Exploring the Contribution of a Content-Infused

Interactive Whiteboard for School Readiness

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Abstract

This exploratory study examined the relationship between use of an interactive (touchscreen) whiteboard and development of school readiness skills. Over one school year, public school regular education prekindergarten classrooms used an interactive whiteboard with preloaded literacy and math activities. The children were low-income and English speaking. Randomly selected children (N=86) from each classroom were tested in the fall and spring using individually administered standardized tests of language/literacy and math. Statistically significant increases were found for children's performance in literacy (namely print knowledge, phonological awareness, and emergent writing), and in mathematics (namely counting, operations, and shapes) over the course of their preschool year, with a 52% increase in literacy readiness and a 28% increase in mathematics readiness for the children. The study supports interactive educational technology as a meaningful and effective instructional component of a quality early childhood program in preparing low-income children to be school ready.

Keywords: interactive technology, whiteboards, touchscreens, preschoolers, school readiness

Introduction

The landmark report *Eager to Learn: Educating Our Preschoolers* highlights that young children are better able to learn than current practices at times allow (Bowman, Donovan, & Burns, 2000). Young children are readily motivated to discover and engage with concepts on their level when allowed and encouraged to draw on their natural eagerness to learn and understand the world around them. Combining child-directed discovery with direct teacher instruction to scaffold and facilitate the experience as young children learn skills represents a highly effective educational environment (Landry, 2005). These approaches similarly apply to the uses of technology with early learners—uses which are systematically emerging as having the capacity to play a key role in such learning.

Experts confirm that preschool-aged children are developmentally ready and able to benefit from instruction with technology (Haugland, 2004; Murphy, DePasquale, & McNamara, 2003). These benefits can best be realized when many opportunities are provided during the preschool years for exploring technology tools in a supportive and playful environment (Van Scoter, Ellis, & Railsback, 2001; Murphy et al., 2003). A number of technology applications can support and extend learning for the young child in early educational settings, provided they are developed following critical design principles such as meaningful context, informative feedback, multiple opportunities for success, and independent use by the child following adult support (Clements & Sarama, 2005; McManis & Parks, 2011).

A common educational experience for young children is attending preschool in order to be prepared for kindergarten. Several major research reports conclude that effective preparation means intentionally attending to academic and cognitive areas. These include such emergent literacy skills as understanding how print is organized, alphabet knowledge, and the awareness of sounds in language (National Early Literacy Panel, 2008); in mathematics, learning about numbers, operations, geometry, and spatial relations (National Research Council, 2009); and helping build beneficial characteristics for positive approaches to learning such as being inquisitive, persistent, and independent (Conn-Powers, 2006).

Such preparation is especially urgent for children of poverty who consistently perform below higher income children in overall cognitive functioning, oral language, emergent literacy, and mathematics. For example, the report *Inequality at the Starting Gate* found the cognitive scores of preschool-aged children in the highest socioeconomic group was 60 percent above those of children in the lowest group (Lee & Burkam, 2002). Compared to their middle-income peers, young low-income children are less likely to develop into mature readers (Arnold & Doctoroff, 2003; Burkam, Ready, Lee, & LoGerfo, 2004). The contribution to these differences can be illustrated by the seminal work of Hart and Risley (1995), who found that by age four, the average child from a family on welfare had 13 million fewer words of language experience than did a child in a working class family. The pattern is similar in mathematics. For example, Jordan and colleagues (Jordan, Kaplan, Nabors Oláh, & Locuniak, 2006; Jordan, Kaplan, Locuniak, & Ramineni, 2007) found that low-income children enter kindergarten far behind their middle-income peers on tasks assessing counting skills, knowledge of number relations, and number operations. Moreover, longitudinal assessment reveals that low-income children are four times more likely than their middle-income peers to show flat growth in these mathematics areas throughout kindergarten and early first grade.

