© Gordon Studer

Finding the Education in Educational Technology with Early Learners

Lilla Dale McManis and Susan B. Gunnewig

Ms. Robin is ready to begin the day. She has reviewed today's goals with Ms. Jan, the teaching assistant, prepared activities for the interactive whiteboard (a large computer-driven touchscreen mounted on the classroom wall), tested the desktop computer software, and charged her digital camera and tablet. We'll catch up with Ms. Robin later to see how the day unfolds.

"Computers have things on them, and when you go there, they have the things you're on."

—*Owen, Age 4*

As many educators and parents have observed, today's children are exposed to advanced technology at an early age, with tablets, e-readers, and smartphones being some prevalent choices (Gutnik et al. 2011; Rideout 2011). Experiences with technology can pave the way for unprecedented learning opportunities. However, without an education component, technology cannot reach its full potential for supporting children's learning and development. In early childhood programs, the education component often means adults being nearby, interacting with children and providing opportunities for peer-to-peer learning to encourage children to gain the skills they need for succeeding in school.

While the literature establishes the use of educational technology and positive outcomes for children (see reviews by Glaubke 2007; McCarrick & Li 2007; Penuel et al. 2009), it also indicates that technology needs to (1) be developmentally appropriate for children, (2) include tools to help teachers implement the technology successfully, and (3) be integrated into the classroom and curriculum (see Clements & Sarama 2003; Glaubke 2007; NAEYC & Fred Rogers Center 2012). In this article, we will discuss these criteria and provide a practical plan, examples, and a tool for evaluating, using, and integrating educational technology in early childhood programs.

Lilla Dale McManis, PhD, is research director for Hatch Early Childhood in Winston-Salem, North Carolina, where she conducts research in education technology for early learners. Previously a teacher and teacher educator, she now focuses on understanding learning environments and positive outcomes for young children. dmcmanis@hatchearlychildhood.com

Susan B. Gunnewig, MEd, develops content for technological hardware and platforms at Hatch Early Childhood. Previously on the faculty of the Children's Learning Institute at the University of Texas Medical School, Susan cocreated the Texas School Readiness project, participated in a number of federal grants, and has been a teacher and administrator. sgunnewig@hatchearlychildhood.com

A study guide for this article is available online at www.naeyc.org/memberlogin.

naeyc® 2, 3

Setting the stage

Teachers have been using technology of one type or another with children for decades, but the development of new technologies and their presence in classrooms is increasing rapidly. Interactive single-touch—and now multitouch—screens in a variety of sizes, from interactive whiteboards to tablets, have changed the way children engage with technology. Alongside these is the explosion in learning content, particularly for mobile devices.

Whether traditional or newer, educational technology plays an important role in children's learning when it is based on research, child development theory, and developmentally appropriate practices, and when it aligns with curriculum goals.

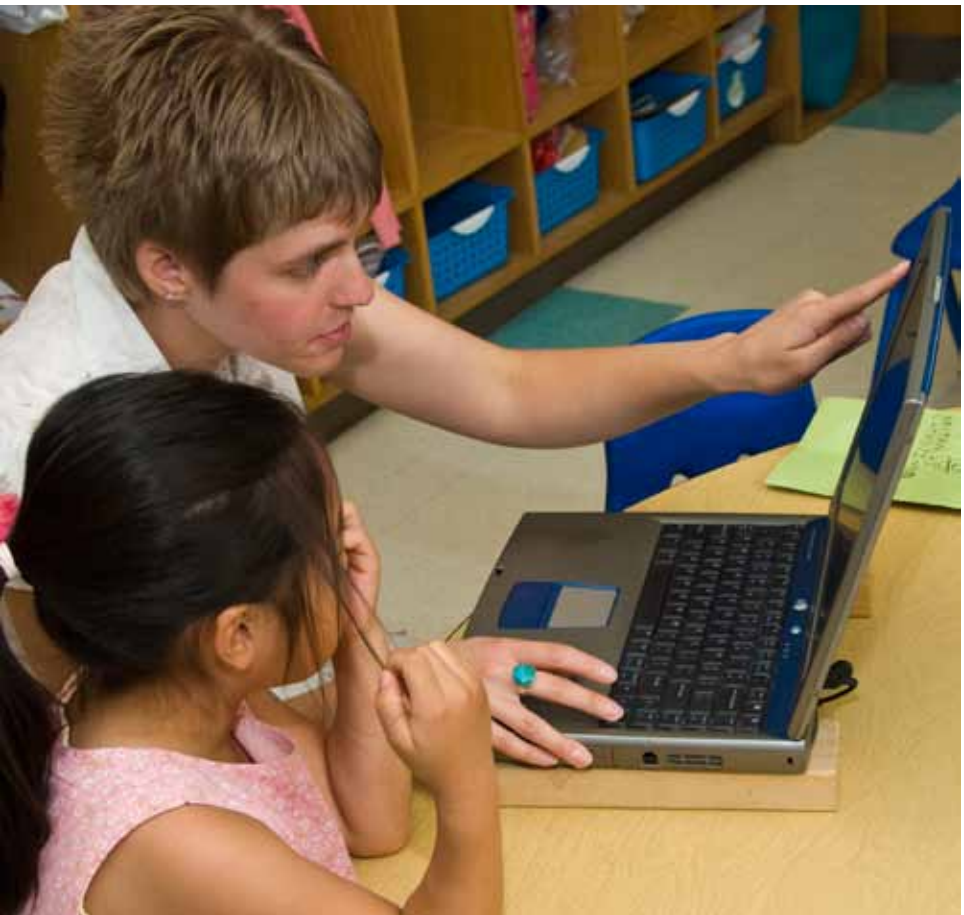
The potential for early childhood education

Research shows that computer use supports and increases young children's skills in the social, cognitive, language, literacy, writing, and mathematics realms. Children in early childhood classrooms interact with peers when using computers. They share and help one another, ask for and provide information and explanations, and collaborate to solve problems (Heft & Swaminathan 2002; Wang & Ching 2003). Adult guidance for children using computers is associated with increases in abstract reasoning, planning behavior, visual-motor coordination, and visual memory (Primavera, Wiederlight, & DiGiacomo 2001; Nir-Gal & Klein 2004). For example, teachers can help children focus on tasks by telling them to look carefully at an action on the screen and observe what is happening, or by asking them what they need to do in a particular situation presented while using a software program.

