Evaluation of computerized reading intervention

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EVALUATION OF COMPUTERIZED READING INTERVENTION

A Thesis

Submitted to the Graduate Faculty of the Louisiana State University and Agricultural and Mechanical College in partial fulfillment of the requirements for the degree of Master of Arts

in

The Department of Psychology

by

Jennifer Lynne Koenig
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Abstract

The purpose of this study was to evaluate the effectiveness of a computer-based reading intervention with eight elementary school children. This program, called the Reading Center, utilizes repeated reading, listening passage preview, word drills, and comprehension questions. A multiple baseline design was used to evaluate the intervention effects on oral reading fluency. Results indicated growth in all eight children, with increases between 8.7 and 20 words per week for intervention passages. The implications of the results for the use of computer-delivered interventions are discussed.
Introduction

One of the most important functions of schools is to teach children to read. It is a basic expectation of both parents and the public that this will be accomplished for every child. Reading plays a vital role in children’s lives, preparing them for successful vocational entry and many other important life benchmarks. Any measure of school accountability will invariably include reading as a fundamental indicator of the success of a school.

How schools are performing with respect to teaching children to read is in constant debate. Although some schools are very effective at teaching children to read, others have a large percentage that are at-risk. The National Assessment of Educational Progress (NAEP) is a congressionally mandated project to administer continual assessment of various subject areas to American students. The NAEP 200 Reading Report Card found that 37% of students failed to acquire basic reading skills by the fourth grade. This problem is particularly acute in areas where poverty is present, as that number jumps to 60% for fourth graders eligible for the free or reduced lunch program. In such areas, children often start school lacking basic pre-academic skills. A child coming from a low-income family will begin kindergarten with a listening vocabulary of about 3,000 words, while a child from a middle-income family will enter with about 20,000 words (Hart & Risley, 1995). They then encounter teachers who are unprepared to teach at-risk children and the children begin to fall further behind (Ferguson, 1991; Ferguson & Ladd, 1996; Kain & Singleton, 1996). Teacher expertise can account for up to 40% of a child’s success in reading (Ferguson, 1991) and evidence shows that poor schools have a greater likelihood of attracting teachers with less experience and expertise (U.S. Department of Education, 2001a). Reading failure leads to an increased probability of placement in special education or eventually, school drop-out (Snow, Burns, & Griffin, 1999).
There is no question that large numbers of children in some schools are at risk for reading failure. The cause of this problem is unclear. Schools often attribute the problem to lack of family support and family literacy. Others point the finger at the schools and indicate the schools are simply not instructing the children properly. Those who blame the school point to successful practices such as direct instruction which has produced dramatic results with low-income children and ask questions about why all schools aren’t implementing similar techniques (Foorman, Francis, Fletcher, Schatschneider, & Mehta, 1998; Stevens, Slavin, & Farnish, 1991).

Children who fall behind benefit from interventions targeting academic deficits (Baker & Brown, 1984; Carnine, 1980; Esveldt-Dawson, Matson, Ollendick, & Shapiro, 1980; Gaskins, Ehri, Cress, O’Hara, & Donnelly, 1997; Knupp, 1988; Rudolph, Wood, & Miller-Wood, 1990; Salend & Nowak, 1988; O'Shea, Sindelar, & O'Shea, 1987; Welch, 1992; Zutell, 1996). Despite the effectiveness of some interventions, teachers often do not use them. The teacher is in a difficult position. Since most schools hold the teacher directly responsible for the class performance by examining student performance aggregated by classroom on high-stakes testing, he/she is under increased pressure to produce achievement gains for all children. "Parents pressure administrators, who then pressure teachers to respond to the low performance, usually by rearranging the curriculum to spend more time on tested topics" (Airasian, p. 347, 1997).

On the other hand, the teacher is legally mandated by the Individuals with Disabilities Education Act (IDEA) (1997 & 1999) to provide high quality interventions for at-risk children. The purpose of these sections (§ 300.530 – 300.536) of the law is to ensure that children are exposed to high quality instruction prior to placement in special education. If the teacher spends twenty minutes per day delivering an intervention to one child, this can be considered by teachers as taking time away from whole class instruction (Witt, 1990). It may not be feasible
for teachers to routinely offer individualized instruction to all students (Witt, 1990) and perhaps it is unrealistic to suggest that teachers can intervene effectively with even a subset of the lowest performing students. Solutions to this problem of delivering high quality intervention to one student while teaching 25 other children effectively have included peer tutoring, home-based instruction, and independent seat work (National Reading Panel, 2000). These strategies allow an intervention to be on-going for one student while the teacher engages the rest of the class. While each of these strategies makes it more feasible for the teacher to respond to the individual needs of at-risk students, these strategies still require a degree of set-up time, training, and teacher monitoring. Noell and his colleagues have data suggesting that with interventions, including some requiring minimal teacher involvement, “that implementation of treatment plans by consultees generally deteriorated to very low levels in the absence of structured follow-up (Noell, Witt, Slider, Connell, Gatti, Williams, Koenig, & Resetar, in submission).

