JRTE, *41*(1), 63–84

A Human-Computer Partnership: The Tutor/Child/Computer Triangle Promoting the Acquisition of Early Literacy Skills

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Abstract

This study involved the analysis of the complex interactions that take place between tutors and preschool children using a computer during early literacy tutoring sessions. Eight five-year-old pre- and early-readers attending a childcare centre participated in daily 20-minute tutoring sessions for two weeks. The literacy software (a beta version) was especially designed to guide tutors while working one-on-one with elementary school students falling into the lower 30% of reading achievement (i.e., at-risk). Parent surveys, videotaped tutor/child sessions, independent observer data, and tutor reports yielded rich descriptions of the tutor/child/computer process. Rigorous grounded theory analyses generated three comprehensive themes: rapport, motivation, and scaffolding. The first focused on interpersonal issues, the latter two on teaching/learning. Implications for practice are discussed. (Keywords: early literacy, computer support, tutoring, observational research.)

Helping develop core reading skills at an early age is arguably the single most important role schools play in the educational process. Unfortunately, a significant subset of children fail to acquire grade level reading proficiency such that by grade three, their ability to effectively address the full range of academic tasks is compromised at best, and permanently impaired at worst (Vellutino & Scanlon, 2001). Early detection and intervention have been identified as the key elements in addressing this problem (Adams, 1990). This research was undertaken to examine how computers might help tutors while they work one-on-one with these at-risk children.

Review of Literature

The Success For All (SFA®) Foundation, a not-for-profit organization associated with Johns Hopkins University, offers a comprehensive school-wide literacy program. The early literacy component, *Reading Roots*, is designed to detect and resolve reading problems as early as possible before they become serious, helping to ensure that children do not fall behind vis-à-vis grade-level reading achievement (Slavin, 2004). The program allows children at-risk of academic failure to achieve success in fundamental cognitive skills that form the foundation of later scholastic achievement (Borman et al., 2005; Slavin & Madden, 2001a).

A key component of the SFA program is one-on-one tutoring for students falling into the lower 30% of reading achievement. One-to-one tutoring is the most effective educational intervention known (Bloom, 1984; Wasik & Slavin, 1993). The essential role of the tutor has been empirically validated via Bloom's (1984) 2-Sigma rationale, suggesting that learning with a tutor yields a two standard deviation advantage over controls. Ideally, the tutor diagnoses student needs and tailors instruction to meet those needs. A recent study shows tutoring to be the most efficient scheme for accelerating reading development (Allington, 2005). Through tutoring, students who fall behind in their schoolwork are identified early and are provided with intensive one-on-one remediation to maximize their chances of future success (Allington, 2005).

Unfortunately, literacy programs have not yet achieved the goal of enabling virtually every child at risk to read. The amount and quality of tutoring provided in typical schools is often insufficient due to fundamental and systemic constraints (Slavin & Madden, 2001b). Certified teacher tutors who have been found to be most effective, are both expensive and in short supply, especially in high-poverty districts across the U.S. and Canada. In addition, even the best tutors can have difficulty with the time demands and adaptation required to adjust to the needs of individual learners. Reading programs also suffer from a lack of proper implementation due to resource constraints.

In response to this challenge, Reading Roots has recently introduced the option of incorporating computer-based support for tutoring, and multimedia supports in an existing paper- and pencil-based reading program (Schmid et al., 2006). Computer-based learning software has been shown to provide children with the opportunity to practice skills in a more interactive and engaging medium than paper-based alternatives (Roschelle, Pea, Hoadley, Gordin, & Means, 2000). Such environments are more stimulating and thus motivating for young children to learn (Hitchcock & Noonan, 2000). Although much research has shown that technology advances children's literacy learning, it is essential that the tutor be included to facilitate early learning and successful reading and writing readiness (Hitchcock & Noonan, 2000; Schmid et al., 2006). Thus, literacy programs can combine the essentials of one-on-one tutoring with the innovation and stimulating aspects of technology.

Using Technology for Learning

Today's schools are moving away from traditional, didactic classroom applications and toward the use of sophisticated, computer-based approaches that utilize the Internet and educational software to support learning (Hitchcock & Noonan, 2000; Judge, 2005; Roschelle et al., 2000). Specifically, computer technology is believed to have the potential to make significant improvements in children's cognitive abilities, namely, critical thinking, analysis, and scientific inquiry by matching technology applications to children's own learning styles (Judge, 2005; Roschelle et al., 2000). Used effectively, computers have unique capabilities to allow learners to interact with content, to provide instantaneous and flexible assessment, to adapt to individual student needs, and to facilitate record keeping (Bereiter & Scardamalia, 2003; Scardamalia & Bereiter, 1994). The key to success, however, is that pedagogy must dictate the use of technology, not the other way around (Mayer, 2006).

Notwithstanding the promise of technology in supporting education, research studies have shown mixed results (Kulik, 2003). Nevertheless, the findings of several meta-analyses of traditional, tutorial-based computer-assisted instruction applications support the notion that the average outperformance varied between 25% and 41% of a standard deviation when technology was used (Bangert-Drowns, Kulik, & Kulik, 1985; Burns & Bozeman, 1981; Kulik, Kulik & Bangert-Drowns, 1990). A meta-analysis by Kulik (1994) showed that based on student achievement tests, positive effects are found on student learning; these effects are largely a result of using computer tutoring applications in classrooms ranging from kindergarten through to high school. However, alternative computer applications such as simulations and enrichment applications showed only minimal influences on children's abilities (Kulik, 1994). Positive effects seem to be dependent upon the context and content of the instructional setting (Lui & Rutledge, 1997; Lui, 1998; Wenglinsky, 1998).

Tutor Mediation in Computer Use

Only in recent years have we seen empirical studies examining computer use in very early childhood (Chen & Chang, 2006; Clements & Sarama, 2003). Most research studies have centered around the effects of computer applications applied to children in middle and high school, and their gains in science and mathematics (Roschelle et al., 2000); this despite the promising evidence to show gains in children's early social (Clements, 1999), cognitive (Clements & Nastasi, 1993; Li & Atkins, 2004), and language development (Clements, Nastasi, & Swaminathan, 1993). Research that does involve young children using computers for educational purposes usually advocates active participation of trained tutors in combination with well-designed computer-assisted activities, helping increase young children's cognitive abilities (Carlson & White, 1998; Chang & Osguthorpe, 1990; Judge, 2005). Since literacy acquisition is based on multiple factors (e.g., cognitive, emotional, social, instructional), there is a need for innovative technological assistance in reading instruction and for software integration designed explicitly for young children (Bredekamp, 1992: Erdner, Guy, & Bush, 1998; Leslie & Allen, 1999; Silvern, Williamson, & Countermine, 1988). Such computer-assisted programs have been effective in early educational programs and offer enticing features for young children, such as visually attractive interfaces and immediate feedback (Blok, Oostdam, Otter, & Overmaat, 2002; Regtvoort & Van Der Leij, 2007).

