
The Effects of Interactive Media on Preschoolers' Learning:

A Review of the Research and Recommendations for the Future

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Introduction

The preschool years are a critical time in every child's life. Nearly everything they do, every moment of every day, can have some effect on their cognitive, socio-emotional, or physical development. Parents and other caregivers provide an invaluable foundation and critical guidance for their children during these early years. For some children, this development is also supported amid the nurturing environment of blocks, books, crayons, paper, pencils, water, dough, sand, toys and devoted teachers that can be found in most preschool classrooms—places that are supposed to foster children's growth in these areas and prepare them for success in kindergarten and beyond.

While some experts believe that technology has the capacity to positively influence even young children's cognitive and socio-emotional development in significant ways, others believe that technology can rob children of many of the essential childhood experiences they need for healthy development or even worse, can cause irreparable harm.

Over the past couple of decades, a debate has grown over the appropriateness of adding computers and other interactive media such as interactive books and toys, video games, and the Internet to the list of learning tools in preschool classrooms. While some experts believe that technology has the capacity to positively influence even young children's cognitive and socio-emotional development in significant ways, others believe that technology can rob children of many of the essential childhood experiences they need for healthy development or even worse, can cause irreparable harm.

This report was prepared to illustrate the current state of research, thinking, classroom practice, and product offerings regarding educational interactive media for preschoolers. The information compiled in this report was collected through an extensive literature review as well as interviews with leading academics, industry executives and advocates who are involved in the debate on preschoolers and interactive media.

Definition of Interactivity

Before attempting to explore the effects that interactive media have on preschoolers' development, we must first clarify what is meant by the term "interactive." Several definitions were found in the literature, each slightly different depending on the focus of the research.

In their examination of the features that are found in successful interactive products, Just Kid Inc. (2002) defined interactivity as "content intended for mass communication through a vehicle which allows for and responds to input from the audience or user."

Calvert, Rideout, Woodard, Barr, & Strouse (2005a) placed greater emphasis on the user's role in interactive media when they defined interactivity as "an exchange of actions or ideas that builds on previous exchanges. Interactivity, embedded in human experiences, involves control, responsiveness and turn taking."

In their effort to empirically test a definition of interactivity, Johnson, Bruner, and Kumar (2006) focused on the user's perceived experience. They defined interactivity as "the extent to which an actor involved in a communication episode perceives the communication to be reciprocal, responsive, speedy and characterized by the use of nonverbal information."

For the purposes of this research, we have borrowed ideas from each of these definitions and have defined interactive media as "technology products that are created for a mass audience, that allow the user to have some level of input and/or control over the action or content, and that respond to the user's input with either verbal or nonverbal information."

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Methodology

Based upon this definition, this review specifically explores the use of computers and computer software, the Internet, video games, interactive books, interactive toys and interactive television programs created for or used by preschool-aged children. It does not include research on digital cameras, cell phones, email, instant messaging, PDAs, iPods or MP3 players or any other wireless devices. Though each of these technologies feature some aspect of interactivity described above and may have useful educational capabilities some day, they are not yet commercially available for preschoolers nor do they meet each of our criteria for interactive media. We have therefore excluded them from our review.

We have, however, included research on traditional television in the literature review. The reason for this is twofold. First, interactive television is in a state of infancy and as such, almost no research currently exists on its uses with or effects on preschool audiences. Second, there are a few educational television shows for preschoolers that attempt to get children to interact with the program. Shows like *Blue's Clues*, *Dora the Explorer* and *JoJo's Circus* feature characters that look directly into the camera and encourage young viewers to participate in the story, either by performing an action with the characters or by responding to their questions. While this is not true interaction in the sense that children do not control the action or the story, children are asked to be active participants in the program, and some may think that they are truly interacting with the characters. The research on these participatory television programs, therefore, may give us a small glimpse into the potential of true interactive television.

The literature review encompasses nearly four decades of research and was restricted to research and writings that deal specifically with investigating preschoolers' (three- to five-year-olds) use of interactive media and the effects those media have on preschoolers' development. Due to the fact that the available research on this topic is relatively sparse, some research on the effects of interactive media on kindergarten students (five- to six-year-olds) was included, as well as research from a few countries outside the United States.

Interviews with leading academics, industry executives and advocates who are involved in the debate on preschoolers and interactive media were conducted in order to include their perspectives. Additionally, we hoped that interviews with media executives would provide information about the current state of children's educational interactive media, as well as a glimpse into the products and programs we can expect to see in the future.

Twenty-one people were asked to participate in our survey and after repeated requests we successfully interviewed thirteen people. We were fortunate to get a good mix of individuals from each field of expertise and selected quotes from their interviews are used throughout the report to provide examples, different perspectives and expert opinions.

We begin by providing an examination of the leading hypotheses and opinions about the effects of interactive media on preschool children. A review of the research that has tested the effects of interactive media on preschool children follows in order to provide empirical evidence to either support or refute each side of the debate.

One overarching theme of the research findings is that it is the content of the media, not the technology itself that makes a difference in children's learning outcomes. We therefore examine research studies that detail some of the design features of successful interactive media. Our hope is that this design section includes information that can help creators of children's educational interactive media develop more effective products for children. Similarly, the next section on best practices offers expert suggestions for preschool administrators and teachers on how to successfully incorporate interactive media into their class curriculum.

Finally, because we noticed a resounding call for further research from nearly every study used for this report, we have compiled a research agenda that outlines some of the technologies and issues that require additional research before any conclusions about the usefulness and effectiveness of incorporating educational interactive media into preschool classrooms can be made.

The Debate

Despite the uncertainty about the effects of interactive media on preschoolers' development, many researchers, caregivers and children's advocacy groups have taken firm stands about how such media affect children and whether or not preschoolers should be exposed to them. Some of these opinions and positions are based on the research that currently exists while others are based upon the fact that not enough research exists that shows a benefit of technology to defend the use of interactive media with young children.

National Association for the Education of Young Children

The National Association for the Education of Young Children (NAEYC), in its position statement, *“Technology and Young Children—Ages Three through Eight”* (1996), explains its support for computers in preschool classrooms (the statement does not address other types of technology) with the caveat that the software must be developmentally appropriate, that it be “integrated into the regular learning environment and used as one of many options to support children’s learning,” and that teachers should “participate with children in the computer activities and encourage children to use computers on their own and with peers.”

NAEYC supports this position by stating that “used appropriately, technology can enhance children’s cognitive and social abilities” and that “developmentally appropriate software offers opportunities for collaborative play, learning and creation.” It acknowledges the ability of software to provide assessment features for teachers, as well as scaffolding, even for very young children.

Alan Simpson, senior director for marketing and communication for NAEYC, added “we need to be concerned about the individual appropriateness, not just age appropriateness, of all classroom materials, even technology. The great thing about technology is that it *can be* scaffolded and designed for different levels of development, unlike books or toys” (Simpson interview, February 14, 2007).

NAEYC does caution, however, that some software programs can reinforce stereotypes and expose children to harmful violence. Alternately, it recognizes that “technology can be used to affirm children’s diversity” and recommends that teachers “actively select software that promotes positive social values.”