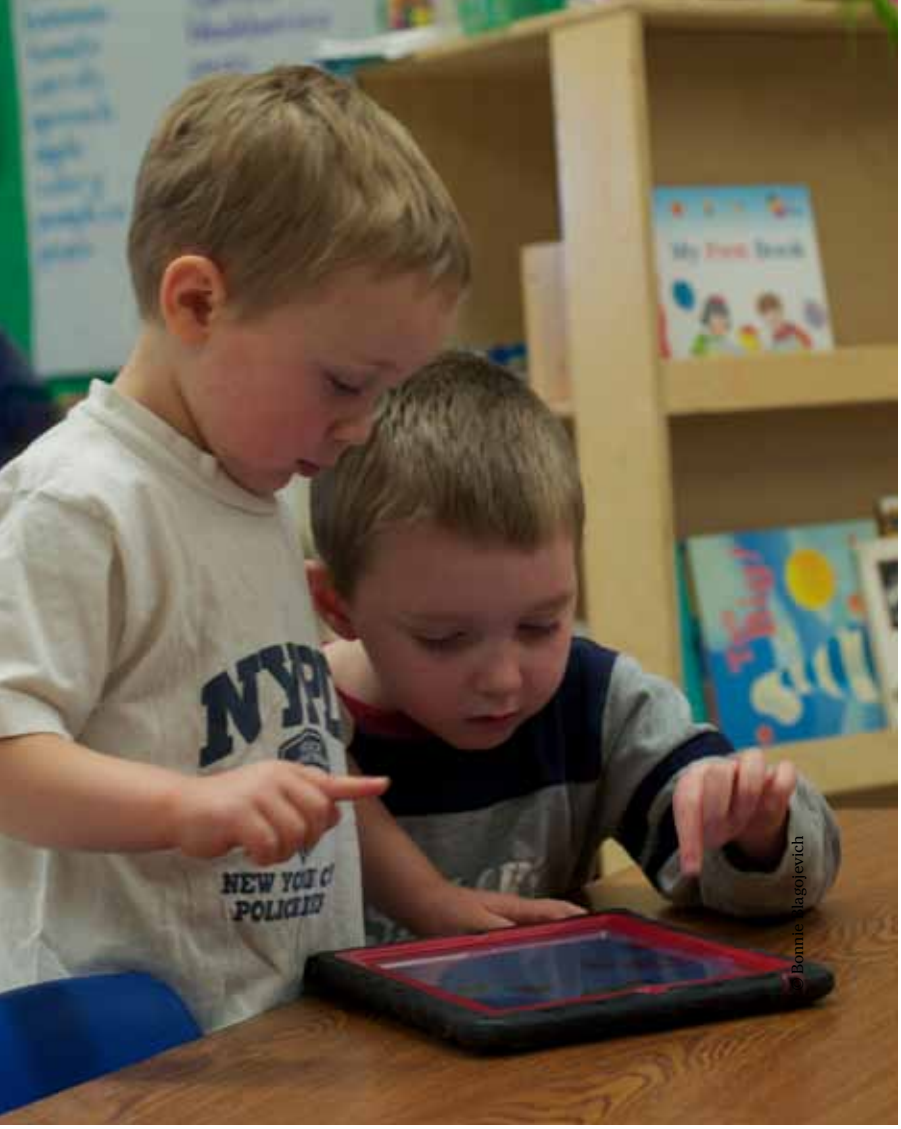
Adult guidance for children using computers is associated with increases in abstract reasoning, planning behavior, visual-motor coordination, and visual memory.

When teachers support children and media-rich content is integrated with the curriculum, technology experiences are associated with better language and literacy outcomes, such as letter recognition, sequencing, and sounds; listening and comprehension; vocabulary; and understanding concepts about stories and print (Primavera,Wiederlight, & DiGiacomo 2001; Nir-Gal & Klein 2004; Penuel et al. 2009). For instance, children who had daily access to a large library of educational software and teacher supervision made gains, but those with a weekly session with a mentor who facilitated use of the technology made even greater gains (Primavera, Wiederlight, & DiGiacomo 2001). When children use computers with adult support, their math concepts increase for number recognition, counting, shape recognition and composition, and sorting (Primavera, Wiederlight, & DiGiacomo 2001; Clements & Sarama 2007).

