The Effects of a Computerized Intervention on Kindergarten Students' Reading Skills

by

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Abstract

The current study examined the effectiveness of the Ooka Island program, a computer assisted instructional program designed to help develop reading skills for children ages 4-7. Ooka Island allows students to learn and practice multiple reading skills, using an algorithm to help students acquire phonemic awareness, word reading skills, and reading comprehension. Forty-nine Kindergarten students used the Ooka Island program for most of a school year in addition to receiving their typical classroom instruction. Thirty-nine students served as a control group who only received their typical classroom instruction and did not use the computer program. There were better reading outcomes for students in the group who used the Ooka Island program on most reading measures, a reflection of those reading skills being directly taught and practiced in the program. Students in the group who used the Ooka Island program scored higher on a post-test phonological awareness blending measure than students in the control group, but there were no group differences on a post-test phonological awareness segmenting measure. Students in the group who used the Ooka Island program outperformed those in the control group on measures of pseudoword reading, word reading and word reading efficiency, controlling for beginning word reading accuracy in the analyses. Finally, students who used the Ooka Island program scored higher on a reading comprehension measure than students in the control group, with initial word reading skills as a covariate in the analysis. These outcomes suggest that Ooka Island can be an effective program to boost early reading skills.

TABLE OF CONTENTS

A Computerized Intervention's Effects on Kindergarteners' Reading Skills

Strong reading skills contribute to educational achievement and personal fulfillment (Fiester, 2013); consequently, the most important academic goals include learning to read and understanding what is read (Yanez et al., 2020). Before the end of early elementary school, students must have developed strong reading skills to avoid potential academic struggles in the future (Juel, 1988). On the other hand, students who struggle to read in early grades have a higher likelihood of later reading difficulties (Torgesen & Burgess, 1998). These reading difficulties may lead to widening achievement gaps between students of different abilities as they progress through school (Stanovich, 1986).

Unfortunately, not all children succeed in becoming proficient readers by the end of early elementary school and they continue to struggle in later grades. Early prevention can help; with timely effective interventions, most later reading challenges can be prevented (Vellutino et al., 2005). Explicit systematic instruction in the complex, interconnected processes of reading can remediate reading difficulties for most students (National Institute of Child Health and Human Development [NICHD], 2000; Vellutino et al., 2006). Early interventions to prevent reading difficulties have a higher impact on student reading progress than interventions in later elementary grades (Wanzek et al., 2018). Therefore, the optimal time to teach and strengthen these skills is at the start of a student's education.

Computer assisted instruction (CAI) programs are designed to help students learn and practice skills with the use of technology. Some of these programs have been designed to teach and practice reading skills. These programs may make prevention or remediation of reading difficulties easier for educational systems to administer and more accessible for students. The current study examined the effectiveness of Ooka Island, a computer program designed to help develop reading skills for children ages 4-7. In this paper, I give a brief

review on the current understanding of early reading skill development needed for students to become effective readers. Following that is an examination of recent quasi-experimental and experimental research studies investigating the effects of CAI programs developed for classroom use for typical students and students at risk of reading failure in the early elementary grades. I then present the current study.

Early Skills in Reading Acquisition

Phonological awareness is an important early skill in reading and contains two subsets, phoneme awareness and phonological sensitivity. Phonological sensitivity includes skills with units of oral language larger than the individual phonemes, such as rhyming and breaking a word into syllables. Phoneme awareness—the ability to discriminate and manipulate phonemes—is a significant predictor of reading progress (Ehri et al., 2001). This awareness of individual phonemes in spoken words makes important contributions to a student's word reading skills (Brady, 2020). Many students who have difficulties learning to read have a deficit in phoneme awareness (Wagner et al., 1997). According to the National Reading Panel's report, there were large benefits for students who were taught to blend and segment phonemes in words (NICHD, 2000).

Phoneme awareness skills can be taught. For example, in one early study, typically developing kindergarten non-readers were placed in one of two experimental instruction groups or a control group for seven weeks: one with a focus on phoneme awareness, one on language activities, and the other a comparison group (Ball & Blachman, 1991). In the phoneme awareness group, small groups of students were taught to segment spoken words into phonemes, using disks to represent each phoneme. They also completed lessons which taught some letter-sound connections. In the comparison language activity group, students in small groups completed activities involving vocabulary and shared story reading. Students in the phoneme awareness group scored higher on word segmentation tasks post-study, and they

also scored higher on a word reading test than the other two groups. In another seminal study, Lundberg and colleagues (1988) found similar results from pre-school phonological awareness training on grade 2 reading skills.

Phoneme awareness skills include segmenting and blending, isolating, and substituting phonemes in words. Instruction in more than two tasks does not benefit overall reading performance (NICHD, 2000). One early study showed the benefit of targeting blending and segmenting. Nonreader kindergarteners were randomly placed into matched groups for an hour per week of additional reading skills instruction (Torgesen et al., 1992). Students were trained in blending activities in one group, both blending and segmenting activities in a second group, and meaning-based activities in a third control group. After eight weeks of this additional instruction, the blending and segmenting group displayed a higher mean score in segmenting words in comparison to the control group. The blending and segmenting group also successfully learned new words more quickly than the control group in a reading analogue task, while the blending group did not score differently from the control group. Because learning both blending and segmenting skills aids in word reading, instruction in phonemic awareness should include these activities.

Along with phoneme awareness, letter-sound knowledge—the knowledge of the letters (group of letters) and the phonemes they represent—is a strong predictor of future reading skills (Lesaux et al., 2007; Lonigan et al., 2000). For example, students who begin first grade with stronger letter-sound knowledge showed faster growth in word reading from first to fourth grade (Peng et al., 2019).

Letter-sound knowledge and phonemic segmentation are needed to move students from Phase 1 to Phases 2 and 3 in Ehri's phase model of reading development, with students using progressively more complete knowledge to sound out unknown words (Phillips & Torgesen, 2006; Foorman et al., 2003, Ehri, 2002). Each of the four phases of reading

development proposed by Ehri describes the knowledge used to read and spell words. In the pre-alphabetic phase, children are pre-readers and may rely heavily on environmental clues and other symbols to recognize words. In the partial alphabetic phase, students read words using their growing but still limited knowledge of letter sound associations, but they cannot fully decode unfamiliar words. Decoding refers to strategically sounding out words using letter-sound knowledge and will be defined as such in this paper. Students in the full alphabetic phase use their thorough knowledge of letter-sound correspondences to decode words; it is through this decoding process that word spellings become stored in memory (Ehri, 1995). Finally, in the consolidated alphabetic phase, students use their lexical memory to read words at "sight," and use their knowledge of spelling patterns to decode unfamiliar words.

