

Technology Infusion in Beginning Reading Instruction: Three Randomized Experiments

Abstract

This symposium will present the findings of three closely linked studies on the infusion of technology in beginning reading instruction. Three year-long randomized experiments were carried out to evaluate the addition of forms of embedded multimedia and of computer-assisted tutoring in the Success for All (SFA) reading program. Multimedia (Mayer, 2001) is content that combines written and spoken words and pictures to help children comprehend and retain complex information. One study evaluated Reading Reels, which embeds multimedia content in SFA Reading. A cluster randomized experiment in 10 urban schools found significant positive effects on reading, in comparison to schools using SFA without embedded multimedia. A second randomized experiment evaluated Alphie's Alley, a computer-assisted tutoring program that provides animated content, assessments, planning guides, professional development videos, and other tools to help tutors succeed with struggling first graders. Positive reading effects were found for schools with high implementation ratings. The third presentation reports the results of a randomized experiment that evaluated an approach combining Reading Reels and Alphie's Alley, which found substantial positive effects of the combined program for children who received tutoring. Finally, a study of time use and affective responses to Alphie's Alley will be presented. Richard Mayer, a leading researcher on multimedia, will serve as a discussant.

Objectives of the Symposium

Since it first began to be used in education, technology has been primarily applied as a replacement for teacher instruction. Applications of instructional television and video have focused on the use of programs intended to teach in themselves. Computer applications have primarily engaged students with tutorial, drill and practice, or writing software that they use independently of the teacher. In reading, these strategies have had inconsistent effects (e.g., Kulik, 2003).

Recently, researchers at the Success for All Foundation, Johns Hopkins University, and Concordia University have begun to develop and evaluate innovative strategies that embed use of technology in classroom instruction, using technology as a tool for the teacher rather than a substitute. Two applications of this concept have been developed: embedded multimedia, in which video content is interspersed in teachers' lessons, and computer-assisted tutoring, in which human tutors use computers to help structure their interactions with struggling first graders. Both of these technology infusion applications are applied to enhance outcomes of the Success for All beginning reading program (Slavin & Madden, 2001), and evaluated in comparison to the SFA program without technology.

Multimedia (Mayer, 2001) is instructional content that combines text or narration with pictures or animation. Multimedia can model skills or content for students, giving them clear demonstrations of proficient performance. Multimedia that models for children also models for teachers, providing "just-in-time" professional development. The embedded multimedia application evaluated in two of the studies reported here use a

set of puppet skits, animations, and live-action skits called “Reading Reels” designed to build the phonics, fluency, comprehension, and vocabulary skills of at-risk first graders.

Computer-assisted tutoring is a strategy that involves providing teachers or paraprofessionals doing one-to-one tutoring with a powerful tool. The particular program evaluated in the studies reported here, called Alphie’s Alley, gives the tutor animated presentation materials, assessments, and incentives for children. It also provides tutors with just-in-time professional development, including video clips showing expert tutors modeling all of the SFA tutoring strategies.

The proposed symposium will present four papers on practical applications of technology infusion, including embedded multimedia and computer-assisted tutoring in beginning reading instruction. Three are randomized field experiments evaluating technology infusion strategies, and one is a companion study of time use and affective responses to the Alphie’s Alley computer-assisted tutoring model.

Achievement Effects of Embedded Multimedia in a Success for All Reading Program

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In 2001, researchers and developers at the nonprofit Success for All Foundation and Johns Hopkins University began a project to enhance the Success for All reading program with embedded multimedia. Success for All teaches beginning reading using a systematic phonics approach. Fifty experimental-control comparisons of one or more years' duration have found positive effects of Success for All on children's reading achievement (see Borman, Hewes, Overman, & Brown, 2003; Slavin & Madden, 2001; Herman, 1999).

The addition of embedded multimedia to Success for All's beginning reading program was intended to enhance the effectiveness of the program by giving children compelling, memorable demonstrations of letter sounds, sound blending strategies, vocabulary, and comprehension strategies.

