Blocks** curriculum a math program for early childhood students provides tailored feedback and activities based on users' input which helps reinforce students' learning or remediate students' errors (Sarama & Clements, 2004).	

Table 3: Examples of applications and media environments and their levels of interactivity (cont.)

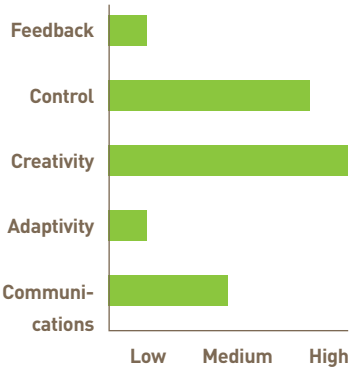
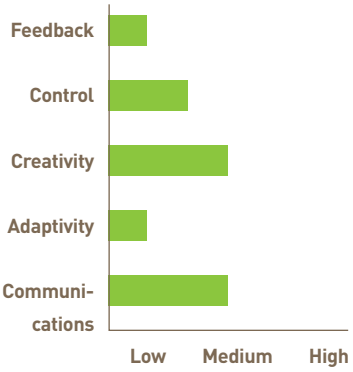
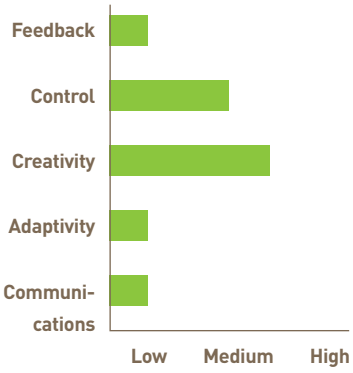
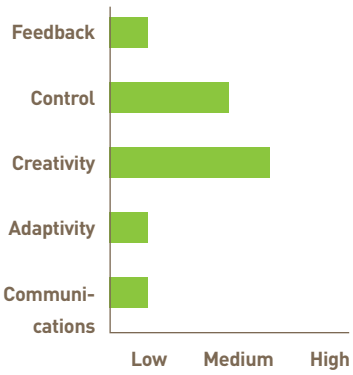
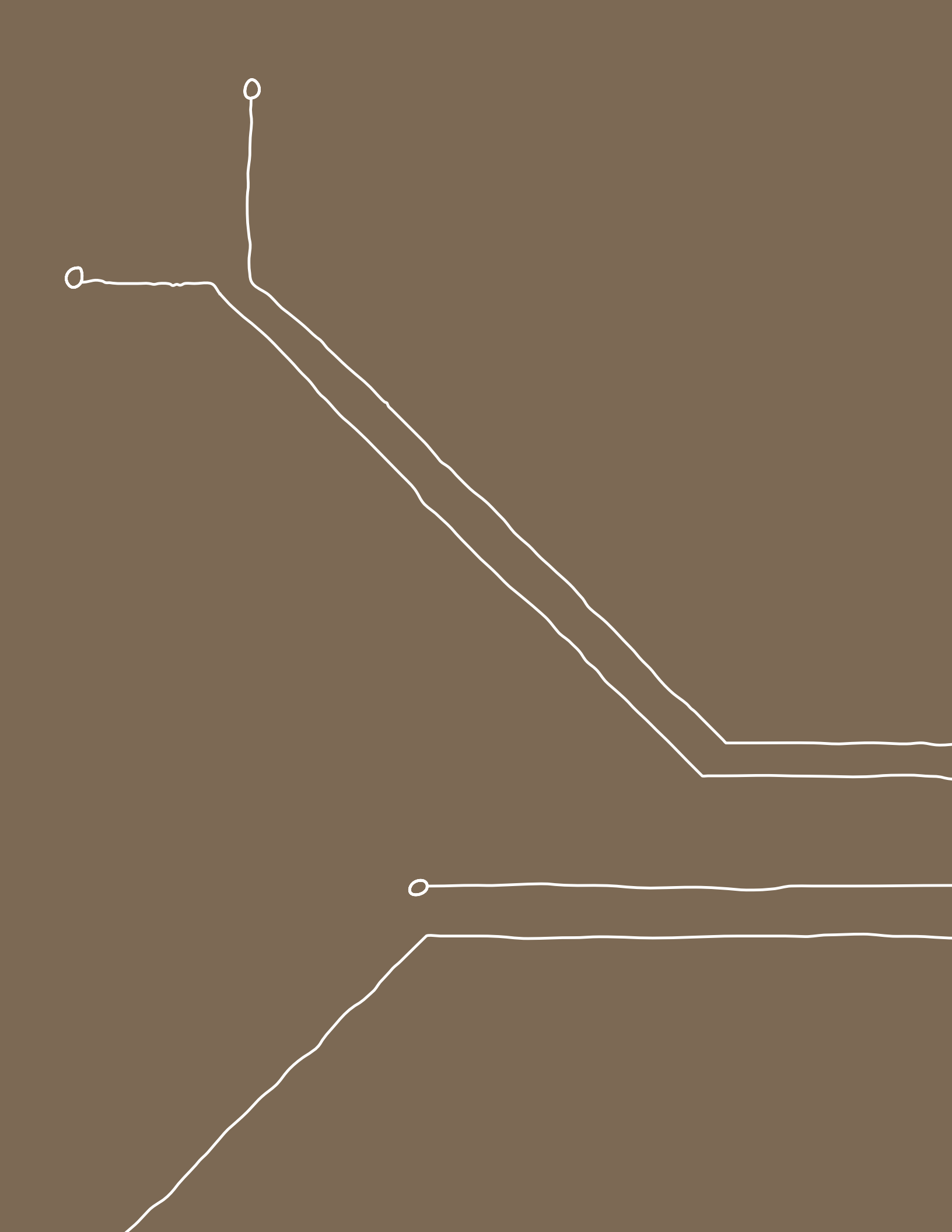
Grade	Technology application	Continuum of interactivity
Pre-K – 2	**StoryMat** (toy)  Young children can use the interactive **StoryMat** toy to record their own stories and hear them played back. They can also listen to other children's stories and change elements of the stories, prompting additional storytelling (Wartella, O'Keefe, Scantlin, 2000).	
Pre-K – 5	**Zoom** (television show)  **Zoom**, a science show for elementary students, seeks suggestions from students about which experiments or projects to include on the show. The episodes are then created based on these suggestions, with credit given to the children who submitted the activities. Students are also encouraged to try the activities on their own and send comments on how they turned out (WGBH, 2005). *Table continues on p.30*	

