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iPad Intervention with At-Risk Preschoolers: Mobile Technology in the Classroom

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Abstract

This study investigated the efficacy of iPad applications to enhance key academic skills areas in Head Start children. Twenty four-year-old Head Start children, selected from a larger study, were pre-and post-tested on upper and lower case alphabet knowledge, matching, and number concepts using criterion referenced measures. Children were randomly assigned to an intervention condition or comparison condition. Children in the intervention condition received one hour of weekly instruction using iPad applications chosen specifically for their focus on alphabet knowledge, matching or number concepts. Children in the comparison condition also interacted with iPad applications one hour per week using applications that did not target the identified academic areas. Children were post-tested following the ten-week study. Gain scores reveal strong effects on multiple variables.

The research question was:

1. Do iPad applications, specifically chosen for their alphabet knowledge, matching and number concepts, enhance these specific skill areas in Head Start children?

Key words: at-risk preschoolers, iPad, mobile technology, literacy, matching, number concepts

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Introduction

With the increasing use of interactive mobile technology, the iPad has become a powerful tool of living and learning; socially, academically, cognitively, and linguistically (NAEYC, 2012). As defined by the Global System for Mobile Communications in their report, *Mobile Education in the United States*, mobile technology encompasses personal portable devices (e.g. e-Readers, tablets, Personal Digital Assistants (PDAs), and smartphones), that utilize a mobile network (2011). Handheld mobile technologies such as the iPad are emerging in classrooms across the country to support dual language learners, increase motivation to learn, improve fluency skills, encourage collaboration, and improve reading comprehension (Shuler, 2009). As the use of educational mobile technology increases, much of the instruction is being implemented via programs or applications. Common Sense Media (2011) reported approximately 72% of iPad applications in the Educational Category are marketed for preschoolers. The question then becomes one of how technologies such as iPad applications are being used, and whether they are effective facilitators of learning.

Research to support mobile technology as a supplemental teaching tool for children shows promising findings. To determine the most fundamental question of whether school age children will even engage in mobile technology, Michael Cohen Group (2012) conducted a qualitative study of young children and iPad use. Sixty children, ages 2-8, were observed interacting with iPads over a period of two months. The researchers found that children moved rapidly from novice iPad users to mastery of the device and application content. The authors suggest that the interactive and exploratory nature of iPad applications may provide an optimal learning experience.

Within educational settings, the majority of mobile technology usage as an educational tool has focused on supporting the literacy performance of school age children. In Escondido Union School District, a group of teachers piloted a study to investigate the effectiveness of iPod application use with first through eighth grade students to improve reading fluency and comprehension, as well as motivation, through digital audio playback of the reader's narration. Students using the iPods were shown to make up to six times the gains in word count per minute over a six-week period, and nearly two years of reading comprehension growth in six months. (Escondido Union School District, n.d.).

The JUMP into Reading for Meaning program assessed an educational game for the Nintendo DS Lite to supplement vocabulary instruction for low performing fourth grade students (Sanchez, Gee, Bus, Moorthy, & Sinicrope, 2009). Over a period of six months, students who interacted with the selected educational game during after-school programs showed greater improvement on post-test measures of vocabulary knowledge than those students who were not provided the opportunity.

Hutchinson, Beschorner, and Schmidt-Crawford (2012) conducted research using the iPad as a tool of literacy instruction in a classroom of 23 fourth grade students. iPad applications, used daily in classroom literacy instruction for three weeks, were selected based on their focus on reading comprehension via visualization, sequencing, and cause and effect. While quantifiable data was not provided, the use of iPads was noted to positively supplement the literacy learning goals within this classroom. Both students and instructor reported positive outcomes related to the technology use such as better visualization and enhanced story comprehension. Encouraging results indicating possible efficacy of mobile technology use to supplement school age literacy learning have been mirrored by research emerging in the field of early childhood education.

In early childhood settings, mobile technology research has emphasized foundational literacy skill development. For example, Horowitz et al. (2006) examined the efficacy of video streaming lessons via cell phones as a means of increasing letter knowledge of preschool students. Participant families streamed two types of video clips to their cell phones: literacy tips for parents on integrating letter knowledge into daily activities, and Elmo “Letter of the Day” clips. Participant families were required to stream three sets of these videos, each set comprised of one literacy tip and one “Letter of the Day”, weekly for a period of eight weeks. Participant report and observation indicated that the combination of literacy teaching tips and instructional alphabet clips showed great potential as a means of supplementing literacy instruction. In addition to resulting in increased alphabet knowledge of participants, the video streaming was reported to ease access to educational information for parents, provide a venue for easy everyday integration of literacy learning, and encourage enthusiasm and motivation to learn about letters by the children.