“It remains unclear whether children who are exposed to computers and the Internet at such an early age are more prepared for kindergarten and grade school—or whether kids who have used computers are no more likely to excel once they begin school.”

—eSchool News (Nov. 12, 2003)

National Parent Teacher Association

National Parent Teacher Association's (PTA) position statement, "Technology Education and Safety," does not specifically address preschoolers since the organization focuses on issues having to do with schools and school-aged children. However, it does state its beliefs in the use of technology for children as young as kindergarten and also identifies some potential challenges and dangers of using computer in classrooms.

"The great thing about technology is that it can be scaffolded and designed for different levels of development, unlike books or toys."

—Alan Simpson, NAEYC

"National PTA believes that technology will be a valuable educational tool if it is a source of (a) high-quality, reliable, non-commercial content for children, and (b) relevant information that can be efficiently found and used for educational purposes. Children should be protected from sexually explicit, violent, racist, hate-filled and abusive electronic content and predators. Parents, the online industry, technology companies, the Federal Communications Commission, and content providers have a responsibility to monitor and provide quality content for children and youth" (National PTA, 2001).

In its resolution on computer technology, National PTA also states, "The PTA recognizes that familiarity with computer technology increasingly is a prerequisite to effective participation in an information-oriented society; and [u]nderstanding and using computers must be included in children's education, as computer technology will be an integral part of their lives as well as of their careers" (National PTA, 1983).

American Academy of Pediatrics

The American Academy of Pediatrics (AAP) does not yet have a position statement on interactive media and children. It is, however, concerned about the amount of advertising, as well as messages about violence, sex, substance abuse and body image that children are exposed to through the media, and has established guidelines recommending that parents "limit children's total media time (with entertainment media) to no more than 1 to 2 hours of quality programming per day" (American Academy of Pediatrics, 2001).

Federation of American Scientists

The Federation of American Scientists (2006) supports the use of computer and video games in classrooms stating that,

"educational games are fundamentally different than prevailing instruction because they're based on challenge, reward, learning through doing and guided discovery in contrast to the 'tell and test' methods of traditional instruction... They can be used to practice practical skills and important skills that are rarely used, to train for high-performance situations in a low-consequence-for-failure environment, and for team building... Games offer attributes important for learning—clear goals, lessons that can be practiced repeatedly until mastered, monitoring learner progress and adjusting instruction to learner level of mastery, closing the gap between what is learned and its use, motivation that encourages time on task, personalization of learning, and infinite patience."

National School Boards Foundation

The National School Boards Foundation (2000) recommends introducing preschoolers to the Internet because “exposure to the Internet can help preschoolers master literacy and other cognitive skills and also can spur integration of these skills early in their development. The Internet can reinforce everyday learning opportunities and be a powerful tool for fostering interaction among adults and young children.”

Alliance for Childhood

The Alliance for Childhood is a non-profit organization dedicated to restoring play to young children’s lives. It believes that computers “get in the way of children’s real interaction with life and the deep learning that comes about through open-ended play and other basic activities” and therefore has called for a moratorium on the use of computers with young children (Almon interview, February 21, 2007).

In its report, *Fool’s Gold: A Critical Look at Computers in Childhood* (2000), the Alliance for Childhood states that interactive technologies may expose children to the risk of a broad range of potential developmental hazards including:

Physical Hazards

- Muscular-skeletal injuries
- Visual strain and myopia
- Obesity and other complications of a sedentary lifestyle
- Possible side effects from toxic emissions and electromagnetic radiation

Emotional and Social Hazards

- Social isolation
- Weakened bonds with teachers
- Lack of self-discipline and self-motivation
- Emotional detachment from community
- Commercial exploitation

Intellectual Hazards

- Lack of creativity
- Stunted imaginations
- Impoverished language and literacy skills
- Poor concentration, attention deficits
- Too little patience for the hard work of learning
- Plagiarism
- Distraction from meaning

Moral Hazards

- Exposure to online violence, pornography, bigotry, and other inappropriate material
- Emphasis on information devoid of ethical and moral context
- Lack of purpose and irresponsibility in seeking and applying knowledge

Academics

Even the leading academics and researchers of children's educational interactive media have not reached consensus regarding the effects of interactive media on preschoolers' cognitive development. Much like the Alliance for Childhood, some researchers, based on the fact that children learn through their bodies in their early years, feel computers distract children from their need for hands-on, imaginative and creative play that is vital to cognitive development (Levin & Rosenquest, 2001; Haugland, 2000; Healy, 1998). Others feel that computers, because they cannot be held and manipulated the way other learning tools can, simply are not effective at supporting young children's understanding and skills (Yelland, 1999).

However, Plowman & Stephen (2003) claim that these concerns are becoming obsolete as interactive technologies are starting to be embedded in traditional learning tools such as blocks and books. Based upon their review of the literature in this field, they claim that "there does not appear currently to be any clear evidence on the deleterious effects of exposure to ICT (information and communication technologies)." However, they do acknowledge a consensus when it comes to concerns about privacy and safety and even advertising issues.

Dr. Sandra Calvert, director of the Children's Digital Media Center based at Georgetown University, is one of the foremost researchers on children and interactive media. She has found that "using participatory and interactive technologies can pull kids into a learning experience. Interactivity allows children to have amazing focus if it's done right. It can be such a responsive environment. The most effective technology teaches children and they have fun doing it without realizing they are learning anything." When asked what she thinks interactive media can teach preschoolers, she explains, "Logical thinking, writing skills, math skills, spatial skills. It can even enhance kids' creativity (although people haven't capitalized on it)" (Calvert interview, February 15, 2007).

But Larry Cuban, professor emeritus of education at Stanford University and a leading critic of the use of computers in classrooms, believes that computers are not worth the price of their investment. "There's very little evidence that kids are doing better academically because of computers in the classroom," he says. "Computers haven't made teaching more productive" (Smalley, 2003).

Warren Buckleitner, editor of the *Children's Technology Review*, agrees interactive digital media, including games, have potential as a tool in teaching preschool-age children because they can provide instant feedback, are flexible, empower children, and foster active learning. He cautions, though, that the quality of early childhood digital materials

varies widely and has declined since the year 2000. Since some interactive media products empower active learning but others detract from it, great care must be taken in selecting quality products (National Institute for Early Education Research, 2006).

School Technology Directors

Even school district technology directors have differences of opinion with regard to preschoolers' use of computers as learning tools (quotes from *eSchool News*, November 12, 2003).

Bob Moore, executive director of information technology at the Blue Valley Unified School District in Kansas believes “very young children need to run and play, not sit at a computer.” Alan Whitworth, technology director for the Jefferson County School District in Kentucky agrees. “I think there are so many things that preschool children need instead of learning how to use a computer,” he said. “My advice to parents is to get [the kind of computer] you want to use, and let your child play with the boxes.”

But Charlie Reisinger, director of technology at the Penn Manor School District in Pennsylvania believes preschool is a great time to introduce children to computers. “Anything that preschools can do to increase student technical skills prior to kindergarten is a good thing,” he said. “If properly implemented, the preschoolers will have a head start on technology before they enter the public school system. The net effect will be to enhance early student computer literacy.”