Table 3: Examples of applications and media environments and their levels of interactivity (cont.)

Grade	Technology application	Continuum of interactivity
1 – 5	**Broken Calculator** (software)  **Broken Calculator** is a stand-alone software program in which students make a target number or solve a problem without using the "broken" keys on the calculator. A history section helps students keep track of their attempts and find out how close to the target they are. Additionally, students can create their own challenges or try solving a problem multiple ways (Collison, Collison, & Schwartz, 2006).	
3 – 8	**Missing Links** (software)  **Missing Links**, a game in which students fill in missing letters to complete a literary passage, allows users to choose the number of players, the difficulty level, and how many guesses are permitted. Children can also create their own passages with missing letters based on stories they are reading or writing.	



imagining and enacting innovation: examples from the field

In this section we provide three cases of successful innovation that showcase approaches to using technology in classrooms and beyond that are consistent with a highly social, interactive, and constructive view of learning. They are also consistent with recent theorizing about the importance of Technological Pedagogical Content Knowledge (TPCK). Our core examples include: (1) repurposing of PBS assets for new interactive formats and new contexts including the preschool classroom, (2) a state-wide laptop initiative in Maine that made possible a school and science research center partnership program, and (3) expansion of the Writer's Workshop model to build on the affordances of participatory culture, facilitated by a one-to-one netbook program. While the latter two programs are not specifically for early childhood education, we feel that their examples are useful ones to apply to an early childhood setting and to professional development approaches for early childhood educators.

example 1

Integrating public media assets to support early learning: Success for All and Ready to Learn

Success for All, a nonprofit devoted to comprehensive school reform through intervention-based literacy development for struggling readers, has been experimenting with embedding multimedia into classroom activities. In one such study (Chambers, Cheung, Gifford, et al., 2006), 30-second to 3-minute video clips were embedded within a teacher's 90-minute lesson. These clips, called Reading Reels, included animations demonstrating sound/symbol relationships ("The Animated Alphabet"); puppet skits enacting word blending, phonemic awareness, spelling, fluency, reading strategies, and cooperative learning ("The Sound and the Furry"); live action skits dramatizing vocabulary words ("Word Plays"); and clips from the Ready to Learn show *Between the Lions*. Results showed that students who watched the embedded video clips scored significantly higher than a control group on the Word Attack skills test (measures a student's ability to correctly sound out letters and/or words) from the Woodcock Reading Mastery Test: Revised (WRMT-R). Other scales including Word Identification and Passage Comparison also showed differences, though they were not significant. In a separate study using digital media produced by Success for All, Chambers et al. (2006), working in two high-poverty elementary schools, found that infusing technology into the curriculum of first-grade beginning reading classes yielded consistently higher reading test scores. The technology introduced took one of two forms: short media clips interspersed throughout the lesson or sessions of computer-assisted tutoring. The research suggests that media clips infused into classroom teaching can help model teaching techniques, particularly for new teachers.

As part of the U.S. Department of Education's Ready To Learn initiative (RTL)[8], the Education Development Center (EDC) and SRI International conducted a study to evaluate the use of video and interactive games from the television series *Super Why!*, *Between the Lions*, and *Sesame Street* as embedded into a preschool curriculum (Penuel, Bates, Pasnik et al., 2010). In addition to providing the curriculum, the initiative provided teachers with ongoing professional development, beginning with a two-hour training orientation then continuing with on-site support visits. In total, 398 low-income children across 80 classrooms participated in the study. Over the 10-week curriculum, teachers were encouraged to engage children while viewing video: introducing skills, pausing to encourage information processing, and reflecting on key learning areas after viewing. The study found that children exposed to the media-rich curriculum performed significantly better than a control group at posttest on letter naming, knowing the sounds of letters, knowing concepts of story and print, and recognizing letters in the child's own name. Additionally, all of the classroom teachers that participated in the study had a favorable review of this media-rich curriculum. Overall, this research indicates that media use in the classroom can be adopted with much success. The key is to integrate media with a clear pedagogical approach.

The comparison group for the RTL study combined full episodes of *Sid the Science Kid* and "focused viewing"[9] segments from *Peep and the Big Wide World* along with associated online games for a 10-week early science curriculum with low-income children. Over the 10-week period, the children spent a total of 25 hours watching the TV episodes and segments, playing online games, and participating in group activities. Professional development played a large part in the curriculum; an instructional coach provided support over the duration of the curriculum in addition to providing scripts, activities, and materials for in-class work. In turn, the teachers engaged students in active viewing of the television assets: introducing key content and vocabulary, pausing the video to engage in discussions and reflections, and repeating the "hands-on investigations" that took place in the Sid shows. Rather than assessing learning increases, the program considered science interest as a fundamental part of science education for preschool children, especially for low-income children who typically do not engage in as much science conversation at home. The study showed that children who took part in the media-rich program were significantly more interested in

[8] Visit http://pbskids.org/readytolearn/ to learn more about the Ready To Learn initiative.

