Original Article

Comparative Effects of Computer-Based Reading Programs on the Early Literacy Skills of At-Risk Students

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Abstract

Students displaying reading difficulties/disabilities at the end of third grade are unlikely to succeed in content areas and graduate from high school. One alternative to meeting the learning needs of students is to provide explicit instructional support in basic literacy skills through computer-based reading programs via after-school programs. This study examined the effects of two computer-based reading programs on the reading skills of 71 randomly assigned at-risk students using a pre–post-test design. Furthermore, tutor and students' perceptions regarding the effectiveness and desirability of the programs were examined. The results indicated that there was a statistically significant difference between the programs on the Word Use Fluency measure and both computer-based programs were effective in facilitating the growth of basic early literacy skills of students at-risk for reading failure. A description of the computer programs, results, implications, and limitations of the study are discussed.

Keywords

computer-based reading programs, early literacy skills, after-school interventions at-risk students, *Funnix*, *Headsprout*

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Successful mastery of basic early literacy skills is pivotal to the development of oral reading fluency and comprehension. However, recent data suggests that a large percentage of students in today's schools do not become skilled readers. For example, 65% of fourth and eighth-grade students performed below the "proficient" level in reading according to the 2017 National Assessment of Educational Progress (National Center for Education Statistics, 2018). Similarly, 20% of 15-year-old students scored below the "proficient" level on 2015 Programme for International Student Assessment conducted by the Organization for Economic Cooperation and Development (Carr, 2016). Failure to learn to read in early grades is associated with adverse consequences such as (a) impaired academic skills in later grades, (b) low self-esteem, and (c) reduced employment opportunities (Hammond, 2012; Mather et al., 2001; Slavin et al., 2009). It is estimated that 70% of students identified as at-risk for reading failure at the beginning of first grade will continue to experience reading difficulties in adult life (Lyon, 2001). Similarly, research suggests that students not having basic reading skills by third grade will have difficulty with (a) reading grade level materials, (b) developing average reading fluency levels, and (c) comprehending what they read (Hammond, 2012). The prevention of reading failure in early grades is fundamental to avoiding later reading skill deficits and continued decreases in motivation to read (Pindiprolu & Forbush, 2009).

In the past two decades, the call for explicit reading instruction to facilitate development of basic early literacy skills of all students including students at-risk for reading failure has increased. The most influential evidence emphasizing explicit literacy instruction came from the National Reading Panel Report (National Institute of Child Health and Human Development [NICHD], 2000). The report emphasized the need for explicit instruction in phonemic awareness and phonics, along with instruction in vocabulary, fluency, and comprehension as essential to the development of skilled readers. This recommendation led to an increased emphasis on explicit-direct instruction in phonemic awareness and phonics to promote early literacy skills of all children, including children with reading disabilities and/or students at-risk for reading difficulties. It has been estimated that 25–173 hr of preventative instruction is essential to successfully accelerate early reading skill development of at-risk students (Scammaca et al., 2007; Torgesen et al., 2010) and explicit, intensive early instruction can help reduce the number of students who experience reading failure by approximately two-thirds (Lyon, 2001).

Unfortunately, many teachers are not adequately prepared to implement evidenced-based instructional practices (Lyon & Chhabra, 2004). Inadequately prepared teachers hinder the implementation of effective literacy instruction for children with reading difficulties. The literature indicates that teachers practicing in the earlier grades are not adequately skilled in delivering explicit instruction in the areas of phonemic awareness and phonics. For example, Mather et al. (2001) assessed teachers' knowledge of early literacy instruction methods and strategies for students at-risk for

reading failure. They concluded that many general education teachers lacked sufficient knowledge about concepts of English language structure, which prevents them from providing explicit instruction in the areas of phonemic awareness and phonics skills to students with reading difficulties. Similarly, Cunningham et al. (2004) examined teachers' knowledge about reading and concluded that teachers in Kindergarten through third grade possess relatively little knowledge of phonemic awareness and phonics. More recently, Piasta et al. (2009) examined the interactions among teacher knowledge, explicit decoding instruction, and students' word-reading abilities; and concluded that students receiving explicit instruction from knowledgeable teachers made greater gains in word reading. The results also indicated that students receiving explicit instruction from less knowledgeable teachers had lower levels of skill gain.