The research on newer technologies and applications has yet to catch up with their availability to children, but there are promising indications. Researchers observe greater collaboration among preschoolers when they use interactive whiteboards (IWBs) than when they use traditional desktop computers (nontouch screen, with mouse and keyboard) (Wood 2001). McManis, Gunnewig, and McManis (2010) found gains in preschoolers' literacy and math skills in classrooms using an IWB preloaded with school-readiness activities. Usability studies with the newest technologies, particularly mobile ones such as tablets, find that preschool children learn to use the devices quickly, independently, and confidently and explore freely (Couse & Chen 2010; Michael Cohen Group & USDOE 2011). Findings related to outcomes for learning from educational content on mobile devices are beginning to come in. A study with iPod touch devices and PBS-created content for children ages 3 to 7 found that the children made gains in vocabulary and phonological awareness, with children ages 3 to 5 making the most gains (Chiong & Shuler 2010). A recent study of kindergartners



© Ellen B. Senisi



© Bonnie Blagojevic

randomly assigned to use an iPad to focus on literacy found that the children using the tablet had consistently greater gains than those not using tablets. The researchers found notably strong effects for the iPad children's level of phonemic awareness and ability to represent sounds with letters (Bebell, Dorris, & Muir 2012).

Less access and use seen with preschool teachers

According to two studies sponsored by PBS (Public Broadcasting Service & Grunwald Associates 2009; 2011), K–12 teachers seem to embrace technology and digital resources, but preschool teachers use such technology and digital resources less often. With regard to the devices themselves, and the Internet in particular, the studies report that preschool teachers have less access.

A recent study with early childhood teachers and providers, conducted by the Fred Rogers Center for Early Learning and Children's Media, supports this finding. Only a little more than half of the teachers say their classrooms have computers (Wartella et al. 2010). Half of the teachers surveyed by PBS felt that the content in fee-based technology resources, such as games or activities from videos or the Internet, is not appropriate for the ages and abilities of the children they teach. This may affect teachers' ability to integrate technology as well. While both K–12 and preschool teachers agree that digital media and resources are more effective when integrated into the curriculum, preschool teachers are more likely to use these resources in very limited ways. For example, preschool teachers reported that they limited their use of technology mostly to downloading images and using digital cameras (PBS & Grunwald Associates 2011).

Is the technology developmentally appropriate?

Research is under way, but we still must find strategies now to ensure that new technologies are educationally sound. The 2012 joint position statement on technology and interactive media use with young children, from NAEYC and the Fred Rogers Center, offers several important insights. It affirms that for technology to be developmentally appropriate, it should be responsive to the ages and developmental levels of the children, to their individual needs and interests, and to their social and cultural contexts.

One of the most critical needs identified is support for early childhood practitioners in gaining the knowledge and skills to select and use technology in appropriate ways with young children. Acknowledging that there can be a negative impact on learning and development when educators lack the needed knowledge and skills to do so, the importance of providing resources, guidance, and support for teachers becomes even more pressing (NAEYC & Fred Rogers Center 2012).

Doing some groundwork before considering options will help ensure that you determine the best educational tech-

For technology to be developmentally appropriate, it should be responsive to the ages and developmental levels of the children, to their individual needs and interests, and to their social and cultural contexts.

nology for children. A first step is to establish learning goals for the children. The goals might include fostering children's literacy and math or social-emotional development. Some products promise successful attention to and integration of all areas of learning, but it is not likely they can deliver and still meet instructional excellence. We recommend ranking and prioritizing the learning goals, although technology does not have to be used to meet all goals.

Next is identifying the hardware on hand or that you'd like for your classroom, because the hardware drives the children's experiences and the available choices for software. For example, software designed as applications (apps) on tablets does not generally transfer to interactive whiteboards.

Now it's time to consider the content of software programs. We will first look at an evaluation tool and then focus on five areas of software programs that have the potential to strongly impact children's learning experiences: the educational value of a program, its ability to engage a child in learning, its child-friendliness, the interactivity between child and program, and a software program's ability to monitor a child's progress. These areas are informed by considerations from researchers and policy makers (for example, Clements & Sarama 2003; Glaubke 2007; International Society for Technology in Education 2008; Penuel et al. 2009). This list is not exhaustive, and some considerations, such as durability and cost of the technology, are not presented here because they do not focus directly on educational aspects.

Analyzing software content: An evaluation tool

Hatch Early Learning created *The Early Childhood Educational Technology Evaluation Toolkit* (McManis & Parks 2011) as the result of a review of the literature on elements to consider when evaluating educational technology for early learners.

The toolkit addresses aspects of current practices and capabilities that newer technologies can support, such as progress-monitoring features. Additionally, it focuses on the context in which the educational technology will be used, such as the ages of the children, type of learners (for example, children who have special needs or children who are dual language learners), type of device (more traditional along with newer technologies), and factors that affect integration, such as professional development to support teachers' technology skills. The toolkit includes a worksheet and accompanying explanations and examples. It can be accessed at www.hatchearlychildhood.com/toolkit.

While individual teachers can use the toolkit, one intent of its use is to bring together a team of invested parties in an early childhood education program. This could be any combination of members—teachers, administrators, parents, technology coaches, curriculum directors, IT personnel, and so on—that makes sense and works for your program. They can use the toolkit to evaluate existing educational technology and for future selections. The toolkit is a support for gathering information in a systematic and thoughtful manner to facilitate dialogue about options. It

Key Steps to Successfully Evaluating Educational Technology

1. Establish learning goals for the children.
2. Identify the hardware or device(s) you have or would like to have.
3. Analyze features and content of the software/program in meeting learning goals.
4. Plan how the educational technology will be integrated into the curriculum.

Early Childhood Educational Technology Evaluation Toolkit

Complete the following worksheet for each major educational technology purchase consideration. Please see accompanying directions for further explanation and examples.