[9] Focused viewing is a method of viewing a video or program in which teachers interrupt the presentation to direct students' attention to certain elements and details.

science (as reflected by their initiation of science talk at home) at the end of the 10 weeks than children who took part in the comparison literacy program (Penuel et al., 2010).

A two-year study also set out to test the effectiveness of *Sesame Street* and *Between the Lions* DVDs in preschool classrooms in low-income, rural communities in Mississippi. While the results of the individual programs were not striking (only minor gains were observed), a secondary result was exhibited: Children who had participated in the *Sesame Street* program as 3-year-olds and then joined in the *Between the Lions* program as 4-year-olds performed significantly better on language and literacy evaluations than children who just viewed *Between the Lions* or were part of the control groups. This indicates that the skills they acquired with *Sesame Street* enabled them to benefit more from *Between the Lions* than those who had not viewed the *Sesame Street* DVDs. Videos of classroom scenes and teacher reflections on their experiences with these materials can be found at http://cct.edc.org/rtl/.

example 2

One-to-one computing and sustained professional development: Maine Learning Technology Initiative

In 2001, Maine kicked off the first statewide effort to provide students and educators across multiple grades with 24/7 access to personal learning devices. The pilot phase of the Maine Learning Technology Initiative (MLTI) outfitted select middle schools in each of the state's nine regions for one-to-one computing. Tools included Apple hardware, software, internal and external school networks and servers, technical support, and educator professional development. MLTI now equips all of Maine's 243 middle schools with wireless Internet access and provides each school with enough laptops for every seventh- and eighth-grade student and educator to use both in and outside school. Since MLTI's inception, more than 37,000 laptops provided by the program have been used by over 100,000 educators and learners throughout the state. The investment in technology has paid off: the state's eighth-grade writing proficiency jumped 12% after statewide one-to-one implementation (Silvernail & Gritter, 2007). Laptop use has also been linked to gains on statewide mathematics tests and improved retention of science course material (Berry & Wintle, 2009; Silvernail & Bluffington, 2009). Inspired by this success, Maine has expanded its laptop initiative to all students in grades 9 through 12. Further, the state is committed to funding wireless Internet access in all secondary schools and has negotiated discounts for districts to provide their students with laptops.

A critical element underlying the success of the model is a sustained commitment to professional development. From the outset, MLTI provided implementation assistance and technical support to educators to ensure that the technology was fully leveraged to support student learning. Their contract with Apple included a dedicated staff of engineers and curricular consultants that lived and worked in Maine. This commitment to professional development has led to the establishment of a new nonprofit organization called the Maine International Center for Digital Learning (MICDL). The mission of MICDL is to research, develop, and promote teaching and learning practices that build strong 21st century skills including digital literacies, citizenship, and collaboration. Partners include school reform and professional development facilitators who collaborate with researchers and school-based educators. Internationally, MICDL collaborates with educators, researchers, and policy makers from OECD's Center for Educational Research and Innovation (CERI) and a variety of countries including Singapore, Brazil, France, Australia, Canada, and Ireland. Funding for MICDL is provided by a diverse set of initiatives including private contributions, foundation grants, government grants, and fee-for-service contracts. This professional development center is itself an innovation that can serve as a model for other states.

In partnership with the MLTI, the Maine Professional Development Collaborative for New Literacies (MPDC) (http://www.micdl.org/initiatives/37) has been designing an effective model of professional

development that builds teachers' skills in teaching digital literacy in one-to-one classrooms. This action research project is led by Donald Leu, an internationally recognized expert on reading and learning from Internet resources, whose research has shown that traditional literacy skills are not sufficient for navigating and comprehending web-based resources (Leu, Zawilinski, Castek et al., 2007). A goal of the Collaborative is not simply to provide a training approach for teachers to adopt, but for teachers to co-design these approaches and continuously revise them to keep current with teachers' needs. The project employs Internet Reciprocal Teaching (Leu, Coiro, Castek et al, 2008), a research-based model for teaching online learning skills in one-to-one laptop classrooms.

The establishment of the MLTI's networked infrastructure has enabled students to collaborate with professional scientists in a statewide effort to document native species. Vital Signs, sponsored by the Gulf of Maine Research Institute, is a field-based science education program that links 7th and 8th grade students and scientists in the rigorous collection and analysis of essential environmental data across freshwater and coastal ecosystems. Innovative technology, relevant content, and critical partnerships create an authentic science learning experience for students, a distributed data gathering network for scientists, and a statewide community of teachers, students, and scientists collaborating to learn about and steward the Gulf of Maine watershed (from: http://vitalsignsme.org/). A website was designed to make exchanges between students, teachers, and scientists possible, and currently more than 50 middle school classrooms contribute to the effort.

Not only does Vital Signs represent a productive partnership between the education and professional science sectors, but the design of the website itself is intended to contribute to science education beyond Maine. The site's default licensing policy is Creative Commons, which means that anyone is free to copy, distribute, adapt, or remix Vital Signs' work as long as they attribute the partnership. They are currently finalizing the Creative Commons licensing for student-contributed, teacher-contributed, and citizen scientist-contributed creative work.