Computer-based reading programs (CBRPs) offer one alternative way of meeting the needs of students with reading deficits and in supporting the limited skills of teachers in early literacy instruction. CBRPs offer multiple benefits. First, they can provide highly specialized instruction in the area of reading for relatively low costs and with high fidelity (Torgesen et al., 2010). Second, well-designed CRBPs can provide immediate feedback and motivate students through features like graphics, game-like activities, and multimodal presentations (Regtvoort & Leij, 2007). Finally, recent literature suggests that CBRPs are effective in facilitating basic early literacy skills. For example, Howell et al. (2000) examined the effects of a computer-based early reading program, *IntelliTools Reading*, on early reading skills (such as onset-rime word decoding skills, phonemic awareness skills, sight word recognition skills, writing and spelling skills) of 55 first-grade students with disabilities and/or who were at-risk for reading failure. Students in the experimental group received 16 weeks of supplemental instruction in addition to regular reading instruction and students in a criterion group received regular reading instruction. The results indicated that students in the intervention group made measurable gains in the areas of phonemic awareness, word reading, and word writing skills. Similarly, Temple et al. (2003) evaluated the effects of *Fast Forward*, a computer-based reading intervention program consisting of seven adaptive practice lessons to improve the auditory and language processing skills of 20 students with dyslexia (ages 8–12 years). The results indicated that after 20 hrs of intervention the children gained in word identification, word attack, passage comprehension, oral language, and rapid naming skills.

Kim et al. (2011) examined the effectiveness of *READ 180 Enterprise* on the vocabulary, comprehension, spelling, and oral reading skills of low performing students in upper elementary grades using a randomized control design. *READ 180* was implemented as an after-school literacy program with students in grades four to six. Students were assigned to the *READ 180 Enterprise* program, or the school district's after-school program. Results indicated that students in the *READ 180 Enterprise* group displayed significant gains on comprehension and vocabulary

scores. The researchers concluded that *READ 180* was more effective with moderate-risk students than with high-risk readers, and when both whole group instruction and three small group rotation components are implemented. They concluded literacy intensive supplementary education programs (which are sequenced and explicit) are more effective than less focused after-school literacy programs.

However, not all studies indicate positive effects for CBRPs. For example, Rouse and Krueger (2004) evaluated the effects of *Fast ForWord* on the language and reading skills of at-risk students in four schools with a high percentage of minority students. The authors concluded (a) that the program was useful in improving some aspects of language skills, (b) the benefits did not translate to actual reading skills, and (c) that gains were smaller than the gains claimed by the program vendor (Rouse & Krueger, 2004). The authors hypothesized the limited effectiveness of computer-based programs could be due to (a) the inability of educators to "harness computer programs" to enhance instruction, (b) educators' difficulties with incorporating computer-based instruction into a school schedule and curriculum, and/or (c) recognition that computer programs may not be an effective replacement for traditional instruction. Similarly, Dynarski et al. (2007) conducted a national study that evaluated the effectiveness of five CBRPs that were implemented in 43 schools across 11 school districts. The authors concluded there were no statistically significant effects on students' reading growth from computer-based instruction. The opposing conclusions on CBRPs effectiveness in the literature creates a need for systematic evaluation of the impact of software products before recommending them for use with students at-risk for reading difficulties.

Given the need to find effective approaches to improve reading skills, especially in an era of high-stakes testing and accountability; a proliferation of computer-based programs in the last decade; and a lack of consensus on the positive effects of CBRPs in the literature; there is a need for studying the effectiveness of educational technology (Agodini et al., 2003). Currently, there is a dearth of rigorous evaluation of the effectiveness of these programs (Rouse & Krueger, 2004). Furthermore, it is estimated that seven million children are unsupervised for some period after school (Durlak & Weissberg, 2007). Additionally, after-school programs could be a source of growth-enhancing learning opportunities for students at-risk for reading failure. The literature on after-school literacy programs suggests that students in after-school reading programs that are systematic and explicit tend to show greater gains than programs that are less systematic and explicit (Durlak & Weissberg, 2007; Kim et al., 2011). It is in this context that this study was conducted.