Design. This study employed a cluster randomized trial (CRT) design, with random assignment of schools to treatments. Ten elementary schools in inner-city Hartford, CT were identified and randomly assigned to standard Success for All (control) or Success for All with embedded multimedia.

Participants. Subjects were 450 first graders, of whom 395 completed pre- and posttests. Almost all students qualified for free- or reduced-price lunches, and 62% of students were Hispanic and 35% African-American. The two groups were well matched on the percentage of students eligible for free or reduced lunch, ethnicity, and the percentage of limited English proficient students in the school. In addition, pretests were used to ensure the comparability of the experimental and control schools.

Treatments

- A. Success for All (control). Students in the control group experienced the Success for All reading program without video content (Slavin & Madden, 2001).
- B. Success for All with Embedded Multimedia. The experimental group used multimedia content, called *Reading Reels*, embedded in teachers' daily 90-minute Success for All reading lessons. *Reading Reels* includes animations designed to teach letter sounds, puppet skits to teach sound blending, and live action skits to teach vocabulary.

Results. Analyses using Hierarchical Linear Modeling found significant positive effects of the embedded multimedia treatment on the individually-administered Woodcock Word Attack scale ($p < .05$, $ES = +0.32$), controlling for Peabody Picture Vocabulary and Woodcock Word Identification pretests. Individual-level analyses of covariance found significant effects on both Word Attack and Word Identification, as well as directionally positive nonsignificant effects on Passage Comprehension and DIBELS.

Discussion. The findings provide support for the use of embedded multimedia in beginning reading instruction. Even though both experimental and control children

received phonics-based instruction, inclusion of multimedia content focused on letter sounds and sound blending significantly improved performance on a phonics measure, Word Attack.

Computer-Assisted Tutoring in Success for All: Reading Outcomes

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Computers have been used in beginning reading instruction for many years. Typically, computer programs for beginning reading provide children with activities they can do independently of the teacher, or with minimal teacher guidance. Research on computer applications in early reading have found few positive effects (see Kulik, 2003, for a review).

Beginning in 2001, researchers and developers at Concordia University in Montreal and the Success for All Foundation in Baltimore designed computer-assisted tutoring software for tutoring in beginning reading called “Alphie’s Alley,” conceived as a support tool for the highly successful beginning reading program used in Success for All (Slavin & Madden, 2001). Approximately one-third of the first-grade cohort is identified for daily, 20-minute, one-on-one tutoring sessions, including assessment, intervention planning, and tutoring, with an eye to helping all tutors achieve excellent reading outcomes with their students.

In Alphie's Alley, tutors use the computers to accomplish three main objectives. First, based on detailed assessments, tutors select animated content that helps children with specific areas in which they need assistance: letter sounds, phonics, sound blending, comprehension, vocabulary, fluency, and so on. The tutor listens to the child to determine correct and incorrect responses and works with the child on difficult material. Second, the computer provides extensive assessments designed to identify areas of strength and weakness and to monitor progress toward goals. The assessment information is shared with the child's reading and homeroom teachers. Third, the computer provides tutors with "just-in-time" professional development, video clips that show expert tutors modeling all aspects of the SFA tutoring process with children who have a given set of characteristics or deficits.

Design and Treatments

The study of Alphie's Alley employed a random assignment design. A total of 25 high-poverty Success for All schools located throughout the U.S. participated. In each, first graders identified for tutoring services were randomly assigned to be tutored either with or without the Alphie's Alley computer-assisted tutoring materials. Tutors within each school were also randomly assigned to treatments.

Participants

A total of 412 first graders who received tutoring were identified for the study. Woodcock Letter-Word Identification pretests were nearly identical for the two groups.

Results

Analyses of covariance with pretest Letter-Word Identification scores as covariates found no significant differences between experimental and control students,

although scores directionally favored the experimental group on four of the five measures.