The use of mobile technology to supplement literacy learning aligns with current discussion highlighting the importance of choosing technology to supplement what is already occurring in the classroom versus changing classroom instruction based on the technology (Harris & Hofer, 2009; McManis & Gunnewig, 2012). Literacy standards-based skills addressed in early childhood classrooms include: alphabet knowledge, rapid digit naming, object sequencing, oral language, arithmetic, and visual processing skills such as matching. All of these skills have been either moderately or strongly correlated with later literacy success (Duncan et al., 2007; Francis, Fletcher, Maxwell, & Satz, 1989; Gallagher, Frith, & Snowling, 2000; Purpura, Hume, Sims, & Lonigan, 2011; Scatschneider, Fletcher, Francis, Carlson, & Foorman, 2004; The National Early Literacy Panel, 2009.)

In the area of alphabet knowledge, Gallagher, Frith, and Snowling (2000) investigated the literacy skills of 97 children; 63 at genetic risk for dyslexia and 34 with no reported risk for literacy impairment. Participants were assessed at 45 months of age in various areas of possibly predictive literacy skills, among them, nonverbal ability and alphabet knowledge. Participants were again assessed at six years of age. Results indicated the strongest predictor of literacy abilities at age six was alphabet knowledge at 45 months.

Schatschneider, Fletcher, Francis, Carlson, and Foorman (2004) demonstrated the importance of letter naming and letter-sound knowledge, as a predictive measure of later literacy skills. 384 children were followed from kindergarten to investigate early reading predictors as measured through Grade 1 outcomes. A subset including 189 children was then selected for continued investigation of the prediction of Grade 2 outcomes. Measures assessed four times during kindergarten included: phonological awareness, alphabet knowledge, rapid automatized naming, vocabulary, visual-motor integration, and recognition-discrimination. Measures of academic achievement in first- and second-grade revealed that phonological awareness, rapid automatized naming of letters and letter sound knowledge were highly predictive of later reading abilities. At the beginning of kindergarten, phonological awareness, letter naming speed, and letter knowledge were fairly comparable in their predictive nature for reading and word identification.

Francis, Fletcher, Maxwell, and Satz (1989) studied the validity of both verbal and nonverbal skills as possible predictors of later literacy abilities, measured at kindergarten and

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grades 2 and 5. This longitudinal study tracked 220 male students. Nonverbal skills measured in kindergarten included perceptual matching, demonstrated through the recognition-discrimination task of geometric figure-matching. Both the measured verbal and nonverbal skills had significant effects on literacy performances between kindergarten and grade 2. Perceptual matching measured through geometric figure-matching was determined to be a strong predictor of reading abilities in second grade.

Finally, Ginsburg, Lee, and Boyd (2008) support the inclusion of mathematics into early childhood education programs to promote later academic achievement. The authors maintain that instruction in mathematics is a type of instruction in literacy and language, a concept that applies to counting, mathematical terminology, and metacognition.

Addressing alphabet knowledge, number concepts, and matching, to support the academic success of school age children is well documented. As a result, early childhood educational agencies continually integrate these skills into the academic standards. Federally funded programs such as Head Start, for example, expect mastery of at least 10 letters during preschool, counting in sequence to 10 and beyond, matching objects, and use of terms such as “more, less, and fewer” before kindergarten (Arizona Department of Education, 2005). Deficits in these areas may put a child at risk for later literacy and academic difficulties. One possible supplemental tool to support these skills in early childhood is mobile technology in the form of Apple iPads. Currently, no empirical data exists substantiating the use of Apple iPad technology to support the learning of these skills in at-risk preschool children. This pilot study investigated the efficacy of using iPads to supplement classroom instruction in teaching alphabet knowledge, matching and number concepts. The research question for this study was: Do iPad applications, specifically chosen for their alphabet knowledge, matching and number concepts teaching, enhance these specific skill areas in Head Start children?

Method

A pretest-posttest comparison condition design was utilized for this pilot study. Criterion referenced measures were used to assess children's upper and lower case alphabet knowledge, matching concepts and number concepts. All measures were administered immediately before treatment began and again within one week after treatment ended. Children were randomly assigned to the treatment or comparison condition. Those assigned to the treatment condition interacted with one of three Apple iPad applications. Those assigned to the comparison condition interacted with Apple iPads programmed with educational applications unrelated to the four academic areas addressed in the treatment condition.