The purpose of the research study was to evaluate the comparative effects of two CBRPs on the acquisition of basic early literacy skills of KG to second grade children with reading difficulties when implemented by tutors in an afterschool program. Additionally, tutor's perceptions of the effectiveness, ease of implementation, and desirability of the program were assessed, and students' perceptions of the effectiveness and desirability of the programs were also assessed.

Method

Participants and Setting

Study participants included students with reading difficulties in KG to second grade. Multiple steps were taken to recruit the students. First, study orientation meetings were held with key personnel of two school districts in Northern Utah and the Cache Valley's Boys and Girls Club (CVBGC) to review the research objectives, procedures, measures, and computer-based programs to be evaluated in the study. Personnel from each of the participating schools operate after-school programs in coordination with the CVBGC to provide after school services to over 500 students in the two school districts. Second, elementary grade teachers working in KG, first, and second grades in nine elementary schools (seven of the nine were in rural areas) located in the two school districts were contacted to identify three students in their classrooms who scored below the 15th percentile on a local or state test of reading achievement. Third, study flyers were sent to parents of the targeted students through classroom teachers. Eight-five parents expressed an initial interest in the study. Of the 85 students, 71 completed all study procedures. After the initial parental consent for participation was obtained, the students were randomly assigned to one of the two CBRPs.

Computer-Based Reading Programs

Three criteria were employed for selecting the CBRPs for the study. First, the program needed to address the critical skill areas of phonemic awareness, phonics, fluency, vocabulary, and reading comprehension. Second, the CBRP curricula should be appropriate for students in kindergarten through second grade. Third, the time to complete a lesson/episode should be similar. Using the criteria, two CBRPs, *Funnix* and *Headsprout*, were selected for the study.

Funnix. *Funnix* is a compact disc (CD) based, reading program developed for parents to teach beginning literacy skills to their children. It includes two levels. The first level is *Funnix Beginning Reading* and the second, *Funnix 2*. Each level provides explicit instruction in the areas of phonological awareness, alphabetic principle, fluency, vocabulary, and comprehension. *Funnix Beginning Reading* consists of 120 lessons, and a consumable student workbook (i.e., the lesson related exercises) after each lesson (Engelmann et al., 2001). *Funnix 2* contains 100 lessons and a hardback reader (Engelmann & Engelmann, 2002). *Funnix* comes with a placement test to determine a student's entry point into the program (see http://www.funnix.com/ for more details). *Funnix* includes a built-in audio–video narrator. The narrator models skills and then presents learning opportunities for children to practice the skills. *Funnix* requires an adult to navigate the program and make appropriate programmatic

choices (pause, repeat, continue, exit, etc.) based on students' responses (Engelmann & Engelmann, 2003). For example, if the student makes multiple errors, the adult can choose to repeat the exercises. Instructions are also provided in the *Funnix* parent training CD on (a) correct sound pronunciations; (b) the recommended criteria for repeating exercises; (c) navigating through exercises in a lesson; and (d) the need for praising students' correct responses. Each lesson begins with a computer narrated introduction and requires students to produce oral responses to stimuli presented on screen, complete workbook exercises, or read from a hardback reader. The *Funnix* program requires persons delivering the program be trained in providing feedback and in error correction procedures.