It is important to understand that Maine's one-to-one laptop experiment was the result of careful planning that made the improvement of teaching and learning its guiding mission. Leadership at the state level was critical to ensuring that the infrastructure model was sustainable and that all teachers had continual opportunities to learn. In Table 4 (p.36), we highlight some of the key features that leaders of the MLTI believe made this "experiment" such a success.

example 3

Using netbooks to engage developing writers: The Writer's Workshop model in Littleton, Colorado

In addition to being an inspiration for other countries, districts in other states in the U.S. have also been inspired by the Maine Laptop model and its impressive results. In 2007, the Littleton, Colorado school district decided to revise its literacy curriculum in favor of a more technology-centered approach. It chose to build a new model around The Writer's Workshop, a well-established and highly respected approach to teaching writing (Calkins, 1994), but with the addition of a one-to-one computing component. In a traditional Writer's Workshop, a class session starts with a mini-lesson about a genre of writing. This is followed by writing time and then a critique session where students take turns sharing their highly edited drafts, and a feedback session from peers. There are various formats for the critiques. One consists of two or more concentric rings of individuals. Those in the inner circle discuss a previously assigned topic, which can include anything from analyzing a novel's setting to critiquing each other's work. Those on the perimeter listen, take notes, and respond to the discussion.

With the support of a technology coordinator, Littleton enhanced this approach by simultaneously adopting netbooks — lightweight wireless devices — that could provide one-to-one computing and allow students to post writing to the Web, explore author's websites, and do research that would enhance their writing. The netbooks cost only $280 per unit and

run on a six-cell battery that lasts all day without charging. The district adopted cloud-based Google Apps[10] so that all students could write and save their written work. They also used blogs, wikis, and Twitter. As of this writing, fifth through tenth graders have access to the netbooks.

Two phases of professional development were offered in Littleton's netbook program rollout: At the start of the summer, teachers were encouraged to learn to use one writing application, such as blogs or Google docs, rather than focus on the device itself. The second phase began just before teachers started working with students. By focusing on writing goals and building upon The Writer's Workshop's established approach, the netbooks were easily integrated into daily classroom life.

Students in Littleton posted their work on blogs, wrote collaboratively, and provided feedback

Table 4: Key Features of the Maine Technology Model

Comprehensive MLTI services contract	Includes: • Devices • Software (updated annually) • Professional development • Wireless networks • Warranty • Support and repairs • Online learning environment (repair center in Maine) • Project management http://www.mlti.org
High capacity Internet	NetworkMaine Consortium, a joint collaborative effort of the Maine Department of Education, Maine State Library, Maine Office of Information Technology, and the University of Maine System, provides Internet and network help desk services to schools and libraries. MLTI was a catalyst for the first major upgrade to the network (56k to T1) and recently a further upgrade (T1 to 10 Mbps-1 Gps, depending on school size). http://www.networkmaine.net
Maine Telecommunications Education Access Fund	Legislation from 1999 that creates a Maine universal services fee on telecommunications bills like the Federal Universal Services fee. These funds combined with E-Rate to cover transport and Internet services for the broadband network. This preceded MLTI, but was a known foundational resource. http://www.maine.gov/mpuc/msln/index.html
Collaborations with organizations	Including: • Establishment of a weekly online webinar for teachers and a monthly webinar for administrators and/or leadership • Housing of Professional Development content online on iTunes U, and on blogs http://maine121.org http://minute.maine121.org http://www.maine.gov/mlti/presentations/

[10] Google Apps for Education are a free (and ad-free) set of customizable email and collaboration tools that enable educators and students to work together and learn more effectively. See http://www.google.com/a/help/intl/en/edu/index.html

to one another online and face-to-face. In an analysis of 391 student blog posts, researchers observed enthusiastic use and constant discussion about writing (Warschauer, Arada, & Zheng, 2010). Specifically, Warschauer and colleagues found the netbooks provided students with:

- ***Tools for better writing.*** Students felt that netbooks helped them draft, revise, and publish their work. They acknowledged the benefits of spelling, grammar, and formatting tools; the ease with which they could edit work; and how word processing helped them avoid fatigue and stop worrying about penmanship.

- ***Access to information.*** Students spoke to the ease with which they could find information online to assist their writing, learning, and civic participation.

- ***The ability to share and learn.*** Students perceived value in sharing their work in the classroom or the public at large, as well as sharing that strengthens their sense of authorship, ownership, and desire to do their best work.

- ***Self-directed learning.*** Students recognized benefits from learning that is individualized, differentiated, and under their own control.

- ***The ability to remain relevant in a technological world.*** Students perceived the benefits of being technologically fluent for their future schooling and careers.

- ***Engagement with new media.*** Students expressed great enthusiasm about writing and learning with laptops.

These three cases all provide illustration of how digital technologies, when used properly and in the right contexts, can enhance an educational experience in ways that traditional methods of teaching cannot. When used in the right situations and deployed appropriately by the teacher, digital technologies can provide added social experiences, such as allowing students to comment on each other's work or communicate with a professional in a field of interest. Videos can provide jumping off points for struggling readers to latch onto a story, and one-to-one computing can empower children who may not have the technologies at home to keep up with the digital world around them. These cases also suggest that proper professional development is key when implementing new technology programs in the classroom. Technology alone is not a teacher, but another tool that all educators should have in their arsenal.

For early childhood educators, professional reform that recognizes the potential role of technology has recently been updated through a major new policy statement that has the potential for wide-ranging impact on teacher preparation and development. The NAEYC's Position Statement on Technology in Early Childhood Programs (forthcoming, 2011) highlights the importance of preparing teachers to integrate technology in developmentally appropriate ways. The statement concludes that when used thoughtfully — in ways that consider the age of the child and his or her corresponding cognitive, emotional, and motor-physical needs — technology can enhance the classroom experience. However, technology should not replace activities that are important for children's healthy development, such as real-life exploration, creative play, physical activity, and social interactions. In other words, technology should be used as a tool in instruction, not the focus of learning in classrooms. Professional judgment is required to determine the right use of certain tools in the classroom, and early childhood educators need proper training to develop the instincts to effectively evaluate and deploy technological resources in their teaching. The NAEYC position statement also asserts that early childhood programs have an obligation to use technology to bridge the digital divide.