Participants

Twenty students, a sub-set of children from a larger study, participated in this project. Children were from five different Head Start classrooms from rural communities in Arizona; the children ranged in age from 48 -59 months. All participants were required to meet the following inclusionary criteria: (a) pass a hearing screening, bilaterally, at 25dB across the frequencies of 500, 1000, 2000, and 4000 Hz; and (b) no report, by parent or teacher, of current or previously identified concerns about cognitive development and (c) a score of four or lower on the Alphabet Knowledge-Upper Case subtest of the Phonological Awareness Literacy Screener – Preschool (PALS – PreK; Invernizzi, Sullivan & Meier, 2001). All children were native English speakers of standard American English.

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By parent report, six participants in the intervention condition were Hispanic/Latino, three were American Indian, one participant was Black and one participant was more than one race. For the comparison condition, seven participants were Hispanic/Latino, two were American Indian and two participants were White.

Procedures

All children meeting the eligibility criteria were administered four criterion referenced measures. The four skill areas assessed were upper and lower case alphabet knowledge, matching, and number concepts. These skills were identified by Head Start as core curriculum skills.

The Upper and Lower Case Alphabet Knowledge subtests of the PALS-Pre-K were used to measure alphabet knowledge. These subtests are administered by showing children a single 8 1/2 x 11 page with several lines of print containing the letters of the alphabet in random order and asking the child to name each letter on the page. The child was prompted with the statement, "As I point to each letter, tell me the name (sound) of the letter." A total score of 26 was possible. Matching and number concepts were assessed using criterion referenced measures developed for this project. The matching measure investigated the child's ability to recognize pictures that were the same. Children were shown ten different 5 ½ x 11 cards. Each card had a color picture on the top of the card and four pictures on the bottom of the card. As the examiner pointed to the single picture at the top of the card, the child was asked to "show me the picture that is the same" from the field of four. A total score of 10 was possible. Appendix A provides an example of several of the matching cards. The number concepts measure investigated the child's ability to use numbers, mathematical relationships and related vocabulary. Tasks ranged

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from asking the child to identify which picture from a small field reflected "more", "most", or "fewer", and to count from 1-10. A total score of 10 was possible. Appendix B provides an example of the number concept cards. Both authors administered the assessments.

Following administration of the criterion referenced measures, children were randomly assigned to a treatment condition or a comparison condition. The treatment condition received one hour of weekly instruction using iPad applications chosen specifically for their focus on alphabet knowledge, matching or number concepts. Specifically, the children were expected to interact with each different application twenty minutes a week. Children in the comparison condition also interacted with iPad applications one hour per week using applications that did not target the identified academic areas.

The iPad applications chosen for this project were selected with several key criteria in mind. The applications focused on the key academic concepts identified for this project, they were appropriate for preschool age children with several levels of difficulty through which children could move independently, and they provided positive or neutral feedback to children's responses. For the intervention condition, the applications provided multiple opportunities for the child to learn about and practice at least one of the skill areas.

Before the study, teachers and assistants received instructions to help insure children received scheduled interventions. A schedule for each child's computer instruction was created in collaboration with the classroom teacher. Teachers were asked to ensure both conditions accessed the iPads and the respective applications at least one hour a week. Classroom teachers tracked student engagement in the logbooks provided by the researchers. The intervention condition was required to use each research application a total of 20 minutes per week. The comparison condition was required to use the non-research applications, saved under a different

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folder, for the same amount of time. On average, the intervention children spent 292 minutes (range = 40-756) on the alphabet knowledge application, 233 minutes (range = 80 – 375) on the matching application, and 210 minutes (range = 60-349) with the number concepts application.

Children were post-tested one week following the intervention using the same criterion referenced measures. Administration of the measures was counterbalanced.

Results

Multiple one-way analysis of variance (ANOVA) were performed to determine the effect of iPad applications to enhance the letter knowledge, matching and number concepts of at-risk preschoolers. No significant differences were found among the four variables on the dependent measures, Wilks's $\Lambda = .65$, $F(4,15) = 2.01$, $p>.05$. However, Cohen's *d* effect size values showed strong effect sizes on upper case letters ($d = .72$), lower case letters ($d = .90$) and number concepts ($d = .83$) results which suggest moderate to high practical significance. Table 1 contains the means, standard deviations, 95% confidence intervals and Cohen's *d* for the dependent variables for the two conditions.