For any intervention to be effective it must be implemented and implemented in a reasonably correct manner (Gansle & McMahon, 1997; Henggeler, Melton, Brondino, Sherer, & Hanley, 1997; Noell, Gresham, & Gansle, 2002; Yeaton & Sechrest, 1981). The degree to which an intervention is as planned is referred to as treatment integrity (Noell et al. in submission; Peterson, Homer, & Wonderlich, 1982). Treatment integrity can be a problem for some interventions (Noell, Witt, LaFleur, Mortenson, Ranier, & Levelle, 2000; Noell & Witt, 1999). If an intervention could be delivered by a machine, then it would be delivered in the same way each time. That is, it would have treatment integrity. Hence, by delivering an intervention via computer, researchers and practitioners can be more confident that the treatment will be administered in the same way to each student (Bond, 1988).
If the computer is a potential alternative method to deliver an intervention to a child, then it offers the possibility that an intervention could be delivered to the child with high integrity (i.e. the computer delivers the intervention in the same way each time). Integrity issues do not entirely disappear with computers because especially given reports that in some situations “learners had minimal access to computers, courseware was not integrated with classroom instruction, computer-based activities did not play a significant role in instruction, and teacher training was inadequate” (Mills & Ragan, 2000). With teacher delivered interventions some of these problems are present in addition to the day to implementation of the actual intervention. Integrity issues aside, there is the important issue of efficacy of computer based intervention. Here, a study conducted by the National Reading Panel (2000) concluded that “there are few truly innovative uses of computer technology in literacy instruction.” Most studies which have compared computer-based versus paper-based delivery have focused on assessment rather than intervention. For example, Evans, Tannehill, and Martin (1995) examined students’ ability to read and decode text presented on a computer screen compared to paper-based presentation. They administered the Woodcock-Johnson (Revised) Tests of Achievement Forms A and B, in both the traditional manner and on a computer, to fifty-one students. Overall, they found a coefficient of equivalence for the two forms to be .86 and concluded that it “supports the ability of computers to measure traditionally assessed reading domains.” While not directly related to intervention, studies such as this show that computers can approximate the delivery of paper and pencil stimuli.

With intervention, it is not sufficient to show that a computer can implement an intervention. Instead, as with all types of interventions, there is a need to show that not only was the intervention implemented and implemented correctly but it also produced changes in the
dependent variable (Yeaton & Sechrest, 1981). A problem with computer-based intervention is that many of the commercially developed programs delivered by computers do not incorporate evidence-based practices (Case & Truscott, 1999). By 1995, over 1000 different commercially developed literacy software titles existed and it can be very difficult for teachers to discriminate between the effective and the inadequate with this many options (Case & Truscott, 1999). In fact, often these programs have been criticized as being more entertaining “edutainment” but have little or no evidence showing that they improve achievement (Balajthy, 1988). In the past, most evidence-based studies conducted to evaluate computer instruction have tended to use practice with feedback (i.e., an indication of whether responses were correct/incorrect, sometimes with error correction) which is generally considered evidence-based because increasing opportunities to respond results in increased learning (Greenwood, Delquadri, & Hall, 1984). Merely providing opportunities to respond is beneficial to students but often additional instruction is still needed with the teacher to target the more complex skills such as comprehension (Hall, Hughes, & Filbert, 2000).

A primary objective of the present study was to evaluate a reading intervention delivered by computer. In this case, the intervention used was constructed by a research team at Louisiana State University (see Method Section for description). It is called the Reading Center and incorporates several evidence-based instructional components. Specifically, the computer-based intervention included research-based components such as Listening Passage Preview (Daly & Martens, 1994), Repeated Readings (O’Shea & O’Shea, 1988; Rashotte & Torgesen, 1985), feedback/error correction for individual words (Jenkins, Larson, & Fleisher, 1983), and reading comprehension assessment (Fleisher & Jenkins, 1983). Each of these strategies singularly, and some in combinations (Daly, Martens, Hamler, Dool, & Eckert, 1999), have been shown to
improve reading accuracy or fluency. A study by Daly, Martens, Dool, and Hintze (1998) examined different reading strategies including repeated reading and listening passage preview. They administered a brief functional analysis to determine the most effective reading strategy for each student. Two of the three students required a combination of strategies while the most efficient treatment for the third student was repeated reading. These types of studies provide indirect support for programs such as the Reading Center which incorporate a package of research based interventions. If it could be shown that a combination of evidence based strategies, delivered by computer, produced improvements in student reading that approximated those observed when the same interventions were delivered by a person, then this would result in possible gains in overall efficiency. Efficiency, or cost benefit, of course come into consideration once effectiveness has been demonstrated (Noell & Gresham, 1993). Hence, the purpose of this study was to evaluate the efficacy of this computer-based reading package for improving the fluency of at-risk readers. If the package were to prove effective, then it would offer the possibility to teachers of an effective intervention that can be used for one student without requiring one-on-one instruction from the teacher. The following sections review the basis behind the instructional model used to create the Reading Center and the specific techniques incorporated into that model.