Building on this key challenge, we propose the following recommendations based on the Digital Age Teacher Preparation Council's work. The Council identified five key goals for the nation to meet by 2020, and suggests discrete step-wise actions to provide significant innovation in instruction and teacher preparation. We must equip educators with both the tools and the knowledge to be able to implement new programs in the classroom that prepare our children for life in a digital world — starting now!

recommendations

In an era of scarce funding for new initiatives, Council members identified a timely opportunity and challenge: By integrating emerging digital technologies into the professional development of educators — beginning with teachers of young children — we can establish a productive, cost-effective pathway that will deeply impact student and teacher performance. The Council's recommendations align with critical design elements for an effective early learning system that include: developmentally appropriate content, integration of the Common Core Standards with new benchmarks for very young children, and a more connected approach to learning across settings.

The Council considered the difficult economic climate facing our public and private institutions today, and recommends potent ways that leadership from each of the pivotal sectors can help modernize teacher practices right from the start. By investing wisely, our nation will take a giant step towards preparing its students to compete and cooperate in a global age.

Drawing on new research and examples of proven and promising practices from the U.S. and abroad, the Council has advanced five key goals for the nation to meet by 2020, as well as discrete, step-wise actions to promote significant innovation in the preparation of teachers of young children.

Goal 1: Modernize program designs and professional development models to promote success

The Council's review identified areas of progress in the design of modern practices for the integration of educational technology in leading teacher education institutions. Unfortunately, the pace of change has been painfully slow. Higher education institutions, schools, and early learning programs have also lacked urgency in changing their educational practices to align with research about how young children learn. Working together, these groups can provide productive educational support across grades and settings by adopting shared standards for student outcomes — standards that reflect the developmental and learning sciences, Common Core approaches, and the full range of learning associated with new technologies. The expanded use of preschool and primary grade units that encourage connected and consistent learning from ages 3 to 8 can drive coordinated efforts from teachers, parents, and the community.

To do so, schools and supporting institutions must gain access to the necessary technology tools and also be freed of the tight constraints of time and tradition to permit more powerful student learning led by capable teachers and other adults. This paradigm shift will require (a) restructuring time and staffing so that teachers can work with one another and with groups of students in new ways supported by digital media, (b) rethinking schedules to promote more *intentional* learning time over the course of the day, and (c) reducing barriers to parental involvement so that families and schools can work together.

To accomplish this first goal, the Council recommends that states, local schools, and Head Start and other preschool program networks:

- ***Recruit, prepare, and retain principals and preschool directors who understand and practice the use of new technologies to promote teaching and learning.*** Professional development is not simply a matter of showing administrators and teachers how to use new devices or tools; rather, it is crucial to support clinical practice that integrates resources into children's learning and social development. Schools of education and other professional certification groups should reform their program credentialing requirements to include both basic and advanced competencies in the integration of technology tools in curriculum, assessment and instruction, thus encouraging a new vision of the modernized early childhood program. Directors and principals with demonstrated leadership skills in this area should receive both professional and financial rewards, linked to performance.

- ***Examine all financial and human resources committed for the training of teachers of young children to determine if program quality priorities can be improved through new forms of technology integration.*** The goal of this review should be to ensure that every early learning environment has an action plan to deploy the digital tools needed to support world-class learning. At a minimum, an early learning community's technology infrastructure should include: an ongoing, location-based professional development plan and the committed resources available onsite for implementation; interactive and portable devices needed to conduct teacher assessments and professional exchanges and powerful group and personalized instruction; access to high speed broadband; and tools to allow shared use of student data and portfolio learning objects among teachers and parents. The infrastructure should also advance individual goals for professional development and provide incentives for teachers and parents to actively share best practices.

- ***Reallocate time and resources to enhance teaching and learning.*** New technologies can help educators move beyond their current approaches to ones that are more personalized, more powerful, and where teachers' time with students — and their colleagues — is extended by technology tools. Further, principals and preschool leaders must leverage technology to rethink schedules and staffing patterns so that students have more time for in-depth learning and teachers can collaborate to develop lessons, teaching strategies, and tools, both in-person and online.

- *Identify a place in every community where teachers and parents can receive support, mentoring, and resources for the productive use of technology.* Teacher centers, libraries, and online virtual schools are all promising as digital learning hubs. Public media assets such as websites, videos and low or no cost e-learning courses that provide teachers with research-tested and engaging materials for young children should be used more extensively within these settings. Other community teaching supports include university-based professional development schools and district or regional teacher induction programs, which may be enlisted to fashion ongoing, substantive professional development opportunities that integrate new technologies.

The Council also recommends that current national investments in teacher education be reconfigured to free resources to:

- *Redesign the teacher education portions of the Elementary and Secondary Education Act (ESEA), to create stable, high-quality sources of technology-enhanced professional development, with a new emphasis on teachers of young children.* Federal matching funds should be provided to states and school districts to designate new partnerships with universities and colleges as well as non-traditional innovators with a goal of modernizing teacher education and expanding the reach of promising technology-rich models

- *Establish a Digital Teacher Corps.* The newly designed ESEA should also provide support for a public-private partnership to deploy a contingent of some 10,000 teachers (targeted at every low performing preschool and elementary school community in the U.S.) to help address the fourth grade achievement gap. This Digital Teacher Corps should be phased-in over the next five years to concentrate on greatly accelerating children's literacy and science, technology, engineering, and mathematics (STEM) skills. The goal of the Corps will be to enable educators to help students move beyond basic reading and math competencies so that they can read and compute to learn, discover, and problem solve.