While older children can benefit from stand-alone computer applications, it is clear that young children need human support to acquire complex skills (Ellis & Blashki, 2004; Hitchcock & Noonan, 2000). Tzuriel and Shamir (2002) found that a computer-assisted condition that included a mediator (e.g., tutor) helped enhance young children's thinking processes significantly more than a condition where children interacted with only the computer or the tutor. They concluded that even though a computer-assisted condition helped encourage children's problem-solving skills, the role of the human mediator was of crucial importance (Tzuriel & Shamir, 2002). Klein, Nir-Gal, and Darom (2000) observed that "integrating adult mediation in preschool computer learning environments facilitates informed use of computer technologies and has positive effects on children's performance" (p. 591). Similarly, Hutinger and Johanson (2000) concluded that young children typically have difficulty engaging in the most appropriate and valuable technology experience independently. A previous and recent work by Yelland and Masters (2007) invoked the concept of scaffolding in such circumstances, suggesting that we must rethink how computer usage contributes positively to the support of student learning. They insist that the scaffolding process must be provided by an "off-computer component," even when children are working together in matched pairs. Scaffolding must also be responsive to the spontaneous actions of children commonly observed in social-cognitive strategy use.

Purpose of Study

To facilitate a better understanding of how computers can support tutoring, the present study focused on the dynamic process enabled by our software. The software was designed to make tutoring more efficient and effective by creating a triad that involves three important elements: the child, the tutor, and the computer. This software served as an electronic performance support system (EPSS) for tutors working with at-risk early readers (Gery, 2002; Schmid et al., 2006). The objective was to observe how the software would influence the tutoring process. Because some tutors may have had little or no previous experience with computers, much less EPSSs, we anticipated the problems tutors might face vis-à-vis both the Reading Roots curriculum and the user-interface issues associated with the tool. This study represented an empirical validation of our design process, and a systematic, in-depth analysis of the dynamics associated with the instructional triad consisting of the tutor, child, and computer.

METHOD

Design, Participants, and Research Context

As noted above, the guiding research question, informing both the data collection strategy and subsequent analyses, was: What are the key behaviors exemplified by the tutors and students that represent constructive (and inhibiting) instructional/motivational factors in interaction with the computer? We employed an evaluation research approach to the design and analyses (Gall, Borg, & Gall, 1996). Our interest was in a flexible, evolving, and emergent process, not outcomes, and data collection was undertaken largely using intensive observation, as described below. Subsequent analyses were then undertaken via the grounded theory techniques recommended by Strauss and Corbin (1998).

Consent forms were distributed to two childcare classrooms at a local English childcare centre that the researchers had access to because it operated in conjunction with the teacher training program of a large Anglophone university in Montréal, Québec. Only classrooms with 4 to 5 year-old children were approached because this age group most closely resembled that of the children using the software. The participants included eight preschool children (four boys and four girls), whose parents volunteered to participate. The average age of the participants was five years and four months. Fourteen parents originally agreed to be part of the project; however, a condition of inclusion was that the child would be attending the Centre daily for the full two weeks. A number of parents consistently bring their children only three or four days a week, and/or were not going to be attending one of the weeks at all. Only eight met the criteria of potential, full attendance.

Measures and Materials

Three measures were used in this study: (a) a background questionnaire completed by the parents, created by the researchers, that provided demographic information such as age, gender, language spoken in the home as well as background information on children's involvement with basic reading (e.g., word- and sentence-level) and computer use (e.g., frequency at home, types of software used); (b) observational field notes that consisted of both observer-based recordings and completed videotapes of each tutoring session; and, (c) observational anecdotal records of the tutoring sessions completed by tutors. An observer protocol was developed by the researchers, based on the implementation strategies recommended by SFA Reading Roots tutoring.

The software was designed to support daily, 20-minute tutoring sessions. It allowed for flexible use, recognizing that students develop reading skills at different rates and in different ways (Slavin & Madden, 2001a). The software supported children's development of alphabetic learning, phonetic awareness, fluency, comprehension and writing, tutor assessment and planning, tutor professional development, and communication between the teacher and the tutor. Tutoring included interactive and educational tutorial activities to support word-level decoding such as letter sounding, word-level blending, spelling, auditory blending, and auditory segmenting. Based on children's developmental levels, the first two objectives of Phonemic Awareness, Letter Sounds and Sound Blending, were deemed appropriate for this group. The following is an example of how the computer-based activities were designed.

To teach the participants how to sound out words, the activity covered auditory skills associated with speech, *not* with print: the child (a) recognizes words that rhyme; (b) recognizes words that begin with the same sound; (c) hears and says initial sounds in spoken words; (d) blends sounds presented orally together to say a word ("Say-It-Fast"); and (e) breaks down a word presented orally and says each sound separately ("Break-It-Down"). Higher-level activities utilized constructivist design principles (Rodrigues, 2000) to encourage creativity and decision-making. A key feature of the software is its automatic scaffolding, such that if a child encounters difficulty (determined by tutor inputs of correct or incorrect responses), the program defers to a simplified level of the process, followed by corrective feedback (Vygotsky, 1978; 1986). Tutors can also intervene at any point to amplify the computer scaffold, or replace it. More information about the software is available at: http://doe.concordia.ca/cslp/ICT-IERI.php

Procedure

Prior to the study, all institutional (university and childcare centre) ethical requirements for data collection were applied. Four students who were enrolled in a preservice teacher training program volunteered to participate as the tutors in this study; two graduate psychology students volunteered to be the observers. The tutor's task was to determine, using assessment and observation, a child's needs and to plan tutoring sessions accordingly (Slavin & Madden, 2001a). Ultimately, their role was to provide instruction, support, and guidance to the children while they engaged in various computer tasks. Prior to the intervention, tutors and observers were trained to become conversant with the software during two full-day sessions. These sessions were conducted by specially trained SFA facilitators. The facilitators used direct and multimedia instruction to teach the program. They allowed both tutors and observers ample time to engage with, and practice using the program, as recommended by Kay (2006).