Emergent readers learn the letter sound correspondences and how to blend the sounds into words in phonics instruction. Research suggests instruction for early readers should include phonics instruction to learn letter-sound correspondences and how to decode and spell words (NICHD, 2000). In one study, researchers explored the effects of supplemental phonics instruction on the reading skills of low-skilled kindergarten students (Vadasy & Sanders, 2010). Students in the treatment group were taught lessons in letter sound correspondences, blending, and segmenting four times a week over five months in addition to their usual classroom instruction. Post-intervention, treatment group students outperformed control group students in letter identification, word reading, and passage reading fluency.

There is a significant relationship between decoding and reading comprehension (Hoover & Gough, 1990; Georgiou et al., 2021; Storch & Whitehurst, 2002). The Simple View of Reading theorizes that reading comprehension is the product of decoding and comprehension, emphasizing the need to develop both decoding and language comprehension skills to become a proficient reader (Gough & Tunmer, 1986). Denton and colleagues' meta-

analysis found that early elementary students who received instruction in decoding skills scored similar gains in comprehension as those who had both decoding and text comprehension instruction, showing the positive effect of decoding skills on comprehension (2022). In another study, first grade students in two experimental groups (decoding and fluency vs. decoding, fluency and comprehension) outperformed control students in word reading and comprehension measures (Fuchs et al., 2019). Even for students who began with weaker word reading skills, students in the experimental groups significantly outperformed students in the control group (Fuchs et al., 2019).

The strong connection between word reading and reading comprehension in the early grades is logical (Peng et al., 2019). It would be difficult to understand a text in which few of the words can be read. Since systematic phonics instruction helps students progress in word reading (Torgerson et al., 2019), it should be taught to students early on in their educational careers (Jeynes, 2008).

Reading fluency is the ability to read texts accurately, at an appropriate rate, with expression. When students can read texts fluently, they progress from a focus on decoding to a focus on meaning (Grimm et al., 2018). There is a bidirectional relationship between fluency and comprehension; fluency both reflects and supports comprehension (Duke, 2021). The ability to read words allows readers to devote more cognitive attention to comprehension (Duke, 2021). Readers have a limited amount of attention and cognitive resources, so when they are able to read words automatically they can then spend their cognitive energy on word meanings instead of word decoding (Laberge & Samuel, 1974). To be able to read words automatically, the word reading process outlined previously must operate without the need to apply conscious decoding strategies to each word separately. Students who do not automatically recognize the majority of words in texts typically experience comprehension difficulties (Kieffer & Christodoulou, 2020).

Vocabulary knowledge, the understanding of word meanings, plays an important role in understanding text (Perfetti & Stafura, 2014). Students with stronger vocabulary in first grade advance faster in reading comprehension in early grades of elementary school (Peng et al., 2019). The breadth of a child's vocabulary in kindergarten is a significant predictor of comprehension in middle elementary (Lonigan, 2008). For at-risk students, vocabulary ability in kindergarten added significantly to the prediction of reading comprehension in grade 3 beyond what word reading skills in grade 2 predicted (Catts et al., 2016). Students were considered to be at risk if they scored in the "some risk" or "at risk" categories on the Letter Name Fluency and Initial Sound Fluency subtests of *Dynamic Indicators of Basic Early Literacy Skills* (DIBELS; Good & Kaminski, 2002).

In a meta-analysis, there were positive effects for vocabulary intervention on comprehension outcomes, particularly for comprehension of passages that included the words that were directly taught in the intervention (Stahl & Fairbanks, 1986). However, gains in vocabulary do not always transfer to general comprehension. Although they might improve oral language skills for students at risk, vocabulary interventions are not sufficiently powerful to close vocabulary gaps, even in preschool and kindergarten years (Marulis & Neuman, 2010). Teaching students meanings of words in texts supports comprehension of that particular text, but not of standardized general comprehension measures (Wright & Cervetti, 2017). Because students must also be able to learn vocabulary words on their own and decipher meanings of new words in texts, instruction in strategies for determining the meaning of unknown words is recommended, along with explicit instruction of vocabulary words (NICHD, 2000). Students will continue to learn new words by the context in which the student reads these words.

Two critical features of effective vocabulary instruction are providing word definitions in a meaningful and supportive context, and multiple and repeated exposures to

word meanings (Coyne et al., 2009). Direct instruction of key vocabulary words in tandem with repeated readings of picture books enhances oral vocabulary acquisition (Pullen et al., 2011). The use of picture books to support vocabulary instruction provides context. Additional activities and review of the targeted words allow for practice in varied contexts (Wasik & Bond, 2001).

Reading comprehension involves the reader extracting and constructing meaning from a text (Snow, 2002). In emergent reading, comprehension is grounded in word recognition ability since students who cannot easily recognize words cannot understand their meaning (Juel et al., 1986). Students who cannot decode the words in a text experience difficulties in comprehension (Kieffer & Christoudou, 2020). If young students can decode the words in a text with sufficient automaticity to read it fluently, they will generally understand the meaning without difficulty. Readers can understand the meaning of a simple text when they can read the words correctly, so early code-focused instruction benefits comprehension. Research supports a simultaneous, rather than sequential, model of reading instruction; as young learners begin to read texts, other aspects of comprehension instruction play an important role (Duke, 2021).

Comprehension instruction for readers should begin in early elementary school (Baker, 2015) and can involve several approaches. First, the National Early Literacy Panel reported that interactive reading interventions yielded larger effect sizes than noninteractive ones, so engagement with the text is important (2008). Teaching comprehension monitoring, a student's understanding of their own comprehension of a text, has proven effective (NICHD, 2000). For example, in one study, students in prekindergarten to third grade were taught and practiced comprehension monitoring, resulting in higher comprehension monitoring skills (Connor et al., 2014). Teaching common text structures has also been effective in supporting comprehension (Fitzgerald & Spiegel, 1983). In one study, students in

kindergarten to second grade who participated in text structure instruction showed growth in comprehension (Al Otaiba et al., 2018). Finally, retelling the story after reading it is effective in increasing comprehension. Practice in story retelling doubled the quantity of information recalled for early elementary students (Davies et al., 2004).