Nancy Messmer, director of library, media and technology at the Bellingham School District in Washington is also a proponent of computers in preschool classrooms. “Computers and a variety of media tools are a part of the environment kids are in. They relate to screens from early ages on, in the home or in public places. I think children should be immersed in work and play that includes talking, rhyming, acting, running, painting, investigating, and maybe interacting with what they find on computers with adults and other kids.”

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—Alan Whitworth, Jefferson County School District

Interactive Media Use by Preschoolers

Though many content producers, especially in television, believe that children are not interested in educational content, young children actually prefer interactive content that supports their cognitive development.

Despite the debate about the appropriateness of young children using technology, many preschoolers already are using it. According to the Kaiser Family Foundation, 70% of four- to six-year-olds have used a computer, 27% use one in a typical day and one out of ten preschoolers use a computer every day. The children who do use computers spend an average of 1 hour 4 minutes on them each day, about half of their total screen media time (2 hours 10 minutes) (Rideout, Vandewater & Wartella, 2003).

Preschoolers are using the Internet as well. According to the 2000 census, 7% of three- to five-year-olds went online at home (Calvert, et al. 2005a). In 2003, nearly one in four preschool students (23%) used the Internet (National Center for Education Statistics, 2005). Although this jump in usage may be due to the increase in home Internet access during the three years between studies, it could also be due to the fact that preschoolers in 2003 may have been logging on at school. In fact, in their investigation of computer use in Texas child care facilities, Lynch & Warner (2004) found that in general, children begin using computers in child care centers between ages two and four, regardless of socioeconomic status.

So what are preschoolers actually doing when they turn on the computer or log on to the Internet? A review of over two decades of research showed that two- to seven-year-olds prefer and spend more time playing educational interactive games than do older children (Wartella, Lee & Caplovitz, 2002). This finding has tremendous implications. Though many content producers, especially in television, believe that children are not interested in educational content, young children actually prefer interactive content that supports their cognitive development.

As for other media, 50% of four- to six-year-olds have played video games, though boys are more likely to play than are girls (56% of boys have played video games vs. 36% of girls). Boys also play video games more frequently than do girls, with 24% of boys playing in a typical day vs. 8% of girls (Rideout, et al., 2003). No research was found detailing preschoolers' use of interactive storybooks, toys or television.

Gender differences only seem to hold true for video games, however. During the preschool years there are no gender differences in amount of computer use or abilities (Calvert, et al., 2005a). The only gender differences that have been found have to do with content preferences, with boys preferring violent and competitive games more than do girls (Kafai, 1995).

A digital divide does still exist based on socio-economic status (SES), level of parental education and race. In terms of access, higher-SES households have more access to computers (Calvert, et al., 2005a; Wartella, et al., 2002a) and the Internet (Calvert, et al., 2005a) than do low-SES households. Children whose parents have higher education and who come from two-parent families also have more access than do children who do not (Calvert, et al., 2005a; Subramanyam, Greenfield, Kraut & Gross, 2001). Furthermore, White and high-income students have more access to quality educational technology that supports their schools' curricula and reflects their culture and life experiences than do Latino, African American and low-income students (Van Scoter, Ellis & Railsback, 2001).

Furthermore, regardless of income, education or family structure, Latino and African American families are still less likely to have Internet access and Latinos are less likely to have home computers than are White families. Yet even without home access, Latino and African American children find ways to spend just as much time on computers as do White children. Likewise, when computer ownership is taken into consideration, race and income no longer predict the amount of computer use (Calvert, et al., 2005a), indicating that access is the key to bridging the digital divide.

While they don't have equal access to computers and the Internet, low-SES families are more likely to own video game consoles or handheld devices (Wartella, et al., 2002a), though there is no research yet on the types of video game systems low-SES families own. This could be of particular interest since traditional video game systems like PlayStation, xBox and Game Boy do not offer many educational software titles. However, there is a growing number of video game systems for young children, such as Leapster and vSmile, that are designed specifically as educational tools and could potentially help fill some of the educational gap left by the digital divide.

Preschoolers' Abilities to Use Interactive Media

Sixty-four percent of four- to six-year-olds are able to use a mouse to point and click; 56% have used a computer by themselves; 40% can load a CD-ROM by themselves; and 37% can turn the computer on by themselves.

One of the arguments against introducing technology into preschool classrooms is that young children may not be developmentally capable of using it. Research conducted over the last few years indicates that this is not necessarily the case when it comes to physically being able to use the computer hardware.

Based upon interviews with parents of four- to six-year-olds, Rideout, et al. (2003) found that 64% of children in this age group are able to use a mouse to point and click; 56% have used a computer by themselves; 40% can load a CD-ROM by themselves; and 37% can turn the computer on by themselves. Most of these skills seem to be acquired

by the time children are approximately 3½ years old (Calvert, et al., 2005a). No gender differences were found for any of these abilities.

In addition to the parental reports, a study of three- to five-year-olds' use of multimedia technologies found that the children had a great interest in using the computers and engaged with them for long periods of time. Furthermore, even though many had never used computers before, the children had little difficulty adjusting to the new learning environment (Liu, 1996).

Naturally, there is more to being able to use a computer or other interactive media than just being able to turn it on and manipulate the hardware appropriately. Plowman & Stephen (2003) warn that traditional reading skills may not be transferable to computer-mediated text, and children may therefore need explicit guidance, just as if they were novice readers.

In their evaluation of an interactive toy based on PBS' Arthur characters that worked in conjunction with a computer program, Luckin, Connolly, Plowman & Airey (2003) found that four- to six-year-olds were able to master multiple interfaces while interacting with both the computer screen and the toy. This ability to multi-task is a valuable skill that will be useful for many different interactive applications.

Unfortunately, little research exists on children's abilities to use other interactive media, such as interactive storybooks, toys, video games, the Internet or interactive television. More research is needed to understand the full extent of preschoolers' abilities to use and understand interactive technologies.

Effects of Interactive Media on Preschoolers' Learning

There is a relatively small but growing body of research on the effects of interactive media on preschoolers' learning and development. Most of this research is focused on the use of educational computer software, though there are a few studies that investigate the effects of interactive books and toys. The research in this section has been organized within the five developmental dimensions through which young children learn: social and emotional, language development, physical well-being and motor development, cognitive and general knowledge, and approaches toward learning (Van Scoter, et al., 2001). In addition, we will explore the research on the effectiveness of interactive media to teach disabled, learning disabled and at-risk students.

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—Erin Dubey, First 5 California

Social and Emotional Development

Although several organizations and researchers advise that technology should never take the place of social interactions and relationships, technology can be used as a catalyst for social interaction and communication between students and with teachers and parents (Van Scoter, et al., 2001; NAEYC, 1996). Children who use the computer with classmates have demonstrated increased levels of spoken communication and cooperation during computer use (Clements, 1994; Haugland & Wright, 1997). Children have been found to play within a set of rules (Addressi & Pachet, 2005), share leadership roles on the computer, take turns, and initiate interactions with others more frequently (Clements, 1994; Haugland & Wright, 1997).