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Table 1

Mean, standard deviations, 95% Confidence Intervals and Cohen's d for changes in Upper & Lower Case Letter Knowledge, Matching and Number Concepts

		Intervention			Comparison		
		Pre	Post		Pre	Post	
DV	*n*	*M (SD)*	*M (SD)*	*n*	*M(SD)*	*M(SD)*	Cohen's *d*
UC	10	.80 (.79)	4.30 (6.62)	10	.60 (.97)	.90 (1.10)	.72
		[.23, 1.36]	[-.43, 9.0]		[-.09, 1.29]	[.11-1.69]	
LC	10	.40 (.97)	1.40 (2.06)	10	.40 (.52)	.40 (.70)	.90
		[-.29, 1.09]	[-.08, 2.8]		[.03, .76]	[-.10, .90]	
MC	10	6.60 (2.41)	8.10 (1.52)	10	5.80 (1.54)	8.00 (1.50)	-.43
		[4.90, 8.32]	[7.00, 9.20]		[4.70, 6.90]	[6.93, 9.10]	

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NC	10	4.60 (2.36)	5.80 (2.40)	10	3.80 (1.93)	4.50 (2.37)	.83
		[2.91, 6.30]	[4.08, 7.51]		[2.41, 5.18]	[2.80, 6.19]	

Note. DV = Dependent variable, UC = Upper Case Letters, LC = Lower Case Letters, MC = Matching Concepts, NC = Number Concepts.

There appears to be a correlation between the average time spent on the different applications and overall effect sizes. Upper case and lower case letter knowledge skills, which revealed large effect sizes of .72 and .90 respectively, demonstrated the highest average time on task (x = 292.4).

Discussion

iPad applications are being used as a supplemental tool for learning within educational environments. This pilot study investigated the efficacy of iPad applications in improving the literacy and overall academic skills in at-risk preschoolers. Results indicated that while statistical significance was not obtained, practical significance was found for the use of iPad applications to support learning in the preschool skill areas of alphabet knowledge and number concepts. Certain limitations were considered as to why statistical significance was not reached. Limitations and directions for future research will be discussed.

Limitations

Limited sample size and length of intervention should be considered limitations of this study. Cohen (1988) states that an increase in sample size correlates to an increase in statistical power. When number of participants must be limited, a minimum of 7 participants per cell is suggested. Comparison of a smaller number of cells, such as the 6 included in this study, requires a larger sample size to maintain statistical power (Wilson VanVoorhis & Morgan, 2007). Another possible contributing factor is the limited time frame of the intervention. While a ten-week intervention, designed for subjects to interact with each of three application programs for a total of 20 minutes per week, is often considered an adequate time frame when investigating educational issues, due to the nature of education programming, no child received the targeted amount of time with the applications. All subjects' exposure to the iPad and applications was limited by school closures, classroom demands, and some even further through absences.

Another limitation of this study may relate to the lack of oversight received by the subjects while interacting with the iPad applications. Conducted within Head Start classrooms, study subjects were presented the option to interact with the applications during daily free time. After classroom teachers prepared the iPad station and invited the subjects to engage with the technology, teachers returned to dividing attention between children involved in the research and the rest of their classroom. This often resulted in visually monitoring the students interacting with the applications from a distance, reducing the ability of the teacher to ensure that students were actively engaged with the pre-selected applications.

A final limitation necessary to discuss in the scope of this study is the selection of the research applications. The applications used in this study were selected by the authors based on observation of (a) availability of differing levels (b) feedback provided by the application and (c) perceived interest of preschool children. No validated or evidence-based rubric was referenced in the selection of the applications used in the study.

Future Research

Promising findings of this study contribute to a foundation supporting the use of iPad applications as supplemental teaching and learning tools. However, limitations encountered in this study should be addressed in future research. Larger sample sizes should be considered and various lengths of interventions should be trialed, taking into consideration the variability found in educational programming, in order to determine the impact of length of intervention on gains in targeted areas. Research should be adapted to allow for supervision of subjects while interacting with iPad applications to facilitate observation of subjects' engagement, individual responses to the activities, collaboration among subjects, and other possible factors impacting results.