Fortunately, data from the last 30 years show that a high-quality early education program can have a major, positive impact on the school readiness of all children, and particularly children of poverty (Reynolds, Temple, Ou, Arteaga, & White, 2011; Klein & Knitzer, 2006; Karoly, Kilburn, & Cannon, 2005). Among other reviews, Karoly and colleagues at RAND conducted an extensive review of 16 programs based on the criteria of well-implemented experimental designs or strong quasi-experimental designs, with the strongest evidence as measuring outcomes at the time of kindergarten entry or beyond. All of the early childhood education programs yielded statistically significant benefits for children's cognition and academic achievement.

One promising area many educators and researchers are now identifying as contributing to the design of a quality early childhood education program is technology. The positive and substantial outcomes of using well-designed educational technology on the cognitive development of children has been emerging for the last three decades and is now represented in a solid body of literature (see reviews by McCarrick & Xiaoming, 2007; Clements & Sarama, 2003). For instance, compared to those who did not, young poverty children who had access to a computer performed better on measures of cognitive development and school readiness. The lead author notes the findings suggest that access to computers before or during the preschool years is associated with the development of cognition and preschool concepts (Li & Atkins, 2004). This study was published in the journal *Pediatrics*, suggesting that the impact of computer use on young children has wide-reaching interest. Technology experiences in which there is media-rich content integrated with the curriculum and teacher support for children are associated with improved language and literacy outcomes for letter recognition, sequencing, and sounds; listening and comprehension; vocabulary; and understanding concepts about stories and print (Penuel, Pasnik, Bates, et al., 2009; Primavera, Wiederlight, & DiGiacomo, et al., 2001; Nir-Gal & Klein, 2004). Children's math concepts have been shown to improve for number recognition, counting, shape recognition and composition, and sorting when they use computers with adult presence (Clements & Sarama, 2007; Primavera et al., 2001).

However, and understandably, the vast majority of research with young children in early childhood settings has been done with traditional desktop computers (non-touch mouse and keyboard driven). As the wide availability of interactive technology opportunities has emerged, there is a need to understand the impact these kinds of tools have on the learning and school readiness of young children. Due to their young age, providing developmentally appropriate educational technology is particularly important for children in the early childhood period. Touchscreens are fast becoming a dominant learning vehicle in K-12, with early childhood settings steadily making the transition as well (PBS, 2009). Further, interactive touchscreen whiteboards are the technology that K-12 teachers most report they want for their classrooms (PBS, 2011). These trends would indicate children's access to them is likely to rapidly increase. Logically, touchscreen technology should be very well suited to young users who are striving to overcome issues of fine motor skills and distractions from having to manipulate peripherals.

Developing and properly using technology with children hinges on many factors. Most proximally is the developmental appropriateness of the physical tool itself, but the developmental appropriateness of the content to which early learners are exposed is also an essential consideration. Knowing more about how touchscreens, and interactive technology more broadly, affect young children will allow us to know more about how these technologies can best be used with this age group. This vein of research can additionally help inform us about the extent to which children may be successful when greeted with these technologies when they begin formal schooling. Understanding how the placement and use of content on educational technology applications in areas research shows children need to learn in order to be ready for school can help solidify the vital role this learning approach can play in young children's school success. The purpose of the present study was to determine the degree of success around these factors of technology tools and content for preschool-aged children in classrooms using an interactive touchscreen whiteboard with literacy and mathematics activities.

Methods

Subjects

The children were drawn from eight public school prekindergarten classrooms across three schools in three separate school districts serving low-income preschoolers in the 2009-2010 school year. The language of instruction was English. Eleven children were randomly selected from each classroom. Data for both pretest and posttest were available for 86 of the 88 children selected. Girls made up 52% of the sample and boys 48%. The mean age of children at pretest was 4.6 years and 5.0 years at posttest. Children's home language was English. To counteract the lack of a control group in this exploratory study, we employed random selection as this can substantially reduce bias in terms of the difference between the results from the sample and the results from the population (Castillo, 2009). Bias is further reduced if attrition is kept low (Trochim, 2006), which was the case for the present study. Additionally, where possible we chose assessments with a norming group which can represent a nonequivalent control group (Trochim & Land, 1982). No other educational interventions were in place in the classrooms.

Procedures

Delivery of instruction through the interactive whiteboard.