SFA has a well-developed training program. The tutors attended this training with the SFA-approved facilitator. This training, plus the software, constituted essentially all of the pedagogical support. The conduct of the sessions was left to the tutor, operating on the principle that the training and performance support features of the software would suffice, especially since this is what was being observed to determine if the support was enough. On a few occasions, tutors asked for advice. However, questions were usually technical in nature (sound/video issues). There were only two, minor pedagogical questions posed by the tutors, and in a few instances, comments/suggestions were made to tutors as a result of the daily researcher/observer debriefing.

Tutors were provided with laptops and a paper-based manual covering all the steps involved in the tutoring process. They also practiced using the software program independently for an additional recommended five hours at home (which they subsequently reported as being the most valuable "training"). The researchers provided observational record sheets to the observers and tutors to annotate any questions or concerns that arose during sessions. In addition, observers were trained to follow specific observational methods such as watching for key tutor-child interactions, describing strategies that tutors used during sessions, and reporting children's behaviors. To address any problems once data collection had begun, the researchers met for a debriefing session with the observers only. Here the researchers and observers reviewed each tutoring session and recorded daily, post-session events. Before the study began, parents completed the short background questionnaire.

Testing period. Data collection for this study occurred over a two-week period from Monday to Friday (i.e., 10 days) between 8 a.m. and 10 a.m. Sessions were conducted in two familiar rooms located in the children's natural environment, their childcare centre. A centre staff member was assigned by the researchers to oversee data collection to ensure the well-being of the children. Children participated in one 20-minute tutoring session per day for a total of 10 sessions with the same tutor. The first tutoring session involved the software-driven assessment of the child's skill level. This automated assessment both captured performance data, and with these results, provided a planning template for subsequent sessions. The following nine tutoring sessions consisted of interactive and educational computer activities individualized to fit the developmental level of knowledge of the child.

In each session, the tutor reviewed the activities from the preceding day and introduced the current day's activities. Children engaged in the activities for approximately 20 minutes and tutors concluded the sessions with fun computer rewards embedded in the software program. At the end of each session, the children also chose a reward (e.g., pencils, stickers, and trinkets) for their participation. The last day of testing (day 10) consisted of a final assessment of the children's progress, which was computed by the software. After each session was completed, the observers recorded anecdotal recordings and remained on-site for the daily post-session review.

Data Analysis and Results

Results obtained from the parent questionnaires revealed that all of the children were read to at least several times a week, all but one child could recognize "many" letters of the alphabet, and a few could read whole, though simple, sentences. All of the children had access to a computer at home, though only three were described as using it other than infrequently. Their primary exposure to the alphabet was via television, e.g., Sesame Street.

Data were analyzed using grounded theory techniques recommended by Strauss and Corbin (1998). The raw data consisted of more than 1,600 minutes of video of the tutor/child/computer interaction, the observer and tutor field notes, and information from the background questionnaires that parents completed. These data offered both multiple perspectives and opportunity for data triangulation (Creswell, 2002) that helped in understanding the phenomenon of the tutor/child/computer relationship.

In the first stage of data analysis, two of the researchers independently watched samples of the video footage. While our design was intentionally open, providing opportunity for the natural emergence of codes and themes, three general aspects guided our analyses. First, the videos provided complete sound records, allowing for analysis of the verbal data that related to task-specific, general learning strategy, and interpersonal/motivational exchanges. Videos also allowed for consideration of content displayed on the computer. Second, the independent observer focused on the instructional interplay. Tutor behavior was assessed independent of the technology, such that issues of scaffolding, motivational support, and attention to software's directives were implemented, and how well. Third, the tutor and researcher field notes enabled us to juxtapose reflections and reactions with both ongoing refinement of the interventions, as well as with interpretation of the data. Tutor explanations of why they used a given strategy were essential in understanding, for example, why extra motivational comments were employed in a given session (e.g., the child seemed tired that day).

As sessions one and ten were assessments, the researchers' time-sampled video sessions number 3, 5, and 8 as global representations of children's interactions with the tutor and computer. As such, because of the sheer volume of video data, the researchers analyzed approximately 40% of the videos, sampling from each the tutor/children dyads, with partial overlap across the researchers (15%). The field notes and observer notes were reviewed throughout the study, and subsequently to facilitate interpretation of the video data. Data credibility was ensured via reflexivity (Creswell, 2002), whereby the observers and tutors were asked for critical self-reflection in their field notes, acknowledging any potential biases and predispositions. Based on all collected data, initial event categories of information about the tutor/child/computer interactions were formed. In this open coding stage, approximately 50 initial codes were generated and cross-checked by using multiple sources and procedures. The codes were corroborated via the establishment of agreement by the different observers and tutors (i.e., member checks), as well as by the third researcher. This process ensured that the research findings represented two levels of reliability verification and ensuring credibility (Creswell, 2002).

From open coding, we proceeded to axial coding techniques to map out recurrent themes and patterns, as well as extraordinary events (Creswell, 2002). During this process, the codes were reduced to 10 major codes by reducing redundancies and codes that did not fit well into a category. This phase required several rounds of analysis and verification by the three researchers, first individually, then collectively. Drawing upon a dense description of the research context, the 10 remaining codes were summarized within three central, emergent themes. The codes of acknowledging difficulties, adapting to needs, and praising/encouragement were categorized under the theme *rapport;* rewards, engagement in task, and children's enthusiasm were collectively categorized under *motivation;* cognitive support, tutor guidance, breaking down tasks, and instructional assistance were categorized under *instructional scaffolding.*

The following section provides a more detailed representation of the data that led to the emergence of the three central themes, or phenomena. As noted above, critical to the interpretative reliability of the themes was the use of triangulation across the three separate data sources of the same event; the videos, the observer field notes, and the tutor field notes. On-going confirmation and verification of these multiple data sources and investigators (i.e., the researchers) were central to the emergence of these themes.

Narrative of data. As summarized above, *rapport, motivation*, and *instructional scaffolding* emerged as the three comprehensive and expansive themes from this study. Within these central themes are additional sub-themes that provide an in-depth description of the human-computer partnership. Our interpretation of these themes or categories is that they constitute essential components of our participants' interaction within the context of early literacy development using a computer-based learning environment, including an EPSS. We have created short vignettes and supplied quotes that constitute the grounded data for the emergent themes in order to establish "interpretive validity."