- *Re-direct federal challenge grants* to encourage professional development school partnerships and the creation of residencies designed to allow prospective teachers to complete extended clinical placements that emphasize the effective integration of modern tools and technologies in schools and preschools — especially in high-need communities.

- *Conduct teacher education funding, certification, and program audits.* Every state should identify and categorize digital learning efforts currently being used in their jurisdictions, as well as update what every teacher should know and be able to do. This should begin with instructors in early childhood classrooms. The resulting reviews would determine how funding is being used, launch new certification efforts, and catalog promising local, state, and global program innovations that can be showcased as models for scaling up.

Goal 2: Train early educators to integrate digital and screen media into their teaching practices in developmentally appropriate ways.

The NAEYC's recent draft of a new technology policy for early childhood professionals serving children ages 3-8 concludes:

> "This statement provides guidance to educators on developmentally appropriate practices with digital technology and screen media. It is the role and responsibility of the educator to make informed, intentional, and appropriate choices about how and when technology is used in early childhood classrooms for children birth through age eight. Technology and media should not replace beneficial educational activities, creative play, or interactions with peers and adults in early childhood settings. Educators must use professional judgment in evaluating and using technology, just as they would any other learning tool or experience, and must emphasize active engagement rather than passive uses of technology and media."

The Council supports this vision and recommends that every accredited early childhood setting be assessed against new technology integration standards to be developed by field leaders such as the NAEYC. Further, state departments of education should incorporate the NAEYC's professional standards and other best practices into their program quality review systems for state-funded pre-K and early grades instructional and professional development programs.

The Council also concludes that a step-wise approach to introducing new professional development capacity to early education programs of diverse professional need should take place via cost effective distance learning methods. Learning in online courses and via other formats will be effective when the lead trainer serves as a guide rather than an authority and allows participants to have significant control over their learning experiences. Effective distance education can advance technology's ability to go beyond merely presenting content to emphasizing connections between the content, teachers' reflections and discussions, and the application of new ideas and methods in the classroom. Drawing on proven models such as the HeadsUp Reading! program, plans must have clear, realistic goals that are compatible with online learning and, based on these goals, must specify the appropriate technologies for deployment. Finally, rather than reinventing distance learning from scratch, programs should collaborate with other research-based model initiatives such as those delivered by professional preparation leaders to design effective courses. Some options include entities such as Erikson Institute, National Louis University, and Bank Street College, as well as by professional associations such as the National Head Start Association and the National Association of Child Care Resource and Referral Agencies.

Goal 3: Expand public media use as a cost-effective asset for teachers

Public media assets developed by highly trusted, research-based educational media distribution organizations such as PBS, WNET, WGBH, and Sesame Workshop are largely untapped, low to no cost resources for teachers. These assets also have the added potential to extend and connect learning that takes place at home and in school. Importantly, new models for preparing educators to use these assets in their teaching can be constructed efficiently — without starting from scratch.

The Council has been impressed by emerging national distribution models for teachers to share their innovations in both the private and public sectors. For example, Apple's[11] deep connections to scalable experiments such as the Maine Learning Technology Initiative (the so-called "laptop experiment"), as well as Google, Cisco, and IBM's leadership with educational networking tools, offer valuable experience in building public-private partnerships in teacher development. These efforts are beginning to use web technologies and new modes of participation (e.g., web portals and recommendation engines), and are being deployed across platforms and settings.

New *learning objects* recently funded by the United States Department of Education and supported by public media groups such as PBS and the Corporation for Public Broadcasting — short video clips, personalized assessments, games, iPhone applications, and digital libraries — may help promote an important but often neglected balance between too much and too little structure in professional development. These resources can help promote a sustainable community of practice across early learning settings. Educational media producers have a central role to play in the development of new resources for teaching and learning. The Council recommends that to make public media an instrumental part of teacher education, policy, media, and philanthropic leaders should:

- ***Create public-private partnerships to support new forms of design and a new distribution system to enable digital innovation in the classroom.*** The Congress and United States Department of Education should prioritize funding for educational media projects that involve collaborations among creative producers, learning scientists, and professional development experts. They should also invest in high quality, economically sustainable broadcast channels

[11] The Apple Learning Interchange was a multimedia database of lesson plans, units, and activities that made use of apple technologies and software. Resources on the database were created and shared by teachers, Apple, and educational institutions affiliated with Apple. The Apple Learning Interchange closed in September 2010.

for teachers. Other nations, from the United Kingdom (Teachers' TV) to China (the nation's own educators' channel), invest significant resources in creating materials for classroom use. New technology professional reform initiatives such as the Khan Academy model and 2tor.com also exemplify the potential value of entrepreneurial initiative in this area. (See Appendix, p. 50.)

Goal 4: Advance coherent and equitable policies to promote technology integration across standards, curriculum, and teacher professional development

At the highest levels of policy, new priority must be accorded to promote better teaching and learning for low-income children right from the start. The Council recommends that the President and Cabinet:

- ***Partner with states and the private sector to ensure that a technology infrastructure exists in every school and community.*** Beginning with Title 1 eligible schools and Head Start centers, make adequate funding for broadband adoption available in every high-need community. The E-Rate[12] should also be extended on a phased-in basis to all accredited early childhood programs and Head Start centers.

- ***Reconfigure national priority programs such as the Enhancing Education through Technology (EET) program*** as part of the renewal of ESEA, and create a crosscutting emphasis on evidence-based technology use across the legislation's priority areas, which should now include early learning programs.