**Instructional Model**

Although several instructional models have been proposed including cognitive models, information processing models, and others; one model that has received considerable support is the instructional hierarchy (IH) (Daly, Lentz, & Boyer, 1996; Haring, Lovitt, Eaton, & Hansen, 1978). The IH posits that in teaching children a new skill, certain instructional techniques lead to better acquisition depending on the instructional level of the child. The stages of the IH progress
from acquisition to fluency to generalization and on to adaptation. In the acquisition stage of learning, the student is learning a new skill but is neither fast nor accurate with that skill. A child in the fluency stage would be accurate in a skill but would perform the skill slowly, perhaps awkwardly, and would need to work on increasing performance speed. In the generalization stage, the student has now become both accurate and fluent but does not reliably perform the skill in other settings and has trouble discriminating this skill from similar skills. The final stage of adaptation is where a child learns to adapt the new skill to novel situations or demands by looking at the components of the skill (Haring et al., 1978). Each stage in the IH has associated instructional procedures used to assist the child to learn at that level. For example, acquisition uses modeling and prompting procedures, fluency benefits from drill practice and reinforcement, generalization is gained through training in a natural context, and adaptation utilizes solving novel problems (Daly & Martens, 1994). In reading, the at-risk learner is one who is likely to be functioning below grade level, reading slowly, and perhaps not understanding what he or she reads. In terms of the instructional hierarchy (Daly & Martens, 1994), these learners often have both accuracy and fluency problems. Recommendations which derive from the instructional hierarchy for children with accuracy problems include modeling (e.g. reading to the child) to establish new skills and corrective feedback in the form of word drill or phase drill. To improve fluency, the instructional hierarchy recommends practice (Daly, Lentz, & Boyer, 1996). Reviewed below is research which pertains to strategies shown to be effective for both accuracy problems and fluency problems.

**Interventions for Reading Accuracy**

A child who is reading at the accuracy level of the instructional hierarchy is typically reading slowly or not at all and is making errors. Two of the more commonly used interventions
for children at the accuracy level of the IH are modeling and corrective feedback (Daly & Martens, 1994). A widely used reading intervention based on modeling is Listening Passage Preview (LPP). LPP consists of a fluent reader working with an at-risk reader, usually in an individualized setting. The fluent reader reads (i.e. models) the story passage aloud while the student follows along (Daly, Murdoch, Lillenstein, Webber, & Lentz, 2002). Passages are often presented via audio-tape to control for any extraneous variables, as seen in a study conducted by Daly & Martens (1994). This study examined fluency and accuracy scores of four students using three methods of reading intervention. The students were tested on both story passages and word lists. The three conditions were subject passage preview in which the subject read orally without help, taped words in which the subject read a word list along with the audiotape of those words, and listening passage preview in which the subject listened to the passage being read on an audiotape and followed along. Of these three methods, both fluency and accuracy increased the most across subjects using listening passage preview.

Another strategy for increasing accuracy in reading is called phase or word drill (O’Shea, Munson, & O’Shea, 1984; Fleisher & Jenkins, 1983; Jenkins & Larson, 1979; Jenkins, Larson, & Fleisher, 1983). This is a relatively simple strategy which can involve a fluent reader and an at-risk student on a one-to-one basis. The student reads the story aloud to a teacher or peer tutor and each time a word is read incorrectly, the correct word is supplied to the student and noted in the passage. Once the entire story has been read aloud, the student is drilled on the troublesome words using index cards. This process can also be altered so that the target words are presented within the phrase where the error occurred (O’Shea et al., 1984).

Fleisher and Jenkins (1983) conducted a study looking at the differences between word drills and comprehension questions on reading comprehension and word recognition. Three
conditions were used with 21 learning disabled fourth and fifth graders. The first condition consisted of comprehension questions following a story reading, the second condition emphasized error correction and word drill, and the third condition was a combination of the first two conditions. No differences were found between conditions on oral reading and comprehension but the error correction/word drill condition produced higher scores on word recognition.

Common to most forms of instruction for children at the accuracy level is the need for someone (or something) to provide modeling and/or feedback. The use of peers is an efficient method for providing these types of instruction since it requires less of the teacher’s valuable time. The Reading Center intervention package includes both a modeling procedure as well as word drill with error correction procedure, both of which should address accuracy issues. Hence, the present study will explore the use of a recorded voice delivered via computer to model the passages. The Reading Center being evaluated in the present study also provides a word drill on difficult words with feedback provided to the child about whether responses are correct or incorrect.

**Interventions for Fluency**

A child with a reading fluency problem is one who is making few errors but is reading slowly. The most common recommendation deriving from the IH for reading fluency problems is the use of practice as a primary intervention component. Perhaps the most widely researched of all practice-based strategies is called Repeated Reading (RR) (Chard, Vaughn, & Tyler, 2002; Rashotte & Torgesen, 1985; Stoddard, Valcante, Sindelar, O’Shea, & Algozzine, 1993; Weinstein & Cooke, 1992). In its most basic form, RR consists of a student rereading a passage until a certain level of fluency is reached. This practice has been shown to improve speed of
reading which in turn will aid in comprehension (Dowhower, 1987). When children can decode passages faster they can concentrate more on deriving meaning from the text (Stoddard et al, 1993). In a study by Dowhower (1987), 18 students were randomly assigned to either an assisted or unassisted reading group to practice repeated reading of passages. Results indicated that regardless of the training group, all students’ rate, accuracy, comprehension, and prosodic reading (ability to segment the text into meaningful phrases) were significantly improved.