Headsprout. *Headsprout Early Reading* (HS) is a web-based supplemental reading program consisting of 80 lessons/episodes, Sprout stories that students read to an adult, and benchmark assessments. The program employs explicit instruction and immediate and cumulative practice to teach phonemic awareness, phonics, vocabulary, oral reading fluency, and reading comprehension (see Layng et al., 2003). It is designed for students' independent use, does not require extensive training, is based on nine patented teaching routines, and around four pedagogical frameworks (see Huffstetter et al., 2010). Unlike *Funnix*, there is no placement test for HS and all students start with episode/lesson 1. Unlike *Funnix*, it is primarily student directed (i.e., the student manipulates the mouse to select a response), requires students to independently use a mouse (has preparation exercises for students to learn to independently use a mouse), and is designed for use without intensive supervision of adults. With HS, students learn literacy skills though cartoon-based episodes set in Space World, Dinosaur World, Undersea World, and Jungle World environments (Layng et al., 2003). HS requires multiple modality responses such as oral production responses and motor selection responses. For example, the narrator asks the student to say a word aloud. Next, the program presents three characters saying the word and the narrator requesting the students to click on the character they think is saying the correct response (among the three alternatives). HS recommends that adults supervising students attend to three tasks. First, they ensure students produce oral responses to program provided prompts. Second, they have students read aloud paper-based Sprout Stories as prompted by the program. Third, they provide corrective feedback for reading errors produced while reading Sprout stories. Further, HS keeps a log of student's responses, login times, duration of program engagement, and the number of correct responses.

Tutor Training and Feedback

The CBRPs were implemented as part of an after-school program. Twenty-four Boys and Girls Club tutors provided the CBRP interventions to the 71 students in the study. The tutors were randomly assigned to each program and were then trained on how to implement the program assigned to them. The training of tutors for the study included

an orientation with key information about their assigned program and the descriptions of key program features. The training also included modeling of key instructional behaviors and opportunities for tutors to practice the program tools under the direction of the trainers. Further, four coordinators were trained to support the tutors. This training consisted of (a) a review of the program required instructional delivery procedures, (b) correct use of the observation tool developed for the study, and (c) scoring program implementation using video footage of students tutored using *Funnix* and HS. The coordinators were required to demonstrate 95% interobserver agreement (IOA) before their observations. The coordinators observed the tutors on a weekly basis and provided feedback on the tutors' implementation of the programs.

Dependent Measures

DIBELS. DIBELS (Dynamic Indicators of Basic Early Literacy Skills) progress monitoring (PM) probes were used to examine the effectiveness of the CBRPs on the students' reading skills. DIBELS fluency probes are administered in 1 min time intervals and are sensitive to small changes in skill acquisition over time. DIBELS consists of seven subtests: letter naming fluency (LNF), initial sound fluency (ISF), word use fluency (WUF), phoneme segmentation (PSF), nonsense word fluency (NWF), oral reading fluency (ORF), and retell fluency (RF) (Good et al., 2001). The DIBELS measures are widely researched, reliable, and valid indicators of students' early literacy skills (see Good et al., 2004 for information on the validity and reliability for each subtest). For this study, PM probe 19 (except for LNF) was used as the pretest and PM probe 20 was used as the posttest for six of the seven measures. For LNF measure, the K-3 benchmark assessment was used as the pretest and the first benchmark at grade 1 was used as the posttest. For ORF measure, the first grade PM probes were used with all KG students. A video resource, modeling, practice, and feedback were employed to train the four project coordinators in the administration of DIBELS probes until they demonstrated the administration skills specified in DIBELS training materials. Furthermore, the IOA among coordinators collected prior to the study indicated agreement was >80% for all the tests.

Social Validity Questionnaire. The researchers developed a social validity questionnaire for tutors and students before the study commenced. At the completion of the study, the social validity questionnaire was administered to elicit participants' perceptions. Students were orally asked about their satisfaction with the program, their perception of specific elements (e.g., stories, graphics, activities), and their perceived effectiveness of the CBRP in teaching them how to read. The project personnel recorded the responses on the questionnaire. Tutors also responded to questions related to ease of using the program, their perceived effectiveness of the program in teaching reading skills, and their overall perception of the program.

Results

Twenty-four tutors implemented the CBRP programs with 71 KG to second grade students. Of the 71 students, 33 were assigned to the HS group and 38 to the *Funnix* group. For the HS group, nine students were in Kindergarten, 13 in first grade, and 11 in second grade. Of the 38 students in the Funnix group, six were in Kindergarten, 18 in first grade, and 14 attended second grade. The programs were implemented for three 30 min sessions a week over a 5-month period. However, there was some variance in attendance and the number of lessons completed by the students. The mean attendance for students in the HS group was 61% (median was 59%). The mean attendance for the *Funnix* group was 63% (median was 69%). Approximately 68% of the students in the HS program and 67% of the students in the *Funnix* program completed 20 or more episodes/lessons and 32% of the students in the HS group and 33% of the students in the Funnix group completed 40 or more lessons. Of the 24 tutors, 12 implemented the HS program and 12 implemented the *Funnix* program.