Governors, chief state school officers, and state legislatures should:

- ***Provide states (and consortia of states) with funding and accountability incentives to align standards, assessments, and curriculum frameworks.*** Building on the recently announced priority for early learning "systems planning" in the U.S. Department of Education's Race to the Top program, states must align both expectations for contemporary technology use and models of best practices for teaching with technology resources. A useful first step would be to allow online curriculum repositories to be organized around early learning instructional resources and interactive data collection systems, so that states and schools can organize professional development around these materials, and teachers can customize individual, group, and online instruction for their needs.

- ***Convene summits on the "future of teaching and learning for young children".*** The White House, governors, chief state school officers, and business groups should organize these meetings to focus priorities for R&D on digital media, and recommend new investments by the government and private sources such as nonprofit organizations and market investors.

Goal 5: Create R&D partnerships for a digital age

Most R&D funding for digital technologies designed to prepare teachers of young children is currently provided by the federal government or generated for product launches within the private sector. Unfortunately, public funding of technology tools and approaches is unevenly distributed, highly fragmented, and lacks mechanisms to foster interagency coordination and collaboration. The large multidisciplinary universe of digital learning and professional reform (which does not fit older models of R&D), requires both innovative methods of funding and incentives to build creative networks of design partners with different areas of expertise.

Building on established priorities of organizations such as the National Science Foundation, the Institute for Educational Sciences, and the National Institutes of Health, a new inter-disciplinary emphasis on early learning professional practice must be established. A promising model is the work of Defense Advanced Research Projects Agency (DARPA), which the U.S. Department of Education is currently planning to adopt for interdisciplinary breakthrough research. (Through the recently announced Advanced Research Projects Agency for Education, ARPA-ED, and "Digital Promise" initiatives). Future efforts should enable an R&D

[12] The E-Rate program is the Schools and Libraries Program of the Universal Service Fund, which provides discounts to assist most schools and libraries in the United States in obtaining affordable telecommunications and Internet access.

network to identify gaps and determine how practices from one content domain such as literacy development could be transferred to others such as STEM. The Council recommends the following:

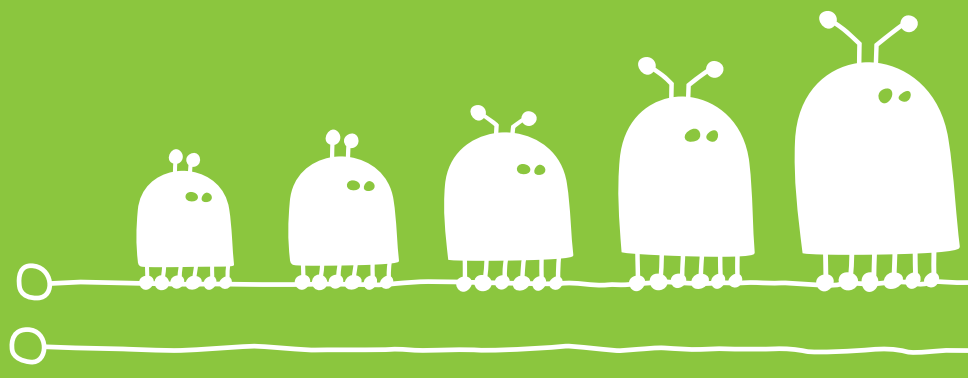
- ***Create a strategic inventory of R&D initiatives.*** We need to know more precisely what is being done to modernize the field of teacher education and professional development for teachers of young children. The federal government, in collaboration with universities, regional labs and private sector partners, should determine what research has been done and is being funded on the use of digital media in teacher education and professional development. Data collection should be coordinated by an entity at the U.S. Department of Education. The information gathered would allow the identification of knowledge gaps and form the basis for a government-wide strategy to support digital media R&D to benefit teaching and learning.

- ***Create incentives for public and private investment in infrastructure that supports R&D design collaborations.*** Development of faster and cheaper multimedia channels of distribution is needed in order for professional development designs to propagate. Important first steps have been taken to secure high-speed broadband access in most schools with a priority on reaching low-income communities. An expansion of the E-Rate program to include preschool classrooms would also help foster research and development on professional practices that work. Other needed infrastructure should include greater support for cyber learning research that connects design partners such as public media, university labs, libraries, and technology firms with local practitioners.

conclusion

Today's kids live in a world where digital technologies are ubiquitous: Children as young as 4 are consuming four hours of media a day, and research indicates that this pattern will certainly continue in the future. (Gutnick, Robb, Takeuchi et al., 2011; Rideout, Foehr, & Roberts 2010) As concerned parents and educators seek to find the right balance to support children's learning and healthy development in a digital age, they must incorporate new strategies. Engaging children's natural inclination for play and

discovery while ensuring they are prepared for the global economy will require urgent reform in current models of early learning. In the next decade, teachers and other educators must establish new forms of practice, enhanced and supported by the most modern and productive technology tools available. If we arm early childhood educators with a new vision and provide the resources they need to deliver a quality education to all, we can finally take a giant step forward. Our children deserve nothing less.



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appendix: list of resources

The following online resources for educators are cited in this report.