Future studies should consider using a validated rubric to evaluate applications before use in research. Members of the educational community are looking to the web, both for advice on application quality and to share their own experiences (e.g. *mindleaptech.com*, *iear.org*, *teacherswithapps.com*, *appsineducation.blogspot.com*). Websites such as *iear.org* (I Education Apps Review) offer a venue in which individuals can access thorough reviews of educational apps but, as noted by Walker (2011), no common language of comparison has been established. By utilizing validated rubrics such as an Evaluation Rubric for Mobile Applications (APPS) (Walker, 2012), the quality of applications can be evaluated by assigning a numerical value to a set of common terms (i.e. curriculum connection, authenticity, feedback, differentiation, user

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friendliness, and student motivation). A consistent measure of the quality of applications could minimize this factor as a variable impacting the results of future research

In the course of this study, instructors frequently reported that English language learners within their classroom showed increased interest in the iPad applications (compared to the native English speaking students). This raised the question of iPad application efficacy in supporting the education of English language learners. Increased interest and motivation in this population could indicate great potential for supporting their learning, a concept meriting further investigation.

Further research should continue to investigate the efficacy of iPad applications to support learning in a variety of subject areas. Alphabet knowledge, number concepts, and matching were skill areas chosen by the authors because of their link to early childhood curriculum standards. It is possible that other skill areas or concepts targeted by iPad applications could lead to more salient changes in the abilities of research subjects.

Finally, future research should consider the use of a mixed method approach to analyze qualitative data gathered from parents and caregivers or through classroom observations during the course of the study. Such analysis would allow for further extrapolation of the data. Of particular interest would be whether prior experiences with iPad technology impacted performance.

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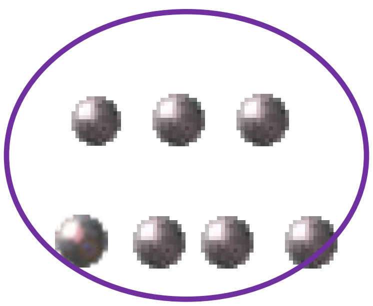
Appendix A

Samples from criterion-referenced measure of number concepts

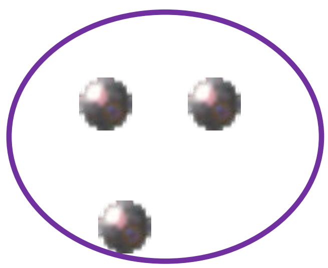
1) Researcher: "Count the beans."

2) Researcher: "Which circle has the fewest balls?"

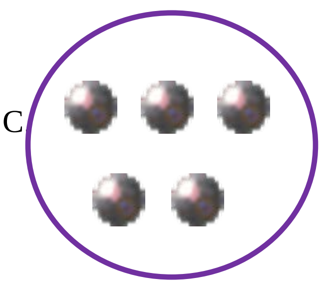
A.



B.

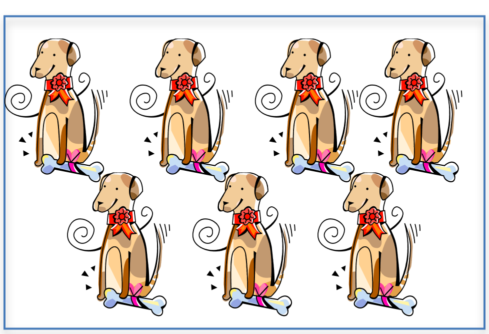


C

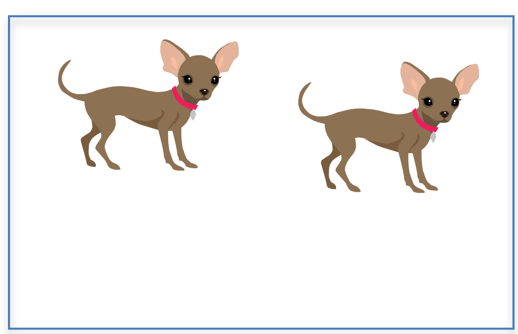


3) Researcher: "Show me seven dogs."

A.



B.



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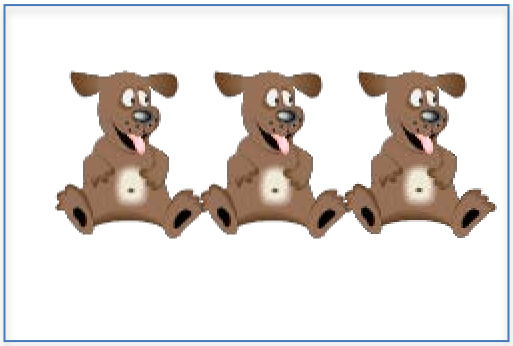
C. 

Appendix B

Samples from criterion-referenced measure of matching

Researcher: "Show me the picture that is the same as this one (while pointing to item presented individually in the first row)."

1) 

A.  B.  C.  D. 

2) 

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A.  B.  C.  D. 

3) 

   

A. B. C. D.