After an extensive search of methods for increasing reading fluency in children, The National Reading Panel (2000) found repeated and guided oral readings to be the most effective. The NRP went on to suggest “substantial research evidence that shows such procedures work under a wide variety of conditions with minimal special training or materials.” In the abundance of research supporting the improvements in fluency that result from repeated readings, there also exist some studies that have discovered ways to improve upon it. Rashotte and Torgesen (1985) investigated three reading strategies, two with repeated reading and one with non-repetitive reading. In the repeated reading conditions, the students read the same passage four times during a session but each session involved a new story passage. The difference between the two conditions was that in Condition 2, the passages had a high word overlap from session to session. The researchers found that using passages with a significant overlap of words increased fluency gains for the twelve students in their study. Repeated reading without shared words was no more effective for improving fluency than non-repetitive reading.

A study by Stoddard et al. (1993) found increases in both fluency and comprehension for all thirty subjects, who were exposed to an intervention based upon repeated readings. These authors also found improvements in reading rate and comprehension when students read a passage three times compared to one time or seven times compared to one time. A study by
Weinstein and Cooke (1992) confirms the notable results that can be reached using repeated reading. The four students in this study dramatically improved their fluency scores in both conditions of RR. Weinstein and Cooke looked at the difference between using either a fixed criterion rate or an improvement rate as a way to regulate movement from passage to passage. They found higher fluency scores when the students were required to reach a criterion of 90 correct words per minute before moving to the next passage over the other condition which required three consecutive instances of improvements in correct words per minute before moving on. In summary, the research pertaining to repeated reading suggest that an optimal of methods for improving fluency would be to use a fixed criterion of correct words per minute with overlapping passages.

**Interventions for Reading Comprehension**

Reading comprehension is what most teachers hope to be the ultimate outcome that occurs when a child interacts with text. Although it is not specifically addressed within the instructional hierarchy, numerous interventions exist in the literature to improve comprehension (Fleisher & Jenkins, 1983; Freeland, Skinner, Jackson, McDaniel, & Smith, 2000, Jenkins et al. 1983; Markell & Deno, 1997). One of the most straightforward is to simply ask the child specific questions about the passage they read. In a study by Fleisher and Jenkins (1983), comprehension was measured before and after three reading treatments were implemented. The three instructional treatments consisted of a simple word-drill error-correction procedure, a comprehension-emphasis technique, and a condition involving a combination of the two previous procedures. Results indicated similar posttest comprehension scores regardless of reading treatment. These findings supported the use of both word drill and post-reading comprehension questions as a means to improve reading comprehension.
Another way to improve passage comprehension is by improving oral reading fluency (Fuchs & Deno, 1991; Jenkins & Jewell, 1993). Markell and Deno (1997) conducted a study to investigate comprehension effects of increases in oral reading fluency. They used comprehension questions and maze probes to assess passage comprehension in 42 third graders. The results indicated that a substantial increase of words read correctly can confidently predict improvements in comprehension.

Reading comprehension is an enormously complicated skill and this technique is a very basic one for children who do not have severe deficits. Since it is included in the Reading Center, it can also serve as an assessment to determine if more specialized interventions are needed.

Purpose of Present Study

The purpose of this study was to evaluate the efficacy of the Reading Center which is a combination of intervention strategies designed to improve reading accuracy, fluency, and comprehension problems. This package is a collection of procedures all of which are evidence-based. Although each of the components of the Reading Center has been evaluated in previous studies either individually or in some combination, they have yet to be assessed when combined into a single procedure. Another goal of this study is to evaluate whether computer-based instruction, which utilizes practices shown to be effective when delivered by people, remains effective when delivered by a computer.
Methods

Participants and Setting

Participants included eight typically developing children, two females and six males, in second through fifth grade from an elementary school in a Southern state. The students were referred by their teachers as having a reading level below that of their peers and permission was obtained from a parent for each child to participate in the study. Five children were referred in the beginning and the second group was created with children referred later in the semester. The second group began with five participants but two children moved away from the school during baseline. The students participated in daily sessions in the school’s computer lab under supervision of either the experimenter or a research assistant. The daily sessions lasted between 20 and 35 minutes, depending on the child’s reading speed.

Materials

A computerized reading intervention was constructed by researchers at Louisiana State University for the purpose of evaluating automatic delivery of reading interventions. The intervention utilized in this study was a package of intervention components referred to herein as the Reading Center. The intervention was constructed using Click 2 Learn ToolBook® which is a software package used to build training tools. The ToolBook computer program provides an easy mechanism to translate ordinary text and sounds into exercises that can be delivered by a computer. The outcome of the ToolBook process is a “book” or lesson that can be placed on a compact disk. The books can be accessed directly from the compact disk. The minimum hardware needed was a 486 MHz processor, standard 15” monitor with 800x600 screen resolution, keyboard, mouse, CD-ROM, and headphones or speakers. Books were made for children in grades one through five. Each grade was designated by a shape and color. Within
each grade level, there were twelve lessons in ascending difficulty. For example, third grade was the “green square” book and its lessons would be designated as 3.0, 3.1, 3.2, etc. Each lesson consisted of three inter-related passages designated as A, B, and C. The lesson begins with the first passage, designated passage A, which was a 150-200 word passage created around the Fry word list (Fry, 1957). The words in the Fry list represent the 3000 most commonly used words in the Basal reading series (Prince & Mancus, 1987; Templeton, 1986). Passage B is the second passage in each of the 12 lessons and has a 75-85% word overlap with passage A. Likewise, the C passage has a 75-85% overlap with passage B. Each passage had been evaluated for readability using the Spache reading formula (Rush, 1985; Spache, 1953) and each lesson is progressively more difficult in readability than the previous lesson.