Background questionnaire: Baseline data. Based on the parent questionnaire, all children had some exposure to reading, and some were able to recognize words and "sentences," especially from familiar children's books. All children had at least some previous experience with computers; all had experience playing with educational games on a home computer. As such, these children would possibly not fit the "at-risk" profile discussed above. On the other hand, they were 6 to 12 months (or more) younger than typical grade-one readers. Thus, their skill levels were comparable.

Emergent Theme # 1: Rapport

Perhaps the most salient outcome of the entire analysis was the central role that the tutor played in animating a session; in short, the tutor was always in "control." Even though the children found the activities engaging and effective, the tutors were constant guides in the process. The rapport between tutor and child was observed to be an essential element of the sessions that would set the stage for learning opportunities. The tutors and the children established this rapport through natural, "off-task" interactions (e.g., chatting about their day, or their favorite game) and various strategies adapted to the children's personality. For example, a shy child was not pushed to "chat," but directed to the various, enticing computer activities; a particularly gregarious child had to be asked, "This is great! Now let's see what we have in this lesson," to establish task-related focus.

Greeting and initiating. At the beginning of each session, the tutor would build rapport with the child by initiating and maintaining conversation about something of interest to them. For example:

Day 3: Introduction to Activities
Child S enters wearing a homemade hat from class; he greets Tutor N.
Tutor N: "What's that?" (tutor points to hat)
Child S: "That's a headlight"
Tutor N: "Oh sorry, it's a headlight. What do you DO with a headlight?"
Child S: "Looking when it's dark"
Tutor N: "Ahhhh, looking when it's dark, good idea!" (child smiles and laughs at tutor, looking at Tutor N to start the daily activity).

All tutors were observed acknowledging that some activities might be difficult for the children and would tell them *"Oh this one is tricky hey?!"* This seemed to increase children's motivation, keep them encouraged, and build a rapport between the tutor and the children. Tutors recognized the children's difficulty in comprehending the activity at hand and applied creative and innovative methods of giving clearer and more developmentally appropriate instructional strategies. One example used throughout the sessions and across all tutors was to repeat the sounding out of letters in a slow manner and to draw letters in creative ways to make them more visually appealing (e.g., the letter S resembled a picture of a snake).

Acknowledgement. Children looked toward tutors for acknowledgement of mastering activities, need for further clarification, and appraisal for correct answers. Children appeared to want to please the tutors, and were often observed looking up at them for affirmation and recognition that they in fact, mastered each letter after an activity.

Day 5: Word Blending Activity
Child S at two separate times is sitting at the table with the tutor to his right, looking at the computer and following the computers instructions on the word level blending activity.

Time 1
Child S: "Is it A? T-T-T?" (child looks up to tutor as he points to the A on the screen)
Child S: "A-A-A-A-G-G-G-G…I don't know that one" (child lifts his shoulders and continues to look at the tutor waiting for a response)

Time 2
Child S: "Where is P?" (child looks up at the tutor again for a sustained period of time)
Tutor A: "Try the top row" (tutor points to the top row of the alphabet on the screen; child clicks the mouse on the letter P; looks up to the tutor with open eyes and big grin on his face)
Child S: "Did I get it right?"

Adapting to individual needs. Tutors were generally observed as responsive to their children's needs and catered to the learning process by smiling, praising, nodding, making eye contact, and addressing them appropriately, taking into consideration their developmental level and personality. All children were observed to respond extremely well to the tutors. When children would ask to change activities, tutors would encourage completion of the task, knowing when to move on to other activities. When the child showed signs of boredom such as fidgeting or yawning, the tutors would make the session as child-friendly and child-centered as possible by providing children with mouse use, or ample time for animated task rewards *"Let's watch another movie cause you really like it!"*

Day 8: Segmenting Activity

Time 1
The tutor and the child are engaged in segmenting words. The child masters four tasks correctly in a row.
Child D: "Yaaaaaayyyyyyy" (child is yelling aloud, smiling, raising his arms high in the air)
Tutor G: "Wow! You're too good and too smart for this activity!" (tutor teases jokingly with a big smile)

Time 2
The tutor notices the child looking around, sighing, and becoming restless with the activity
Tutor G: "Let's finish up this last part, and then we can go to the Alphabet Theatre."

Praise and encouragement. The tutor was fundamental in providing ample stimulation and encouragement, often observed saying *"good job… very good… I think you're better at this than I am."* This was essential in setting up children to master word activities by responding to their individual needs. Tutors were observed to persist with an activity that children were clearly doing well and enjoying *"Wow, you are good at this, let's do another one."* The tutors were cognizant of just how salient their role was when the computer's instructions were too difficult for the children to comprehend *"Yah, that one is tricky…I will repeat it for you."*

Day 3: Phonological Awareness Activity via animated alphabet
The computer displays a picture of a cartoon chipmunk, which is used to emphasize the 'CH' sound; the two letters appear together as "CH".

Child S: "K" (child points to the two letters on the screen and tries to sound it out)
Tutor A: "Close" (an animated chipmunk appears on screen)
Tutor A: "What's that a picture of?" (tutor points to the chipmunk)
Child S: "That's a squirrel" (child points to the image)
Tutor A: "Good try…it looks like a squirrel but it's a chipmunk" (tutor turns to face the child as she says this in a soft comforting voice)
Child S: "CH-CH"
Tutor A: "The chipmunk chooses cheese!" (tutor repeats what the computer is saying)

Emergent Theme # 2: Motivation

Almost every child arrived each day excited to get started. The children were immediately attentive, with interest persisting throughout the session. Interest was noted by their body language such as sitting up and facing the computer, leaning in closer to the computer screen, and initiating the computer task "*I want to hold the mouse,"* and looking at the tutor during the instructions and focusing on their words.

Day 5: Word Blending Activity
The child has just finished a word level blending task. He looks at the tutors, takes the mouse, and begins to click on items on the screen.

Child J: "I want to show YOU something now" (looks at tutor with big smile and looks back at screen, begins to click at items)
Tutor G: "Sure! What do you want to show me?"
Child J: "A fun movie. Do you want to see it? I want to show you a fun one."
Tutor G: "You want to show me a fun one?"
Child J: "Yes, it's at the end…"

Evident in sessions was how the tutor and computer software worked in tandem to motivate and support children's learning. The tutors played a crucial role in motivating the children throughout the 10 sessions and keeping them motivated when they encountered difficulties. Even though the software includes an automatic reward system, all tutors were observed to use the "movies" regularly as rewards when they would see fit.

