Computer-Assisted Tutoring in Success for All: Reading Outcomes for First Graders

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Abstract

This article presents a randomized experiment evaluating a computer-assisted tutoring program. The software program, Alphie's Alley, provides reading tutors with animated activities for students, assessment tools, and professional development. In a year-long study involving 25 schools using the Success for All reading program, 412 low-achieving first graders were randomly assigned to be tutored with or without Alphie's Alley. On individually-administered reading measures there were no significant differences overall, but among students with tutors rated as "fully implementing," children whose tutors used Alphie's Alley scored significantly better on three of four measures. These results suggest that if well implemented, technology that enhances the performance of tutors has promise in improving the reading performance of at-risk children.

Key words:

Computer-assisted instruction

Tutoring

Beginning reading

At-risk students

Randomized experiments

Computer-Assisted Tutoring in Success for All

For the past 30 years, the computer revolution in education has been eagerly anticipated, but never realized (Cuban, 2001). As the cost of computers has decreased and as computers have become commonplace in homes and businesses, the numbers of computers in America's schools have steadily grown, with a 1998 estimate of 69 computers in every elementary school (see Becker, 2001). Yet computers remain largely separate from core instruction in classrooms. They are typically used by students for word processing, enrichment, skill practice, remediation, or reference, all applications that have little role for the teacher (Becker & Ravitz, 2001).

In beginning reading instruction, computers are often used for skill practice and remediation, but there is limited evidence of their effectiveness. In a recent meta-analysis, Kulik (2003) found that most studies reported no difference between computer-assisted instruction and traditional reading lessons. There have been some promising applications of computers in teaching skills such as phonological awareness (Foster, Erickson, Foster, Brinkman, & Torgeson, 1994; Segers & Verhoeven, 2005; Wise, Ring, and Olson, 1999), letter and word recognition (Mioduser, Tur-Kaspa, & Leitner, 2000), and other specific reading skills (Greenlee-Moore & Smith, 1996; Torgeson & Barker, 1995). However, much remains to be learned about how computers can help improve children's reading outcomes.

In reading, computers are frequently used to provide one-to-one tutorial instruction to supplement classroom instruction, especially to children who are at risk or performing below expectations. In this application, computers may be seen as less costly alternatives to human tutors. However, human tutors are far more effective. Studies of one-to-one tutoring find substantial positive effects on the reading performance of at-risk first graders (Wasik & Slavin, 1993, Torgeson, Wagner, & Rashotte, 1997; Pinnell, Lyons, DeFord, Bryk, & Seltzer, 1994; Hock, Schumaker, & Deshler, 2001; Morris, Tyner, & Perney, 2000).

One possible reason for the often-disappointing results of computer-assisted instruction is that the computers are expected to replace teachers in providing one-to-one instruction to students. Computers can provide outstanding graphics, excellent assessments, and precise diagnosis and prescription, but they may not be very good tutors, especially for young children. No computer can perceive children's difficulties, explain difficult concepts, or motivate children like a caring, capable tutor. Young children work in school because they want to please their teachers, who are valued adults. Computers cannot replace the human relationship between teacher and child.

The present research was undertaken to test the idea that tutors and computers working together could enhance the reading achievement of at-risk first graders better than tutors alone. This strategy, which we call *embedded technology*, is intended to enhance the effectiveness of human tutors by providing children with compelling multimedia presentations, frequent assessments, and evidence-based diagnosis and prescription, and providing tutors with just-in-time professional development, planning tools, and record-keeping applications. In other words, the intention was to integrate the strengths of both tutors and computers to make tutoring consistently effective for at-risk first graders.

Success for All

The present research took place within schools using the Success for All comprehensive reform model (Slavin & Madden, 2000, 2001). Success for All provides high-poverty elementary schools with well-structured, phonetic materials in beginning reading, and materials emphasizing metacognitive skills in the upper elementary grades. It makes extensive use of cooperative learning, a rapid pace of instruction, and frequent assessment. Most importantly for the present research, Success for All provides daily tutoring for children in grades 1-3 who are experiencing difficulties in learning to read. More than 50 experimental-control comparison studies have evaluated the reading impacts of Success for All, and have found overall positive effects (Borman, Hewes, Overman, & Brown, 2003; Herman, 1999; Slavin & Madden, 2000, 2001). A recent longitudinal randomized evaluation involving 38 schools has also found positive effects of the program (Borman, Slavin, Cheung, Chamberlain, Madden, & Chambers, in press). The present study does not evaluate Success for All, which was a constant in both treatment conditions, but Success for All provided important context for the study.