Computer Assisted Instruction in Reading Development

Though research has established key skills needed for reading acquisition and methods of instruction of these skills, dedicated time and effort from schools and teachers are needed to ensure that students learn and practice these skills. With evidence-based design and implementation, CAI programs may hold the promise to help teachers achieve these educational goals for their students (Abrami et al., 2020). CAI programs could be uniquely positioned to help students master literacy skills that take a lot of repetition and practice (McTigue et al., 2020). The promise of technology-enabled instruction and practice is that the possibilities are there to help students practice skills to mastery. Technology can be programmed to monitor student skills and adjust practice opportunities on an individual basis so students can spend their time practicing skills at the correct level needed for mastery.

However, this promise has not yet been fulfilled; the design of educational technology has often not followed the established evidence base to ensure optimal development. In a study of fourteen commercially-available reading apps, Wood and colleagues found that even some more comparatively comprehensive reading instruction CAI programs did not deliver on activities spanning the full range of effective reading-skills instructional components (Wood et al., 2017). CAI programs also might be more effective for some aspects of reading instruction than for others. While skills like phoneme awareness and letter knowledge are perhaps easier to teach and practice, word reading and comprehension skills are more complex. Early meta-analyses of computer-assisted instruction have suggested that key reading skills like phoneme awareness and decoding can be positively influenced by CAI

programs (Hall et al., 2000; MacArthur et al., 2001). A majority of CAI reading programs focus on these early literacy skills. In their meta-analysis of CAI effects on early literacy skills, an overall positive effect was found on phoneme awareness skills and related reading skills like letter-sound correspondences and decoding (Verhoeven et al., 2020).

One meta-analysis of the effects of CAI programs on the reading skills of beginning readers showed small effects (Blok et al., 2002). Another meta-analysis on programs on reading outcomes for students in grades K-12 found educational technology applications had a small positive effect, with larger effects for older students than for younger students (Cheung & Slavin, 2012). Therefore, CAI programs have shown small but positive effect sizes on lower-level skills, and may be better for older students than younger students.

The following is an analysis of quasi-experimental or experimental studies of CAI programs that were used by early elementary students since the year 2000 in North America. The CAI programs are categorized by the focus on skills taught and practiced within the program: phoneme awareness and letter-sound correspondence skills only, or a combination of multiple skills.

For students at risk of reading failure, using a phoneme awareness and letter-sound correspondence skills-enhancing CAI program resulted in better scores in the targeted skills than similar at-risk students who used a math computer program (Anthony, 2016; Mitchell & Fox, 2001). In one study, randomly assigned kindergarteners (n=247) in schools serving students from low SES areas either used Earobics activities involving rhyming, syllable segmenting, blending, and word segmenting, or a math computer program for 90 minutes a week over 21 weeks (Anthony, 2016). Students chose activities within Earobics, and activities increased in difficulty as students worked through the levels with correct answers. For struggling readers, those students who performed below the median on initial phoneme awareness scores, Earobics accelerated skills on non-standardized tests of similar activities as

learned and practiced in the program: rhyming, blending, and segmenting. However, the results did not reveal significant signs of advantage for students not struggling to learn to read. Furthermore, there were no end of year differences in standardized assessments of word reading, pseudoword reading, or reading comprehension.

In another study, 72 kindergarten and first grade students at risk of reading failure used either a reading CAI program, a math CAI program, or were taught reading skills by a teacher (Mitchell & Fox, 2001). DaisyQuest and Daisy's Castle are CAI programs that teach and practice phonological awareness skills such as rhyming, isolating sounds, blending, and segmenting. Students using DaisyQuest and Daisy's Castle were allowed to set their own goals and choose their activities. Lessons for the students in the teacher-taught control group targeted the same concepts as DaisyQuest and Daisy's Castle, using explicit instruction and hands-on student practice. After five hours of intervention, students in the CAI program and teacher-led groups exhibited higher skills in rhyming, phoneme isolation, blending, and segmenting than math CAI program group students. As well, the teacher-led group of students outperformed the experimental CAI program group. The researchers suggested a possible explanation for this was that students may have focused too much attention on navigating through the technological aspects of the program, distracting them from the topic at hand (Mitchell & Fox, 2001). Alternatively, CAI programs are perhaps successful at teaching some skills but are outperformed by teachers.

Most studies of CAI programs that focused on more than one skill revealed positive results on phoneme awareness and letter-sound knowledge compared to control groups who did not use the CAI. A quasi-experimental study explored the effects of 8 weeks of a CAI program offered as a supplement for 88 pre-reading urban kindergarten students (Bauserman et al., 2005). Activities included rhyming tasks, identifying beginning, middle and ending sounds, blending onsets and rimes, and activities such as letter identification and letter

directionality. Comprehension activities targeted main idea identification and sequencing. After 5-6 hours of CAI program activities, experimental students performed significantly better on the Phonological Awareness Test, Concepts About Print measure, and moderately better on an informal listening comprehension measure than the control group. The success with phoneme awareness and letter-sound knowledge suggests that short interventions can sometimes be potent with these early skills, while building comprehension skills could take more time.

The Waterford Early Reading Program (WERP) is a year-long program for kindergarten students that introduces print concepts in addition to phoneme awareness and letter-sound knowledge. One study randomly assigned kindergarten classes into treatment groups to receive 10 months of training for 15 minutes a day of the CAI program (Tracey & Young, 2007) or into a control group with no additional CAI program. Students in treatment performed better than control students in literacy skills using a program-related measure and the Lindamood Auditory Conceptualization Test (Lindamood & Lindamood, 1971), even though control students performed better than treatment students for pre-assessment measures.

Istation® was developed to assess student reading skills before program use, and to adjust the level of question difficulty based on previous results, in each of the five categories set out as pillars of reading (Mathes et al., 2012). In a quasi experiment, typically developing kindergartners used Istation® in addition to regular classroom instruction (Putnam, 2017). For students in the treatment group, phoneme awareness and letter-sound knowledge improved more than those of control group students who experienced their typical classroom instruction.

On the other hand, two large-scale studies found no significant positive effects in literacy learning for typical or low-achieving first graders after using a CAI program.

Students (n=2619) used one of five CAI programs or experienced no computerized reading program use in 10-30 minute sessions for a total of 8-61 hours (Dynarski et al., 2007). Standardized assessment measures of word reading showed an effect size for experimental students not significantly different from zero (ES=+0.03). In a follow-up, assessment measures showed that program use for first grade students at risk for reading failure actually had a negative effect on word reading (Campuzano et al., 2009).