Recent research suggests that the Internet can also help connect children with others rather than isolating them (Wartella, O’Keefe, & Scantlin, 2002b). Each of these findings seems to allay the concerns that computers are socially isolating for children (Cordes & Miller, 2000; Healy, 1998) and that they weaken bonds with teachers and the community (Cordes & Miller, 2000).

Interactive technologies also have been found to support children’s emotional development. Computers are intrinsically motivating for young children (Van Scoter, et al., 2001). Calvert, Strong, & Gallagher (2005b) found this to be true with a *Blue’s Clues* interactive storybook and Addressi & Pachet (2005) found similar evidence with an interactive music program. So did Erin Dubey, child development consultant for First 5 California, who explained, “From my experience, preschool children are typically very excited about interactive media...I have observed that interactivity helps children stay attentive. In my classrooms, attention span with computer programs was always good and frequently longer than with other types of classroom activities” (Dubey interview, February 21, 2007).

Computers have also been found to enhance children's self-concept and improve their attitudes about learning (Lewin, 2000; Sivin-Kachala & Bialo, 1994). Luckin, Connolly, Plowman & Airey (2003) found that age appropriate, interactive toys featuring lovable characters can help strengthen children's emotional connection with the learning experience.

One negative effect that interactive technologies have on children's social and emotional development is the increase in aggressive behavior that some children experience after playing violent video and computer games. The great majority of research on interactive media focuses on the effects of violent games. This research overwhelmingly shows that preschoolers who play violent video games are more likely to behave aggressively than those who do not (Calvert, 2006; Wartella, et al., 2002b).

Language Development

Interactive media are capable of supporting the development of language and literacy skills of young children through the opportunities and motivation they provide (Siraj-Blatchford & Siraj-Blatchford, 2001; Van Scoter, et al., 2001). Children who use educational computer software have been found to use more complex speech patterns (Davidson & Wright, 1994) and to engage in high levels of verbal communication (Clements, Nastasi & Swaminathan, 1993). One reason for this is that children tend to narrate what they are doing as they move objects and pictures and engage with the program (Bredekamp & Rosegrant, 1994).

In an evaluation of DaisyQuest, a software program designed specifically to increase phonological awareness, preschool children who used the software significantly outperformed a control group on three measures of phonological awareness (Foster, K., Erickson, G., Foster, D., Brinkman, D., & Torgesen, 1994).

Interactive toys that "listen" to children have been found to support children's emergent literacy behaviors and affect their subsequent writing skills (Cassell, 2004). Another study found that through modeling, an interactive toy named "Sam" improved preschoolers' ability to tell sophisticated stories with more complex language and context. Children that interacted with Sam also learned how to clearly present narratives to audiences, which is crucial to early literacy learning (Ryokai, Vaucelle, & Cassell, 2003).

Chera and Wood (2003) found that interactive storybooks were effective at improving children's phonological skills and story telling abilities, but not their word recognition. However, Lewin (2000) found that interactive storybooks that allowed children to control the story and ask for help, rather than electronic storybooks that only read a story to children, were most effective at helping beginning readers to recognize words through word identification features.

Physical Well-Being and Motor Development

There are currently no research studies on the effects of interactive media use on preschoolers' physical health and development. There are, however, several concerns that excessive computer use can become addictive and can cause physical harm to young children in the form of muscular-skeletal injuries, such as carpal tunnel syndrome, visual strain, and obesity due to lack of exercise (Plowman & Stephen, 2003; van Scoter, et al., 2001; Cordes & Miller, 2000). In addition, there are concerns about children's privacy, safety and exposure to advertising on the Internet (Plowman & Stephen, 2003; American Academy of Pediatrics, 2006).

In order to protect children from these physical dangers, the American Academy of Pediatrics (2001) recommends restricting young children's total screen time (computers, television and video games) to one to two hours per day. Following ergonomic standards, encouraging frequent breaks, engaging children in vigorous physical activities and implementing online safety procedures are other actions that can be taken to protect children (NAEYC, 1996; van Scoter, et al., 2001).

Cognition and General Knowledge

Though still few in number, most of the experimental studies conducted on interactive media and preschoolers test technology's ability to support children's learning. The results of the research are varied, with some showing positive effects on cognition and some showing either no effect or no harm. Regardless of the findings, however, most researchers conclude that it is the content of the interactive material, not the technology itself, that has the impact.

Calvert, et al., (2005b) studied the effect of control on learning experiences by showing preschoolers an online *Blue's Clues* interactive storybook. They found that although control of the program increased children's interest in and engagement with the content, control did not influence the children's learning of the verbal or visual material. One explanation they offered for the lack of effect was that for this particular program, the learning activities were not closely linked to the story.

Another study looked at the effect of interactive books on 5- and 6-year-olds and found that basic interactive books that simply read a story aloud and highlighted words and phrases as they were spoken were most beneficial for children with lower reading abilities. An enhanced version of the book, which included feedback, reinforcement activities and hints, was more effective for children who already had acquired sight vocabulary (Lewin, 2000).

In another study of interactive books, Labbo & Kuhn (2000) found that other interactive features in the books, the clickable hot spots, influence the books' effectiveness. When the book included clickables that reinforced or complemented the story, children's storytelling benefited. However, when the clickables produced actions, sounds or rewards that were incidental story material, storytelling suffered.

Although the Arthur interactive toy described above demonstrated that children are able to attend to two interactive features at the same time, the evaluation of the interactive toy found that it was inadequate and inappropriate as a tool for helping children play the software games. The feedback the toy gave was often out of synch with the child's activities, and the toy's repertoire was not deep enough to support learning (Luckin, et al., 2003).

The developmental- and age-appropriateness of interactive media programs are also an important aspect of their effectiveness. Haugland (1992) found that preschoolers who used developmentally appropriate computer software had significantly greater gains in intelligence scores, nonverbal skills, dexterity, and long-term memory than did preschoolers who used non-developmentally appropriate computer software. In addition, when the children used supplemental learning activities with the computer program they also improved in verbal and conceptual skills.

Preschoolers who used developmentally appropriate computer software had significantly greater gains in intelligence scores, nonverbal skills, dexterity, and long-term memory than did preschoolers who used non-developmentally appropriate computer software.

Providing evidence that content, rather than the technology itself, has more of an effect on children's creativity, Haugland (1992) also found that creativity was reduced among the children who used non-developmentally appropriate software, but not among those who used age-appropriate programs. Additionally, use of drill-and-practice software, rather than more open-ended, discovery based programs, can lead to a loss of creativity (Van Scoter, et al., 2001).

One of the benefits of interactive media, especially computers and the Internet, is that they allow children to engage with people, concepts and artifacts that they would normally not have access to and in ways that would not be possible in the real world (Van Scoter, et al., 2001). One example of this is "curlybot," an autonomous two-wheeled

vehicle that can record how children move it on a flat surface and then play back the motion accurately. Children can program curlybot to repeat the movements, thereby creating geometric shapes and designs. Observational studies of preschoolers using curlybot found that young children were able to use the interactive toy and that it provided a "fun and engaging way for children to play with advanced mathematical and computational concepts in a much more fluid and expressive fashion" (Frei, Su, Mikhak, & Ishii, 2000).