The study teachers had been using the interactive whiteboard with content for approximately one year prior to the study to ensure there was not a differential learning curve for the hardware and software. All teachers received a similar training when the system was installed in their classrooms and received an additional two-hour booster training session prior to the study. The system features strategies and activities in the skill areas of literacy/language, mathematics, social studies, and science. The content is aligned with national prekindergarten standards (CTB-McGraw Hill, 2002; Kendall & Marzano, 2004; National Association for the Education of Young Children, 2008; Administration for Children, Youth, and Families, 2003; Harms, Clifford, & Cryer, 2005). The literacy and mathematics content is based on the findings of the National Early Literacy Panel (2008) and the National Research Council's Committee on Early Childhood Mathematics (2009).

The activities are designed to be used by children in large groups, small groups, or individually. Scaffolding is a foundational design principle that gives teachers the capability to choose emerging, still developing, developed, and for some activities, extension levels. For the study, teachers were asked to prioritize utilizing literacy and math activities (of which there are approximately 500), and to monitor that the randomly selected children were engaged with the system at least/approximately one hour per week. However, teachers and children could use activities in any of the areas as well as in Free Play. Teachers were provided an informal scope and sequence to use if they chose and a simple tracking sheet to help them ensure that the study children were involved in the literacy and math activities. An example of the navigation (the search feature for locating activities) for literacy is shown in Figure 1 and an example of a literacy activity is shown in Figure 2.

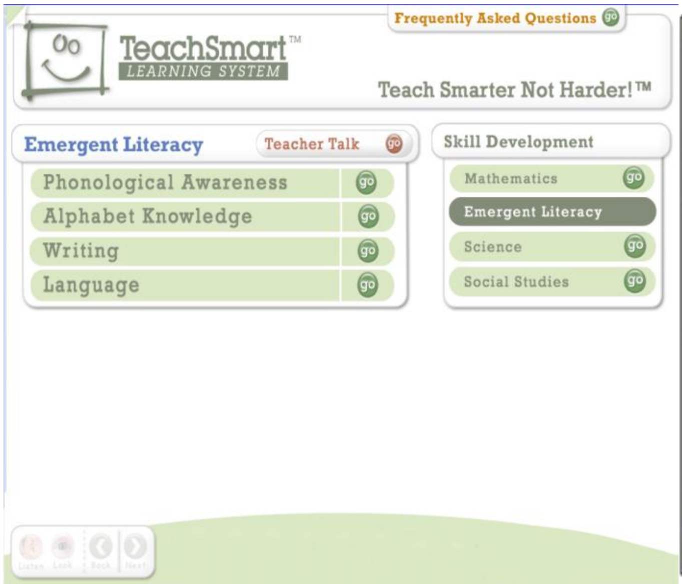

Figure 1. Literacy Navigation to Select Activities

Figure 2. Literacy Activity

All of the activities have both visual and auditory instructions as well as tutorials (the teacher and children can actually see through movement and narration on the screen how to do the activity). Many of the activities also have a built-in check of correct responses for the children to use. In addition, there is a lesson plan feature for the teacher which explains how to use the activity, an area for teachers to access to see the alignment between the activity and the standards, and the capability to create digital portfolios. Various options are available for the children to move objects (fingers, tennis ball, other objects) and to mark/write on the board (pens or fingers/objects). Figure 3 shows a child at the board.

Figure 3. Child using IWB.

Measures.

Three assessments were used to measure children's school readiness skills. All have good reliability and validity and have been used extensively with preschool populations of various socioeconomic and ethnicity backgrounds and early childhood education program types.

The Test of Preschool Early Literacy is designed to identify preschoolers aged 3 years to 5 years who are at risk for literacy problems. It has three subtests of print knowledge, definitional vocabulary, and phonological awareness. Subtests are combined to derive an age-adjusted composite score called the Early Learning Index, which according to the test developers, ultimately best represents a child's emergent literacy skills; and which can be compared directly to the normative sample. Internal consistency is .96. The correlations of the Early Learning Index (ELI) with the TERA-3 (Test of Early Reading Ability, 3rd Edition) are .67 and with the Get Ready to Read! Screener .70; both moderately strong. The norm group comprises 842 children ages 3 to 5, representing all geographic regions and with similar major demographic characteristics to those in the U.S. population (Lonigan, Wagner, Torgesen, & Rashotte, 2007).