Results were very different, however, depending on ratings of the quality of implementation of the tutoring model. All tutors were rated on a 3-point scale from “fully implemented” to “poorly implemented.” Among the 203 children in high-implementing schools, effects strongly favored the children who received the computer-assisted tutoring. Significant positive effects were found on Woodcock Letter-Word Identification ($ES=+0.45$, $p<.01$) and Word Attack ($ES=+0.31$, $p<.05$), and on Gray Oral Reading Tests (GORT) Fluency ($ES=+0.23$, $p<.05$). Directionally positive but nonsignificant differences were found on the GORT Passage Comprehension ($ES=+0.05$). Among medium and low implementers, however, no significant differences were found.

Discussion

The results of this study supported the effectiveness of the Alphie’s Alley computer-assisted tutoring model only if it was well implemented. Observations of the computer-assisted tutoring session and conversations with tutors showed very positive attitudes toward Alphie’s Alley, but it took many of the schools several months to fully implement the program with fidelity. With tutors experienced with the software the percentage of tutors doing high-quality implementations would surely rise, and the positive outcomes seen in this study for high implementers could come to characterize outcome for the whole school. Further research is needed to test this possibility.

Technology Infusion in Success for All:
Reading Outcomes for Tutored and Non-Tutored First Graders

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The development, piloting, and successful evaluations of the Reading Reels embedded multimedia program and the Alphie's Alley computer-assisted tutoring program created the possibility to test the effects of a combined intervention incorporating both components. The purpose of the study was to determine whether schools could effectively integrate embedded multimedia and computer-assisted tutoring to meet the needs of struggling students, those who receive tutoring in Success for All.

While the main purpose of this study was to determine the combined impact of Reading Reels and Alphie's Alley, the non-tutored children, who experienced only Reading Reels, provided an opportunity to replicate the Chambers et al. (in press) study of the impact of Reading Reels.

Design and Treatments

The study employed a randomized design. Two multi-track year-round schools in California and Nevada that had been using the Success for All program for several years agreed to assign first graders at random to different tracks. The tracks were then assigned at random to

implement all of the technology enhancements evaluated separately in previous studies. That is, in the experimental tracks all students experienced Reading Reels (embedded multimedia), and tutored students experienced Alphie's Alley (computer-assisted tutoring). All students were also given the Alphie's Alley videos to view at home. Control students used the Success for All reading program without technology.

Participants

A total of 159 first graders were randomly assigned to treatments and completed pre- and posttests. Almost all were Hispanic students in very high poverty schools. The two groups were nearly identical on the pretest, the Woodcock Letter-Word Identification scale.

Results

Analyses of covariance using fall Letter-Word scores as covariates found strong positive effects on three of four reading scales: Woodcock Letter-Word Identification ($ES=+0.33$, $p<.01$), Woodcock Word Attack ($ES=+0.28$, $p<.03$), and GORT Fluency ($ES=+0.28$, $p<.02$). Directionally positive but nonsignificant differences were found on Woodcock Passage Comprehension ($ES=+0.17$, n.s.).

Different treatments were received by children who did or did not receive tutoring, so analyses were broken down on this factor. Tutored experimental students experienced the Alphie's Alley computer-assisted tutoring program as well as Reading Reels embedded multimedia at school and at home, while non-tutored experimental students experienced only Reading Reels.

Among 60 tutored students ($E=32$, $C=28$), there were again no pretest differences. Posttest differences were statistically significant ($p<.05$ or better) and quite large in effect

sizes on all measures, ranging from $ES=+0.39$ on Word Attack to $+1.02$ on GORT Passage Comprehension.

Among 99 non-tutored children ($E=43$, $C=56$), effects were all directionally positive but not all statistically significant. Significant positive effects were found on the Woodcock Letter-Word scale ($ES=+0.35$, $p<.03$) and, marginally significant effects were found on GORT Fluency ($ES=+0.27$, $p<.07$). Directionally positive but nonsignificant differences were found on Woodcock Word Attack ($ES=+0.27$) and GORT Passage Comprehension ($ES=+0.04$).