Computer-Assisted Tutoring

The Success for All daily 20-minute tutoring sessions in foundational reading are provided to approximately one-third of first graders who are struggling in reading. Students are excused from tutoring when they reach grade level on formal assessments given every nine weeks. Originally, Success for All required certified teachers as tutors, but due to limitations on the availability of certified tutors, as well as their cost, most schools now use paraprofessionals to do much or most of their tutoring. Having tutors use computer-assisted tutoring software tailored to the SFA tutoring program was expected to improve the tutoring that students experience and get students up to grade level more quickly.

Based on previous research and experience, computers were expected to improve the outcomes of tutoring in three main areas. In presenting content to children, the computers provided engaging animations to engage students' attention and motivation, to give them grater control over their own learning, and to give them immediate feedback on their performance. In assessment and prescription, the computer enabled tutors to diagnose reading difficulties through multiple means, track children's progress carefully, and provide detailed suggestions to tutors for next steps, based on each child's unique needs. In professional development, the computers provided demonstrations of effective instruction precisely attuned to the tutor's immediate needs and helped increase implementation fidelity.

The computer-assisted tutoring model, called "Alphie's Alley" (Danis, Rainville, Therrien, Tucker, Abrami, & Chambers, 2005) was designed to help tutors make effective use of tutoring sessions to help at-risk children make adequate progress in reading. Alphie's Alley structures the entire 20-minute tutoring session. The computer helps assess children, and suggests individually tailored plans based on the assessments. It provides students with multimedia screens containing 12 types of activities designed to build skills such as phonemic awareness, sound blending, comprehension monitoring, and connected reading. The tutor has an active role in guiding the child, assessing his or her ongoing progress, and modifying plans in light of the child's needs, so the computer serves as an aid, not a replacement for the tutor.

Making learning relevant, understandable, and engaging so that time-on task increases is especially important for students struggling to read. Alphie's Alley was designed to increase students' task engagement and self-efficacy beliefs.

The computer also provides a performance support system for the tutor, including video clips showing expert tutors implementing each type of activity with children with various strengths and weaknesses (Gery, 2002). This "just-in-time" professional development is expected to help tutors to become more thoughtful and strategic in working with their at-risk students (Chambers, Abrami, McWhaw, & Therrien, 2001). It builds on models of cognitive apprenticeship (Collins, Brown, & Newman, 1989) and self-regulated learning (Randi & Corno, 2000).

Alphie's Alley was designed to support the human tutor rather than replace the tutor (Everson, 1995; Mandl & Lesgold, 1988; Mitchell & Grogono, 1993). It contains a complex database that allows the computer to make "intelligent" decisions on interventions, based on the individual performance of each student, both between and within sessions (Everson, 1995; Mitchell & Grogono, 1993). The computer analyzes the student's responses and provides to the tutor suggested templates of instruction for that individual student. The tutor can choose to have the student engage in the suggested activities or can choose other activities, based on his or her knowledge of the student's abilities. The computerized diagnostic and assessment activities simplify record-keeping so the tutor's full attention can be devoted to the student.

There are several key concepts that underlie the design of Alphie's Alley. One is the use of embedded multimedia. Embedded multimedia (Chambers, Cheung, Madden, Slavin, & Gifford, in press) refers to strategies in which animations and other video are woven into teachers' lessons. The use of embedded multimedia is based on theoretical work by Mayer (2001) and his colleagues demonstrating that well-designed multimedia can greatly enhance learning and retention of concepts. Two studies of this application in classroom (not tutorial) instruction have found that adding brief video content on letter sounds and sound blending to class lessons in first grade reading enhances decoding outcomes (Chambers et al., in press; Chambers, Slavin, Madden, Abrami, Tucker, Cheung, & Gifford, 2005). Giving the students animated representations of concepts such as letter sounds, sound blending, and sequence of events in a story is expected to help children master reading skills. For example, the computer progressively moves letters closer to each other to represent sound blending, and it shows pictures from stories out of order for children to put in proper sequence.

Second, as noted earlier, the interaction of tutor and computer builds on the strengths of each. The computer organizes and presents attractive animations, keeps records, and so on, but the tutor listens to children, gives them feedback, and most importantly, forms human relationships with them. Finally, the computer's professional development capacity is expected to help tutors build their own understandings of how to implement the program and, more importantly, how to reach a broad range of children with diverse learning strengths and difficulties.

