A Comparative Study of the Effects of Computer-Assisted Instruction on the Reading Achievement of First Graders

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Abstract

With reading proficiently by the end of third grade as a common goal, many school districts are exploring options to enhance early reading instruction. The purpose of this study was to investigate whether the supplemental, computer-assisted reading program i-Ready would significantly affect first grade students' reading achievement. Participants (n=159) were first graders at two elementary schools - treatment (n= 82) and comparison n= 77). An independent samples *t*-test was used to compare the mid-year reading achievement scores of the treatment and comparison groups and found no statistically significant differences between groups. Following 10 weeks of twice-weekly 45-minute sessions of i-Ready reading instruction for the treatment group, an independent samples *t*-test showed that no statistically significant differences in reading achievement existed between the treatment and comparison groups. Several possibilities for this finding are discussed.

Keywords: reading, first grade, computer-assisted instruction

Literacy competency may be regarded as the cornerstone of academic success. Both educators and parents recognize the longstanding effects of literacy failure on the development of self-confidence and motivation to learn, which adversely impacts overall academic performance (Armbruster et al., 2001; National Reading Panel, 2001). With the transition from learning to read to reading to learn that occurs around fourth grade, ensuring that children are successful readers by the end of third grade is of utmost importance (Fiester, 2010; Reynolds et al., 2011). In fact, seventy-five percent of students who are poor readers in third grade will remain poor readers in high school (Fiester, 2010). Further, relationships have been found between third grade reading deficits and ninth grade course failures (Dorsey, 2015). This need to ensure early reading success has led many school districts to explore options for enhancing early reading instruction.

Beginning Reading Instruction

Reading instruction and the acquisition of reading skills have been popular topics of interest for over 50 years, and the research is both prevalent and varied. Despite multiple theories and various models which offer frameworks for approaching reading instruction, learning to read continues to present a struggle for many students. The National Reading Panel (NRP, 2000), viewed as quite conservative in its numbers, reported an estimated 20% of children encounter reading difficulties before third grade, while Reynolds, Wheldall, and Madelaine (2011) supports Adams' (1990) broader claim that at least a third of the population has or is experiencing literacy acquisition difficulties.

Gaps in reading achievement have been consistently identified in comparing performance between White and Black students, English language learners and native English speakers, and disabled and nondisabled populations of students. As a result, there is a pervasive need to address the disparate reading abilities among these different groups (Coffee et al., 2014). The creation of the NRP in 1997 was one of the first organized approaches to evaluating the research on reading inclusive of "alphabetic, fluency, comprehension, teacher education, and computer technology" (Coffee et al., 2014, p. 82). The NRP cited five essential components for reading instruction; known as the "Big 5," these components are phonemic awareness, phonics, vocabulary, fluency, and comprehension (National Reading Panel, 2000). A noted limitation in the NRP report, however, was that its scope included reading for school-age children, and it did not address the research on early childhood.

In consideration of NRP's limitation, the National Early Literacy Panel (NELP) was convened

in 2002 with the purpose of synthesizing the existing research on the development of literacy skills in early childhood. NELP identified six fundamental emergent skills. These skills consist of alphabet knowledge, phonological awareness, automaticity in naming letters and numbers, automaticity in naming objects or colors, writing letters or names, and phonological memory. NELP also identified five categories of intervention: code-focused intervention which involved establishing the relationship between the letters in written words with the sounds in spoken words, shared reading interventions, parent and home programs, pre-school and kindergarten programs, and language enhancement interventions (National Reading Panel, 2000; National Early Literacy Report, 2008).

Both the NRP and NELP substantiate the scientific basis for instructional targets and intervention, but the translation of such massive reports and publications still proves to be challenging (National Reading Panel, 2000; National Early Literacy Report, 2008). Overwhelmingly, the research has established a need for instructional competency during the first couple of years of schooling to overcome literacy deficiency (Reynolds et al., 2011).

Methods for Delivery of Reading Instruction

Reading instruction can align with various theoretical concepts or frameworks. The NRP's evaluation of the various instructional approaches and its establishment of the "Big 5" provides a narrowed focus for approaching reading instruction. Phonemic awareness, phonics, vocabulary, fluency, and comprehension are essential to any program choice or explicit instructional practice. The question of how efficient and how applicable a given program may be for a particular setting remains largely unanswered due to the scarcity of affirmative data.