Finally, some studies have concluded that simply having access to computers is enough to support learning gains. Hess & McGarvey (1987) gave computers and reading and math software to three kindergarten classes. One class received home computers as well. At the end of the study they found that the computer-use students had greater gains in reading readiness and keyboard knowledge than non-computer-use students. Those students who were given computers for home-use had even greater learning gains than the school-use group. Similarly, a program that introduced computers to UK preschool classrooms found that children gained a better understanding of how to use, access, control and gather information once they had access to computers. The teachers in

these classrooms also felt that students' knowledge of colors and shapes, as well as their literary skills, were enhanced due to computer use (Siraj-Blatchford & Siraj-Blatford, 2001). It should be noted that it is possible that the content of the programs used for each study may have been a factor influencing students' learning, however, neither study performed analyses of the content.

Approaches Toward Learning

Interactive media can be beneficial in helping some students with different learning styles find new ways to explore and understand material and to demonstrate their learning. Software can be created that has special features for visual, verbal, auditory and tactile learners. Though little research has been conducted in this area, some researchers are working on products that take advantage of this flexibility such as "The Continuator," an interactive music program (Addressi & Pachet, 2005) and curlybot, the mathematical robot described above (Frei, et al., 2000). However, there currently are no studies assessing the educational effectiveness of these programs.

Disabled and Learning Disabled Children

Regardless of one's position on the introduction of interactive technologies to preschool classrooms, there appears to be universal support for the use of technology to assist students with disabilities and special needs (NAEYC, 1996; Alliance for Childhood, 2000). According to the National Association for the Education of Young Children (1996),

"...for children with special needs, technology has many potential benefits. Technology can be a powerful compensatory tool—it can augment sensory input or reduce distractions; it can provide support for cognitive processing or enhance memory and recall; it can serve as a personal 'on-demand' tutor and as an enabling device that supports independent functioning...With adapted materials, young children with disabilities no longer have to be excluded from activities."

Though there is little research in this area, it is possible that interactive technologies can be used to help teach children with physical and learning disabilities. A number of studies provide evidence that computers promote a virtual play environment for children with special needs (Malone & Langone, 1999). Computers help children with disabilities by providing opportunities for social interaction with other children, working cooperatively, gaining confidence in themselves, controlling their environments, and making gains in language and communication (Hutinger & Johanson, 2000).

Regardless of one's position on the introduction of interactive technologies to preschool classrooms, there appears to be universal support for the use of technology to assist students with disabilities and special needs.

Elliot & Hall (1997) looked at the effect of computer-based math activities on preschoolers who were identified as at risk of early learning difficulties. Results of the study showed that students who used a computer-based, teacher-guided math program

scored significantly higher on a subsequent standardized math test than did students who participated in non-computer discovery-oriented math activities. This finding is especially interesting considering the current trend of discovery based preschool environments.

In an interview with Children Now, Sandra Calvert, director of Georgetown's Children's Digital Media Center, explained some work that she is doing with computers and children with learning and developmental disabilities. "We've used production features to work with kids who are at-risk. Action helps kids who are poor readers remember as many words as good readers do. However, if there is no action, if objects on the screen don't move, good readers remember more objects than the poor readers do. Movement is the bootstrap to help poor readers." Her work with children with autism has led to the discovery that "sound effects and whirling objects and bright colors engage kids with autism. For preschool-aged children who have autism, those who used a computer wanted to play longer than those who did not have a computer. Specifically, they learned more words; their vocabulary increased. Because autistic kids don't like face-to-face interaction, the computer allows a neutral territory without the threat of eye contact."

Socio-economics, Race and Ethnicity

Little research currently exists on interactive technology's effects on socio-economically disadvantaged children or on children of different races or ethnicities. As discussed earlier, research shows that children from different races and socio-economic groups have different access to educational technology and that the access they have often varies in quality. Some people believe one benefit of providing an interactive curriculum in preschools is that it addresses some of these inequities (Van Scoter, et al., 2001).

However, Snyder, Angus, & Sutherland-Smith (2002) found that merely giving computer and Internet services to families that have historically lacked them does not bridge the "digital divide" as previously thought. Instead, families need to see the technology as useful and appropriate to their own lifestyles and values before they are able to take advantage of the educational opportunities offered by the technology. More research is needed to understand whether the same would be true in a preschool setting.

Calvert, Strong, Jacobs & Conger (in press, 2007) found that when it came to an interactive *Dora the Explorer* television program, engagement with the story content predicted children's learning of the educational material. In addition, Latino girls learned the content better when they were able to control the program with the computer interface rather than when they simply observed the program with a live adult. These findings highlight the importance of having characters in educational media content that equally represent both genders and a wide variety of ethnicities and cultures.

Effects of Television on Preschoolers' Learning

As discussed earlier, there is currently no research exploring the effects of interactive television—positive or negative—on young audiences. Yet, as Sandra Calvert explains, when one of their favorite television characters asks them to help pull a rope or find a clue, many children believe they are actually interacting with the television character. If interactivity is truly in the eyes of the beholder, it may be useful to examine non-interactive television effects on preschoolers' learning in order to get a sense of the impact that interactive television may have someday.

Cognitive Effects of Educational Programming

Numerous research studies show that educational television can have positive effects on the intellectual and academic development of young children. For example, studies have found a strong association between *Sesame Street* viewing and preschoolers' readiness for kindergarten, regardless of their families' socio-economic status. Preschoolers who watched the program showed significantly higher gains in a range of academic skills related to letters, numbers, body parts, relational terms and sorting and classification (Fisch, 2004). Another study showed that young children who watched participatory programs such as *Blue's Clues* and *Dora the Explorer* had larger vocabularies and higher expressive language scores than children who watched other educational preschool programs (Linebarger and Walker, 2005).

Not only can educational programming positively influence young children's readiness to start school, it also can affect their ability to do well over time. One study showed that children who watched educational shows such as *Sesame Street* were better prepared for school three years later. (Wright, et al., 2001). Furthermore, these positive educational effects often can last into high school, even when factors such as family income and level of parental education are accounted for (Anderson, et al., 2001; Huston, et al., 2001). In fact, by the time young viewers of educational television got to high school, they also read more books, had higher confidence in their abilities and participated in more extra-curricular activities than children who did not watch educational television. In addition, males were more likely to receive better high school grades in English, math and science if they were frequent viewers of preschool educational television (Anderson, et al., 2001).

“Interactivity is in the eyes of the beholder: if children think they are having an interaction, they may well benefit from that belief. For instance, if they believe that Dora is responding to them, then they may become more engaged and learn more when exposed to her, even if it is a television program with pauses built into it.”

—Dr. Sandra Calvert, Children's Digital Media Center, Georgetown University

Social Effects of Television

As with video games, a great deal of research has been conducted on the effects of violent television programming on children's behavior (Bushman & Heusmann, 2001). Much of it shows a positive correlation between viewing of violent television and preschoolers' subsequent aggressive or violent behavior (Fisch, 2004). However, research also shows that young children are just as likely to be influenced by pro-social messages in television programs, learning and internalizing messages about friendliness, altruism, cooperation, self-control, delay of gratification and the reduction of stereotypes (Fisch, 2004).