In developing Alphie's Alley, a combination of existing research, surveys, focus groups, consultations, observations, and annual testing for formative evaluation were used to create a tool that was theoretically sound, practically useful, and empirically supported. Initial reports from a year-long pilot test include a limited amount of quantitative data collected in a quasi-experimental design in a pilot year. Students in regular Success for All tutoring were compared to students who participated in Success for All tutoring with Alphie's Alley. A significant multivariate effect size of +0.39 (N=27 tutees) was found in favor of those who were tutored using Alphie's Alley on Word Identification, Word Attack, and Passage Comprehension subtests of the Woodcock Reading Mastery Tests-Revised and DIBELS Oral Reading Fluency, when pretest scores on the Peabody Picture Vocabulary Tests were used as a covariate.

Schmid, Tucker, Jorgensen, Abrami, Lacroix, and Noclaidou (2005) examined tutor reactions to Alphie's Alley versus traditional "paper and pencil" forms of tutoring support within SFA, using pretest and posttest surveys. They concluded that Alphie's Alley assumed and maintained a central role throughout the year. Tutors consistently reported that students were highly motivated to come to tutoring and appeared to learn at a rapid pace.

Alphie's Alley was evaluated in a contemporaneous study as part of a combined treatment with the Reading Reels embedded multimedia program. A randomized experiment in two primarily Hispanic Success for All schools found very positive effects of the combined treatment of Alphie's Alley and in-class embedded multimedia (Reading Reels) for the reading achievement of low-achieving first graders who received tutoring. Significantly positive effects were found on the Woodcock Letter-Word and Word Attack scales and on the Gray Oral Reading Test Fluency and Comprehension scales, with a median effect size of +0.53.

The Present Study

The present study was undertaken to determine the independent effects of the Alphie's Alley computer-assisted tutoring model. It used random assignment of tutored children within schools to receive tutoring with or without Alphie's Alley. Random assignment eliminates selection bias as a possible confound. The study schools were experienced Success for All schools, so instruction, curriculum, grouping, and other factors were equal for all students.

Method

Design

The study took place in 25 Success for All schools located in eight states throughout the U.S. In each school, first graders who were identified for tutoring due to low scores on curriculum-based measures were assigned at random to tutors who themselves were randomly assigned to either use Alphie's Alley or to continue their usual tutoring strategies, as specified in the Success for All program.

Participants

Subjects were 412 low-achieving first graders who received tutoring across the 25 schools and completed pre-and posttests. The schools' population was 49% Caucasian, 30% African American, 18% Hispanic, and 3% other. Across the schools, 71% of the students received free and reduced-price lunches.

Experimental Treatment: Computer-Assisted Tutoring

Students who experienced difficulties in reading in Success for All were assigned to daily 20-minute one-to-one tutoring sessions. In the experimental group, tutors used Alphie's Alley, the computer-assisted tutoring program, designed specifically to align with the SFA curriculum. The program has four components: assessment, planning, computer activities, and just-in-time professional development.

Assessment. Alphie's Alley assesses children's reading strengths and difficulties in the areas of phonemic awareness, phonics, fluency, and comprehension. It communicates this information on an assessment report for each student. The program continuously updates information relevant to the student's progress.

Planning. The program suggests a two-week tutoring plan based on the child's assessment. The tutor may modify the plan in light of the child's performance and needs. From the tutoring plan, the student and tutor choose a goal for the student to focus on each week. At the end of the two-week period, a new plan is generated based on the student's performance on the activities.

Computer Activities. Alphie's Alley is a computer-based learning environment built around Alphie the Alligator and his friends. Students work on Alphie's Alley computer activities specifically designed to reinforce skills taught in their core reading program. In each activity, students have an opportunity to respond, but if they cannot produce a correct answer, the computer gives them progressive scaffolding until they can reach the right answer. Students respond to the tutor, who records whether the student's response was correct or not, and provides individualized explanations and help if the child runs into trouble. Specific activities that students encounter are as follows:

1. <u>Letter Identification.</u> The computer gives a sound, and the student must select a letter or letter combination that makes that sound.
2. <u>Letter Writing.</u> Same as letter ID, except that the student must type or write the letter or letter combination.
3. <u>Auditory Blending.</u> The computer presents sounds for 2, 3, or 4-phoneme words, which the student blends into a word for the tutor.

4. Auditory Segmenting. The computer says a word and the student must break it into its separate sounds for the tutor.
5. Sight Words. The computer displays sight words, which the student reads to the tutor.
6. Word-Level Blending. The computer displays a word and the student uses sound blending to decode it to the tutor.
7. Spelling. The computer says a word and the student types it. At higher levels, the computer reads a sentence that the student types.
8. Story Preparation. Before the child reads a decodable story, the computer displays story-related words (both phonetically regular and sight words) for the student to practice. This activity is particularly important for ELLs, who can learn the story vocabulary before they encounter it in a book or on screen.
9. Tracking. The student reads a story book on the computer to the tutor, and uses an arrow key to track work by word. The computer models appropriate decoding strategies if the student cannot decode a word, and orally presents sight words that the student does not know.
10. Fluency. The student reads a story to the tutor, who notes errors and times to compute words correct per minute. Fluency practice and assessment focuses on accuracy, then smoothness, then expression, then rate.
11. Comprehension Questions. The computer displays questions about the stories that the student answers to the tutor.
12. Graphic Organizers. The student completes a graphic organizer to represent main ideas from the stories.