There are eight components which make up the steps of the program. Each component is listed here and the more detailed explanations are given in the following sections.

1) Instructions

2) Listening Passage Preview (A)
   - The passage is presented one sentence per page both printed on the screen and heard auditorily by the child.

3) Word Drill
   - A five question quiz using the most difficult Fry words from the preceding passage.

4) Listening Passage Preview (B)
   - Again the passage is presented visually and auditorily but in full paragraph form.
5) Repeated Reading
   - The passage is presented printed in full paragraph form while the child reads it silently. This step is then repeated.

6) Comprehension Check
   - A three question comprehension quiz is administered.

7) Test on Passage C
   - A one minute timed reading is administered using passage C to obtain the child’s oral reading fluency (ORF) score. A words read correctly (WRC) score is achieved using the CBM guidelines provided by Shinn (1989).

**Procedure**

**Assessment/Placement.** Each child was assessed to determine the appropriate grade level for intervention and to verify the teacher’s referral. The assessment step of the program was completely paper-based and performed individually with a researcher. Three random grade-specific passages were administered to each child. The child was timed for one minute while reading each passage and the total number of correctly read words was calculated. The median score was computed from among the three scores. This process follows the curriculum-based measurement procedures described by Shinn (1989). If that score fell within the instructional range for the child’s grade level, then the child began on that level. If that score fell below the instructional range, the same process was repeated with each grade level until instructional level was identified. Instructional range was defined according to Deno and Mirkin (1977) as requiring between 40 and 60 correctly read words per minute in grades one and two and between 70 and 100 correctly read words per minute for grades three, four, and five.
**Baseline.** Following assessment, each child entered the baseline phase consisting of daily progress monitoring. The child was asked to read three passages randomly selected from the appropriate Reading Center level for one minute each. Words read correctly (WRC) were recorded for each passage and the median score was plotted for that session. Once the graph was judged to be stable for at least three consecutive sessions, the student was able to begin intervention phase.

**Computer and Software Training.** Once the baseline phase was completed, each child met individually with a researcher to receive formal training for using the computer apparatus and a demonstration of the computer program. The experimenter modeled mouse control and left mouse clicks, as well as connecting and utilizing the headphones. Next the researcher aided students as they moved through each page of the program. The experimenter demonstrated all of the required responses on each page, then asked the student to replicate those actions. The child was required to complete a full C passage lesson demonstrating proficiency in each step of the program before being permitted to begin the intervention phase. The practice C lesson was pulled from the level below the designated intervention level. Proficiency was shown when the child moved through an entire passage unaided and followed the directions with 100% accuracy. This task took only one try with all children. During each session, the experimenter or research assistant was present at all times.

**Intervention.** The researcher initiated each intervention session by selecting the appropriate room and level. The child was then left to follow the instructions given by the program. Within the program, each new instructional activity provides explicit directions to the child. The directions are printed on the screen and presented auditorily in spoken English by the program. Within the Reading Center, the first step in the series of instructional activities is a
listening passage preview activity. In this session, a 100-150 word story passage is presented one sentence at a time. The computer automatically presents a sentence on the screen and reads the sentence to the child. A female voice reads the words at a rate of approximately 80 words per minute. The child is instructed to point to each word on the screen as it is read and to follow along. Each page of the program contains a button, which, if depressed by the student, allows the student to repeat instructions or stimulus material that may have been missed. The child controls the presentation of the next sentence with a button that allows the student to move from page to page at his or her own pace, but only after the computer had completed all the readings presented on that page. Once all sentences within the passage have been presented, the screen changed and the child is provided with instructions about the next step.

The next segment of the program, word drill, is comprised of a short five question quiz and uses practice word recognition. The instructions direct the child to listen to the word presented and select the correct word from the choices given on the screen. When the child opened the first word page they heard a word, the word was then presented in a sentence, and then spoken again in isolation. For example, the computer would present the word “dog” auditorily and then read the sentence “Sally likes to walk her dog” and then present the word “dog” again. The four alternatives were presented in a multiple choice format with one correct answer and three foils. When the child clicked on a word he or she was given an auditory stimulus of “correct” or “try again.” If the incorrect answer was chosen, the child was allowed to choose again until the correct answer was selected. Once the correct answer had been identified the program automatically proceeded to the next page. This process was repeated for all five words.
The next step incorporated listening passage preview once more and the child heard the story passage again. This time, for LPP, the entire passage was presented on the screen at once while the child was directed to listen and follow along. The next step in the program is repeated reading. First the passage was presented in paragraph form printed on the screen and the child was directed to read it to themselves. The next page instructs them to complete this step once more resulting in a repeated reading of the entire passage.