Surveys of parents support these findings. Most parents (87%) report that they have seen their children imitate positive behaviors they saw on television while almost half (47%) note they have witnessed them imitate aggressive behaviors (Rideout, et al., 2003). Developmentally, by the age of three, children can readily imitate what they see on television, including both pro-social and anti-social behaviors (Calvert, 2006).

These findings from traditional television reinforce the conclusions from the research on interactive media: it is the content of the message, not the medium, that has the greatest impact on children's development. It is therefore necessary to look at the features of interactive content that effectively support preschoolers' learning.

The Future of Interactive Media

One goal of this research review was to provide a description of what future interactive media, especially interactive television, will look like and what their educational potential might be. Our interviews with media executives were designed to illicit such information from them, and we were very pleased to secure the participation of executives from several leading media companies such as PBS, Cartoon Network, Scholastic and Yahoo! Kids.

We were disappointed to realize, however, that the media executives were unable to share information about their current or future work on interactive television. It is possible that many of these companies are simply not planning interactive television programming at this time. As Alice Cahn from Cartoon Network explained when asked about her company's plans for interactivity, "Right now, every project we develop is created with an eye across platforms. We are not thinking about interactive television, we're more focused on creating content and community across platforms." Most of their work, it seems, is currently focused on creating material for their websites.

That is not to say that media companies are not doing anything with interactive media. In what may be our only example of future interactive television offerings, PBS executives described their new Game Lounge on DirecTV in which children can play simple television games featuring PBS characters using their remote control. PBS also has recently released research on the effectiveness of streaming PBS Ready to Learn educational content to children through parents' cell phones (PBS Press Release, October 19, 2006). Finally, their Next Generation Media Initiative is "a commitment that PBS will think differently about children's use with media and technology, to balance academic expectations and help to educate parents and teachers on how to most effectively use media to teach children" (PBS interview, February 14, 2007).

Scholastic has just teamed up with ION Media Networks, NBC and Telemundo to create the Qubo children's programming block (formally called "Smart Place for Kids") which is broadcast across multiple distribution platforms, including three national broadcast networks, a 24/7 digital broadcast kids channel, video on demand services and a branded website. Although the television programming is not interactive, content related to the programming is available on the Smart Place web site (Alexander interview, February 15, 2007).

Although he couldn't offer any insight into the future of interactive television, Paul Marcum, general manager of youth content for Yahoo!, predicted greater educational capabilities on the Internet. "We are so early in the use of this technology for education and entertainment, but the educational potential is great," he said. "We've already seen how social networking and video on the Internet promotes incredible learning opportunities. Further development into harnessing and sharing knowledge in an educational space will happen as technology improves."

After all of the research and interviews, it is still unclear what interactive television will look like. What types of educational programming will interactive television offer? Will there be content for preschoolers? Will there be links to non-educational or marketing web sites? Will programs be designed specifically for interactive television or will interactivity simply come to television once there is convergence with the Internet? It appears that it is still too early in the development of the technology to answer these questions.

Effective Educational Design

What are the design elements that make interactive educational content effective?

A review of the literature found five different features that content designers should consider when creating educational interactive media for preschoolers. These include: age- and developmental-appropriateness, responsiveness, production value, motivational elements, and the use of formative and iterative research.

Age- and Developmental-Appropriateness

Almost without exception, the number one recommendation for creating a successful educational interactive media product is to make it age- and developmentally-appropriate (Calvert, 2007; Markopoulos & Bekker, 2003; Plowman & Stephen, 2003; Just Kid Inc., 2002; Gilutz & Nielsen, 2002; Luckin, 2001). According to Luckin (2001), the goal of the software designer is to enable the program to provide enough high quality assistance, and to target the assistance in a way that will fit the learner's Zone of Proximal Development, the difference between the child's actual level of development and the level they could achieve with the assistance of a more competent adult or peer.

There are five features that should be considered when designing effective educational media for children: age- and developmental-appropriateness, responsiveness, production value, motivational elements, and the use of formative and iterative research.

Fortunately, one of the benefits of technology is that it can easily incorporate scaffolding into a program by creating different levels of difficulty for different ability levels (Simpson interview, February 14, 2007). This makes it possible to design programs that are not only appropriate to a particular age group, but also to different developmental levels within that age group.

When asked to describe how LeapFrog assures the age- and developmental-appropriateness of their products, Suzanne Barchers, editor-in-chief and vice president, explained, "We start with our scope and sequence, a framework of skills based on key state standards, plus the national standards in areas such as math, language arts, and reading. We then analyze play patterns, skills, and features of the platform(s). During the development process we test for viability, engagement, and function, adapting content along the way. We also update the scope and sequence regularly to reflect recent research in the field, using our Educational Advisory Board and other nationally-recognized consultants who verify or redirect the development" (Barchers interview, February 20, 2007).

Also, preschoolers' learning must be rooted in their personal, real-life experiences. Therefore, interactive content created for them should be based in real-world contexts (Roschelle, Pea, Hoadley, Gordin, & Means, 2000); should not be too abstract and should accommodate preschoolers' underdeveloped reasoning skills (Markopoulos & Bekker, 2003).

It is not just the cognitive abilities of the users that must be taken into consideration, however. Designers of interactive media must also consider preschoolers' social and physical development. For example, preschool-aged children need to play with other children. Media for this age group must therefore offer opportunities for collaboration and social engagement (Plowman & Stephen, 2003; Roschelle, et al., 2000) and create materials that work within children's existing play patterns (Just Kid Inc., 2002). For example, Just Kid Inc. warns against creating an interactive doll to teach reading since children use dolls for comfort and love, not storytelling.

It is also important to take children's physical development into consideration. Since they have smaller hands and may not yet have mastered their fine motor control, preschoolers should be allowed to work with a smaller mouse and larger keyboard buttons to accommodate their physical needs (Plowman & Stephen, 2003).

Responsiveness

Since it is one of the defining features of interactivity, responsiveness is integral to any interactive media product. It fosters children's engagement with the content and consequently sustains their learning (Calvert, 2001). As many researchers have found, however, just any type of response or feedback to children's input is not sufficient to support preschoolers' learning.

Interaction and feedback must be frequent enough to engage and assist children, appropriate to the action and context of the current situation, have enough depth and variability to accommodate a variety of situations and, finally, should not be patronizing.

Interaction and feedback offered to children must first be frequent enough to engage and assist them (Roschelle, et al. 2000). Interaction with the user must also be appropriate to the action and context of the current situation (Plowman, 2004) and should have enough depth and variability to accommodate a variety of situations (Luckin, 2003).

Finally, feedback should not be patronizing. Even the youngest of children seem to become annoyed when constant positive feedback is given to them (Plowman, 2004).

As discussed earlier, even non-interactive video can give the appearance of responsiveness if it provides social cues, such as questioning the audience and pausing, to suggest that the television characters are serving as conversational partners (Troseth, Saylor & Archer, 2006). This makes children more likely to pay attention and, therefore, more likely to learn the content of the program.