A Balanced Reading Approach for Canadians Designed to Achieve Best Results for All, known as ABRACADABRA (ABRA) is a CAI program developed to target reading skills in beginning readers. Its four modules incorporate different aspects of reading skills: phoneme awareness and letter-sound knowledge, reading fluency, comprehension, and spelling. Kindergarten students can also listen to, then complete comprehension tasks about, a selection of stories in ABRA.

One study of ABRA compared synthetic versus analytic approaches to phonics within the program, showing significant improvement in reading skills. A team analyzed 144 typically-developing grade 1 students in a classroom-wide randomized control trial, after an average of 13 hours of ABRA program use (Savage et al., 2009). Compared to a no-ABRA control group, both phoneme-based synthetic and rhyme-based analytic groups of treatment students showed significant gains in reading skills compared to the control group. This was especially true for the phoneme-based synthetic group in terms of phoneme awareness, listening comprehension and reading fluency, and for the rhyme-based analytic group in terms of letter-sound knowledge.

In Canada's largest randomized control trial of a computer reading program, as well as the first classroom effectiveness trial of ABRA, 1067 students in grades kindergarten, 1 and 2 were divided into a business as usual control group and an experimental group that used ABRA an average of 2 hours a week for 10-12 weeks in addition to their usual

classroom instruction (Savage et al., 2013). Experimental classroom teachers chose the activities their students used in ABRA, with a suggested breakdown of 10 minutes at the word level (including phoneme awareness, letter-sound knowledge, phonics, and word-building), 10 minutes of fluency and comprehension work, and 20 minutes of extension work. Suggested extension activities enabled teachers to connect ABRA activities to collaborative classroom work. While students in the ABRA group showed significant improvement over the control group in letter-sound knowledge and blending at the end of the study, similar improvements were not found in segmenting, word reading, fluency or comprehension. Researchers speculated that progress in word reading, fluency and comprehension scores may improve with time using their newly gained phoneme awareness and letter-sound knowledge skills to develop further skills (Savage et al., 2013).

In a cluster randomized control trial of 203 kindergarten and Grade 1 students, students in the experimental group showed significant gains in letter-sound knowledge compared to students in the control group after 10-12 total hours of ABRA program use (Piquette et al., 2014). No significant effects for the students in the experimental group were seen on standardized measures of blending, word reading, or listening comprehension scores.

Students from low SES backgrounds can sometimes experience challenges in reading achievement (Romeo et al., 2020). Because of this it is worthwhile to study what influences their reading progress. For multi skill CAI programs that are used with students from low SES backgrounds or those who have low assessment scores, results are mixed. When CAI programs are added in addition to tutoring, results are positive (Chambers et al, 2008; Madden & Slavin, 2017; Kreskey & Truscott, 2016). Alphie's Alley is a CAI program designed to be used with the assistance of a tutor. It assesses students, then gives tips and information to the tutor on how best to meet their needs. In a quasi-experiment, 159 low-scoring first graders were randomly chosen to either use Alphie's Alley and its application to

individual tutoring or no-technology tutoring (Chambers et al., 2008). Because students exited from tutoring when they met grade level standards in reading, more students in the experimental group were served than students in the control group, meaning that more students in the experimental group were able to reach grade level skills over the course of this study than students in the control group. According to standardized assessment measures of pseudoword reading, word reading, fluency, and comprehension at the end of the school year, means favored students in the experimental group for each score, with the biggest gains for comprehension. The length of time that students were using the tutoring was not reported.

The effects of adding Tutoring with Alphie to tutoring for low SES schools was explored in two studies by Madden and Slavin (2017). In each study, first grade students who scored in the lowest 30% of their class in reading skills were randomly chosen to participate in 30 minutes of tutoring each school day over seven months. The activities included videos that modeled the pronunciation of sounds, sound blending and substituting, as well as vocabulary and comprehension strategies. Students were paired, enabling them to read decodable books aloud to each other, coach each other, and answer comprehension questions. At the end of the school year, the scores of students in the experimental group were higher than those of students in the control group on standardized tests that consist of a combination of word reading, pseudoword reading, fluency, and reading comprehension tests. However, mean scores for neither group were at grade level by the end of the intervention.

The Headsprout Early Reading System was designed for pre-readers, teaching letter-sound correspondences, segmenting and blending, awareness of print, vocabulary, and comprehension. After completing six episodes, each student read a Headsprout storybook aloud, which included familiar sounds presented in the program. In a data exploration of 51 low-achieving kindergarten students who finished at least 25 episodes of Headsprout, change in DIBELS Letter Name Fluency and spring Nonsense Word Fluency scores revealed no

significant differences between students who had used Headsprout and those in a matched group who did not (Kreskey & Truscott, 2016). However, researchers note that most students were only able to complete at most 60% of the episodes by the end of the school year, which suggests more time could be needed to raise scores.

There are several limitations in the body of research comparing measures of reading skills after CAI program use. Larger-scale studies and studies that measured the transfer of foundational skills to progress in more intermediate reading skills like word decoding and fluency were more likely to show limited results. For the studies that did suggest strong positive results for experimental students, many of the outcome measures were not standardized.

Do CAI programs aid in reading development? Studies suggest these can help in the development of phoneme awareness skills and letter-sound knowledge. However, effects on decoding words, reading fluency, comprehension, and vocabulary have not been consistently demonstrated. There could be different reasons for this: the skills were not targeted specifically within the computer program; the skills did not have time to fully develop over the course of the study; or the foundational skills were not developed and automatic enough to have an effect on more complex skills. Few longitudinal studies exist that measure reading results after computer literacy programs, so it is unclear the long-term results of these interventions.

The Current Study

The current study examines the effects of Ooka Island, now renamed Scholastic F.I.R.S.T. (Scholastic F.I.R.S.T., 2019), a CAI program to teach and practice reading skills for students from preschool to grade 2. Ooka was developed by Kay MacPhee, the creator of SpellRead™ (SpellRead™, 2012). SpellRead™ has been successful in building reading skills in struggling readers (Metsala & David 2017; Torgesen, 2006; Rashotte et al., 2001). Ooka

Island's algorithms are designed to have students complete each activity's questions correctly, cycling students through various activities until mastery of the material is measured by accuracy.