Date: _____ Evaluator(s): _____

Organization: _____

Age group: _____ Older Toddlers _____ Preschoolers _____ School Age (Grades _____)

Type: ____ Regular Education ____ Special Needs (Disability: _____) ____ ELL ____ Title 1

GOALS

_____ a. Approaches to learning (curiosity, attention, flexible thinking/creativity, persistence)

_____ b. Language/Literacy _____ c. Mathematics _____ d. Science

_____ e. Social Studies _____ f. Social-Emotional (cooperation, collaboration, identifying emotions)

HARDWARE

_____ a. Desktop or laptop computer (mouse and keyboard) _____ b. Desktop or laptop computer (touch screen)

_____ c. Interactive whiteboard _____ d. Tablet _____ e. Multi-touch table or surface

SOFTWARE

Software Title: _____ (1 = No 2 = Unsure 3 = Somewhat 4 = Yes)

1. Educational	a. Learning versus focus on winning?	1	2	3	4
	b. Content research and/or learning standards based?	1	2	3	4
	c. Feedback informative/teaches?	1	2	3	4
2. Appropriate	a. Appropriate cognitive skill(s)/subject matter?	1	2	3	4
	b. Set in interesting/appealing context?	1	2	3	4
	c. Pre/non-readers can navigate?	1	2	3	4
	d. Free from bias?	1	2	3	4
3. Child-Friendly	a. Simple/clear choices?	1	2	3	4
	b. Multiple, positive opportunities for success?	1	2	3	4
	c. After adult support, children can use independently?	1	2	3	4
4. Enjoyable/Engaging	a. Enough activities with variety?	1	2	3	4
	b. Appropriate use of rewards?	1	2	3	4
	c. Realistic graphics and appealing to intended age?	1	2	3	4
	d. Activities match well to attention span?	1	2	3	4
5. Progress Monitoring/Assessment					
	a. Covers all the key areas the software teaches?	1	2	3	4
	b. Easy to use and interpret?	1	2	3	4
6. Individualizing Features	a. Can be customized for child's needs?	1	2	3	4
	b. Allows creation of new activities?	1	2	3	4

INTEGRATION

a. Initial training/professional development on integration included?	1	2	3	4
b. Ongoing training/professional development opportunities?	1	2	3	4

SCORE

(Total Score ÷ 80) × 100 = _____

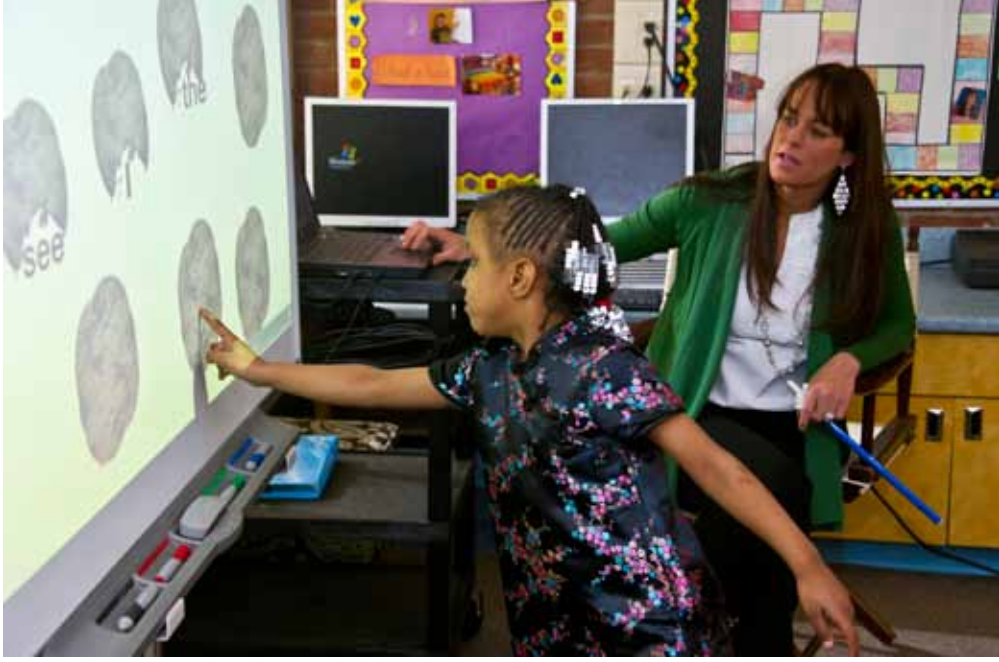
(90-100 = A, 80-89 = B, 70-79 = C, 60-69 = D, <59 = F)

_____ Purchase _____ Continue to Consider this Option

_____ Do Not Purchase _____ Consider other Options

COMMENTS

can also help families better understand a teacher's or program's decisions and contribute to families' own efforts to evaluate technology for their children. For example, if a program decides to invest in a software package and has evaluated this choice with the toolkit, staff can share the ratings with families to help them understand why that particular software was chosen as part of the curriculum offered to their children.



© Ellen B. Senisi

Educational value

Is the content based on research/standards? The skills the software helps promote should be those deemed necessary by research and/or applicable early learning guidelines. For example, the content aligns with recommendations by the National Research Council (2009) for mathematics, or the content aligns with the early learning standards used in your state or program.

Does the software follow the correct developmental course and effective teaching paths? The content should follow and use the appropriate teaching path before asking children to make responses. For instance, the software introduces letter names before asking children to identify letters, and children learn about individual geometric shapes before using them to make patterns.

Engagement to enhance learning

Are the activities presented in a playlike fashion? Qualities of play should be obvious, including offering children opportunities to make choices and create scenarios and encouraging children to use their imaginations. Presentation in the context of a game can be appropriate, but not when the object is winning over learning.

Are rewards used appropriately? Teachers should make the association for children between the internal reward, such as feeling satisfaction in helping a peer or mastering a skill, and the external reward, such as collecting a star or points. Feedback such as "You helped your friend feel better" or "You kept at it and figured that out!" helps children want to engage with the activities for the positive internal feelings.