CBRP Effectiveness

First, a one-way multivariate analysis of variance (MANOVA) test was conducted to determine if there were differences between the groups on the seven dependent measures before the intervention. Results indicated that the groups did not differ in a statistically significant way. The *Wilks's Λ* was 0.88 and not significant at the 0.05 level: $F(7, 63) = 1.27$, $p = .28$. The subsequent analysis of variance results suggested a statistically significant difference between groups on the ORF pretest measure (0.05). Second, the results of the one-way MANOVA to determine the effects of the two CBRPs on the seven posttest DIBELS measures indicated a statistically significant difference with a Wilks's Λ of 0.753, which was statistically significant, $F(7, 63) = 2.95$, $p = .01$. The multivariate $\eta^2 = 0.25$ indicates that 25% of the multivariate variance of the dependent variables is associated with the group factor. Subsequent analysis of covariances with pretests as a covariate were undertaken to examine the differences between the groups after the interventions. The only statistically significant difference between the groups was found on the WUF measure in favor of HS group; $F(1,68) = 6.86$, $p = .01$. The partial eta square was 0.092, indicating a *medium* effect size (see Table 1).

Third, the standardized effect size index *d* was computed for each group to evaluate the pre–post gains (across grade levels; see Table 2). For the HS group, the effect size was *large* for LNF (0.84) measure; *medium* for the ORF (0.71), PSF (0.66), and NWF (0.66) measures; and *small* for the ISF (0.49), WUF (0.38), and RF (0.36) measures. For the *Funnix* group, the effect size was *large* for LNF (0.80) measure; *medium* for NWF (0.60), ORF (0.53) measures, and PSF (0.5) measures; *small* for the ISF (0.46) measure, and none for the WUF and RF measures. When the program by grade level analysis was undertaken, the following effect size gains were found. At the kindergarten level, the *Funnix* group had a *large* effect size on the LNF, NWF,

Table 1. Means, Standard Deviation, and Adjusted Means on the Posttests for the Two Groups.

Posttest	Group	*n*	Mean	*SD*	Adjusted means
LNF	*Headsprout*	33	64	15.05	66.35
	Funnix	38	70.47	15.05	68.42
ISF	*Headsprout*	33	30.25	14.14	30.95
	Funnix	38	31.50	14.34	30.89
PSF	*Headsprout*	33	57.93	12.10	58.63
	Funnix	38	59.63	14.65	59.02
NWF	*Headsprout*	33	59.78	29.88	64.51
	Funnix	38	69.65	33.11	65.51
WUF	*Headsprout*	33	47.21	16.88	46.83
	Funnix	38	37.18	15.02	37.51
ORF	*Headsprout*	33	43.00	33.62	49.88
	Funnix	38	51.57	36.92	45.60
RF	*Headsprout*	33	18.90	20.98	20.34
	Funnix	38	19.34	17.24	18.09

LNF = letter naming fluency; ISF = initial sound fluency; PSF = phoneme segmentation; NWF = nonsense word fluency; WUF = word use fluency; ORF = oral reading fluency; RF = retell fluency.

Table 2. Means and Standard Deviations on the Pretests and Posttests for the Two Groups.