Ooka Island presents activities that teach and practice phoneme awareness and phonics including those in which students match letters and sounds, identify the position of sounds in words, and blend sounds into words. As students are introduced to new sounds and their spellings, they begin practicing activities with them. For example, in one activity students identify letters that match the target sound by tapping them on the screen. In other activities, students identify the sounds they hear in a targeted position within a word and practice saying the sounds of the letters presented. Students also drag and drop letters to match those that they hear in a syllable. Students blend onsets and rimes, then individual sounds together into syllables. Students also learn and sequence the letters of the alphabet. Finally, students choose whether a word presented is a real word or a pseudoword.

Ooka Island provides direct instruction and practice in vocabulary and comprehension. Introducing words in a meaningful context over repeated readings was identified as important to vocabulary acquisition. In Ooka Island, words are introduced in the context of storybooks that are read to the student, providing the meaningful context. Students are read storybooks from Ooka Island's Popcorn Library and are encouraged to return to reread books. Vocabulary activities include those that ask students to identify sight words and match words to their meanings. In one activity, students match words to those in a sentence. Students are also asked to replace a word from the story with an appropriate synonym or antonym.

Activities that teach and practice comprehension include those that ask students to recall information with the use of pictures, sequence events, and answer questions about the story that was read to the student. After each storybook is read, students answer multiple

choice questions about the story. When a student guesses the incorrect answer, the page of

the story in which the question is answered is reread to help the student to determine the

correct answer, modeling a solution to determining the correct answer. Students also

sequence events from the story, practicing story retelling. Think-alouds are regularly asked

by the computer narrator as the ebooks are read, modeling comprehension monitoring.

The current study compared reading skills of students who used the Ooka Island

program in addition to their typical classroom instruction to the reading skills of students who

did not have exposure to a CAI reading program. The first research question for this study is

whether the use of Ooka Island in addition to classroom instruction improves the

foundational reading skills of kindergarten students. Anthony (2016) and Mitchell & Fox

(2001) found that phonemic awareness skills were influenced positively by program use for

students at risk of reading failure. Similarly, Bauserman and colleagues (2005) and Putnam

(2017) found that multiskill CAI programs improved classes of typically performing students.

I hypothesize that students' phoneme awareness skills will be better than those of the control

group because these skills are directly taught and practiced in the CAI.

My second question is whether the use of Ooka Island improves word reading.

Phoneme awareness skills contribute to the development of word reading, as does learning

letter sound correspondences and practice reading words and pseudowords. In addition, Ooka

Island presents activities with a combination of real words and pseudowords, so students have

direct practice with decoding. Therefore, I hypothesize that students in the group who used

Ooka Island will perform better than students in the control group on word reading,

pseudoword reading measures, and word reading efficiency.

My third research question is whether the use of Ooka Island goes beyond

enhancement of foundational skills to also impact comprehension. Ooka Island includes

learning in vocabulary, text reading, and comprehension, so I hypothesize that students who

used Ooka Island will perform better on reading comprehension than students in the control group. To further explore the factors that contribute to a potential advantage in Ooka Island group reading comprehension outcomes, I will use hierarchical regression to determine the relative contribution to reading comprehension by word reading skills and Ooka Island use. Put another way: does the Ooka Island condition predict variance beyond word reading, or is the possible association between Ooka and increases in comprehension totally accounted for by increased word reading skills?

Method

Participants

Participants of this study contributed to a larger study investigating language and reading by Dr. Metsala. In this study, I analyzed data for students in eight kindergarten classrooms from three Atlantic Canadian schools. In four classrooms, students used the Ooka Island computer program from mid-November until the end of May. The remaining four classrooms of students did not use Ooka Island. Each class using Ooka Island in a school had a class in the school not using Ooka Island. There were 49 participants in the experimental Ooka Island group, and 39 participants in the control group. Methodologically, students in the treatment and control groups are considered comparable because they are all in the same 3 schools and one school district, thus receiving similar classroom literacy instruction under the same district and provincial guidelines.

Reading Measures

Two measures were collected at pre-test, the CTOPP Blending subtest (Wagner et al., 1999) and the Word Identification subtest of the WRMT-R (Woodcock, 1987). These measures were also collected at post-test, along with the CTOPP Elision subtest (Wagner et al., 1999), the Word Attack subtest of the WRMT-III (Woodcock, 2011), the Sight Word

Efficiency subtest of the Test of Word Reading Efficiency (Torgesen et al., 1999), and

Passage Comprehension subtest of the WRMT-III (WRMT-III Woodcock, 2011).

Pre-test Phoneme Awareness

The CTOPP Blending subtest required students to blend spoken phonemes or

syllables into the real word. After 3 consecutive errors, testing was discontinued. According

to the manual, the test-retest reliability for kindergarten students is .88.

Pre-test Word Reading

Word reading was measured using the Word Identification subtest of the Woodcock

Reading Mastery Test-Revised (WMRT-R; Woodcock, 1987) at pre- and post-test. Students

were asked to read a list of increasingly difficult real words out loud. After 6 consecutive

errors, testing was discontinued. According to the manual, the Spearman-Brown split-half

reliability coefficient for kindergarten students is .98 (Woodcock, 1987).

Post-test Phoneme Awareness

The CTOPP Blending and Elision subtests were used at post-test (Wagner et al.,

1999). In the CTOPP Elision subtest students heard a word, then were asked to repeat the

word without a given segment. After 3 consecutive errors, testing was discontinued.

According to the manual, the test-retest reliability is .88 (Wagner et al., 1999).

Post-test Word Reading

Word reading was measured at post-test using the Word Identification subtest of the

Woodcock Reading Mastery Test-Revised (WMRT-R; Woodcock, 1987). Students were

asked to read a list of increasingly difficult real words out loud. After 6 consecutive errors,

testing was discontinued. According to the manual, the Spearman-Brown split-half reliability

coefficient for kindergarten students is .98 (Woodcock, 1987).

Post-test Pseudoword Reading

COMPUTERIZED INTERVENTION

Pseudoword reading was measured using the Word Attack subtest of the WRMT-III (Woodcock, 2011). Students were asked to read a list of increasingly difficult pseudowords aloud. After 4 consecutive errors, testing was discontinued. According to the manual, the reliability of this subtest for kindergarten students is .89 (Woodcock, 2011).

Post-test Word Reading Efficiency

Students completed the word reading subtest of the Test of Word Reading Efficiency (Torgesen et al., 1999). Students read from a list of words in 45 seconds. According to the manual, test-retest reliability for kindergarten students is greater than .90 (Torgesen et al., 1999).