Child-friendly

Are there multiple opportunities for success? Children should be able to re-process (think again about the situation and information and apply a more effective strategy) and respond again. Equally important is whether a program is intuitive enough to determine when a child is repeatedly not experiencing success. Does it include a mechanism to help the child, such as making a tutorial available, moving the child back a level, and/or informing the teacher that additional instruction is needed?

Can children use the software independently? After adult modeling, children should be able to proceed with minimal assistance. Continually getting stuck or confused isn't conducive to learning, nor does it encourage a positive feeling about using technology. Understandable and logical instructions integrated with supports and prompts are essential. It is also important for children to get help when they need it. Independence should not be taken to mean working alone at all times. Children working with technology in teacher-led activities or in peer groups can be a powerful type of learning, particularly for additional language and social skills development.

Interactivity

Does the program respond to and/or can it be customized to the child? The most meaningful interactions between a child and technology take place when a software program is adapted to suit the child's needs. This occurs when the teacher can set a predetermined level, the program presents the appropriate level or activities, or the teacher can move the child manually through levels as the child is ready. This can be particularly important for children who have special needs, are dual language learners, or have less access to technology.

Does the program allow for creation of new activities? Such options increase usability, interest, and higher-order thinking. This feature can take many forms. Children might use a basic drawing application to create their own representation of pets versus having to always choose from a predetermined set of pictures offered in a software package. A focus in this area can substantially increase children's understanding so that technology is truly a learning tool.

Progress monitoring

This area relates to information teachers gain as a result of children's use of technology.

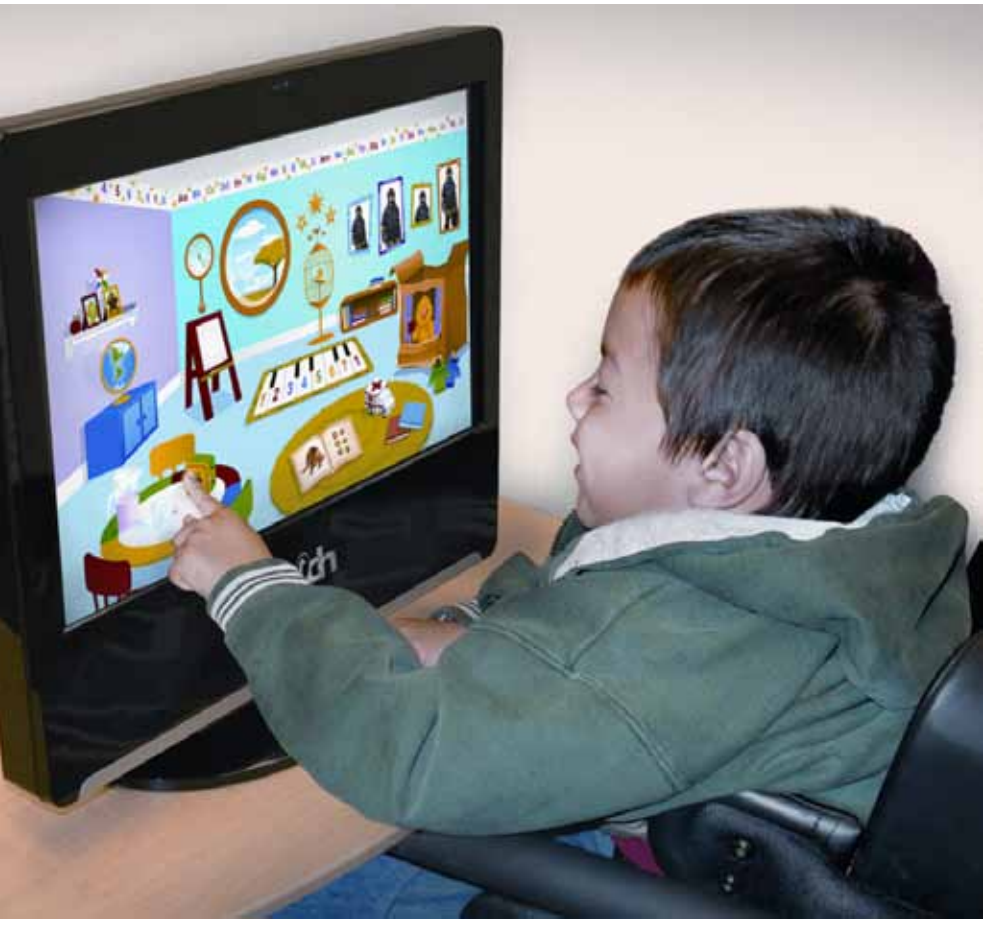
Is there a progress-monitoring feature? Such a feature collects information about how children are interacting with the learning content (often as automatic capturing of the responses children make compared to a set criterion) and then shows how children are moving toward competency. For example, depending on the criteria design, children may show mastery as a percent (100% mastery, 80% mastery, 60% mastery, and so on) of being able to choose the numeral that represents a set of objects they see over a number of opportunities to do so (they choose the numeral *5* for five bears having a picnic). This feature is more in demand because of the growing recognition of the critical role monitoring progress plays in guiding instruction to reach positive child outcomes (Shapiro 2008).

How are the results presented, and are they easily used? Some programs provide reports at levels such as the class, group, and/or individual child. Reports that provide more specific information and give that information over time are most useful—for example, breaking out the skills that make up phonological awareness versus one global indicator, or showing children's progress monthly or quarterly versus just at the end of the use of the software program.