Day 8: Segmenting Activity
The child is engaged in a segmenting task at the computer and looks up at the tutor.
Child M: "Can we watch two movies?"
Tutor N: "Well, we will only watch one and maybe at the end you can watch two.
Before you click on the movie you'll have to tell me the name of the letter."
Child M: "F-F-F-F……Flower" (sound of letter and watches movie)
Tutor N: "You said the SOUND of the letter so what is the NAME of the letter"
Child M looks around the room
Tutor N: "Come on! You can do this!!"(tutor tries to refocus his attention)

Engagement. Children showed anticipation and curiosity toward the activities, verbally expressing their interest to the tutor *"What happens when we pass this and win?,"* and when they were positively supported by the tutor *"You get to choose a letter from the animated alphabet and watch it in the Theatre!"* One child did a wiggle dance in his seat each time he heard the sound that followed a correct response—this was coupled with a pat on the back and words of praise and encouragement by the tutor, which made the child incredibly content. Other children were clearly stimulated by the program's animation effects—the tutor would "treat" the children by showing them additional characters and animation effects, all the while helping them acquire important literacy skills through repetition and scaffolding.

Day 3: Letter Sounding
The computer instructs the child on what to do (stretching) for the letter sounding task.
Tutor N: "What's this sound here?"
Child R: Names the sound (computer dings wrong answer)
Tutor N: "You're so close!" (tutor points to the screen)
Child R: Names the sound (computer dings for correct answer)
Tutor N: "Wow great! Because you did so well on the first sound, we are going to go onto the second sound"
Child R: Names the sound (computer dings correct answer and alligator on the screen climbs up the ladder)
Child R: "Look…look! I made it, I made it go up!" (referring to the alligator)

Variability in motivational strategies. There was, however, considerable variability across tutors with regard to use of verbal praise and enthusiastic, task-specific support. Indeed, via the daily feedback review, several tutors were coached to increase their affective support. What became clear was the central importance of the rapport that developed between the tutor and child. On several occasions, a normally active child would arrive willing to participate but visibly tired and fidgety. Additional attention lapses would then emerge when the child became frustrated with repeated failure. It is in circumstances such as these that the role of the tutor in building rapport was critical—they were cognizant of when to increase their support in various ways such as verbal praise *"Great job…you know how to do this so well!,"* nonverbal praise (e.g., a high five or a pat on the back and a smile), and instructional support, (e.g., switching tasks or giving new directions in different ways).

No EPSS can detect and intervene when a child needs that additional, inventive form of help; clearly, this can only be provided by human interaction. In several instances, children would turn to the tutors to ask for clarification despite already hearing the program's instructions. Tutors judged what they needed to do in order for the child to understand instructions, such as repeat words slowly, change their tone of voice, and simplify language. Other times, children who were clearly not mastering the activities and merely guessing at answers were observed trying harder when the tutor provided additional words of encouragement. All these events increased in frequency and intensity over time. Interestingly, while each of the pairs of child/tutor developed a positive, warm, and constructive rapport, in a few cases where we had to substitute tutors, the children did not seem to mind. Though this occurred only twice, we observed that the child's attention moved more to the computer for a time, providing a sort of anchoring role.

Emergent Theme # 3: Instructional Scaffolding

Scaffolding is a core design principle in the software we used, whereby the child receives increasingly precise and basic support when s/he is having difficulty completing a task (Vygotksy, 1978, 1986). Tutors were observed to use scaffolding as an instructional technique during computer activities in order to promote children's learning while new concepts and skills were being introduced. For example, tutors guided children during difficult tasks to problem solve and obtain correct answers, directly taught concepts (e.g., differences between the sound of a letter and the name of a letter), provided them with additional examples and resources (e.g., used paper and pencil pictures), gave extensive prompting and cues (e.g., *"sounds like… "*), monitored their work throughout the process, and tailored their instructions to support children's individual needs (e.g., repeated words, played the computer instructions over again, showed them where the keys were on the keyboard).

We observed the program to effectively scaffold cognitive tasks, while the children expected and received significant interaction with the tutor for task orientation. This one-to-one dynamic interface was particularly apparent when tutors would *fail* to provide sufficient transitional instructions from one activity to the next. For example, children would continue to do the previous task (e.g., stretch words and repeat after the computer) when tutors forgot to give prior instruction of what they were supposed to do next (e.g., Say-it-Fast). In other words, transitions sometimes required tutor intervention.

Children and tutors also became quite inventive and spontaneous in their interactions, and within a few days, the children were even able to communicate what supports they needed to be able to work through their difficulty (self-regulation). For example, child to tutor: *"I need a picture,"* or tutor to child: *"Let's ask the computer what we should do."* Tutors often turned to prompts and cues when they noticed that children were not grasping, for example, letter recognition—*"What does the letter M look like when you hold it upside down?"* or *"Let's sound it out together to hear what it sounds like—GGG-OOO-AAA-TTT."*

Finally, the use of scaffolding interacted with entry skill levels, or the lack thereof. Interface design and tutor support were especially important when children experienced difficulties. Some of the most gratifying moments occurred when a child would make a breakthrough because of scaffolding *"Ahhh, the name is 'S' but its sound is SSSSSSS."* In other cases, when a child was stuck on the blending process, simply changing the word was enough to encourage them to re-focus.

It is important to remember that the software was designed to support both the child's acquisition of literacy skills, and guide the tutor's instructional strategies. In the latter respect, in all reviewed sessions, the tutors followed goals set for the session, and relied upon the software to present and engage the child throughout. The example noted above of turning to the computer to provide instructional scaffolding illustrates how sessions remained "on task." When necessary, however, the tutors felt free to improvise—they treated the EPSS as a companion, not a lock-step process. Following is an example.

Day 8: Letter Recognition

Tutor N point to letter N on the screen.

Tutor N: "This is the letter N, do you know another word that starts with N

Child points to the letter N on the screen as well

Tutor N: "That's the letter N, do you know MY name is *NOREEN. Does MY name start with the letter N?"

Child N nods in agreement

Tutor N: "What is your name?"

Child N: "Nick!"

Tutor N: "Does NICK start with the letter N?"

Child N nods in agreement

Tutor N: "Do you know any OTHER words that start with the letter N? How about NO, does NOOOO start with letter N?"

Child N nods in agreement

Tutor takes out a piece of paper and draws the letter 'N' in large print. She writes 'E' and 'T' to spell the word 'Net'

Tutor N: "What about the word NET?"

Child looks at the word and is silent

Tutor N sees that the child is not responding. She takes her hand and covers the E and the T to help the child concentrate on one letter at a time.

Tutor N: "This is the letter 'N'. It says NNNNNNN…. Say it with me"

Tutor moves her chair closer to the child. They make the 'N' sound together. Tutor does this for E and then T.