The Get Ready to Read! Early Literacy Screening Tool is designed to determine how far along a four-year-old is on the path to learning to read. The screening tool samples knowledge and skills in the three areas of print knowledge, emergent writing, and linguistic awareness. The screening tool also gives a score that indicates whether the child's skills are still very basic, beginning to develop, making progress, almost ready, or ready to learn to read and write. The Get Ready to Read! Screener was normed on 342 children from the northeastern and southeastern regions of the U.S. The internal consistency is .78. The correlation between the 20 items on the screener and the Developing Skills Checklist for emergent literacy is .69; indicating a moderately strong relationship (Whitehurst & Lonigan, 2003; Phillips, Lonigan, & Wyatt, 2008).

The C-PALLS Math Screener provides a good indication of what researchers typically think is important in early mathematical skills for preschoolers. The screener evaluates child skills across multiple math content areas, including counting (rote counting and counting sets), number identification, operations, shape naming, and shape discrimination. A cut score of ≤ 12 is used to conceptualize progress. Children scoring at or below 12 indicates a need for more assistance/support in relation to early math skills. Children who score at or above 12 can be described as making adequate progress in relation to early mathematical development. The correlations between the C-PALLS Math Screener are strong with the Child Math Assessment at .73 and moderately strong with the Woodcock-Johnson Test of Academic Achievement–3rd Edition Applied Problems Subtest at .58 (Assel, Landry, Swank, & Gunnewig, 2007).

Data collection.

An alphabetical list by child last name was provided by classroom teachers. A list of randomly generated numbers matched to the number of children in the class was used to select the eleven children. If a child was selected but was repeatedly absent during the pretesting window, another child on the list was selected. Trained assessors worked with children one-on-one in the school to administer the screeners. The battery lasted approximately 30 to 45 minutes per child. Pretesting was conducted from approximately mid-September to mid-October and post testing from approximately mid-April to mid-May.

Results

Literacy.

A comparison of the mean pretest Test of Preschool Literacy Early Learning Index (ELI) to the posttest ELI showed a significant increase in early literacy skills over the course of the year for the study children ($t(86) = 4.06$; $p < .001$). The median ELI for all children at pretest was 94, which is the 35th percentile of the normative sample. The median ELI for all children at posttest was 100, which is the 50th percentile of the normative sample; showing that the children began well below average and ended as average.

A comparison between the Get Ready to Read! (GRTR) Screener pretest and posttest mean scores showed a statistically significant increase from fall to spring for the children ($t(86) = 12.22$; $p < .001$). The score calculated from the Get Ready to Read! Screener also provides an index of the child's readiness to learn to read. The score is used to rank readiness into one of five steps. Children at steps one through three are considered to need additional readiness instruction while those at steps four or five are considered ready to learn to read. At pretest, 54% of the children were at step three or lower, needing additional instruction before being ready to read. At the posttest, just 18% of the children were at step three or lower. (Conversely, at pretest, 46% were ready to read; at posttest, 82% were in this category.) (See Figure 4.)

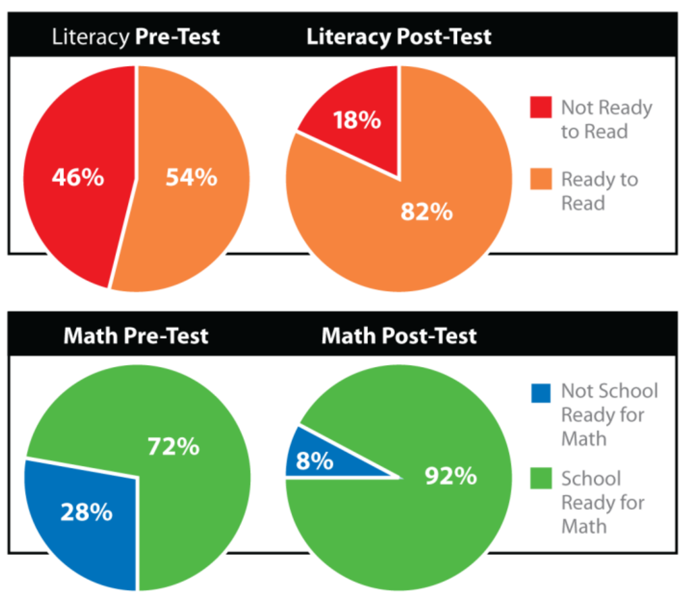

Figure 4. Pre- to Posttest Change in Percent School Ready.