	DIBELS	Pretest		Posttest	
Group	Measure	Mean	*SD*	Mean	*SD*
Headsprout	LNF	51.33	19.93	64.00	15.05
	ISF	23.28	10.29	30.25	14.14
	PSF	43.24	21.89	57.93	12.10
	NWF	44.00	26.94	59.78	29.88
	WUF	38.48	17.98	47.21	16.88
	ORF	25.96	26.05	43.00	33.62
	RF	12.48	15.49	18.90	20.98
Funnix	LNF	59.60	19.24	70.47	15.05
	ISF	25.55	13.32	31.50	14.34
	PSF	49.92	18.18	59.63	14.65
	NWF	55.44	29.97	69.65	33.11
	WUF	36.18	19.60	37.18	15.02
	ORF	40.65	36.12	51.57	36.92
	RF	16.81	22.07	19.34	17.24

DIBELS = Dynamic Indicators of Basic Early Literacy Skills; LNF = letter naming fluency; ISF = initial sound fluency; PSF = phoneme segmentation; NWF = nonsense word fluency; WUF = word use fluency; ORF = oral reading fluency; RF = retell fluency.

WUF, and ORF measures; a *medium* effect size on the PSF measure, and a *small* effect size on the RF measure. The HS group had a *large* effect size on the LNF, PSF, NWF, and ORF measures; a *medium* effect size on the WUF measure, and a *small* effect size on the ISF measure. At the first-grade level, the *Funnix* group had a *large* effect size on the NWF measure; a *medium* effect size on the LNF, ISF, PSF, ORF, and RF measures; and *none* on the WUF measure. The HS group had a *large* effect size on the LNF, NWF, and ORF measures; a medium effect size on the ISF, PSF, and RF measures; and a small effect size on the WUF measure. At the second-grade level, the *Funnix* group had a *medium* effect size on the LNF and ORF measures; a *small* effect size on the ISF, PSF, and NWF measures; and no effect on the WUF and RF measures. The HS group had a *medium* effect size on the PSF and ORF measures; and a small effect size on LNF, ISF, NWF, WUF, and RF measures.

Tutors' Perceptions

The results from the social validity questionnaires administered with the tutors indicated that 50% of the tutors implementing the HS program and 33% of the tutors implementing the *Funnix* program thought the CBRPs were good programs. Similarly, 58% of the tutors in the HS program and 42% of the tutors in the *Funnix* program indicated the CBRP was useful in teaching reading skills. Regarding the ease of using the CBRP, 75% of the tutors in the *Funnix* program and 100% in the HS program indicated starting the lesson was easy, 58% of the *Funnix* tutors and 100% of the HS tutors indicated the students were able to easily follow the narrator's instructions, and 42% of the *Funnix* tutors and 75% of the HS tutors indicated computer graphics helped maintain their students' attention. Regarding the appropriateness of teaching activities, 50% of the *Funnix* tutors and 83% of the HS tutors rated the activities for teaching sounds of letters and to read words were appropriate. More *Funnix* tutors (75% vs. 42%) felt the activities for teaching comprehension were appropriate and the instructional time was sufficient (83% vs. 75% for HS). Approximately 67% of the *Funnix* tutors indicated the workbook activities (unique to *Funnix*) were useful in teaching reading skills and 58% of the HS tutors indicated the Sprout stories were useful in teaching reading skills. Finally, 67% of the *Funnix* tutors and 75% of the HS tutors indicated their feedback helped their students learn to read (see Table 3).

Students' Perceptions

Approximately 79% of the students in the *Funnix* group indicated they liked the program compared to 63% of the students in the HS group. When asked if the program helped them learn to read better, 66% of students in the CBRP groups answered "yes." However, only 40% of the students in the *Funnix* group (and 24% indicated "no") and 41% of the students in HS group (and 13% indicated "no") replied their friends would like the CBRP. Regarding the various features of the

Table 3. Tutor's Perceptions of Computer-Based Reading Programs.

Questions	Funnix % Agree	Headsprout % Agree
1. Starting a lesson was easy.	75	100
2. Students could easily follow the narrator's instructions.	58	100
3. Overall quality of the program was very good.	33	50
4. The program was useful in teaching reading skills.	42	58
5. Activities for teaching sounds of letters and read words were appropriate.	50	83
6. Activities for teaching comprehension were appropriate.	75	42
7. Workbook activities (Funnix)/Sprout stories (HS) for practicing reading skills were useful.	67	58
8. Computer graphics helped maintain child's attention.	42	75
9. My feedback to students helped them learn to read.	67	75

Funnix program, 55% the students indicated they liked the graphics in the program (37% indicated sometimes), 47% indicated they liked the workbook activities (29% indicated sometimes), and 87% indicated they liked the stories (8% indicated sometimes). Regarding the features of the HS program, 41% the students indicated they liked the graphics in the program (34% indicated sometimes), 59% indicated they liked the games (22% indicated sometimes), and only 47% indicated they liked the stories (22% indicated sometimes) (Table 4).