The final task in the Reading Center is a three question quiz to test the child’s comprehension of the story. On each page, the child was shown a question related to the story and the question was read aloud to the child. Like the word quiz, the child was given feedback for their response and unlimited chances to choose the correct answer. A button was provided on these pages whereby the child may return to story in order to aid him or her in answering the question. This activity sequence was followed for passages A, B, and C in each lesson. At the end of passage C, the student was shown the entire story once more and instructed to get their teacher or reading helper in order to read the passage aloud to that person. This final step was completed by the experimenter or research assistant for reliability purposes in this study. The researcher timed the reading of that passage for one minute to obtain a fluency score.

**Movement within the program.** Each grade level had a goal fluency score that is consistent across passages. If the words per minute score for passage C exceeded that goal score the child would move on to the next level in the subsequent session. If the score fell below the goal score the child would repeat that level in the subsequent session. The student was given three chances to repeat a level and achieve the goal fluency score. If the student did not accomplish this, the intervention was halted and alternative interventions were considered.
**Progress Monitoring.** Each child in the study was monitored daily for progress. The experimenter or research assistant administered three passages, selected at random, from the level of the Reading Center in which the child was currently working. The child was timed for one minute while reading each passage using the CBM scoring guidelines provided by Shinn (1989). The median score from the three passages was taken and plotted on the progress monitoring graph included in the instructional element of the Reading Center (See Appendix A).

**Generalization.** The second group was administered probes for both progress monitoring and to investigate generalization across reading passages. This group was monitored for generalization twice weekly using randomly chosen, reading level appropriate passages in both baseline and intervention phases. The passages used to monitor generalization were novel passages to the students. The progress monitoring sequence was followed for generalization, using three timed passages and recording the median score.

**Experimental Design**

Reading acquisition was studied using a multiple baseline across students design. First, each child was assessed to determine their placement for the program. The initial baseline phase consisted of daily progress monitoring of reading fluency. Progress monitoring probes were administered daily by the researcher or a research assistant. The children were monitored using probes corresponding to the grade level they would be using once introduced to the Reading Center. Words per minute was calculated for each session and graphed. Each child was required to have a stable graph before being introduced to the Reading Center. Once a child entered the intervention phase, progress monitoring continued daily in the same method as the baseline phase and the words per minute score was graphed at each session. In addition to this procedure,
the students in group two also received progress monitoring twice weekly using generalization probes throughout both baseline and intervention phases.
Results

Data collected through progress monitoring sessions were plotted graphically for each child. Visual inspection was used to analyze these graphs and determine the progress of each student. Reading acquisition could be seen in how quickly the child’s fluency score ascended. The slope of the intervention graph was compared to baseline as a means of evaluating the intervention to be helpful in reading for these specific children.

Group One

Ben. Ben was a fifth grade male reading at the beginning fifth grade level. Figure 1 shows Ben’s words read correctly (WRC) for each session. Ben had three days of baseline sessions in which his WRC score was between 81 and 85. Ben started the intervention phase at a rate of 80 WRC per minute. His daily scores climbed to 106 WRC per minute after 15 sessions. Ben’s average increase was 6.43 words per week.

Tony. Tony was a male in second grade and was reading at the first grade level. Figure 1 shows Tony’s reading progress over his 15 sessions of intervention. His WRC scores during intervention increased from 42 to 76 words per minute after a baseline average of 44. Tony’s average increase in baseline was 2.5 words per week while increase during intervention was 12.34 words per week.

Bob. Bob was a male in third grade and his assessment indicated that he was reading instructionally at a second grade level. Figure 1 shows Bob’s WRC across all sessions. Since Bob’s baseline sessions were variable, treatment began once the variability showed a pattern and developed a stable trend. His performance ranged from 52 to 74 words per minute but only equaled an increase of 1.25 words per week. At the beginning of the intervention phase, Bob’s performance showed a similar pattern. At about session 19, Bob’s performance began to
stabilize and increase systematically in response to intervention. Bob’s intervention WRC scores began at 64 and finished at 95 words per minute. Bob’s average increase was 9.67 words per week.

**Joan.** Joan was a female third grader and her assessment showed her to be reading on a second grade level. Figure 1 shows Joan’s 11 baseline sessions and her progress through 12 intervention sessions. Joan’s baseline session scores fell between 55 and 73 words per minute and had an average increase of 4.75 words per week. Her scores increased upon entering intervention and continued to improve from 73 to 110 WRC per minute. Joan’s average increase in intervention was 19.96 words per week.

**Tommy.** Tommy was a male second grader assessed to be reading instructionally on the first grade level. Figure 1 shows Tommy’s progress over baseline and 14 sessions of intervention. Tommy’s baseline scores ranged from 41 to 74 words per minute with an average increase of 2.56 words per week. Once Tommy entered the intervention phase his scores began to increase. They became level from sessions 19 through 27 then increased again to 111 WRC per minute at the final session. Tommy’s average increase was 7.94 words per week.

**Group Two**

Group two differs from group one in that they were administered generalization probes twice weekly on top of the daily progress monitoring probes. The generalization data are represented by the dark square data points on the last three graphs. Group two also serves as a replication of group one.

**Carla.** Carla was a female third grader assessed to be reading at a second grade level. Figure 2 shows her WPC scores across 3 baseline and 14 intervention sessions. Her baseline
Figure 1: Group One – Words Per Minute Scores
scores averaged 60 words per minute. Carla’s intervention scores started at 51 and ended at 103 words per minute with the last four sessions being her sharpest climb. Her average increase was 14.74 words per week. Carla’s generalization score in baseline phase was 51 WRC. Her generalization scores during intervention began at 66 and rose to 73 WRC, an increase of 3.89 words per week.