The Better Kid Care Program: Provides professional development opportunities and educational information on caring for children at http://betterkidcare.psu.edu/

Google Apps for Education: Google is currently offering schools an ad-free solution for their email, calendar, and chat through Google Apps for Education, an integrated communication and collaboration solution at http://www.google.com/a/help/intl/en/edu/index.html

HeadsUp! Reading: HeadsUp! Reading is no longer broadcast live, but is still available through Ready to Learn Providence at http://www.r2lp.org/matriarch/MultiPiecePage.asp_Q_PageID_E_61_A_PageName_E_WhatInvestingHeadsUpReading

iTunes U: Following the close of the Apple Learning Interchange, iTunes U was created as a distribution system for educational digital content "from lectures to language lessons, films to labs, audiobooks to tours". An innovative way to get educational content into the hands of students and teachers. Visit http://www.apple.com/education/itunes-u/

Khan Academy: A nonprofit organization with the goal of changing education by providing a free world-class education to anyone, anywhere. Find videos, practice exercises, and assessments at http://www.khanacademy.org/

Literacy Web at the University of Connecticut: Students can search the web, connect with other grade-matched classrooms, and learn about literacy-related topics on this site. Teachers can access lesson plans or other professional development resources., Available at http://www.literacy.uconn.edu/

Maine Learning Technology Initiative (MLTI) on iTunes U: Multiple series of podcasts for professional development with a focus on professional development activities and supporting the integration of technology into the classroom. Found at http://maine121.org/itunesu/

PBS's Teacher and Parent sites: Offers digital and print-based pre-K through12 resources grouped by grade level/age and subject area. Includes online communities. Visit http://www.pbs.org/teachers/ and http://www.pbs.org/parents/

PBS Teacherline: Offers standards-based graduate-level courses for teachers. Sign up at http://www.pbs.org/teacherline/

Raising Readers: Lessons, articles, and curricula are available at http://pbskids.org/island/teachers/

Reading Rockets: This initiative of WETA (which produces for PBS) provides teachers, parents and other educators with free print reading guides in addition to a variety of research and resources. Visit http://www.readingrockets.org/

Ready to Learn Summative Evaluation: Videos of classroom scenes and teacher reflections on their experiences with the Ready to Learn Literacy and Science curriculum materials can be found at http://cct.edc.org/rtl/. Also visit http://pbskids.org/readytolearn/ to learn more about the Ready To Learn initiative.

Teachers' Domain: VITAL, New York on Teachers' Domain, is a free digital media service for educational use funded and maintained by New York State public broadcasting stations and their partners. Media resources, support materials, and tools for classroom lessons, individualized learning programs, and teacher professional learning communities are included. Visit http://www.teachersdomain.org

Teachers TV: Teachers TV was a website and television channel which provided video and support materials for those who work in education in the UK. While Teachers TV officially closed in April of 2011, the UK Department of Education has signed a number of non-exclusive distribution agreements to ensure that the 15 minute programs in the archive will still be available to watch online. Find the current URLs here: http://www.education.gov.uk/schools/toolsandinitiatives/teacherstv/

Tools of the Mind: A research-based early childhood program that builds success in preschool and kindergarten children by promoting their intentional and self-regulated learning. Learn more at http://www.mscd.edu/extendedcampus/toolsofthemind/

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Brigid Barron is an Associate Professor at the School of Education at Stanford, a faculty co-lead of a an NSF funded Science of Learning Center (http://www.life-slc.org/), and directs the YouthLab research group (youthlab@stanford.edu). A developmental and clinical psychologist by training, she studies processes of learning in and out of school. In a five year NSF supported CAREER award, she documented adolescents' learning ecologies (e.g. learning opportunities across home, school, libraries, virtual communities, clubs, and camps) for technological fluency development across diverse communities in the Silicon Valley region. This work used multiple methods tocreate chronological maps of children's learning that reveal the evolution of interest based activities and the networks of learning partners and resources that have supported learning in and out of school. Barron is PI on a three year grant funded by the John D. and Catherine T. MacArthur Foundation that follows students longitudinally as they participate in programs designed to develop their technological fluency through activities such as game design, robotics, and digital movie making. A special focus of this work is articulating the processes that spark and sustain interest in learning as children engage in formal and informal collaborative learning with new technologies.

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Gabrielle Cayton-Hodges is a Postdoctoral Research Fellow at the Joan Ganz Cooney Center. She received her Ph.D. in Mathematics, Science, Technology, and Engineering (MSTE) Education at Tufts University in 2009. Her dissertation, entitled "Young Children's External Representations of Number," focused on 4 through 8 year-olds' understandings of properties of the number system as demonstrated through various methods of external representation. The inspiration for her work stems from her work as an undergraduate at MIT in Brain and Cognitive Sciences where she studied 3-year-olds' acquisition of the principle of mutual exclusivity of numbers. Dr. Cayton-Hodges is also a member of a number of collaborations with Tufts University and TERC including the Early Algebra Project and the Inquiry Project, both focusing on learning and instruction with third through fifth graders in the Boston area.

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Michael H. Levine oversees the Joan Ganz Cooney Center's efforts to catalyze and support research, innovation and investment in educational media technologies for young children. Prior to joining the Center, Dr. Levine served as Vice President of New Media and Executive Director of Education for Asia Society, managing the global nonprofit organization's interactive media and educational initiatives to promote knowledge and understanding of Asia and other world regions, languages, and cultures. Previously, Dr. Levine oversaw Carnegie Corporation of New York's groundbreaking work in early childhood development, educational media, and primary grades reform, and was a senior advisor to the New York City Schools Chancellor, where he directed dropout prevention, afterschool, and early childhood initiatives. Dr. Levine has been a frequent adviser to the U.S. Department of Education and the Corporation for Public Broadcasting, writes for public affairs journals, and appears frequently in the media. He was named by *Working Mother* magazine as one of America's most influential leaders in shaping family and children's policy and serves on numerous nonprofit boards. Levine is also currently a senior associate at the Edward Zigler Center in Child Development and Social Policy at Yale University.

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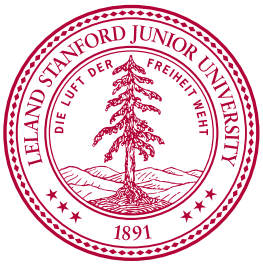

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