Another example of presenting results of children's learning is through digital portfolios. Digital portfolios serve the same purpose as traditional portfolios—to be an authentic record of a child's learning process. The main difference is that the items in the portfolio are in a digital (electronic) format versus the usual paper format. Some, but not all, technology and accompanying software have a digital portfolio function so the work children complete/create on the computer can be stored this way. For example, certain interactive whiteboards have a recorder that, when enabled, captures the actual movements the child is making as she interacts with the content on the board and records her verbalizations. Teachers can retrieve and play the video to analyze the child's processes as often as they like. For instance, if a child is repeatedly having difficulty forming certain letters, the teacher can see very clearly exactly where in a letter's formation the child is struggling.

Children working with technology in teacher-led activities or in peer groups can be a powerful type of learning, particularly for additional language and social skills development.

Additionally, showing families their child actually creating and speaking about what he is doing is a powerful experience. It allows teachers to both showcase a child's work and discuss with families exemplary learning as well as areas where the child may not be meeting a learning goal.



© Bonnie Blagojevic

The role of supported learning in using technology: Scaffolding

When children use technology, teachers often think about demonstrating, trouble-shooting, or monitoring turn taking. They tend to give less attention to interacting with children to bolster positive learning approaches and increase children's knowledge. However, doing so exemplifies the education in educational technology. Putting this into practice

with technology means active engagement, group participation, interactivity and feedback, and connecting technology to real-world contexts. One approach is scaffolding children's use of technology.

When teachers do so, children can meet established learning goals more often, work more effectively, and use higher levels of thinking than when they are expected to solve tasks without assistance (Barbuto et al. 2003; Yelland & Masters 2007). Yelland and Masters identify three types of scaffolding teachers can implement when using technology with children: cognitive, technical, and affective.

Cognitive scaffolding

Teachers use *cognitive scaffolding* to develop children's understanding of concepts, and it most obviously resembles traditional scaffolding between adult/teacher and child. Activities include questioning, modeling, and encouraging collaboration with peers. Keeping in mind the power of play in learning, these scaffolds can make use of spontaneity, choice, creativity, and imagination. One method is to use an app for mobile devices that allows children to create animated stories. Working individually or with peers, children can create, dictate, and/or illustrate a story on a tablet. They can retrieve the story later and continue working on it while the teacher encourages (scaffolds) use of new vocabulary and more complete story structure. For example, the children may begin by learning simple words about a farm animal, such as *chicken,* and over time learn *hen, rooster,* and *chicks.* They bring this vocabulary to life by finding or drawing pictures that represent additional words and placing these in the story.

Technical scaffolding

Technical scaffolding uses the features of the technology to support learning. That is, the technology itself can facilitate understanding and problem solving. For example, computer programs are easily able to move shapes around in space, so an activity that helps children understand that a shape stays constant, no matter its orientation, uses technical scaffolding. Another example is a computer program that moves the activity's level up or down, based on a child's responses, so that the child works or plays at a level appropriate for her.

Affective scaffolding

Yelland and Masters also identify children's need for *affective scaffolding* to help keep them on task and encourage higher levels of thinking when using technology. Examples are a teacher staying physically close by when a child

uses a computer program and giving a thumbs-up when the child is successful, or if the child experiences difficulty, saying, "I saw you do that yesterday; try to remember how you did it" and "I thought you could figure that out!"

The software program itself can offer affective scaffolding through positive feedback, often seen with characters accompanying a child on her journey. For example, a character may show the child what to do or may appear after a portion of the game or activity to affirm or encourage the child to keep going.

Integration

There is growing recognition of the importance of incorporating technology in meaningful and authentic ways into the curriculum and day-to-day practices, and of the teacher's crucial role in the full development and use of technology in the early childhood classroom (Swan et al. 2002; ISTE 2008; USDOE 2010; NAEYC & Fred Rogers Center 2012). The joint position statement from NAEYC and the Fred Rogers Center emphasizes this eloquently: "The adult's role is critical in making certain that thoughtful planning, careful implementation, reflection, and evaluation all guide decision making about how to introduce and integrate any form of technology or media into the classroom experience" (6). However, research also documents that technology integration does not happen to the degree it needs to in order to fully realize its potential to support children's learning (Swan et al. 2002; ISTE 2008; USDOE 2010; Barron et al. 2011; NAEYC & Fred Rogers Center 2012).

The lack of time for professional development is one of the most serious obstacles to fully integrating technology into the curriculum that teachers identify (USDOE 2010). Feasible options for early childhood programs to consider include built-in technology supports and learning communities.

Built-in supports

When considering a software program, look for features that (a) support teachers in a technical sense, such as tutorials and help functions; (b) guide the use of the content, such as sample lessons, extension activities, and options for teachers to create their own additional activities; and (c) bolster teachers' ability to effectively provide instructional support to children, such as results and reports from the progress-monitoring features in software programs and explicit connections to the curriculum or to learning standards.

Learning communities

Learning communities represent a powerful approach for bringing people together around a common goal. There is no one-size-fits-all when it comes to forming and participating in a learning community. There are, however, several characteristics of effective learning communities, such as those identified by Ellen Galinsky (2012). Among others, these include bringing new players together, members learning from and with one another rather than always from an "expert," and an active focus on learning.

A recent report from the Joan Ganz Cooney Center, "Take a Giant Step: A Blueprint for Teaching Children in a Digital Age" (Barron et al. 2011), lays out national goals and immediate actions, acknowledging that leaders in education must restructure time and staffing so that teachers can work together and with students to use technology. The report includes recommendations for creating communities of practice that have abundant collaboration among teachers and for training early educators in integrating technology using developmentally appropriate practices.