While reading instruction may be delivered explicitly by an educational professional using any variety of programs that address the skills determined most essential, the era of technology has also ushered in the option of computer-based instruction (Messer & Nash, 2018). Consequently, there are multiple software programs across the educational spectrum created to addresses student needs by program design.

Messer and Nash (2018) affirm the success of one-on-one tutoring in phonics instruction but also hold that efficacy is greater with the instruction coming from a professional educator rather than a paraprofessional. It is, however, costly to employ adequate personnel to implement such instructional practices. The costly nature of a professional educator's time opens the door for the more cost-effective

nature of computer-based instruction. The availability of computer-assisted instruction provides the opportunity for professional instruction at a greater economic advantage since differentiated instruction or even individual attention can be provided despite staffing limitations allowing students to receive supplemental instruction without pulling a classroom teacher away from other responsibilities.

Along with cost effectiveness, computer-assisted instruction also offers such advantages as enhanced motivation, individual pacing, instant feedback, and a combined sense of learning with judgment-free response (Messer & Nash, 2018). Computer-assisted instruction provides a variety of supports, like pictures and animations, that facilitate emerging literacy skills (Macaruso & Rodman, 2011) that may also improve motivation. Additionally, computerized feedback is instant for all students without the time required by teachers to work through assignments that have been submitted by an entire class (Blok, et al., 2002). Prompt response allows students to work at their own pace and level, thus, the appropriateness of independent practice may be substantially enhanced.

Two studies investigating kindergarteners' phonological awareness training using computer-assisted instruction provided via *Waterford Early Reading Program* (*WERP*) found positive results. Hecht and Close (2002) reported that at-risk kindergarteners using *WERP* scored higher on tests of phonological skills, letter-sound knowledge, and word reading than those who did not use *WERP*. In a study by Cassady and Smith (2004), kindergartners using *WERP* made greater gains than controls on tests of phonological awareness.

Macaruso and Walker (2008) examined the benefits of Lexia's *Early Reading* as a supplement to a phonics-based reading curriculum for kindergartners. Two matched classes (morning and afternoon sessions taught by the same teacher using the same curriculum) in an urban, public school system served as the treatment and comparison groups. Results showed a significant increase on posttest measures of phonological awareness skills for students receiving computer-assisted instruction, particularly for those with the lowest pretest scores.

Similarly, Macaruso and Rodman (2011) conducted two studies examining the use of computer-assisted instruction to supplement a phonics-based reading curriculum for urban preschoolers and kindergartners. For preschoolers, the treatment group made significantly greater gains in phonological awareness. For kindergartners, treatment students with low pretest scores made significantly greater gains, particularly in word reading. Overall, preschoolers and low-performing kindergartners benefited from the intensive practice provided through computer-assisted instruction.

Gibson, Cartledge, and Keyes (2011) examined the effects of a computerized supplemental reading program on the oral reading fluency, reading growth rates, and comprehension of eight African American first graders. Using the Dynamic Indicators of Basic Early Literacy Skills (DIBELS) oral reading fluency (ORF) as a posttest measure, all participants increased their reading fluency and improved their comprehension scores. Seven of the students increased their reading rate. These findings led researchers to support computer-assisted programs as supplementary interventions.

Bennett, Gardner, Cartledge, Ramnath, and Council (2017) conducted a study investigating the effects of a multicomponent, supplemental intervention on the reading fluency of seven urban, African-American second graders who showed reading and special education risk. The packaged intervention combined repeated readings and culturally relevant stories, delivered through a novel computer software program to enhance oral reading fluency and comprehension. Results showed that participants exceeded the growth rates for comparison peers, thus, supporting the beneficial effects of both repeated reading strategies and computer delivered instruction.

Keyes and Vostal (2016) investigated the impact of a computer-assisted intervention on the oral reading fluency of four elementary (1st-6th grade) students with learning disabilities. The students engaged with the computerized repeated reading program for 30 minutes three times a week for 10 weeks in an inclusive classroom during the reading-language arts block. Data revealed mixed results as all students increased their oral fluency on progress monitoring generalization passages and tended to reach their goals, but only two of the four students showed a positive level change on the computerized repeated reading intervention passages.