Just-in-Time Professional Development. Alphie's Alley offers just-in-time performance support for tutors in the form of video vignettes and written suggestions on how to help remediate students' particular problems. Once a diagnosis has been made about specific problems a student may have, the tutor can view a variety of intervention strategies to help remediate that problem. For example, if a tutor determines that a child has a problem with visual tracking, then the tutor can view video vignettes of other tutors modeling ways to help children learn to track. Short audiovisual vignettes provide immediate expert guidance to the tutors focused on the exact problem they are confronting.

Control Treatment

Students in the control treatment experienced Success for All including tutoring without the technology elements. The use or non-use of the technology was the only factor differentiating experimental and control treatments.

Measures

Participants were individually pretested in September, 2004 and posttested in May, 2005. Specially trained testers unaware of children's experimental assignments administered the tests. The measures were as follows.

1. <u>Woodcock Letter-Word Identification.</u> (Pre, post). The Letter-Word Identification scale of the Woodcock-Johnson III Tests of Achievement was used as a pretest and again as a posttest. It requires subjects to identify isolated letters and words.
2. <u>Woodcock Word Attack.</u> (Post). Word Attack asks subjects to read nonsense words, as an assessment of phonetic skills.

3. Gray Oral Reading Test-Fluency. (Post). GORT-Fluency asks subjects to read connected text, and scores them on rate and accuracy.
4. Gray Oral Reading Test-Comprehension. (Post). GORT-Comprehension is a multiple-choice test based on questions asked of subjects after they read the passages used in the Fluency test.
5. Gray Oral Reading Test-Total. (Post). GORT-Total subsumes the Fluency and Comprehension subscales.

Analysis

The data were analyzed using analyses of covariance, controlling for Letter-Word Identification pretests.

Results

Overall Findings

Table 1 summarizes results for all students. There were no differences at pretest ($p < .99$). At posttest, there were also no significant differences across the five outcome measures.

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Table 1 Here

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High Implementers

In this first study of Alphie's Alley, implementation was highly variable. Some tutors assigned to the experimental group never implemented Alphie's Alley at all, and some did so very poorly. Others implemented the program very well. The use of random assignment of tutors to computer and non-computer conditions within schools created particular problems, as it sometimes created confusion about what each tutor was expected to do. For this reason, a separate analysis of the schools that did fully implement the experimental treatment was carried out.

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Table 2 Here

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SFA trainers, who were responsible to oversee program training and follow-up implementation, rated program implementation for all experimental schools on a 3-point scale: "fully implemented" to "poorly implemented." Tutors in 13 schools, teaching 203 students (49% of the student sample), were rated as "fully implementing." Those in 9 schools were rated "partially implementing" and 3 schools were rated as "poorly implementing."

Separate analyses by implementation rating showed sharply differing outcomes. There were no program impacts for partial and poor implementers. However, for fully implementing schools, results were generally positive.

As is shown in Table 2, pretest differences among experimental and control students in fully-implementing schools were not significant. At posttest, there were significant positive effects on three of the four independent measures. Effect sizes (adjusted mean differences divided by unadjusted standard deviations) and p-values were as follows: Woodcock Letter-Word Identification (ES = +0.45, $p < .001$), Woodcock Word Attack (ES= +0.31, $p < .05$), and GORT Fluency (ES= +0.23, $p < .05$). There were no differences on GORT Comprehension (ES = +0.05, n.s.) or GORT Total (ES = +0.18, n.s.).

Discussion

The findings of this randomized experimental evaluation of the Alphie's Alley computer-assisted tutoring program indicate that the outcomes depended completely on quality of implementation. Schools with high implementation quality had significant positive achievement effects on three out of four independent measures, with a median effect size of +0.27. However, there were no significant effects for partial or poor implementers, or for all schools taken together.

These findings should be considered in light of a second study, by Chambers et al. (2005). That randomized experiment also evaluated Alphie's Alley, but experimental students experienced the Reading Reels embedded multimedia content in their regular reading classes as well as Alphie's Alley in their tutoring sessions. Implementation quality was high, and the problem of having experimental and control tutors in the same schools was largely solved by locating the study in multitrack year-round schools in which students were randomly assigned from a common pool to distinct "mini-schools." In the Chambers et al. (2005) study, treatment effects for tutored students on the same Woodcock and GORT measures used in the pretest study were very positive and significant, with a median effect size of +0.53.