Discussion

This study examined the impact of two CBRPs on the basic early literacy skills of K-2 at-risk students. The results indicated that (a) there was a statistically significant difference between the two groups on the WUF measure in favor of the HS program, (b) the HS group showed gains on all the seven DIBELS measures, (c) the *Funnix* group showed gains on five of the seven measures, (d) a slightly higher percentage of students in the *Funnix* group liked the program (and components) compared to HS group, and (e) a slightly higher percentage of HS tutors rated the program as a good program and useful in teaching reading skills. The results, limitations, and contributions of the study are discussed below.

A significant finding of this study is that both programs facilitated gains (both overall and across grade levels) in the areas of the phonemic awareness (as measured by ISF) and phonics (as measured by NWF), which are crucial early literacy skills. Similarly, the students in both groups exhibited a gain in their oral reading skills (both overall and across grades as measured by the ORF measure). Furthermore, the students in the HS group had *small* gains in the areas of vocabulary and oral reading

Table 4. Students' Perceptions of Computer-Based Reading Programs.

Questions	Funnix % Agree	Headsprout % Agree
1. Do you like computer programs that teach reading?	76	69
2. Did you like the CBRP?	76	63
3. Did the program help you read better?	66	66
4. Did you like the stories?	87	47
5. Do you think your friends will like the CBRP?	40	41

CBRP = computer-based reading program.

fluency. These findings support Watson and Hempenstall (2008) findings that computer-based programs can facilitate the growth of basic early literacy skills of at-risk beginning readers. Also, these findings extend the results of Kim et al. (2011) after-school intervention study with elementary to middle-grade students. The results suggest that the two CBRPs can be used in after-school programs to provide focused, explicit interventions in the areas of phonemic awareness, phonics, and fluency and thereby prevent the compounding of reading deficits across years.

Students' Perceptions

Most of the students liked the programs and thought the programs helped them read. Students in both programs liked the stories in the programs. However, a higher percentage of students in the *Funnix* program liked the stories (87% vs. 47%), visuals (55% to 41%), the program itself (79% to 63%), and the stories (87% to 47%). Having all students start from Lesson 1/Episode 1, irrespective of their current grade level, could have been a factor in lower likeability ratings of HS program and needs to be examined in future studies. One significant finding is that a lower number of students (~40% in both groups) thought their friends would like the program. A plausible explanation for this lower rating could be students' perceptions that their friends do not require reading interventions, which needs to be examined in future studies.

Tutors' Perceptions

Unlike the students, tutors liked the HS program and felt that HS program was a good program (50% vs. 33%), useful in teaching reading skills (58% vs. 42%), and easy to use. *Funnix* being an adult-mediated program required more training than HS. The adult is required to navigate the program, provide error correction, feedback, and so on. This could be an influencing factor for the lower ratings by the tutors. In addition, the results indicated that the HS tutors indicated it was easy to start the program and the

children could easily follow the narrator's instruction, which could have influenced their perceptions of the ease of use of the programs and higher ratings.

Limitations

There are three limitations of this field study that need be considered when examining the results of the study. These include (a) the absence of control group, (b) limited power of the statistical tests, and (c) treatment intensity. One, the lack of a control group is not an issue if there is considerable literature with evidence of effectiveness for each program. When there is no such evidence, researchers can overcome this factor by including an observational group that acts as a control group during the first phase of the study and then provide intervention to the control group during the second phase of the study using a multiple-baseline group design. Two, effect size calculations, undertaken in this study, to a certain extent can help with proper interpretation of results when limited power is an issue. However, the best way to increase the power is to increase the sample size. This will require greater resources and will involve conducting a study in a large school district or collaborating with multiple school districts or collaborating with researchers across different geographical regions. When resources are an issue, the use of the matched-pairs design can reduce the variability and increase the power. Three, treatment intensity is often overlooked variable when examining CBRPs. One can address this by getting necessary approvals and pretesting during the summer before the school year starts so that the intervention can be implemented 5 days a week and throughout the year or undertake a longitudinal study that is conducted over multiple years.