Donny. Donny was a male third grader and his assessment showed him to be reading on the second grade level. Figure 2 shows a baseline with scores ranging from 38 to 43 words per minute but on a decreasing trend. Donny’s intervention scores are somewhat variable, beginning at 20 and ending at 68 WRC during his 15 sessions of intervention. Donny’s average increase was 13.18 words per week. Donny’s generalization score in baseline phase was 38 WRC. His generalization scores during intervention began at 29 and climbed to 55 WRC, an increase of 9.79 words per week.

Stan. Stan was a male third grader that was initially assessed to be reading instructionally on a second grade level. After 11 sessions of baseline data, Stan was showing a clear improvement so he was reassessed. The second assessment indicated he was instructional at the third grade level. Figure 2 shows both of Stan’s baseline phases and his 12 days of intervention sessions. Stan’s baseline data for the third grade level showed a decreasing trend of 1.7 words per week. His intervention sessions began at 72 and finished at 105 words per minute. Stan’s average increase was 12.48 words per week. Stan’s generalization score in the baseline phase was 66 WRC. His generalization scores during intervention began at 66 and ended at 71 WRC, an increase of 3.19 words per week.
Figure 2: Group Two – Words Per Minute Scores
**Procedural Integrity**

Procedural integrity and inter-rater agreement were calculated to insure that administration and scoring of the reading probes was conducted correctly. The reading probes were administered by the experimenter, other graduate students, and undergraduate students. All research assistants were trained by the researcher to administer progress monitoring probes and to operate the Reading Center program prior to the start of the study. Each research assistant achieved at least 95% accuracy in inter-rater agreement prior to beginning the study to be considered a reliable data collector. A checklist was developed for intervention sessions, progress monitoring sessions, and generalization sessions to assess the procedural integrity of each researcher (See Appendices B and C). Progress monitoring and generalization sessions followed the same integrity checklist. These checklists were used as a guide for each session and to calculate percentage of accurate steps for all sessions evaluated for integrity. Procedural integrity was measured by dividing the number of steps completed correctly by the total number of steps required to administer the probe correctly. The daily progress monitoring probes and the generalization probes each required 22 steps to complete and the intervention checklist required 13 steps to complete. Procedural integrity was collected for 40% of the total sessions and calculated at 100% for intervention, 98% for daily progress monitoring, and 100% for generalization. Inter-rater agreement was collected for 34% of all probes administered. This was assessed by dividing the number of words in agreement by the number of agreements plus disagreements. The mean inter-rater agreement was calculated at 94%.
Discussion

The benefits of a computer-based reading program were evaluated with eight elementary school children. The purpose of this study was to assess the benefits of a package of intervention strategies designed to improve reading accuracy, fluency, and comprehension. The Reading Center intervention provided instruction using listening passage preview, word drill, repeated reading, comprehension questions, and timed progress monitoring.

The results indicated that the intervention package increased words per minute reading scores for each child. The greatest improvements on the intervention passages came from Joan whose daily progress monitoring showed that he gained an average of 19.96 words per week. The lowest of the eight was Ben and his score was still a notable increase of 6.43 words per week on average. Fuchs, Fuchs, Hamlett, Walz, and Germann (1993) monitored the reading progress of 374 students in first through fifth grade using curriculum-based measurement (CBM) reading probes (Deno, 1985). The results indicated that an average student receiving normal instruction gained between 0.3 and 1.5 words per week depending upon grade level. The children in this study, who had been designated as at-risk and performing below that of their peers, showed gains in the range of 8.7 to 20 words per week. These progress monitoring results although promising, are a liberal estimate of the actual gains made by each student since these data were taken from passages used in the intervention. The daily progress monitoring passages were randomly chosen but by the end of the intervention, the student had been trained on each of the 36 possible passages.

Group two in the study received generalization passages twice weekly in addition to daily progress monitoring on intervention passages. The results using generalization passages were not as clear as the progress monitoring data but indicated modest gains for most children when
evaluated with generalization passages. The gains per week for the three participants ranged from 2.1 to 8.65 words per week on average which is above the normal range indicated by Fuchs et al. (1993). Also, since the generalization data were taken from the readings of untrained passages, rate of progress was not expected to show as noticeable of an effect as the progress monitoring data. It is promising, however, that there was some generalization to novel story passages.

These results support and extend the existing research on repeated reading, listening passage preview, word drill, and comprehension strategies by showing that their benefits can transfer to other mediums, specifically computer assisted instruction. This study also shows, as have others (Daly et al. 1999; Fleisher & Jenkins, 1983) that a combination of reading strategies such as those utilized by the Reading Center produces consistent improvement in words read correctly. Although some studies (Eckert, Ardoin, Daisey, & Scarola, 2000; Daly, Martens, Dool, & Hintze, 1998) have used a brief functional analysis before implementing the appropriate reading strategy, this program found marked growth from all students by administering a combination of the best strategies without a prior functional assessment.