Discussion

The findings of this randomized experiment strongly support the effectiveness of technology infusion in enhancing the reading outcomes of Success for All. Tutored students, who experienced all technology components, performed substantially better than tutored students who experienced all SFA program components except the technology. The median effect size was $+0.58$. Non-tutored students, who experienced only the Reading Reels embedded multimedia components at school and home, showed less consistent but still quite positive effects, with a median effect size of $+0.27$. This latter finding is consistent with a previous experimental study of Reading Reels (Chambers et al., in press).

Implementation Fidelity of Computer-Assisted Tutoring
in Success for All

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Tutoring has always been a central part of Success for all (SFA), as it is the most important mechanism for early, intensive intervention to identify and solve children's reading deficits before they become serious or ingrained. However, the amount and quality of tutoring provided in SFA schools is often insufficient. Certified teacher tutors, who have been found to be most effective, are both expensive and, with the current teacher shortage, are in short supply, especially in high-poverty districts. In addition, even the best tutors can have difficulty with the time demands and adaptation required to adjust to the needs of individual learners. This project developed a complete, technology-based performance support system, called Alphonse's Alley (AA), to address the above noted problems, with the goal of increasing program implementation fidelity.

To examine implementation fidelity, pre- and post-implementation surveys were developed. SFA student assessments, tutor and facilitator reports, and in the case of AA, trace data triangulated the tutor surveys. This study focuses on the results of tutor self-report performance and affective reactions from both the control and experimental groups. Overall program implementation fidelity was examined descriptively.

Methods

A survey was administered to all tutors, AA and control, regarding perceptions of the tutoring experience and methods. Tutors rated elements of the model in terms of ease of use, helpfulness in student learning, and likelihood of being implemented. These data were gathered in late September, at the beginning of program implementation, and in mid-May, 2005.

Results

A total of 79 tutors returned both pre- and post-data. The present analysis focuses on these respondents only.

Overall program effectiveness. Responses to program support for tutoring needs and student learning were very positive, with means of 1.97 and 1.83, respectively (1 being “extremely well”). There were no differences between treatments, or across tutor experience levels.

Treatment effects. Difference did emerge, however, across both treatments and user experience when specific features were examined. An abbreviated sampling is offered here; full results will be presented at the symposium.

Treatment vs. control. Over time, AA tutors reported planning to become easier (from $M= 2.86$ to 2.11 ; control tutors reported increasing difficulty (2.49 to 2.75), $p < .004$). A similar effect emerged for “useful sessions”, $p < .03$. These results were more pronounced for novice tutors. AA tutors found assessments increasingly helpful, control tutors less helpful ($p < .06$). An interesting three-way interaction occurred in relation to teacher-tutor communication in terms of helpfulness. AA tutors, particularly the novices, reported significant improvement; control tutors found it less helpful. Questions directly addressing frequency of occurrence showed moderate

use of goal setting, marginal improvement in planning ($M=3.4$ to 3.8 , $p < .058$), and generally good levels of effective sessions, assessment, and communication.

The evaluation of activity usefulness was overwhelming positive, with a range of means from 1.35 to 1.97, 1 being “very useful”. Student motivation was reported to increase over the year by 45 tutors, 23 said it stayed the same, and 5 that it dropped.

AA users reported almost constant use of the tool; 30 between 91% and 100% of the time, 6 between 76% and 90%, and only 3 under 75%. The tool’s Suggested Plan (an individualized plan automatically created based on periodic learner assessment data) was always used by 79%, frequently by 14%, and sometimes by the rest. The professional development component of AA was used “daily” by over 50%, and “a few times” by 31%.

Discussion

Overall results were highly positive across treatments and experience levels vis-à-vis program effectiveness, tool usefulness, and student motivation. The program’s features and activities were deemed very effective, regardless of the user experience or treatment. Novice tutors were able to implement the program with high fidelity, a core objective of the design. AA tutors consistently reported the positive effects of the performance support in a number of key areas.