Production Values

Production values, or the aesthetic, video and audio quality of a product, are also important to capturing children's attention and thereby affecting their learning (Calvert, 2001). For example, sound effects, loud music and character vocalizations can attract children's attention. Placing educational messages right after the attention-grabbing devices can result in better comprehension of the messages (Calvert, 2006).

According to Francie Alexander, senior vice president and chief academic officer at Scholastic, “It’s important to design media in such a way that it’s educational/ instructional and appealing to children through its look and feel. It needs to have a ‘cool’ factor” (Alexander interview, January 31, 2007).

In a usability study of the Internet, Gilutz & Nielsen (2002) found that poor usability, such as unclear navigation, combined with kids’ lack of patience in the face of complexity, resulted in many simply leaving websites. Instead, children preferred simple interfaces, such as those created for adult users, which tend to be straightforward and easy to navigate. Extensive text was problematic for young children as well, since many are just beginning to read. Boys were significantly more annoyed by verbose pages than were girls. In contrast, girls were more frustrated than boys when sites lacked clear instructions.

Motivational Elements

The motivational elements of an interactive media product are those features that inspire children to play with them—features that make an interactive toy, book, web site or computer activity fun and engaging (Calvert, 2001). Several motivational elements have been identified in the literature including:

- *Control*—Children, especially boys, want to have control over the learning environment. They like to see how their actions affect the outcome (Calvert, 2001).
- *Action*—Some research has shown that action is another feature of media that can aid preschoolers’ comprehension. However, other research has shown that action can interfere with children’s memory of program content. (Calvert, 2006).
- *Clickables*—Children love to search the computer screen with the mouse to find “hot spots” that, when clicked-on, create a sound effect or animation sequence (Gilutz & Nielsen, 2002).
- *Humor*—Children enjoy content that is funny, colorful, entertaining and that uses multimedia effects (Gilutz & Nielsen, 2002).
- *Gender differences*—There are some gender differences to consider. While girls prefer writing, colors and drawings, boys enjoy control and action (Passig & Levin, 2000).

The Use of Research

In order to have a positive impact on preschoolers’ cognitive development, the creators and producers of children’s interactive media need to incorporate the theoretical frameworks and proven teaching strategies of child development and early education. One way to do this is by hiring educational experts to consult on the development of their products. In their study of nine media companies that create educational interactive media for children, Garrison & Christakis (2005) found that all nine made use of expert consultants. Just Kid Inc. (2002) advises that product developers would be wise to also conduct formative and iterative research to help inform the development of their products.

In addition, because evaluative research is usually not conducted, little is known about whether or not specific interactive media products successfully teach children the intended educational lesson. Without this information it is very difficult for teachers or parents to know which products are effective learning tools or for media companies to make any claims about their products' success. In the study mentioned above, Garrison & Christakis (2005) found that only one of the nine media companies—Sesame Workshop—performed publicly available scientific outcomes research on their products, though a couple of the other companies expressed interest in partnering with universities or non-profits to do so. The fact that Sesame Workshop's research is publicly available is important for two reasons: first, consumers can be informed about the educational value of their product, and second, other media companies can learn from their successes and failures, thereby helping to improve the quality of all educational interactive media.

Also, as Cartoon Network's Alice Cahn pointed out, research must be shared among the media companies as well. "The children's media industry hungers for research on media and young children," she says. "We keep up with the journals, stay in touch with key academics, work with outside research firms, subscribe to listservs, etc.," she says. But since much of the usability and design research is conducted in-house at media companies, "we must figure out how to get proprietary research shared and how it can be shared more efficiently." One solution she suggested was to hold conferences where attendees could hear industry executives talk about "their past successes and failures. People want to hear about the case studies" (Cahn interview, January 31, 2007).

"The children's media industry hungers for research on media and young children...[W]e must figure out how to get proprietary research shared and how it can be shared more efficiently."

—Alice Cahn, Cartoon Network

Best Classroom Practices

The Primrose School Franchising Company began using laptops, rather than desktop computers, in their preschool classrooms a few years ago. They found that they have access to more age-appropriate content via the Internet, that it is easier to integrate the company's proprietary curriculum into the classroom, and that it is more affordable than putting desktop computers in the classroom since a whole school can share one cart of laptops. Each child in Primrose classes spends about 20 minutes a day, three days a week on a computer exploring pre-selected, kid-friendly websites that relate to a subject they are currently studying. Teachers have found that 20 minutes is the perfect amount of time since the children are engaged with the material for about that long before they are done and ready to move on to something else (*eSchool News*, November 12, 2003).

“Rather than asking at what age children should use computers, we should ask, ‘What are appropriate and meaningful uses of technology with children?’”

—Van Scoter, et al. (2001)

“The best use of interactive media in preschool classrooms? Let the children take it apart and see what’s inside.”

—Joan Almon, Alliance for Childhood

Research on the use of computers in a Head Start classroom found that computers are just one of many learning tools offered to students and the open-ended software programs they use encourage children to explore, stretch the boundaries of their thinking, and bridge the divide between concrete and abstract thinking. Allowing students to use computers in pairs or small groups also stimulates cooperative behaviors among children and encourages them to help others who may have difficulty using the computer (Fischer & Gillespie, 2003).

These case studies provide examples of how some preschools have been able to successfully integrate educational interactive media in their classrooms. Unfortunately, very few case studies like these were found in our literature review. There were, however, some position statements, guidelines and studies that offered suggestions on how to create an effective interactive technologies plan for preschool classrooms. Since there was a great deal of agreement among these recommendations (which implies a significant level of validity and reliability for them) we have compiled the works of Fisch (2004), Van Scoter, et al. (2001), and Siraj-Blatchford & Siraj-Blatchford (2001), as well as the position statements and guidelines of the National Parent Teacher Association (2001), and the National Association for the Education of Young Children (1996) into one best practices resource that school administrators and preschool teachers should consider when implementing an interactive technology plan.

Classroom Logistics

- Computers should be located in the classroom rather than in a computer lab.
- Interactive media activities should be integrated into the classroom curriculum and used as one of many activity choices and learning tools provided for students.
- Computers and other interactive media should be arranged to allow children to work with one or two partners in order to encourage communication, cooperation and turn taking.
- Children's media use should be frequently monitored and facilitated by a teacher.
- Care should be taken to ensure that all students, regardless of race, gender or level of achievement have equal access to the media. Children with special needs should have increased access when this is helpful.

Selecting Effective Programs and Products

Great care must be taken in selecting appropriate educational programs and products for use in preschool classrooms. Garrison & Christakis (2005) pointed out that 17 of the top 20 selling products for three- to four-year-olds made educational claims, as did all of the video game systems for young children, despite a lack of actual scientific outcomes research to support their assertions. Therefore, educators must do more than just read

the packaging to determine whether or not a program or product is going to be effective for their students. Quality educational interactive media should be:

Seventeen of the top 20 selling products for three- to four-year-olds made educational claims, as did all of the video game systems for young children, despite a lack of actual scientific outcomes research to support their assertions.

- Age-, developmentally- and culturally-appropriate to all students, taking into account their cognitive, physical and technological abilities. The product should provide scaffolding and assistance in performing tasks that students might not be able to perform by themselves.
- Open-ended and allow students to control the action, explore and make decisions without the fear of making mistakes. Drill and practice software and activities should be limited.

