THE INSTRUCTIONAL EFFECTIVENESS AND EFFICIENCY OF THREE
INSTRUCTIONAL APPROACHES ON STUDENT WORD READING
PERFORMANCE

DISSERTATION

Presented in Partial Fulfillment of the Requirements for
The Degree Doctor of Philosophy in the Graduate
School of The Ohio State University

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* * * * *

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ABSTRACT

Literacy is becoming more and more crucial for survival, however illiteracy rates are on the rise in the United States. Increasing evidence over the years has shown that America’s school children are not mastering important reading skills. Once reading difficulties begin, they are difficult to overcome. The majority of children who have reading difficulties do not catch up with their peers, and the gap between good and poor readers widens over time. Teachers are becoming more and more concerned about identifying and implementing proper strategies for promoting the reading skills of children who struggle. Although many reading interventions are available, few have been carefully investigated with respect to treatment effectiveness and treatment efficiency.

The current study examined the instructional effectiveness and efficiency of three word reading interventions on students’ cumulative number of words read accurately and cumulative learning rate. Specifically, alternating treatments designs were used to compare the effects of interspersal drill and practice training (presenting one known word prior to every third unknown word for a ratio of 67% unknown to 33% known), an incremental rehearsal condition (the repeated interspersing of one unknown word throughout 9 known words), and a traditional drill and practice procedure (presenting
only unknown words) on word reading mastery. This study also extended previous research findings of the positive outcomes of three interventions by examining the retention, maintenance, and generalization of words that were taught under the three instructional conditions. Social validity of the three instructional methods was also assessed.

The results showed increased word acquisition for all six of the students who participated in the study. Specifically, incremental rehearsal was found to be the most effective while traditional drill and practice was the most efficient in terms of increasing word reading performance. All six of the students demonstrated a preference for the traditional drill and practice approach. Social validity results indicated that all three instructional techniques are a socially valid way to teach word reading skills to students identified as having word reading difficulties.
Dedicated to my parents, Tom and Patty Nist, and my brother Matthew Nist, whose overwhelming love and support have inspired me to reach my dreams.

In loving memory of Bozworth.
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CHAPTER 1

INTRODUCTION

This chapter provides background information relevant to the current study, along with the following: statement of the problem, purpose of the study, research questions, significance of the study, and definitions.

Background

Literacy is becoming more and more crucial for survival, however illiteracy rates are on the rise in the United States (Chard, Simmons, & Kameenui, 1995; Snow, Burns & Griffin, 1998). Increasing evidence over the years has shown that America’s school children are not mastering important reading skills. In 1997, the National Assessment of Educational Progress found that reading difficulties affect students in essentially every social, cultural, and ethnic group. They showed that 29 percent of whites, 69 percent of African-Americans, 64 percent of Hispanics, 22 percent of Asian-Americans, and 52 percent of American Indians read below basic levels in fourth grade. National longitudinal studies show that about 10 million children will encounter reading difficulties in the first three years of their schooling (National Reading Panel, 2000).

Reading problems usually begin in the early stages of reading acquisition. Once reading difficulties begin, they are difficult to overcome (Juel, 1988). Eighty-eight
percent of children who read below grade level at the end of first grade remain below grade level through fourth grade. Approximately seventy-five percent of students who read below grade level in first grade will continue to be poor readers at the end of high school (Francis, Shaywitz, Stuebing, Shaywitz, & Fletcher, 1996). The majority of children who have reading difficulties do not catch up with their peers, and the gap between good and poor readers widens over time (Juel, 1988). Stanovich called this the Matthew Effect, meaning that children experiencing reading problems tend to fall further behind their peers over time (1986). Therefore, it is essential that children who experience reading difficulty receive assistance as soon as possible.

Approximately one third of children in the United States are at-risk for school failure upon entering kindergarten due to socially and economically poor conditions (Lerner, Lowenthal, & Egan, 2003). The performance gap between children from low-income families and their peers continues to increase as they advance through school (Bowman, 1994). Fortunately, there is strong agreement that many reading problems can be prevented or minimized through intensive early intervention programs (Elliott, Lee, & Tollefson, 2001).