Keyes et al. (2016) examined the effectiveness of a supplemental repeated reading intervention delivered through a computer-assisted instruction program on the oral reading fluency (ORF), comprehension, and generalization of second graders who were at risk for reading failure. Six students received the Read Naturally Software Edition (RNSE) treatment passages three to four times a week for 7 to 12 weeks. A multiple baseline across participants design with embedded changing criteria tactics revealed ORF increases for all six participants. AIMS-web stories and classroom reading materials were used to assess clinical and classroom generalization. Five of the six participants increased their ORF on both generalization measures. Comprehension assessments revealed mixed results.

Todtfeld and Weakley (2013) found that 3rd-grade students using i-

Ready in Ohio public schools showed significant improvements on state tests in comparison with those who did not use the program. It should be noted, however that third, fourth and fifth grade students were studied, and there was only evidence that i-Ready made a difference in MAP Communication Arts Composite scores for third graders.

Given the broad availability of computer-assisted program options and the fact that there is still a significant gap in achievement, their classroom use must be investigated further. Since the current body of research acknowledges at least minimal positive effects of computer-based programs in providing supplemental reading instruction (Messer & Nash, 2018), it is important to explicitly consider program attributes when assessing potential effectiveness (Coffee et al., 2014). Among the many program options, some may offer more relevant insight and ease of accessibility that may be more, or less appealing, and ultimately more or less effective depending on the individualized needs of the targeted student population.

Significance and Purpose

The extent to which new technologies effectively support reading instruction and learning in the classroom is unknown. There is little empirical research on the topic generally and even less that specifically addresses computer-assisted reading instruction for first graders. There is, however, promising evidence of the effectiveness of reading instruction, such as computer-based technology, that integrates print and visual texts (Todfeld & Weakley, 2013).

For the past three years, many first-grade students in a large, southern school district have not demonstrated proficiency on the STAR Early Literacy Test, which is the district's primary measurement tool for reading achievement. In effort to increase reading achievement, the district recently adopted a new reading program (*Wonders*) aligned to Common Core State Standards. Two years later, the district piloted a new computer-assisted supplemental reading program (i-Ready) with the goal of significantly improving students' reading achievement. The purpose of this study was to investigate whether the computer-assisted reading program had a positive impact. The specific research question is as follows: Are end-of-the-year STAR scores higher for first graders who receive supplemental reading instruction through the i-Ready program?

Method

Participants

Purposive sampling was used to identify a school that implemented

i-Ready and a demographically similar school that did not implement i-Ready. Participants (n=167) were first grade students at two public elementary schools within the same district located in the Southeastern United States. Both were Title I schools in an urban setting, serving a high poverty student population with all students receiving free lunch. School size was also similar, as both enrolled over 500 students in kindergarten through fifth grade with over 35 teachers.

The treatment group (n=85) included four first grade classes, and the comparison group (n=82) included five first grade classes. Table 1 shows the demographics for both groups.

Table 1
Participant Demographics

	Gender		Race	
Group	M	F	Black	Other
Treatment	45	40	81	4
Comparison	47	35	82	0
Total	92	75	163	4

First grade teachers at both schools had previously participated in a half-day professional development for the i-Ready program. Participants in the treatment group received 150 minutes of core instruction daily using the McGraw-Hill literacy curriculum *Wonders* and two 45-minute session of i-Ready computer-assisted reading instruction each week.

Teaching and Learning Materials

Wonders is a literacy program developed by McGraw-Hill aligned to Common Core State Standards (Dorsey, 2015). It provides a comprehensive set of connected resources for teaching elementary (K-6th) students reading, writing, and critical thinking skills along with a social emotional learning curriculum for kindergarten and first grade. The *Wonders* program is equipped with teacher lesson plans and materials for full implementation as well as professional development resources (McGraw-Hill, 2019). All print resources are also available digitally, and the program is equipped with a data dashboard that provides for organization and recording of student assessments and other links (Shafferman, 2016).