Teachers gathering regularly in small groups to discuss their own goals, and methods for meeting them, is probably the easiest way to start a learning community. A second is curriculum development teams consisting of staff gathering to develop lessons using technology. A third kind of learning community includes technology coaches and mentors, as research shows novice teachers make good progress alongside skilled partners (Chen & Chang 2006).

Visiting Ms. Robin's preschool class for a technology-infused morning

This week's theme in Ms. Robin's class is "The Ants Go Marching." The children learn about living and nonliving things, related vocabulary, being part of a group, phonological awareness, and counting. On arrival, children write their names on the interactive whiteboard using their choice of the pens, their fingers, or a tennis ball. At circle time Ms. Robin plays "The Ants Go Marching" song, inviting children to march to the carpet. She uses the IWB to focus on the concepts *living* and *nonliving*, introducing vocabulary and having children move objects while encouraging each child to talk and share ideas. She finishes with a read-aloud on the topic.

There is growing recognition of the importance of incorporating technology in meaningful and authentic ways into the curriculum and day-to-day practices, and of the teacher's crucial role in the full development and use of technology in the early childhood classroom.

Next, they take a walk outside. Ms. Robin takes digital pictures as the children point out living and nonliving things. Then the children play on the playground equipment, with Ms. Robin encouraging them to imagine they are ants or bees working together to look for food. Now it is time to go to centers—dramatic play, blocks, writing, art, and computer.

Ms. Jan, the teaching assistant, visits the computer center where a child is engaged in phonological awareness activities. She encourages him to say the sounds aloud. Others work with Ms. Robin on the IWB to practice counting. She has pulled up a picture of an ant and used the replicator (a feature that makes duplicates or copies) to make graphic manipulatives. The children use their fingers to touch and move the ants as they count.

While the children nap, Ms. Robin downloads the pictures from the walk onto her tablet. She will use photo management software to enlarge or crop the pictures, adjust brightness/contrast, and rotate/flip, as needed. She collaborates with the children to choose a set of the photos to create a class book about living and nonliving things. The children will take turns bringing home the book and a DVD (a video Ms. Robin will make of Ms. Jan turning the pages slowly) for families and children to read and view together. Ms. Robin is looking forward to beginning this project tomorrow!

Summary

Finding the education in educational technology is important for supporting early learners' positive development. We have discussed educational technology in three areas: developmental appropriateness, supported implementation, and classroom and curriculum integration. When considered together, these areas can strengthen the potential of technology to facilitate meaningful learning for young children. We hope the ideas, examples, and evaluation toolkit support your own technology journey with the children in your program.

Teachers gathering regularly in small groups to discuss their own goals, and methods for meeting them, is probably the easiest way to start a learning community.

References

Barbuto, L.M., S. Swaminathan, J. Trawick-Smith, & J.L. Wright. 2003. "The Role of the Teacher in Scaffolding Children's Interactions in a Technological Environment: How a Technology Project Is Transforming Preschool Teacher Practices in Urban Schools." In *Young Children and Learning Technologies,* eds. J. Wright, A. McDougall, J. Murnane, & H.J. Lowe, 13–20. Conferences in Research and Practice in Information series. Melbourne, Victoria: Australian Computer Society.

Barron, B., G. Cayton-Hodges, L. Bofferding, C. Copple, L. Darling-Hammond, & M. Levine. 2011. "Take a Giant Step: A Blueprint for Teaching Children in a Digital Age." New York: The Joan Ganz Cooney Center at Sesame Workshop. http://joanganzcooneycenter.org/upload_kits/jgcc_takeagiantstep.pdf.

Bebell, D., S. Dorris, & M. Muir. 2012. "Emerging Results from the Nation's First Kindergarten Implementation of iPads." Research summary.https://s3.amazonaws.com/hackedu/Adv2014_ResearchSum120216.pdf.

Chen, J.-Q., & C. Chang. 2006. "Testing the *Whole Teacher* Approach to Professional Development: A Study of Enhancing Early Childhood Teachers' Technology Proficiency." *Early Childhood Research & Practice* 8 (1). http://ecrp.uiuc.edu/v8n1/chen.html.

Chiong, C., & C. Shuler. 2010. "Learning: Is There an App for That? Investigations of Young Children's Usage and Learning with Mobile Devices and Apps." New York: The Joan Ganz Cooney Center at Sesame Workshop. http://pbskids.org/read/files/cooney_learning_apps.pdf.

Clements, D.H., & J. Sarama. 2003. "Strip Mining for Gold: Research and Policy in Educational Technology: A Response to 'Fool's Gold.'" *AACE Journal* 11 (1): 7–69.

Clements, D.H., & J. Sarama. 2007. "Effects of a Preschool Mathematics Curriculum: Summative Research on the *Building Blocks* Project." *Journal for Research in Mathematics Education* 38 (2): 136–63.

Couse, L.J., & D.W. Chen. 2010. "A Tablet Computer for Young Children? Exploring Its Viability for Early Childhood Education." *Journal of Research on Technology in Education* 43 (1): 75–98.

Galinsky, E. 2012. "Learning Communities: An Emerging Phenomenon." *Young Children* 67 (1): 20–27.

Glaubke, C.R. 2007. "The Effects of Interactive Media on Preschoolers' Learning: A Review of the Research and Recommendations for the Future." Oakland, CA: Children Now. www.childrennow.org/uploads/documents/prek_interactive_learning_2007.pdf.

Gutnick, A.L., M. Robb, L. Takeuchi, & J. Kotler. 2011. "Always Connected: The New Digital Media Habits of Young Children." New York: The Joan Ganz Cooney Center at Sesame Workshop. www.ictliteracy.info/rf.pdf/jgcc_alwaysconnected.pdf.