Assessing Relative Significance of Results. Even though the effect sizes indicate skill growth in phonemic awareness, phonics, and oral reading, the lack of a control group makes it difficult to understand the relative significance of the results. Previous studies that examined the effectiveness of these two CBRPs (see Huffstetter et al., 2010; Watson and Hempenstall, 2008) have supported the literacy gains of these programs and thus one can rule out the gains were solely a result of school-based reading instruction. The presence of a control group could have additionally helped to understand the unique contributions of CBRPs as an after-school intervention. However, it is ethically and practically very difficult to have a control group when working with at-risk students. A multiyear study with a combination of multiple baseline design and randomized controlled group design features is needed to address this issue. Using a combination of design methodologies, future research should be undertaken with a control group to understand relative effectiveness of the CBRPs in facilitating the reading skills of at-risk students when implemented as an after-school program.

Statistical Power. The final sample of the study consisted of 71 students. The sample size is considered small given the number of tests conducted. This is especially true for the grade level tests undertaken and those results should be considered exploratory. When sample sizes are small, the power of statistical tests in rejecting the null hypotheses is weak. For this study, despite conducting multiple tests, the null hypothesis was tested at the 0.05 significance level (two-tailed test) to increase the power of the test. Furthermore, effect sizes were computed to overcome the issue of limited power of the statistical tests. The effect sizes computed did indicate that the results of this field investigation are promising. However, the results should be considered as exploratory and future studies are necessary to replicate the findings with a larger sample.

Intensity of Interventions. This study was completed during an academic year with 5 months of intervention. Thus, the students did not complete the entire CBRP. Approximately 20% of the students (in both groups) completed 50 or more lessons. The results of the study should be viewed within this limitation. Furthermore, there were some variances in attendance rates, a major variable of after-school intervention programs. The above factors could have differentially mediated the results of the study. Future studies with longer duration of intervention and a control group (for controlling the attendance variable) are essential to understand the true effects of the two CBRPs examined in the study.

Significant Contributions of the Study

First, this study adds to the small literature base on the effectiveness of two CBRPs in promoting basic early literacy skills of at-risk beginning readers when implemented by tutors during an after-school program. These findings are valuable as CBRPs (a) can help overcome the limited knowledge of early literacy instruction of providers, (b) can be implemented with high fidelity, and (c) are very cost-effective. Furthermore, as indicated in the study by Kim et al. (2011), explicit instruction is essential for improving the literacy skills of students in after-school programs. The CBRPs reviewed not only provide the intensive supplementary instruction in all five essential reading skill areas thus aid the reading growth of students at-risk for reading disabilities but they also can help overcome the difficulties of incorporating computer-based instruction into a school schedule. Furthermore, as previous literature suggests that CBRPs may not be an effective replacement for traditional instruction (Rouse & Krueger, 2004), the use of CBRPs in the after-school programs can serve as a supplement to traditional reading instruction. Second, the present study measured the perceptions of tutors and students regarding ease of use, likeability, and effectiveness of the programs. Social validity data is not prevalent in the CBRP literature. Social validity data on the ease to use and desirableness is essential for sustainability of program

implementation in practice. Social validity data provides providers/teachers/practitioners a complete picture of the programs and thus aid in their selection and use of programs.

Given the high prevalence of students identified as at-risk for reading failure at the beginning of first grade, the debilitating consequences of failing to read, and a huge number of children being unsupervised for some period after school, it is imperative that school and parents consider additional reading intervention supports for students at-risk for reading failure. Given the positive results of the study and the social validity data, schools and families should consider the CBRPs as two possible options for school, after-school, or home-based supplemental reading interventions to facilitate early literacy skills development and future academic success of children at-risk for reading failure.

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