Post-test Reading Comprehension

Students were assessed using the Passage Comprehension subtest of the WRMT-III (Woodcock, 2011). Students silently read a sentence or passage, then were asked to supply the missing word. After 4 consecutive errors, testing was discontinued. According to the manual, the reliability of this subtest for kindergarten students is .74 (Woodcock, 2011).

Procedures

Ipads and headphones were supplied in the classrooms for each student. There was an introductory overview to teachers by Ooka Island personnel to help teachers to log students in and answer tech questions. Teachers encouraged students to log a total of 40 hours of activities, with a goal of each individual session lasting about 20 minutes. Teachers reported shortening the classroom circle or playtime in order to make time available for Ooka Island use, and students could sometimes choose to use Ooka Island during times when other students were working in small groups.

Ooka Island is a computer reading program consisting of various activities that teach and practice phonemic awareness, phonics, vocabulary, and comprehension. Many activities are presented as games. For example, in one activity, students practice letter-sound

correspondence by popping bubbles to match letters with the sounds they hear. Activities generally take only a few minutes to complete, so students can expect to complete several activities per sitting. While individual activities end after a certain amount of repetitions and move onto another activity, students later return to an activity until they are able to complete it with a higher level of accuracy.

Pretreatment assessments were completed two weeks before the start of program use, in November. Post-tests were completed in early June, two weeks after program use was completed. All classes followed the usual English Language Arts program for their grade level. This school district follows a balanced early literacy program (Prince Edward Island [PEI] Department of Education and Early Childhood Development, 2008). The PEI kindergarten integrated curriculum document notes that oral language skills, involving the knowledge of the sound structure of English, are important skills that are most successfully developed when practiced within a language-rich environment. Teachers are given examples of "natural and spontaneous" ways in which these skills can be highlighted, including "through music and movement, singing, reading, rhyming, playing with language, etc." Reading strategies are also presented, such as predicting words based on pictures or what the reader thinks would make sense (PEI Department of Education and Early Childhood Development, 2008).

Results

Before conducting the statistical tests, I examined the data to verify that the assumptions for the statistical tests that would be carried out were met. The raw score distributions for all variables were normally distributed with the exception of pre- and post-test word reading and post-test pseudoword reading. To correct for mild positive skewness, log transformations were applied for these 3 measures (Tabachnick & Fidell, 2007). Analyses

were completed on participants' raw scores on each measure, with the exception of these

transformed scores. Only 2 data points were missing, each for the post-test word reading

efficiency measure. These two participants were not included for the analysis that included

word reading efficiency, and this is reflected in the corresponding degrees of freedom. The

assumption of homogeneity of variances, as assessed by Levene's test of homogeneity of

variances ($p > .05$), was met for each of the Analysis of Covariance (ANCOVA). Since all

questions and hypotheses are unidirectional, all p values are reported for one-tailed tests.

Means and standard deviations by group, for all major variables in this study, are presented in

Table 1.

Table 1

Performance on Reading Measures

	Ooka Island Group		Control Group	
Reading Measures	*M*	*SD*	*M*	*SD*
Pre-test Blending	2.33	1.96	3.00	2.44
Pre-test Word Identification	.47	1.93	.44	1.33
Post-test Blending	7.65	3.36	6.54	3.14
Post-test Elision	5.43	3.76	5.46	3.47
Post-test Word Attack	2.12	3.11	1.56	2.53
Post-test Word Identification	5.61	4.84	3.77	3.69
Post-test Sight Word Efficiency	16.52	13.24	12.08	8.65
Post-test Passage Comprehension	6.24	4.04	4.21	2.68

The first research question addressed whether the use of Ooka Island had positive

effects on the phonemic awareness skills of kindergarten students. An ANCOVA was

performed for each of the phonological awareness blending and elision subtest scores, with

pre-test blending scores as the covariate and group (Ooka vs. comparison) as the between

participant factor. The first ANCOVA showed there was a statistically significant difference in post-test blending, $F(1, 85) = 5.933$, $p = .009$. The students in the group who used the Ooka Island program performed better on post-test blending than the control group, and this was associated with a medium effect size, $\eta p^2 = .065$. The effect of group for the ANCOVA for post-test elision scores was not statistically significant, $F(1, 85) = .966$, $p = .165$.

The second research question asked if the use of Ooka Island had positive effects on the word level reading skills of kindergarten students. First, two ANCOVAs were performed for the word and the pseudoword reading measures, with pre-test word reading as the covariate. After adjustment for pre-test word reading scores, there was a statistically significant difference in post-test pseudoword reading scores, $F(1, 85) = 3.181$, $p = .039$. The students in the group who used the Ooka Island program outperformed the students in the control group and this was associated with a small effect size, $\eta p^2 = .036$.

There was also a statistically significant effect of group in the ANCOVA examining word reading scores, after controlling for pre-test word reading: $F(1, 85) = 4.926$, $p = .015$. The students in the group who used the Ooka Island program performed better on post-test word reading than the control group, and this was associated with a medium effect size, $\eta p^2 = .055$.

I also examined whether sight word reading efficiency was better for the Ooka versus the control group. An ANCOVA was calculated to examine the effect of Ooka on post-test word reading efficiency scores after controlling for pre-test word reading scores. A main effect was revealed, $F(1, 83) = 6.596$, $p = .006$, showing a statistically significant difference between the groups. The students who used the Ooka Island program outperformed the students in the control group and this was associated with a medium effect size, $\eta p^2 = .074$.

The third research question addressed whether the use of Ooka Island had a positive effect on reading comprehension. An ANCOVA was performed for reading comprehension

scores, with pre-test word reading scores as the covariate and group as the between participant factor. The ANCOVA showed there was a statistically significant difference in post-test reading comprehension, $F (1, 85) = 10.099$, $p = .001$. The Ooka group performed better on post-test reading comprehension than the control group (see Table 1 for means and standard deviations), and this was associated with a large effect size, $\eta p^2 = .106$.

Finally, to examine whether the use of the Ooka Island program accounts for unique variance in reading comprehension beyond the program's effect on word reading, a hierarchical regression was performed with reading comprehension as the dependent variable. In Step 1, two variables were entered. To control for initial student word reading ability, pre-test word reading was entered ($r = .46$ with reading comprehension). To control for word reading outcomes, post-test word reading was entered ($r = .74$ with reading comprehension). The first step accounted for 55.0% of the variance in reading comprehension (see Table 2) with post-test word reading as a significant predictor. In the second step, Group (Ooka vs control) accounted for an additional 2.5% of the variance in reading comprehension.