Mathematics.

There was a significant increase in the CPALLS+ Math Screener mean score from pretest to posttest for the children ($t(86) = 9.27$; $p < .001$). The score calculated from the screener additionally provides an index of the child's progress toward school readiness in mathematics. A score greater than 12 at the preschool age represents adequate math knowledge for kindergarten. The results from the pretest showed that 72% of children achieved a high enough score to be considered ready for math in school. At posttest, that number had increased to 92%. (Conversely, at pretest 28% were not school ready in math. At posttest, 8% were not school ready in math.) (See Figure 4.)

Comparing to Business-As-Usual

The current study did not have a true control group, however the norming group can be used for a control group. For example, in a comprehensive reliability and validity study, the GRTR! Baseline (right before children began their preschool year), showed the children's mean score as 10.12 and then at short-term follow up (three to seven months later) their mean score was 9.85. There was no intervention in this sample and it was composed of children from Head Start (41 percent), public prekindergarten (33 percent), and private preschool (25 percent). At pretest, our mean score for the randomly selected children (n=86) was 11.20 and six months later at posttest it was 15.18. Further, by the end of the pre-kindergarten year, two-thirds of typically developing children have the early literacy skills they need to succeed in school (i.e., scores of 16+). The other third needs additional focused educational intervention. Our study children began the year with 46% of the children having these skills and ended the year with 82% of the children (much more than two-thirds) demonstrating they have the early literacy skills needed for school success.

Discussion

Giving children meaningful instructional activities through educational technology that is developmentally appropriate supports their success in learning important concepts needed for school readiness. New technologies that young children now have the opportunity to engage with, such as the one used in this study with interactive modalities that use touchscreens and that have the capability to make the actual process salient, authentic, and demonstrable in real time, are becoming more prevalent, with trends indicating they will continue to rise sharply (PBS, 2009, 2011). When we have children engage with technology in an educational environment, the goals and outcomes expected should be made clear. In the case of preschool, this is fundamentally school readiness—namely, the preparation for kindergarten. To meet this goal fully using technology requires its successful integration into the early childhood education program's curriculum and daily practices around developmentally appropriate content. In this study we have chosen to focus on literacy and mathematics for the content, as it is well established that these areas provide the foundation for school success. In order to be successful readers, children must first be competent in key emergent literacy skills (National Early Literacy Panel, 2008); and it is strongly recommended that direct and singular instruction in mathematics be present in the early childhood classroom (National Research Council, 2009). This is even more critical for young children at risk of school failure owing to life circumstances such as disadvantaged backgrounds, as they show lower levels of cognitive and academic achievement than do middle- and higher-income children, and because further, without intensive instruction, they quickly fall even further behind their more affluent peers in school (Lee & Burkam, 2002; Arnold & Doctoroff, 2003). Moreover, providing children with challenging tasks and meaningful activities that can be mastered, while chaperoning these efforts with support and encouragement, facilitates the development of a robust sense of self-efficacy—a self-regulatory characteristic that promotes vital, positive approaches to learning such as motivation and persistence (Bandura, 1993).

Serving as a bridge for children into an experience that allows and encourages their eagerness to learn, many early childhood education programs are embracing the promise of better preparing their charges for entry into formal schooling using educational technology. It is hoped the current study contributes to demonstrating that, similar to traditional desktop computers, technology of an interactive and touch-based nature which can promote group learning, can serve successfully as a vehicle for bringing relevant content to early learners to support a positive beginning for their future learning and educational experiences.

Limitations and future directions. There are limitations in this exploratory study that warrant noting. Mainly, even though the children were randomly selected from among their classmates and their results compared to a national norm group, the findings need to be replicated with a control group. We have plans to do so and to include a wider range of early childhood program types as well.

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