The prevention of reading problems has been targeted as a reform goal at both the state and national levels (Walpole, Justice, & Invernizzi, 2004). Prevention focused initiatives have stressed school and classroom strategies for decreasing the number of children who experience reading failure. National educational goals assert that all children will begin school ready to learn to read and will assume reading competency by the end of fourth grade (National Education Goals Panel, 2000). Classroom teachers are responsible for directly supporting the reading needs of all children. Teachers are
becoming more and more concerned about identifying and implementing proper strategies for promoting the reading skills of children who struggle (Walpole et al., 2004). While many struggle to read, there is strong agreement that many reading problems can be prevented or minimized. An increasing body of research indicates that children at risk for reading problems can be identified early (Elliot, Lee, & Tollefson, 2001; Good, Simmons, & Kameenui, 2001) and can succeed in a reading program that includes comprehensive instruction in: phonemic awareness, alphabetic principle, or the knowledge that letters in written words represent sounds; word identification skills, and comprehension.

School psychologists and educators are likely to encounter two types of students with reading problems, students with IQ-reading achievement discrepancies and students with a combination of low ability and low reading achievement (Joseph, 2002). Those who have IQ-reading achievement discrepancies usually have average to high average intelligence and listening comprehension scores (Aaron & Joshi, 1992). Students with dyslexia are also included in this group of poor readers. Often, dyslexia is associated with neurological impairments that result in poor word recognition skills, such as phonological processing.

Low ability readers incorporate the largest number of poor readers (Joseph, 2002). They usually have below average intelligence and below grade level listening comprehension, word recognition, and reading comprehension. Poor readers who have word recognition difficulty tend to over rely on pictures and other words to identify
unknown words in a passage (Kim & Goetz, 1994). Those who over rely on textual cues to identify unknown words usually decrease their likelihood of converting unknown words into sight words. (Adams & Henry, 1997).

**Word Reading Skills.** An essential reading skill that should be addressed early is word identification. Stahl defined word identification as techniques a reader uses when he or she does not recognize a word at sight (1990). Efficient word identification strategies are important for the development of rapid word recognition ability (Tunmer & Chapman, 2002). The ability to identify words is a key step in reading because successful reading acquisition necessitates the development of efficient strategies for identifying unfamiliar words in text (Tunmer & Chapman, 2002). In addition, high levels of automaticity in word recognition free up cognitive resources for allocation to comprehension and text integration processes, both of which are essential for making progress in learning to read (Perfetti, 1985). McCormick asserted that once a student has acquired competency in using word identification strategies, they can read unfamiliar words without the assistance of a teacher (McCormick, 1999).

Skilled readers recognize large numbers of words at sight, and they also know what to do when they come to words that are unknown to them (McCormick, 1999). Knowledge of strategies to use when confronted with unknown words is critical for reading advancement. Once these strategies are used, great strides are made in the number of words they can read (Juel, 1991). Therefore, the development of word identification strategies leads to comprehension because students can read more (Daneman, 1991). Research has also shown that when students can link sounds with the words they read, they can better hold the words in short-term and long-term memory,
therefore improving recall of what they have read (Mann, Liberman, & Shankweiler, 1980). In addition, dependable word identification strategies make recall of words at sight easier. Students also make fewer errors when they read words by sight (Ehri, 1991). Overall, word identification skills accelerate reading acquisition (Stanovich, 1991b).

**Sight word approaches.** In order to develop reading fluency, readers must obtain both word identification strategies and sight word recognition strategies (McCormick, 1999). Students at the beginning stages of word learning must often read words by sight because they do not yet have sufficient concepts and skills for reading words through phonological recoding systems, in other words, they have not yet internalized the prerequisites to word identification strategies (Ehri, 1991). Sight word reading, sometimes referred to as whole word reading, can be successfully taught with systematic instruction (Browder & Snell, 2000; Slaton, Schuster, Collins, & Camine, 1994). The following includes a discussion of the use of the sight word techniques of traditional drill and practice, interspersal training, and incremental rehearsal.

**Traditional Drill and Practice**

Chase and Symonds (1992) indicated that “the most effective device that can be applied to learning is to increase the amount of drill and practice (p. 289).” Many researchers have indicated that for students to develop complex skills such as solving math problems, writing compositions, or comprehending, it is imperative that they develop fluency with the tool skills involved (e.g., decoding words and spelling words) (Cooke & Guzaukas, 1993). Standard drill and practice techniques consist of new material being presented over and over in isolation and/or in context for the learner to practice until the response is automatic (Cooke & Guzaukas, 1993). Drill tasks are
important in academic remediation for children who do not have prerequisite skills and are not able to perform higher order tasks, but must first learn the basic information in order to move to that level (Burns, 2004).

Researchers have often evaluated different drill models as a way to increase the overall instructional effectiveness of repetition (MacQuarrie-Klender, Tucker, Burns, & Hartman, 2002). In order to prevent and overcome academic skill deficits, Skinner, Belfiore, and Watson (1995) recommended that school personnel should determine which interventions are most efficient by measuring students’ learning rates under different instructional conditions. Interspersal training is a method of drill and practice where the delivery of trials of previously learned behaviors is interspersed among trials of behavior to be learned.