- Aligned with the classroom curriculum and should have a real purpose. Products should enrich curriculum content, and should reflect and build upon what students already know.
- Focused primarily on the educational lesson. They should make educational content central not peripheral to the plotline, portray educational concepts in a clear manner and repeat important concepts for memory acquisition.
- Fun and engaging for children, featuring humor, dynamic and compelling visuals, sounds, music and/or voices.
- Capable of providing student assessments.
- Free of stereotyping or violence, but should involve an awareness of health and safety issues.

Teacher and Parent Involvement

Research has found that the positive educational effects of interactive media are strengthened when teachers engage with the technology with students and when children also have access to the technology at home (Snyder, et. al., 2002; Hess & McGarvey, 1987). As NAEYC's Alan Simpson noted, "You cannot sit a kid in front of any media, even a book, and expect them to have an enriching experience without engagement with an adult. Computers can help provide that engagement, but children still need the involvement of an adult" (Simpson interview, February 14, 2007).

Virginia Tech professor Peggy Meszaros agrees, "The more children and parents can experience the technology together, the better [the educational benefits will be]. Co-viewing is very useful as media is being introduced. Parents need to understand what is going on with the technology and they need to see what the effects are. Using the computer can be a family activity" (Meszaros interview, February 7, 2007).

Following are some additional recommendations for ways teachers and parents can support children's interactive media use in the classroom:

- Teachers need in-depth training and ongoing support to be adequately prepared to make decisions about technology and to support its effective use.
- Interactive media should be used to help provide and support teacher technology training.
- Parents should also be educated about the benefits of interactive media and encouraged to be involved in their children's media activities in order to reinforce the use of educational interactive media at home.
- Teachers, in collaboration with parents, should advocate for more appropriate technology applications for all children.

Developing a Research Agenda

“There are far more questions than there are answers about what computers and video games and Internet use mean to the social, intellectual and physical development of children today. As a result, we risk losing an extraordinary opportunity to help shape a robust environment that rewards editorial quality and educational value—an environment in which new media producers can thrive by understanding children as more than just a commercial market.”

—Wartella, O’Keefe, and Scantlin (2002)

After reviewing the research on educational interactive media and preschoolers, it is clear that this field of study is still in its infancy. Nearly every study in this review either acknowledged the dearth of research or called for additional research on this topic. The proposed research agenda that follows is based both on the call to arms from within the academic community and on our own discoveries of gaps or shortcomings as we investigated this body of research.

Effects Research

- Continue exploring the effects of computer use on preschool children’s cognitive development (Calvert, et al., 2005a; Schmidt, et al., 2005; Shields & Behrman, 2000).
- Expand research in this field to include experimental studies on the effects of all other forms of interactive media, including but not limited to, interactive toys, interactive books, educational handheld games, cell phones, wireless devices and interactive television (Wartella, Caplovitz, & Lee, 2004; Plowman & Stephen, 2003).
- Move beyond studies on the effects of video game violence to explore the effects of educational and pro-social messages in video games (Calvert, 2006; Wartella, et al., 2004).
- Broaden the scope of the research to include experimental assessments of the impact of interactive media on preschoolers’ social and physical development (Wartella, et al., 2002; Jordan & Fenichel, 2001). Specifically, there was no research found on the effects of interactive media use on preschoolers’ vision, obesity rates, muscular-skeletal health, or privacy.
- Study the short- and long-term effects of interactive media on preschoolers’ development (Calvert, 2006; Jordan & Fenichel, 2001).
- Conduct effects research to begin to explore the effects of interactive media on English language learners and children of different races and ethnicities (Calvert, et al., in press, 2007) as well as disabled, learning disabled and disadvantaged children.

Design Research

- Create an environment of collaboration between academia and the media industries so that research on effective design elements and educational content can be shared (Wartella, et al., 2002).
- Continue to pursue research that identifies features that effectively support learning for each interactive medium (Federation of American Scientists, 2006; Wartella, et al., 2002).
- Perform usability studies to determine which interactive features preschoolers' enjoy, attend to, and are capable of using.

Content Analyses

- Although there have been some content analyses of interactive media for young children (Moore, 2006; Children Now, 2001), broaden the scope of research to include all interactive media and update as necessary (Wartella, et al., 2002; Jordan & Fenichel, 2001). Research should especially focus on the educational content, violence, and racial and gender diversity present in each medium.

Usage Studies

- Explore what young children are actually doing with media in their everyday environments (Jordan & Fenichel, 2001). This research should also analyze differences in use by gender and race.
- Examine the amount of advertising that preschoolers are exposed to in educational interactive media, both at home and at school. Determine if action is required to reduce advertising in children's media products.

Evaluations of Classroom Practices & Case Studies

- Help inform decisions about the future role of computers in the classroom by identifying the uses that most effectively support learning and the conditions required for successful implementation (Roschelle, et al., 2000).
- Identify effective teacher training practices and determine whether technology training should be required for preschool teachers.
- Examine the costs required to bring quality educational technology into preschool classrooms. Identify how the standard of "quality" will be determined.
- Analyze programs offered in K-12 classrooms to see if connections exist between the media used in preschool classrooms and those used in K-12 classrooms or if collaboration between preschool and K-12 administrators is necessary to ensure preschoolers' smooth transition to technology in K-12 classrooms.

Conclusion

Since the early years of childhood are such a busy and important time for children's cognitive, social, emotional and physical development, it is imperative that we develop a strong and thorough understanding of interactive media's effects as well as the product features and adult practices that can help ensure effective use and positive educational outcomes.

Whether adults like it or not, children are spending a significant amount of time using interactive media such as computers, the Internet, video games and interactive toys and books. Since the early years of childhood are such a busy and important time for children's cognitive, social, emotional and physical development, it is imperative that we develop a strong and thorough understanding of interactive media's effects as well as the product features and adult practices that can help ensure effective use and positive educational outcomes.

The body of research on the effects that these media have on young children's development is far from conclusive. And though the majority of studies indicate that interactive media have potential to support positive learning outcomes for preschoolers, the need to expand upon the current body of research is great—so great, in fact, that Senators Brownback,

Clinton, Lieberman and Santorum have sponsored the Children and Media Research Advancement Act (CAMRA) that will provide funding to support further research on the effects of digital media on children.

While the funding provided by CAMRA will be invaluable for helping answer some of the many questions that remain about interactive media, there are many things that can be done right now to improve the depth of knowledge and quality of practices in this field. This report provides recommendations of things that interactive media producers, educators and academic researchers can do to help create a truly educational interactive media environment for young children. In addition, Children Now remains committed to this issue and will continue our efforts to bring experts from each field together to share their experiences, ideas, successes and failures. For it is only when every stakeholder works together that we will finally be able to ensure a healthy media environment for all children.

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Interview conducted February 21, 2007

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Children Now is a nonpartisan, nonprofit organization dedicated to giving all children the opportunity to reach their full potential. Our work on children and media issues has made Children Now a leading national public policy organization working to ensure children have a healthy and diverse media environment.

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