All schools in this study used the Wonders program as a core reading curriculum. Teachers implemented this program within their two-hour literacy block in their daily schedule. In addition to the core curriculum, one school in the present study piloted the iReady, a supplementary computer-based program.

The i-Ready software package delivers student instruction, performance diagnostics, and progress reports based on K-12 Common Core State Standards in Mathematics and Reading. Designed to provide differentiated instruction

in order to simultaneously address the individual needs of multiple students, the program can be used as a supplement to teacher-directed whole and small group instruction. The adaptive diagnostic varies in difficulty based on the student's previous answers so that correct answers lead to more challenging questions while incorrect answers lead to easier questions. Immediately following the diagnostic, students work on customized online instruction that includes an interactive lesson, example problems, and practice problems. While the target audience is students who are struggling academically, i-Ready can be used to promote growth of all learners, since assessment data is used to match online lessons to a specific standard or sub-skill based on individual need. The program uses student centered engagement features, such as choosing a custom theme, earning tokens, and playing games, to motivate student participation (EdSurge, 2019).

The STAR Early Literacy Test was used in this study to measure reading achievement. Designed for use from kindergarten through second grade, it is a computer-adaptive assessment that assesses proficiency in early literacy skills, such as general readiness, phonemic awareness, graphophonemic awareness, phonics, vocabulary, comprehension, and structural analysis (Renaissance Learning, 2014). Using the Rasch ability scale, the test data provides a score ranging from 300-900 called the Scaled Score (SS), which identifies a student's reading level as emergent (SS below 675), transitional (SS 675 -774) or probable (SS 775 and above) (Renaissance Learning, 2014).

Data Collection and Analysis

Having received necessary permissions from the district, school administrators, and the University's Institutional Review Board, mid-year (January) and end-of-year (May) STAR Early Literacy data for both groups (treatment and comparison) were acquired from the databases of the two sample schools. Missing scores resulted in the analysis of data for 82 treatment participants and 77 comparison participants. To protect confidentiality, names were removed, and each participant was given an identification number.

SPSS Statistical Software was used for data analysis. In order to control for differences in reading achievement between groups, the mid-year reading achievement scores, as measured by the STAR Early Literacy Test, were compared using an independent samples *t*-test. Results indicated no statistically significant differences in reading achievement at the beginning of this research study, $t(157) = -0.08$, $p = .94$. This provided additional evidence of the similarity between the groups. Then, the end-of-year reading achievement scores, as measured by the STAR Early Literacy Test, were compared using

an independent samples *t*-test to determine if differences existed between the two groups at the conclusion of the treatment.

Results

The results of an independent samples *t*-test conducted at the end of the year to compare the reading achievement of the treatment and comparison groups indicated no statistically significant difference in scores for students who participated in the i-Ready program (M = 712.08, SD = 99.20) and those who did not participate in the i-Ready program (M = 726.87, SD = 106.11), $t(157) = -0.91$, $p = .37$. Table 2 provides the means and standard deviations for the treatment and comparison groups.

Table 2
Means and Standard Deviations for Groups on Reading Achievement

	N	Mean	Standard Deviation
Treatment i-Ready Program	77	712.08	99.20
Comparison No i-Ready Program	82	726.87	106.11

Discussion

While computer-assisted instruction could have merit for targeting instruction to student's needs with respect to improved reading achievement, the results of this study did not support this position. Findings from this study are like those of Dynarski et al. (2007), who evaluated five computer-based reading programs used to provide first-grade instruction in reading in 42 schools with 2,619 students and did not find a significant impact on reading growth from computer-based instruction. While Dynarski and colleagues attributed less direct instruction as contributing to the non-significant influence of computer-assisted instruction, that does not appear to be the case here. There are, however, several possible reasons that could account for the limited measurable benefit of the i-Ready supplemental computer-assisted reading instruction for first graders in this study, which include implementation procedures, student age, student engagement, and student selection.

First, implementation procedures could have possibly affected the results. In this study, students were expected to spend 45 minutes on computer-assisted instruction in reading during two sessions on two separate days each week. Scheduling conflicts resulting from field trips, assemblies, and school-wide early dismissals along with student absences could have caused inconsistency in the occurrence of computer-assisted instruction sessions per student. Similarly, technical difficulties and

lack of computer proficiency could have resulted in students receiving less than the total 45 minutes during each session that occurred. If all students participated in an entire 45-minute session twice weekly, the results may have been different. Given time constraints within the school day, supplemental computer-assisted reading instruction provided outside of the regular instructional day may yield more significant results.