An important contribution made by this study is its advancement of the research on computer based interventions. To this point, most research addressing computer based learning has been focused mainly on assessment (Pomplum, Frey, & Becker, 2002; National Reading Panel, 2000; Evans et al. 1995). The progress of these eight students is encouraging on its own but to be able to achieve this type of progress with an intervention requiring little teacher involvement is definitely a step in the right direction. Although a researcher was present at all times during these sessions, they gave no attention or instruction to the students besides the administration of the progress monitoring probes in order to create a similar situation as would
be found when the intervention is teacher administered. Since most classrooms presently have at least one computer, the Reading Center can be used as a tool to enhance the normal daily reading time.

It is important to realize that this study used ideal conditions in which to conduct the sessions, especially compared to a normal school classroom. These ideal conditions included a quiet, distraction-free work area and close control to insure the optimal performance of the computer system. This was done to ensure that whatever effects were seen could be attributed to the intervention. There are possible limitations that could come into effect when utilizing this intervention in a normal classroom setting and without the controlled conditions in which these participants were allowed to work. Students can get distracted or fail to complete each step of the intervention to their fullest potential when they are left without close supervision. Also, these children were all attending an inner city school and there is no evidence of how well these results might generalize to other settings. Given that marked effects were found through the use of the Reading Center, it is anticipated that the intervention would be beneficial without the more controlled conditions in place for this study.

It must also be taken into account that reading instruction was going on in each child’s normal classroom while the intervention was in place. This is seen in the baseline scores for those students who did evidence some growth. However, there is a substantial increase in WRC once they began intervention. For some children, the simple action of holding them accountable for reading and giving a daily score to their performance may be all they need to show progress. This seems to have been true in Stan’s case since he improved in baseline until more difficult materials were implemented.
The Reading Center intervention is not appropriate for all reading problems and should not be used with children considered to be non-readers. These would be children who have yet to gain decoding skills or who are lacking basic reading accuracy skills. While the intervention does contain some drill to increase reading accuracy, it is most appropriate for students showing some accuracy but little fluency in reading.

Future research with this intervention should explore more thoroughly the effects found when implementing in the classroom under teacher supervision with the normal classroom distractions. This might include an evaluation of using the classroom teacher or perhaps a peer to administer the progress monitoring passages and oversee the implementation. Overall, the results obtained from this study are promising, indicating that perhaps such interventions are both efficient and effective. The purpose of implementing a computerized intervention is to help those children falling behind their classmates in reading without putting an extra strain on the teacher’s time and attention. With the Reading Center, a child can receive an intensive intervention with only a modest amount of individual teacher attention, perhaps the most precious commodity in any classroom.
References


Appendix A

GREEN SQUARE READING ROOM
PROGRESS MONITORING GRAPH

Student: ___________________________  Teacher: ___________________________

Current Grade: (circle one)  1st  2nd  3rd  4th  5th

Instructions:

- For each Session across, follow the dotted line up to the horizontal line closest the score achieved in that session (from “Session Score” column on Progress Monitoring Form).
- Put an X on the dotted line to mark the point of that session’s score.

Progress Monitoring Sessions

Date of Session

- Connect the X’s across in red ink to show the line of progress across sessions.
Appendix B

**Integrity Checklist**

**Progress Monitoring and Generalization**

- 1. Sit one-on-one with the child in a quiet place so that they may concentrate on reading.
- 2. Tell the child “You will be reading three different passages. I will time you for one minute. When you come to a word you don’t know I will tell it to you so that you can continue reading. Please do your best reading.”
- 3. Give the child the student copy of the passage and be sure you have the teacher’s copy of the same passage.
- 4. Instruct the child “Begin reading aloud now.”
- 5. Start timing when the child reads the first word.
- 6. Mark any incorrect or missed words.
- 7. Tell the child to stop after one minute is up.
- 8. Count up the total number of correctly read words and write that number on both the teacher’s copy of the passage and the appropriate blank on the progress monitoring form.
- 9. Repeat steps 3 through 8 for the next two passages.
- 10. Enter the median score into the appropriate blank on the progress monitoring form then graph that number on the progress monitoring graph.
Appendix C

**Integrity Checklist – Daily Intervention**

1. Have child sit down at computer station and be sure they have working headphones.
2. Insert appropriate Reading Center disc into the CD-ROM.
3. Consult Completion Checklist for appropriate passage to begin.
4. Type the child’s name into the login box that appears on the screen.
5. Select the passage for the student and direct them to follow the instructions given by the program.
6. When the child reaches the end of lesson C, instruct them to read the passage to you.
7. Supply them with the student copy of the passage on paper. Make sure you have the teacher’s copy of the same passage.
8. Tell the child “I will be timing you for one minute. If you come to a word you don’t know, I will tell it to you. Do your best reading.”
9. Start the timer when the child reads the first word.
10. Mark any incorrect or missed words.
11. Count up the correctly read words and record that number on the both the teacher’s copy and the Completion Checklist.
12. If that score is higher than the goal score, check the blank for “go to next lesson”. If the score is lower than the goal score, check the blank for “retry this lesson”.
13. Check off each lesson that the child completed that session.
Vita

Jennifer Koenig earned her Bachelor of Science degree in psychology from Louisiana State University in May 2000. She is currently a doctoral student at Louisiana State University in the school psychology program. Her clinical and research interests include academic assessment and interventions, teacher implementation, and resistance to intervention.