Table 2

Predicting Reading Comprehension

	R	R^2	ΔR^2	B	SE	β
Step 1	.742	.550				
Pre-test Word Reading				.867	.624	.117
Post-test Word Reading				6.213	.776	.675*
Step 2	.758	.575	.025			
Pre-test Word Reading				1.055	.616	.143
Post-test Word Reading				5.808	.780	.631*
Ooka condition				-1.178	.532	-.162*

*$p < .05$

Discussion

This study examined the effects of the use of Ooka Island computer reading program on the literacy skills of kindergarten students. I asked whether phoneme awareness, word-level reading skills, and reading comprehension improved for kindergarten students who used the program as a supplement to their classroom instruction compared to students who did not use the program. Students who used the Ooka Island program scored better on most outcomes measures than those who did not. Overall, the types of reading skills that were directly taught and practiced in the program saw comparatively better scores for students in the group who used the Ooka Island program.

The study examined student outcomes on two phonological awareness measures, with initial blending skills controlled. Students who were in the group who used the Ooka Island program scored higher on the phonological awareness blending measure than students in the control group. The effect was associated with a medium effect size; the use of the Ooka Island program improved these skills by a fair and meaningful amount. The program models this skill and students directly practice blending units of sound into words. This benefit to blending skills is consistent with other studies that have found positive effects of computerized instruction on phoneme awareness skills when these skills were practiced in the computerized intervention (Savage et al., 2013; Bauserman et al., 2005; Anthony, 2016). Blending is comparatively easy to practice within the context of CAI programs (Verhoeven et al., 2020). It is important for students to develop this skill since blending sounds into words is a key component of decoding, and strong phonemic decoding abilities are needed in order to build efficient word recognition (Ehri, 1998).

There was no advantage for the students in the group who used the Ooka Island program on the measure of elision. Elision has been shown to be a more difficult

phonological awareness skill for young students to master (Yopp, 1988). Overall, both groups were in the average range on this measure. This means students were likely able to delete a syllable from two syllable words (for example, "say bedroom without the bed") and to delete some initial or final sounds from one syllable words (e.g., "say bin without the /b/"). Items then get harder and require medial sounds to be deleted. Deleting sounds in this manner is not directly taught or practiced in any of the Ooka activities. There are also no activities in which students segment words into sound units, an aspect of deletion tasks. Thus, it is perhaps not surprising that the students who used the program were not better on this elision measure. The findings in the current study are similar to those of Savage and colleagues (2013); these authors found that the ABRA computer program had a positive effect on blending skills, but not for segmentation skills. It may take more time and more direct instruction in CAI programs to affect phonological segmentation and deletion skills.

The next analysis examined whether the group who used the Ooka Island program had better outcomes on reading of pseudowords. Decoding words, or the ability to sound out unfamiliar words, is an important skill in early reading when most written word forms are unfamiliar. Furthermore, skill with this process of strategically decoding unfamiliar orthographic patterns leads to later word reading efficiency, or what is called sight word reading (Ehri, 2014; Share, 1995). Students who had used the Ooka Island program outperformed those in the control group, with beginning word reading controlled in the analysis. The difference was associated with a small effect size, which means that these skills were improved by a small but important amount from Ooka Island program use. Certain activities in Ooka involved the use of pseudowords, in which students either practiced blending sounds into pseudowords or identified whether a given syllable was a pseudoword or a real word. Also, learning of sound-letter correspondences and how to apply these to reading words would be expected to positively influence pseudoword reading. In previous

research on CAI programs, one study found students in the experimental group similarly experienced better outcomes in pseudoword reading (Madden & Slavin, 2017). However, there were also studies in which pseudoword reading scores for students in the experimental group were not different from students in the control group (Anthony, 2016; Kreskey & Truscott, 2016). The students in the latter studies had no direct computerized intervention practice with pseudowords, which may have affected the results.

As noted, decoding helps to create fluent word reading by developing the ability to identify large numbers of words by sight (Torgesen et al., 2001). I directly examined students' accuracy for reading real words and their efficiency or rate of reading words. Comparisons for both word reading and sight word reading were statistically significant. Students in the group who used the Ooka Island program performed better than students in the control group on both measures, and the differences were associated with medium effect sizes. Thus, the differences were sizable on both these measures. Word reading accuracy and rate are key skills in early reading. The young reader cannot begin to decipher the meaning of text until they can read the words on the page (Hoover & Gough, 1990). For young children, word reading skills have been shown to account for the bulk of the variance in reading comprehension (Storch & Whitehurst, 2002).

Given the importance of word reading in acquiring literacy skills, it is one focus of the learning activities in the Ooka Island program. Students are taught sound-letter correspondences and how to blend the sounds together when reading written words to derive at the pronunciation. Past research with ABRA has sometimes found boosts to word reading accuracy (Savage et al., 2009). However, two other studies examining the ABRA program found no advantage in word reading accuracy (Savage et al., 2013; Piquette, 2014). The authors suggest that additional time using the ABRA program could allow for further skills development, arguing that more time was needed for this type of skill development (Savage

et al., 2013). Furthermore, those studies with ABRA did not examine word reading efficiency or rate.

Even though students used only 35-70 hours of the Ooka program, these findings were apparent for both word reading accuracy and efficiency. The Ooka Island program presents opportunities for students to learn and practice decoding of real words and pseudowords through different approaches and activities. For example, one activity requires students to associate letters with their most frequent phoneme, then blend the sounds together to read pseudowords and real words. Students also read words that are categorized as irregular; that is, they contain less frequently associated letter-to-sound correspondences, yet are often encountered in everyday texts. Students are required to read these words in multiple contexts, like in storybooks and in matching games. These repeated opportunities to read pseudowords, regular words and irregular words may help students become more efficient in both decoding and in building up orthographic representations of learned words and the letter patterns in words; even for words that do not completely follow the regular sound-spelling patterns. This may help explain the successful findings at these word level outcomes for students in the group who used the Ooka Island program.

A primary goal of reading is to comprehend text (Snow, 2002). Students who used the Ooka Island program scored higher on the reading comprehension measure than the control group, with initial word reading skills as a covariate in the analysis. The effect was associated with a large effect size, meaning that the Ooka program contributed a sizable amount of variance to the comprehension outcomes. Learning activities in the Ooka Island program which directly target understanding text include modeling comprehension monitoring and story retelling; both of these skills help increase understanding and recall (NICHD, 2000; Davies et al., 2004). This comprehension measure would also be influenced by the better word reading outcomes of the group that used the Ooka Island program.