Since age is typically a predictor of maturity, the age of students in this study could have been a substantial factor as well. Student's ability to focus for 45-minute intervals of computer-assisted instruction requires a functional level of maturity that may be beyond many 6-year-olds. Getting distracted easily, having poor concentration, lacking time management skills, and/or tiring easily may have prevented students in this study from receiving the maximum benefits of the computer-assisted instruction.

As with all instructional success, student engagement may have also been a crucial factor, as students lacking motivation for proficiency will not perform to their highest abilities. Students who were bored and unfocused or disinterested in the computer activities were very likely to have made random selections in their responses rather than a vested effort to answer cognitively with intentional accuracy.

Another factor of particular relevance to explaining this study's finding is the student selection. Participant scores were analyzed for in-tact classes without any regard to students' reading level. There was no categorical focus in the selection process. Computer supported instruction has been found to engage readers labeled at-risk in ways that may help compensate for inadequate reading ability (McKenna et al., 1999), and those at-risk of academic failure are sometimes the most adept and interested in understanding and utilizing computer-based learning (Alvermann, 2001). Further, research studies have shown positive, albeit inconsistent effects of computer-based instruction on improving reading abilities for students with learning disabilities and reading difficulties (Stetter & Hughes, 2010). Thus, supplemental computer-assisted instruction may result in the greatest gain for low-performing students. If the students had been intentionally selected based on certain performance competencies or lack of competency, such as low mid-year STAR scores, then the results may have yielded a different outcome.

A final factor contributing to the limited positive influence of computer-assisted instruction in this study could be a lack of alignment with instruction delivered via computer with that delivered by the teachers. In a study of first-grade students at risk for reading disabilities

by Torgesen, Wagner, Rashotte, Herron and Lindamood (2010), there were no differences in student reading performance between students assigned to the different intervention conditions using computer-assisted instruction, but the combined-intervention students, who received instruction delivered by specially trained teachers to prepare students for their work on the computer, performed significantly better than control students who had been exposed to their school's normal reading program. Thus, researchers concluded that reading instruction integrated very closely with students' experiences on the computer were needed to obtain a positive result. In this study, no attempt was made to coordinate teacher-delivered instruction with the computer-assisted instruction.

Limitations

There are several limitations that should be considered when examining the results of this study. The primary limitation of this study was the limited sample size (n=85). A larger sample size would increase the precision of being able to generalize the findings to a larger population. Furthermore, the study site was likely not representational of all elementary schools. Another limitation of the study is that class enrollment cannot be considered random selection, thus, limiting the generalizability of the study findings to individuals with similar demographics. A final limitation is related to the measure used. Although the reported reliability of the STAR Early Literacy Test is known, all measures are subject to some error, and the reliability with the specific participants in this study was not known.

Future Research

It is difficult to ascertain a specific reason for the outcome of this study, but the results do provide insight into the essential need for further research to support the selection and purchase of instructional materials. Currently, there is a lack of research evaluating the effect of computer-assisted instruction on reading achievement. With the overwhelming saturation of computer-related products that will surely become available to educators in the years to come, more studies are needed to inform and justify decisions regarding their purchase and implementation. Additional research is needed to further investigate the effectiveness of computer-assisted instruction delivered for students of various ages and reading abilities. Research on the effectiveness of various programs providing computer-assisted reading instruction across kindergarten, first-, and second-grade classrooms should be conducted, and it is recommended that the computer-assisted instruction provided is intentionally aligned with the instruction being delivered by teachers as part of the normal reading

curriculum. Studies with a larger sample size, longer research timeline, and a more controlled environment conducted over multiple sites would be additionally informative. Research ensuring diverse demographics of participants would be particularly beneficial as this would increase the generalizability of results.