Heft, T.M., & S. Swaminathan. 2002. "The Effects of Computers on the Social Behavior of Preschoolers." *Journal of Research in Childhood Education* 16 (2): 162–74.

International Society for Technology in Education. 2008. "National Educational Technology Standards for Teachers." Washington, DC: Author. www.iste.org/standards/nets-for-teachers/nets-for-teachers-2008.aspx.

McCarrick, K., & X. Li. 2007. "Buried Treasure: The Impact of Computer Use on Young Children's Social, Cognitive, Language Development and Motivation." *AACE Journal* 15 (1): 73–95.

McManis, L.D., S.B. Gunnewig, & M.H. McManis. 2010. *Exploring the Contribution of a Content-Infused Interactive Whiteboard for School Readiness.* Winston-Salem, NC: Hatch Early Childhood. ED528703. www.eric.ed.gov/PDFS/ED528703.pdf.

McManis, L.D., & J. Parks. 2011. "Evaluating Technology for Early Learners." E-book and toolkit. Winston-Salem, NC: Hatch Early Learning. www.hatchearlychildhood.com/toolkit.

Michael Cohen Group & USDOE [US Department of Education]. 2011. "Young Children, Apps & iPad." New York: Michael Cohen Group. www.mcgrc.com/wp-content/uploads/2011/07/ipad-study-cover-page-report-mcg-info_new-online.pdf.

NAEYC & Fred Rogers Center for Early Learning and Children's Media. 2012. "Technology and Interactive Media as Tools in Early Childhood Programs Serving Children from Birth through Age 8." Joint position statement. Washington, DC: NAEYC; Latrobe, PA: Fred Rogers Center for Early Learning at Saint Vincent College. www.naeyc.org/files/naeyc/file/positions/PS_technology_WEB2.pdf.

National Research Council. 2009. *Mathematics Learning in Early Childhood: Paths Toward Excellence and Equity.* Committee on Early Childhood Mathematics, C.T. Cross, T.A. Woods, H. Schweingruber, eds. Center for Education, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press. www.nap.edu/catalog.php?record_id=12519.

Nir-Gal, O., & P.S. Klein. 2004. "Computers for Cognitive Development in Early Childhood—The Teacher's Role in the Computer Learning Environment." *Information Technology in Childhood Education Annual, 2004*, 97–119.

Penuel, W.R., S. Pasnik, L. Bates, E. Townsend, L.P. Gallagher, C. Llorente, & N. Hupert. 2009. "Preschool Teachers Can Use a Media-Rich Curriculum to Prepare Low-Income Children for School Success: Results of a Randomized Controlled Trial." New York: Education Development Center; Menlo Park, CA: SRI International. www.cct.edc.org/rtl/pdf/RTLEvalReport.pdf.

Primavera, J., P.P. Wiederlight, & T.M. DiGiacomo. 2001. "Technology Access for Low-Income Preschoolers: Bridging the Digital Divide." Paper presented at the American Psychological Association Annual Meeting, in San Francisco. www.knowledgeadventure.com/jumpstartworld/_docs/ChildTechnology_White_Paper.pdf.

Public Broadcasting Service & Grunwald Associates. 2009. "Digitally Inclined: Annual Survey of Educators' Use of Media and Technology." Arlington, VA: Author. www.pbs.org/teachers/_files/pdf/annual-pbs-survey-report.pdf.

Public Broadcasting Service & Grunwald Associates. 2011. "Deepening Connections: Teachers Increasingly Rely on Media and Technology." Arlington, VA: Author. www.pbs.org/teachers/grunwald/pbs-grunwald-2010.pdf.

Rideout, V. 2011. "Zero to Eight: Children's Media Use in America." San Francisco, CA: Common Sense Media. www.commonsensemedia.org/sites/default/files/research/zerotoeightfinal2011.pdf.

Shapiro, E.S. 2008. "Best Practices in Setting Progress Monitoring Goals for Academic Skill Improvement." In *Best Practices in School Psychology V,* eds. A. Thomas & J. Grimes, 141–57. Bethesda, MD: National Association of School Psychologists.

Swan, K., A. Holmes, J.D. Vargas, S. Jennings, E. Meier, & L. Rubenfeld. 2002. "Situated Professional Development and Technology Integration: The Capital Area Technology and Inquiry in Education [CATIE] Mentoring Program." *Journal of Technology and Teacher Education* 10 (2): 169–90.

US Department of Education. 2010. "Transforming American Education: Learning Powered by Technology." Washington, DC: Office of Educational Technology. www.ed.gov/sites/default/files/netp2010.pdf.

Wang, X.C., & C.C. Ching. 2003. "Social Construction of Computer Experience in a First-Grade Classroom: Social Processes and Mediating Artifacts." *Early Education and Development* 14 (3): 335–61.

Wartella, E., R.L. Schomburg, A.R. Lauricella, M. Robb, & R. Flynn. 2010. "Technology in the Lives of Teachers and Classrooms: Survey of Classroom Teachers and Family Child Care Providers." Latrobe, PA: Fred Rogers Center for Early Learning and Children's Media at St. Vincent College. www.fredrogerscenter.org/media/resources/TechInTheLivesofTeachers.pdf.

Wood, C. 2001. "Interactive Whiteboards: A Luxury Too Far?" *Teaching ICT* 1 (2): 52–62.

Yelland, N., & J. Masters. 2007. "Rethinking Scaffolding in the Information Age." *Computers & Education* 48 (3): 362–82.