Developing word reading and story comprehension and vocabulary skills concurrently in the Ooka Island program could help explain the higher outcomes on the reading comprehension measure. No significant differences in reading comprehension were found for experimental students in some other multi-skill CAI programs (Savage et al., 2013; Piquette et al., 2014). Notably, those two studies also did not find significant differences in word reading for students who used the ABRA program. There were also no significant differences on reading comprehension measures following CAI programs targeting phoneme awareness and letter-sound correspondence skills (Anthony, 2016). Positive effects in comprehension were, however, found in several studies in which students used multi-skill CAI programs (Bauserman et al., 2005; Chambers et al., 2008). The students in Bauserman and colleagues' experimental group experienced gains in listening comprehension, likely as a result of the comprehension work in their computerized instruction (2005). Chambers and colleagues found that students in the experimental group also experienced gains in pseudoword and word reading skills; this supports the idea that reading comprehension for young students relies on their ability to read words (2008). While many reading CAI programs for younger students were designed to teach and practice aspects of reading such as phoneme awareness and word reading, reading comprehension and especially vocabulary are areas that are underrepresented in CAI programs for younger students (Jamshidifarsani et al., 2019). Kindergarten students benefit from early instruction in all areas of reading (NICHD, 2000). Therefore, the use of CAI programs that target skills beyond phoneme awareness and letter sound correspondences is recommended.

Findings from the current study reinforce this notion that focusing on aspects of both word reading and comprehension may be needed to increase early reading comprehension outcomes. The Ooka Island program targets aspects of comprehension directly through such activities as story sequencing, question answering, and vocabulary building. In a final

analysis, it was shown that after accounting for the effects of word reading gains, the Ooka Island program accounted for additional variance in reading comprehension outcome scores. Thus, aspects of the program over and above those focused on increasing word reading skills directly influenced reading comprehension outcomes.

Practical Implications

Kindergarten students who used the Ooka Island program benefitted in their overall reading skills. Because of the importance of developing strong reading skills early in a student's schooling, it is beneficial to implement programs to prevent later reading difficulties (Vellutino et al., 2005). The use of computerized instruction to supplement classroom instruction could provide extra teaching and practice opportunities, and may be one aspect of helping to prevent later reading difficulties.

The Ooka Island program might also be used by young children in their homes, before formal schooling. Ooka is easily navigated by young children, therefore guardians would not need intensive time or reading knowledge (Scholastic F.I.R.S.T., 2019). It can be challenging for families to identify the most effective computer-based reading programs (Wood et al., 2017). Studies like this one may be critical to help families select evidence-based programs (Wood et al., 2017).

The computerized nature of this and similar reading programs could provide additional benefits. Programs can be pre-programmed to not move ahead in subskills until appropriate and to provide practice until mastery. Thus, like Ooka Island, these programs can ensure that concepts are reviewed until they are proficient. Ooka Island's algorithm was designed for students to return to activities until they become able to complete them with a certain level of accuracy (Scholastic F.I.R.S.T., 2019). In an ABRA program study in which teachers could determine the activities students used within the program, there was no significant difference on word reading and comprehension skills than those of students who

did not have the additional computerized instruction (Savage et al., 2013). Having an algorithm determine whether mastery has been obtained before moving up in levels could thus be beneficial for students.

Limitations

This study, like all research, has limitations which need to be taken into account when considering the findings. One limitation was that classrooms could not be randomly assigned to treatment conditions. Rather, the school principals determined it would be fair if the first teacher(s) within a school who volunteered for the study was able to use the Ooka Island program. The advantage of randomizing classrooms to treatment is that it would better cut down on the potential for systemic between-classroom differences that could have affected outcomes. That being said, all students did receive similar instruction based on the school district's balanced reading curriculum (PEI Department of Education and Early Childhood Development, 2008).

Another limitation of the current study was that the program was found effective within the Balanced Literacy context of the province (PEI Department of Education and Early Childhood Development, 2008; for discussion, see Spear-Swerling, 2019). Further research should explore whether the same positive outcomes would be found when teachers are systematically and explicitly teaching word reading skills, as well as directly teaching comprehension and vocabulary. Some research has found greater gains when CAI and classroom instruction are more integrated (Cassady & Smith, 2004). When a CAI program is similar to classroom instruction, it could provide an additional opportunity for students to review and master the content that is taught in the classroom (Potier Watkins & Dehaene, 2023). The approach in Ooka Island would be more consistent with direct, explicit teaching of both foundational word reading skills, vocabulary, and understanding stories. It may be that Ooka would have stronger outcomes when used with a consistent program.

A final limitation of this study was that the Ooka Island program takes approximately 80 hours to complete (Scholastic F.I.R.S.T., 2019). The students in the current study completed, on average, 44.4 hours of program use, meaning that they did not complete the full program. However, most studies reviewed in this paper also analyzed the results of partial CAI program completion. Total CAI program use ranged from 5 hours (Mitchell & Fox, 2001) to 61 hours (Dynarski et al., 2007), with most studies reporting that students did not complete the full program. In one study, students experienced increases in reading skills even after a relatively short period of time, 5-6 hours of program use (Bauserman et al., 2005). Further research could help determine whether students benefit from full program use.

Future Research

Further study should investigate long-term reading outcomes for students who use CAI reading programs in early elementary school. In most computerized reading instruction research, outcomes were measured directly after the period of treatment (Jamshidifarsani et al., 2019). For example, the current study suggested that the reading skills of students who used the Ooka Island program improved compared to those of the students in the control group when assessed directly after the program use period. After strong early reading skills are established, further reading growth depends on the child's further reading experience and practice (Snow et al., 1998). Early word recognition abilities help to produce later reading comprehension abilities (Cunningham & Stanovich, 1998). Longitudinal studies could explore potential long-term benefits of CAI reading programs that target multiple reading skills.

Summary

This study contributes to the understanding of the effects of a computerized reading instruction program when used in addition to typical classroom instruction for kindergarten students. Whereas many studies have focused mainly on phoneme-awareness-focused CAI

programs and their effects on student reading skills, this study explored the effects of a multi-skill CAI program on important reading skills that correspond with those practiced in the program. This provides further evidence that CAI programs that target language comprehension and foundational word reading skills could be more effective on student understanding of text. The positive outcomes for students who used the Ooka Island program indicate that it can be a useful method to foster strong early reading skills.

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