Conclusion

Although the data were not conclusive, this study opens a doorway for developing future studies and provides meaningful data for school and district administrators responsible for spending funds to purchase programs for computer-assisted instruction. The level of popularity and perceived effectiveness of computer-based instruction in reading may vary, but computers have won a permanent place in today's classrooms. Computer technology may be part of the long-term solution for dyslexic and other at-risk students as a result of its capacity to provide highly specialized instruction and practice for relatively low cost with relatively high fidelity (Torgesen et al., 2009). Similarly, iPads® have been utilized in educational programs for individuals with Autism Spectrum Disorder (Neely et al. 2013; El Zein et al., 2016). Beneficial results of computer-assisted instruction with specialized populations, however, does not guarantee that it will yield similar favorable results with all students. Northrop and Killeen (2013) recognize that incorporating technology into academic instruction has the potential to increase engagement and motivation but caution that academic achievement could be hindered as children gain proficiency with technology rather than with the targeted literacy concepts. For many, varied reasons, further investigation of supplemental, computer-assisted reading instruction and teachers' use of technology for meaningful reading and writing instruction must also be explored.

References

Adams, M.J. (1990) *Beginning to Read: Thinking and Learning about Print*. Cambridge, MA: MIT Press.

Alvermann, D. E. (2001). Reading adolescents' reading identities: Looking back to see ahead. *Journal of Adolescent & Adult Literacy, 44*(8), 676–690.

Armbruster, B. B., Lehr, F., Osborn, J., O'Rourke, R., Beck, I, Carnine, D., & Simmons, D. (2001). *Put reading first.* Washington, DC: National Institute for Literacy. https://doi.org/10.1037/e365682004-005

Bennett, J. G., Gardner, R, Cartledge, G., Ramnath, R & Council,

M. R. (2017). Second-grade urban learners: Preliminary findings for a computer-assisted, culturally relevant, repeated reading intervention. *Education and Treatment of Children, 40*(2), 145–186. https://doi.org/10.1353/etc.2017.0008

Blok, H., Oostdam, R., Otter, M. E., & Overmat,M. (2002). Computer-assisted instruction in support of beginning reading instruction. *Review of Educational Research, 72*(1), 101-131. https://doi.org/10.3102/00346543072001101

Cassady, J. C. & Smith, L. L. (2004). The impact of a reading-focused integrated learning system on phonological awareness in kindergarten. *Journal of Literacy Research, 35*(4), 947–964. https://doi.org/10.1207/s15548430jlr3504_2

Coffee, G., Newell, M. L., & Kennedy, A. S. (2014). Supporting collaborative efforts in implementing evidence-based reading interventions: The role of online databases. *Journal of Educational & Psychological Consultation*, *24*(2), 81–95. https://doi.org/10.1080/10474412.2014.903188

Dorsey,W. (2015). Balanced reading basals and the impact on third-grade reading achievement. *Journal of Organizational & Educational Leadership. 1*(2), 2.

Dynarski, M., Agodini, R., Heaviside, S., Novak, T., Carey, N., & Campuzano, L. (2007). Effectiveness of reading and mathematics software products: Findings from the first student cohort. Washington, DC: U.S. Department of Education.

EdSurge, (2019). *i-Ready*. https://www.edsurge.com/product-reviews/i-ready

El Zein, F., Gevarter, C., Bryant, B., Son, S., Bryant, D., Kim, M. & Solis, M. (2016). A comparison between iPad-assisted and teacher-directed reading instruction for students with Autism Spectrum Disorder (ASD). *Journal of Developmental & Physical Disabilities, 28*(2), 195–215. https://doi.org/10.1007/s10882-015-9458-9

Fiester, L. (2010). Early Warning! Why Reading by the End of Third Grade Matters. KIDS COUNT Special Report. *Annie E. Casey Foundation*.

Gibson Jr., L., Cartledge, G, & Keyes, S. E. (2011). A preliminary investigation of supplemental computer-assisted reading instruction on the oral reading fluency and comprehension of first-grade African American urban students. *Journal of Behavior Education, 20*(4), 260-282. https://doi.org/10.1007/s10864-011-9136-7

Hecht, S. A., & Close, L. (2002). Emergent literacy skills and training time uniquely predict variability in responses to phonemic awareness training in disadvantaged kindergartners. *Journal of Experimental Child Psychology 82*(2), 93–115. https://doi.org/10.1016/s0022-0965(02)00001-2

Keyes, S. E., & Vostal, B. R. (2016). "But, did it work?" Effects of teacher-implemented computer-assisted instruction in oral reading fluency for students with learning disabilities. *International Journal of Humanities and Social Science Invention*, *5*(3), 29-37.