Tutor N: "Can you say this word?"

Child N: "N-E-T!"

Tutor N: "Very good!"

The tutors would also frequently refer back to previous activities to support both learning and motivation.

Day 8: Word Level Blending Activity
Tutor takes a minute to explain to the child various word level blending examples.
Child D: "That was a tricky one"
Tutor S: "It was tricky but you were doing it REALLY well, and you did it much better than I thought. What was the sound? Remember the Apple movie A for apple, A for apple. Yes that's another word you read!"
Child D: "Is that a P or T?"
Tutor S: "That's a P"
Tutor writes the letter P in the air
Child D: "P-P-P-I-I-T-T-T. P-I-T"
Tutor S: PIT…that's the pit sound. Good! And you said the sound really well. You remembered that one from yesterday.
Child Points to the rocket on the computer screen
Tutor S: "Oh! Maybe it will take off today?"
Child smiles at the tutor and nods his head
Tutor S: "That one was tricky; I thought you wouldn't know it this time!" (smiling)
Tutor S points to the letter 'G' on the computer screen
Tutor S: "This last sound is the beginning sound of…"
Child D eagerly responds: "GGG"

Finally, minor problems and suggestions for implementation and screen design were communicated to the design team (e.g., adding a "mute" button for auditory feedback when the tutor wished to provide the feedback him/herself). Sound level was also sometimes a problem; a problem that would be typical in a noisy classroom/resource room/computer lab.

Day 8: Word Level Sound
Tutor N: "The computer is going to show you some letters and its going to ask you to say its sound. Do you know that game? I know you know that game!"
Child H: "Yah…"
Computer sounds out a word but not clear enough for the child; tutor intervenes when she sees the child appears uncertain
Tutor N: "The word is Taaaaaannnnnn. TAN. T-A-N"
Tutor repeats the word, stretching it out and overemphasizing the pronunciation
Child H: "I don't know"
Tutor N: "You don't know? Do you want to hear the word again?"
Child H puts ear to computer
Tutor N: "I'll put the sound louder. Listen to the word again."

DISCUSSION

Comparative studies using our software with large samples have demonstrated its effectiveness in significantly improving achievement in basic skill acquisition (Chambers et al., in press). The present study adds depth to our understanding of program effectiveness by describing how such an EPSS can provide instructional and motivational support for the tutor and child, offering a non-threatening, attractive platform for engagement, even when learners were confronted with cognitively daunting tasks. As seen by the grounded theory approach utilized in this study, the data collection and analysis procedures were successful in generating and validating the emergent themes.

From a program design standpoint, a primary concern was the scaffolding and support feature, both at the session level (support for tutor behavior), and task level (breaking down the task for the learner). Seen as a "teaching team," the tutor/computer's joint role is to engage students' prior knowledge and interest by providing tasks that are manageable and motivating, resulting in the achievement of instructional goals. The tutor, guided by the computer-based tasks, must look for discrepancies between students' efforts and the solution, control for frustration and risk, and model the behavior (Hausfather, 1996).

Our data showed a pattern of almost instant "learner-centeredness"—children felt almost immediately comfortable with the triadic environment. They quickly became active participants rather than passive observers in the process. They displayed interest in, and achievement of the software-based literacy tasks. For example, when challenged with a problem that they could not solve, they would respond with comments, turning to the tutor and asking *"What do YOU think!?"* or they would invoke the motivational features of the software via the video theatre rewards before returning to the task at hand. In short, they had fun while learning.

Interestingly, we also observed that when a tutor was "uninspired" (e.g., personality, tired, new), the child tended to focus on the computer software and what it had to offer, such as interesting visuals of animated alphabets and lively characters. When the approach of the tutor was playful and affective, s/he became more so the center of attention. The needs of the child were thus met by a dynamic balance between tutor and computer, with the child as an active member of the process.

Tutor "effectiveness" is based on program implementation fidelity. This EPSS offered the tutors guidance in both assessment and activity use. The software was designed explicitly to provide tutoring support, but computer-based resources are often used as stand-alone frameworks, especially when they contain a wide variety of engaging activities that *appear* to address precise instructional objectives. The mixed results of technology use cited by Kulik and others are likely based at least in part on mis-matches between instructional objectives and adequate support for the learner (Kulik, 2003). For beginning readers, our study showed that even with a well-designed, computer-based tool, the tutor plays a pivotal role in guiding and motivating the child, especially when the learner encounters difficulties. Perhaps as students acquire the basic literacy skills, computer applications can be undertaken with increasing independence. However, corrective feedback continues to be indispensable, as monitored by the tutor.

In addition, one of the central themes that emerged was the tutor's consistent use of scaffolding strategies to help the child progress, or to sustain the child's interest and motivation. The use of the scaffolding strategies might be a direct result of the tutors' backgrounds-that is, all four tutors were student teachers in an elementary teacher training program that adheres to the use of a constructivist and child-centered approach to early childhood and elementary education.

Recommendation for Practice and Future Research

Based on the findings, we offer a set of prescriptions for creating an effective tutor/child/computer triad. The first relates to teacher/tutor professional development. The "teacher" must be familiar and comfortable with the tool prior to implementation (Kay, 2006). No matter how intuitive the software, it is essential that users understand how to navigate through the interface. Tutors reported that the most effective "training" was personal "play time" with the program for a duration of approximately five hours. As with children, there is no substitute for the hands-on experience. A test of a tool's user-friendliness might be made in part by the extent to which the person can largely teach him/herself.

The second prescription relates to the relative value of computer-based performance support, and how it can be exploited. In the case of this software, expertise in instructional strategies for the content was "secondary" to sensitivity to the dynamics of the adult-child interaction. None of our tutors were reading specialists, yet with the guidance of the EPSS, they effectively conducted sessions that followed the prescribed program and prompted appropriate child behavior. The results of this study verify that a well-designed performance support tool can offer effective, motivating learning opportunities for young learners, even from tutors/teachers with perhaps only moderate knowledge of the content or process.

While instructional effectiveness was not the primary focus of this study, achievement gains were made by all the children (observed in successive videos). The prescription that EPSSs can be used must, however, be qualified. As noted repeatedly, the relationship between the tutor and child must still be carefully managed to assess, set goals, and provide supportive guidance. At no time have we assumed that this EPPS could serve as a stand-alone instructional tool. It must also be noted that our tutors, while not reading experts, were clearly experts in the skills they were teaching the children. What the tool provided was the research-based instructional strategies matched to the needs of novices (e.g., one might not naturally invoke "segmenting" when teaching a child to read).