Beyond the overall effects, the present study differs from Chambers et al. (2005) in patterns of reading outcomes. In Chambers et al. (2005), the largest impacts were seen on the GORT Comprehension measure, with an effect size of +1.02. In contrast, Comprehension was the only measure that showed no differences between experimental and control groups among students in high-implementing schools in the present study.

The different findings in these two similar studies could be due to the use of Reading Reels (which had positive separate effects in two studies, by Chambers et al., in press, and Chambers et al., 2005). It could also be the case that implementation quality made the difference, as suggested by the findings of the present study. Further research is under way to more fully understand these effects.

Both studies of the reading effects of the Alphie's Alley computer-assisted tutoring model agree that when well implemented, this program can have a significant and educationally meaningful impact on the reading performance of at-risk first graders. This finding suggests that integrating technology to enhance the work of human tutors can lead to greater reading impacts than those likely to be achieved by tutors alone. More attention needs to be paid to implementation quality, however. Over time, tutors using the tool are likely to come to resemble the high implementers who achieved excellent outcomes in both studies. The studies to date establish the principle that adding well-designed computer activities can make tutors more effective. Given the expense of one-to-one tutoring, anything that can enhance tutoring outcomes is an important contribution to enhancing overall cost-effectiveness.

It is important to recall that the present study compared two versions of SFA tutoring, one using Alphie's Alley and a second using traditional "paper and pencil" SFA tutoring. The traditional version of SFA has already demonstrated its effectiveness compared to non-SFA controls (see Slavin & Madden, 2001). Had the present study also used non-SFA controls as the comparison group, it is likely that the treatment effect would have been substantially larger.

Future investigations should focus on understanding the cognitive and motivational processes by which computer-assisted tutoring enhances learning. Do the self-efficacy and self-regulation of students and tutors increase over time with use of the technology-enhanced SFA curriculum? Do tutors become more effective by using computer-assisted tutoring?

The present study, and related studies by Chambers et al. (2005, in press), suggest a new role for technology in education: enhancing rather than replacing teachers' instruction. This concept may have much broader implications than its application in first grade reading instruction, and is worth exploring on a broader scale. Perhaps the technology revolution will finally come in education when the computer becomes the teacher's partner, rather than the teacher's replacement.

Table 1

Reading Outcomes for All Students

	N	Pre	Post	Adj. Post	ES
Letter-Word ID					
Exp mean	224	375.31	436.96	436.96	+0.13
(SD)		(22.62)	(28.95)		
Control mean	188	375.32	433.82	433.82	
(SD)		(24.23)	(24.31)		
Word Attack					
Exp mean	224		482.16	482.43	+0.06
(SD)			(22.24)		
Control mean	188		481.46	481.42	
(SD)			(18.19)		
Fluency					
Exp mean	224		11.54	11.54	+0.06
(SD)			(9.77)		
Control mean	188		10.96	10.96	
(SD)			(9.54)		
Comprehension					
Exp mean	224		6.32	6.32	-0.02
(SD)			(5.82)		
Control mean	188		6.43	6.43	

(SD)		(6.08)		
<u>GORT Total (F+C)</u>				
Exp mean	224	17.84	17.85	+0.03
(SD)		(13.80)		
Control mean	188	17.39	17.38	
(SD)		(13.54)		

Table 2

Reading Outcomes for Students with Fully-Implementing Tutors

	N	Pre	Post	Adj. Post	ES
Letter-Word ID					
Exp mean	110	380.55	444.15	442.81	+0.45***
(SD)		(26.27)	(27.75)		
Control mean	93	374.74	429.12	430.70	
(SD)		(26.26)	(26.68)		
Word Attack					
Exp mean	110		485.96	485.32	+0.31*
(SD)			(22.44)		
Control mean	93		479.30	480.07	
(SD)			(16.92)		
Fluency					
Exp mean	110		13.65	13.04	+0.23*
(SD)			(10.43)		
Control mean	93		9.99	10.71	
(SD)			(10.13)		
Comprehension					
Exp mean	110		7.65	7.40	+0.05
(SD)			(6.50)		
Control mean	93		6.81	7.10	

(SD)		(6.11)		
GORT Total (F+C)				
Exp mean	110	21.31	20.45	+0.18
(SD)		(15.10)		
Control mean	93	16.80	17.82	
(SD)		(14.23)		

*p < .05

*** p < .001

Notes

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