Keyes, S. E., Cartledge, G., Gibson, L., Jr., & Robinson-Ervin, P. (2016). Programming for generalization of oral reading fluency using computer-assisted instruction and changing fluency criteria. *Education and Treatment of Children 39*(2), 141-172. doi:10.1353/etc.2016.0011

Macaruso, P., & Rodman, A. (2011). Efficacy of computer-assisted instruction for the development of early literacy skills in young children. *Reading Psychology*, *32*(2), 172–196. https://doi.org/10.1080/02702711003608071

Macaruso, P., & Walker, A. (2008). The efficacy of computer-assisted instruction for advanced literacy kills in kindergarten children. *Reading Psychology, 29*(3), 266–287. https://doi.org/10.1080/02702710801982019

McGraw-Hill. (2019). *Wonders: Resource Overview*. https://s3.amazonaws.com/ecommerce-prod.mheducation.com/unitas/school/explore/sites/reading-wonders/wonders-2020-overview-brochure.pdf

McKenna, M.C., Reinking, D., Labbo, L.D., & Kieffer, R.D. (1999). The electronic transformation of literacy and its implications for the struggling reader. *Reading and Writing Quarterly, 15*(2), 111-127. https://doi.org/10.1080/105735699278233

Messer, D., & Nash, G. (2018). An evaluation of the effectiveness of a computer-assisted intervention. *Journal of Research in Reading. 41*(1), 140-158. https://doi.org/10.1111/1467-9817.12107

National Early Literacy Panel (US). (2008). *Developing early literacy: Report of the National Early Literacy Panel: A scientific synthesis of early literacy development and implications for intervention.* National Institute for Literacy.

National Reading Panel. (2000). *Report of the National Reading Panel: Teaching children to read: An evidence-based assessment of the scientific research literature on reading and its implications for reading instruction*. NICHD Clearinghouse.

Neely, L., Rispoli, M., Camargo, S., Davis, H., & Boles, M. (2013). The effect of instructional use of an iPad®on challenging behavior and academic engagement for two students with autism. *Research in Autism Spectrum Disorders, 7*(4), 509 –516. https://doi.org/10.1016/j.rasd.2012.12.004

Northrop, L., & Killeen, E. (2013). A framework for using iPads to build early literacy skills. *The Reading Teacher, 66*(7), 531 –537. https://doi.org/10.1002/trtr.1155

Renaissance Learning. (2014). *STAR Early Literacy Technical Manual.* Wisconsin Rapids, WI: Renaissance Learning, Inc.

Reynolds, M., Wheldall, K.,& Madelaine, A. (2011). What recent reviews tell us about the efficacy of reading interventions for struggling readers in the early years of schooling. *International Journal of Disability, Development, and Education. 58*(3), 257-286. https://doi.org/10.1080/1034912x.2011.598406

Shafferman, B. (2016, November 16). Wonders: Data Dashboard [Blog post]. https://techtiptuesdayblog.wordpress.com/2016/11/16/wonders-data-dashboard/

Stetter, M. E., & Hughes, M. T. (2010). Computer-assisted instruction to enhance the reading comprehension of struggling readers: A review of the literature. *Journal of Special Education Technology, 25*(4), 1-16. https://doi.org/10.1177/016264341002500401

Todtfeld, D., & Weakley, W. (2013). The impact of instructional reading technology programs on student reading achievement. (Doctoral dissertation, Northwest Missouri State University) https://www.nwmissouri.edu/library/fieldstudies/2013/Todtfeld,%20Danny.pdf

Torgesen, J. K., Wagner, R. K., Rashotte, C. A., Herron, J., & Lindamood, P. (2010). Computer-assisted instruction to prevent early reading difficulties in students at risk for dyslexia: Outcomes from two instructional approaches. *Annals of Dyslexia, 60*(1), 40-56.