Finally, should concerns arise that computer-based tools might actually detract from psychosocial processes as recommended by Erikson (1968) and Vygotsky (1986), evidence from this study demonstrated that the influence of such a tool was not detrimental to the establishment and maintenance of positive, constructive teacher/student interaction. Indeed, further research is needed to examine whether such a learning environment might even enhance interaction, the reasoning being, that an EPPS ensures instructional fidelity so the teacher can focus more on students' individual needs.

The third prescription addresses motivation. We observed children highly motivated to engage in tasks often perceived as work (Schmid et al., 2006). The children appeared to truly enjoy the computer activities, and they were creative and adept at using them. This software was a reverse form of Greene and Lepper's (1974) turning "play into work." Our participants were preschoolers. Any instructional intervention that makes learning letter-identification fun, that promotes smiles, and success when blending or segmenting letters into words, for example, is a positive step in pursuit of creating a literate, motivated future generation. The prescription here is to ensure that both software and the teacher work as a team to invite active participation and fun into the otherwise very serious work of mastering cognitive skills. The key to success is ensuring that software design stays true to evidence-based instructional strategies, and that "play" supports, rather than detracts from learning. While the development costs of such tools is high, once produced, widespread scaling of implementation can distribute the front-end investment, and help prevent the very sort of mis- (or non-) use of technology bemoaned by researchers as Larry Cuban (2001).

Limitations of Current Study

The primary "limitation" to this study was that we did not assess achievement. Making observations and recommendations about effective instructional interaction must ultimately be tested against demonstrable learning gains. The study by Chambers et al. (in press) constitutes a large scale randomized control trial that has independently established the effectiveness of the software relative to controls. Our observations, on the other hand, were based on a small sample size with a group of learners that may not match typical implementation conditions. Additional research in varied contexts with different subject matter is needed to examine the relative strengths and weaknesses of computer-based learning environments.

CONCLUSION

A more systemic, theoretical synopsis of our implications is that constructivist approaches (Brown, Cocking, & Bransford, 2000) to learning and instruction can effectively manifest themselves in the types of applications described in this study. Technology can play an important, supporting role, but it cannot take the lead (Nir-Gal & Klein, 2004). For non-reading children or those with reading challenges, one may assume that the computer can play a support role, but not more. Our conclusion is that by introducing the human element with a well-designed tool, the instructional scaffolding necessary to bridge the knowledge and skill gap can indeed be created.

Contributors

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References

Adams, M. J. (1990). *Beginning to read: Thinking and learning about print.* Cambridge, MA: The MIT Press.

Allington, R. L. (2005). How much evidence is enough evidence? *Journal of Reading Recovery, 4*(2), 8–11.

Bangert-Drowns, R. L., Kulik, J. A., & Kulik, C. C. (1985). Effectiveness of computer-based education in secondary schools. *Journal of Computer-Based Instruction, 12*(3), 59–68.

Bereiter, C., & Scardamalia, M. (2003). Learning to work creatively with knowledge. In E. De Corte, L. Verschaffel, N. Entwistle, & J. van Merriënboer (Eds.), *Powerful learning environments. Unravelling basic components and dimensions of powerful learning environments* (pp. 55–68). EARLI Advances in Learning and Instruction Series. Oxford, UK: Elsevier Science.

Blok, H., Oostdam, R., Otter, M. E., & Overmaat, M. (2002). Computer-assisted instruction in support of beginning reading instruction: A review. *Review of Educational Research, 72*(1), 101–130.

Bloom, B. S. (1984). The 2 Sigma problem: The search for methods of group instruction as effective as one-on-one tutoring. *Educational Researcher, 13*(6), 4–16.

Borman, G. D., Slavin, R. E., Cheung, A., Chamberlain, A. M., Madden, N. A., & Chambers, B. (2005). Success for all: First-year results from the national randomized field trial. *Educational Evaluation and Policy Analysis, 27*(1), 1–22.

Bredekamp, S. (1992). What is "developmentally appropriate" and why is it important? *Journal of Physical Education, Recreation & Dance, 63*(6), 31–32.

Brown, A. L., Cocking, R. R., & Bransford, J. D. (2000). *How people learn: Brain, mind, experience, and school.* Washington, DC: National Academies Press.

Burns, P. K., & Bozeman, W. C. (1981). Computer-assisted instruction and mathematics achievement: Is there a relationship? *Educational Technology, 21*, 32–39.

Carlson, S. L., & White, S. H. (1998). The effectiveness of a computer program in helping kindergarten students learn the concepts of left and right. *Journal of Computing in Childhood Education, 9*(2), 133–147.

Chambers, B., Slavin, R. E., Madden, N. A., Abrami, P. C., Tucker, B. J., Cheung, A., & Gifford, R. (in press). Technology infusion in Success For All: Reading outcomes for first-graders. *Elementary School Journal.*

Chang, L. L., & Osguthorpe, R. T. (1990). The effects of computerized picture-word processing on kindergartners' language development. *Journal of Research in Childhood Education, 5*(1), 73–83.
Chen, J., & Chang, C. (2006). Using computers in early childhood classrooms: Teachers' attitudes, skills and practices. *Journal of Early Childhood Research, 4*(2), 169–188.
Clements, D. H. (1999). Young children and technology. *Dialogue on early childhood science, mathematics, and technology education*. Washington, DC: American Association for the Advancement of Science, Project 2061. Retrieved November 20, 2000, from http://www.project2061.org/newsinfo/earlychild/experience/clements.htm
Clements, D. H., & Nastasi, B. K. (1993). Electronic media and early childhood education. In B. Spodek (Ed.), *Handbook of research on the education of young children* (pp. 251–275). New York: Macmillan.
Clements, D. H., Nastasi, B. K., & Swaminathan, S. (1993). Young children and computers: Crossroads and directions from research. *Young Children, 48*(2), 56–64.
Clements, D. H., & Sarama, J. (2003). Young children and technology: What does the research say? *Young Children, 58*(6), 34–40.
Creswell, J. W. (2002). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research.* Upper Saddle River, NJ: Merrill Prentice Hall.
Cuban, L. (2001). *Oversold and underused: Computers in the classroom.* Cambridge, Mass: Harvard University Press.
Ellis, K., & Blashki, K. (2004). Toddler techies: A study of young children's interaction with computers. *Information Technology in Childhood Education Annual, 20*(1), 77–96.
Erdner, R. A., Guy, R. F., & Bush, A. (1998). The impact of a year of computer assisted instruction on the development of first grade learning skills. *Journal of Educational Computing Research, 18*(4), 369–386.
Erikson, E. H. (1968). *Identity, youth, and crisis*. New York: Norton.
Gall, M. D., Borg, W. R., & Gall, J. P. (1996). *Educational research: An introduction.* (6th ed.) White Plains, NY: Longman.
Gery, G. (2002). Achieving performance and learning through performance centered systems. *Advances in Developing Human Resources, 4*(4), 464–478.
Greene, D., & Lepper, M. R. (1974). Intrinsic motivation: How to turn play into work. *Psychology Today, 8,* 49–54.
Hausfather, S. J. (Summer, 1996). Vygotsky and schooling: Creating a social context for learning. *Action in Teacher Education, 18*, 1–10.
Hitchcock, C. H., & Noonan, M. J. (2000). Computer-assisted instruction of early academic skills. *Topics in Early Childhood Special Education, 20*(3), 145–158.
Hutinger, P., & Johanson, J. (2000). Implementing and maintaining and effective early childhood comprehensive technology system. *Topics in Early Childhood Special Education, 20*(3), 159–173.

Judge, S. (2005). The impact of computer technology on academic achievement of young African American children. *Journal of Research in Childhood Education, 20*(2), 91–101.
Kay, R. H. (2006). Evaluating strategies used to incorporate technology into preservice education: A review of the literature. *Journal of Research on Technology in Education, 38*(4), 383–408.
Klein, P., Nir-Gal, O., & Darom, E. (2000). The use of computers in kindergarten with or without adult mediation: Effects on children's cognitive performance and behavior. *Computers in Human Behavior, 16*(6), 591–608.
Kulik, J. A. (1994). Meta-analytic studies of findings on computer-based instruction. In E. L. Baker & H. F. O'Neil, Jr. (Eds.), *Technology assessment in education and training* (pp. 9–33). Hillsdale, NJ: Lawrence Erlbaum.
Kulik, J. A. (2003). *Effects of using instructional technology in elementary and secondary schools: What controlled evaluation studies say.* SRI Project Number P10446.001. Arlington, VA: SRI International.
Kulik, C. C., Kulik, J. A., & Bangert-Drowns, R. L. (1990). Effectiveness of mastery learning programs: A meta-analysis. *Review of Educational Research, 60*(2), 265–299.
Leslie, L., & Allen, L. (1999). Factors that predict success in an early literacy intervention project. *Reading Research Quarterly, 34*(4), 404–424.
Li, X., & Atkins, M. S. (2004). Early childhood computer experience and cognitive and motor development. *Pediatrics, 113*(6), 1715–1722.
Lui, M. (1998). A study of engaging high-school students as multimedia designers in a cognitive apprenticeship-style learning environment. *Computers in Human Behavior, 14*(3), 387–415.
Lui, M., & Rutledge, K. (1997). The effect of a "learner as multimedia designer" environment on at-risk high school students' motivation and learning of design knowledge. *Journal of Educational Computing Research, 16*, 145–177.
Mayer, R. E. (2006). *Cambridge handbook of multimedia learning*. New York: Cambridge University Press.
Nir-Gal, O., & Klein, P. S. (2004). Computers for cognitive development in early childhood—the teachers' role in the computer learning environment. *Information Technology in Childhood Education Annual, 2004*(1), 97–119.
Regtvoort, A., & Van Der Leij, A. (2007). Early intervention with children of dyslexic parents: Effects of computer-based reading instruction at home on literacy acquisition. *Learning and Individual Difference, 17*(1), 35–53.
Rodrigues, S. (2000). The interpretive zone between software designers and a science educator: Grounding instructional multimedia design in learning theory. *Journal of Research on Computing in Education, 33*(1), 1–15.
Roschelle, J. M., Pea, R. D., Hoadley, C. M., Gordin, D. N., & Means, B. M. (2000). Changing how and what children learn in school with computer-based technologies. *Children and Computer Technology, 10*, 76–101, Retrieved February 20, 2006, from http://www.futureofchildren.org/pubs-info2825/pubs-info.htm?doc_id=69787
Scardamalia, M., & Bereiter, C. (1994). Computer support for knowledge building communities. *The Journal of the Learning Sciences, 3*(3), 265–283.
Schmid, R., Tucker, B., Jorgensen, A., Abrami, P. C., Lacroix, G., & Nico-

laidou, N. (2006, April). *Implementation fidelity of computer-assisted tutoring in Success for All.* Paper presented at the annual meeting of the American Educational Research Association, San Francisco, CA.

Silvern, S. B., Williamson, P. A., & Countermine, T. M. (1988). Young children's interaction with a microcomputer. *Early Child Development and Care, 32*(1), 23–35.

Slavin, R. E. (2004). Built to last: Long-term maintenance of Success for All. *Remedial and Special Education, 25*(1), 61–66.

Slavin, R. E., & Madden, N. A. (2001a*). Success for all: Research and reform in elementary education.* Mahwah, NJ: Lawrence Erlbaum.

Slavin, R. E., & Madden, N. A. (Eds.) (2001b). *One million children: Success for All.* Thousand Oaks, CA: Corwin.

Strauss, A., & Corbin, J. (1998). *Basics of qualitative research: Techniques and procedures for developing grounded theory* (2nd ed.). Thousand Oaks, CA: Sage.

Tzuriel, D., & Shamir, A. (2002). The effects of mediation in computer assisted dynamic assessment. *Journal of Computer Assisted Learning, 18*(1), 21–32.

Vellutino, F. R., & Scanlon, D. M. (2001). Emergent literacy skills, early instruction, and individual differences as determinants of difficulties in learning to read: The case for early intervention. In S. Neuman, & D. Dickson (Eds.), *Handbook for research on early literacy* (pp. 295–321). New York: Guilford Press.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes.* Cambridge, MA: Harvard University Press.

Vygotsky, L. S. (1986). *Thought and language.* Cambridge, MA: The MIT Press.

Wasik, B. A., & Slavin, R. E. (1993). Preventing early reading failure with one-to-one tutoring: A review of five programs. *Reading Research Quarterly, 28*(2), 178–200.

Wenglinsky, H. (1998). *Does it compute? The relationship between educational technology and student achievement in mathematics.* Princeton, NJ: Educational Testing Service.

Yelland, N., & Masters, J. (2007). Rethinking scaffolding in the information age. *Computers & Education, 48*(3), 362–382.