**Interspersal techniques.** Researchers have investigated the notion of student choice behavior. Research has suggested that when individuals are given the choice of two behaviors, and everything else is held constant, individuals are more likely to engage in the behavior that requires the least amount of effort (Billington & Skinner, 2002). Choice behavior is of significant importance in the classroom because when students choose to engage in assigned tasks, more than likely they will increase their skill acquisition, fluency, generalization, and maintenance (Binder, 1996; Skinner, Fletcher, & Henington, 1996). Techniques intended to increase the probability of students choosing to engage in academic tasks can increase the rate of learning and decrease inappropriate behavior (Skinner, 2002).

Neef, Iwata, and Page (1977) were among the first to study the effects of interspersing techniques on student achievement and retention of spelling words. Six
adolescents with mental retardation participated in the study. The interspersal training sessions consisted of 10 known words from the pretest presented alternately with each of 10 test words that were incorrect on the pretest. In the control condition, students were presented with 10 unknown words. The results indicated that the students acquired and maintained more words in the interspersing condition than in the control condition, where the students were presented with 10 unknown words only.

In a later study by Neef, Iwata, and Page (1980) the effects of interspersing on student achievement and retention of spelling words were further examined. Three students with mental retardation participated in the study. During the experimental condition, 10 known words from the pretest were presented alternately with 10 test words. Correct responses were praised, while incorrect responses were corrected by the examiner. The student was then required to write the words correctly 3 times. Following baseline, a high density reinforcement condition was implemented, in which the student received social reinforcement (noncontingent on correct responses) for paying attention, writing neatly, and trying hard. The results indicated that the interspersal training was effective in facilitating acquisition and retention. These findings replicate the findings of Neef et al.(1977).

Browder and Shear (1996) examined the effectiveness of interspersing known items in a treatment package to teach sight words. Three middle school students with moderate mental retardation and severe behavior disorders participated in the study. The dependent variable was the number of unknown words read correctly on a sight word test.
A second dependent variable was the percentage of error responses for unknown words. Finally, a third dependent variable was the generalization of sight word reading to the newspaper report of the weather.

A multiple probe across participants was used to examine the effectiveness of the treatment package. Ten known and 10 unknown words were presented to the students (50/50 ratio). The results indicated that the interspersal of known items positively influenced the rate of student learning. Skinner and colleagues also demonstrated that the interspersing of known items within an assignment increased student preference for the assignment (Cates & Skinner, 2000; Skinner, Fletcher, Wildmon, & Belfiore, 1996; Wildmon, Skinner, & McDade, 1998) along with the probability of students choosing to engage in assigned work (McCurdy, Skinner, Grantham, Watson, & Hindman, 2001).

In a recent study, Cates and colleagues (2003) examined the interspersing technique. The purpose of the study was to examine the extent to which taking into account instructional time and student learning rate affected academic treatment decisions. Five second grade students who had difficulties in spelling participated in the study. The students were exposed to three spelling interventions: traditional drill and practice, interspersal training, and high-p-sequencing (Cates et al., 2003).

During the traditional drill and practice sessions, students were presented with the 6 target words only. The high-p-sequencing condition consisted of presenting the 6 target words to the students and 18 known words. During this condition, 3 known words were presented before each of the target words. Finally, the interspersal condition consisted of 3 known words being added and interspersed following every third target word. The first word was a known word.
Experimental sessions were conducted on 12 consecutive school days. Students were exposed to two of the three conditions, (a) Traditional Drill and Practice (TDP), (b) Interspersing Technique (IST), and (c) High-P Sequencing. Conditions were randomly selected and presented in counterbalanced order across school days in order to control for sequence effects. Students completed each set of spelling words two times during each condition. A stopwatch was used to measure the number of seconds to complete each condition.

During each session, the experimenter read the word aloud, used the word in a sentence, and then read the word again. The experimenter then observed the student write the word on paper. All correct responses were followed with verbal praise, while incorrect responses were followed by an overcorrection procedure. The experimenter presented an index card with the word spelled correctly and instructed the student to write the word correctly three times.

Target words were counted as mastered when the student’s initial response was correct across both trials during a session. Words that were newly mastered were replaced with a new randomly chosen target word and included in the next days’ sessions. Words not mastered were used as target words during the next session. Maintenance was measured following days 6 and 12. Students were presented with a maintenance list that contained all words that he or she had mastered during the 6 treatment sessions.

The researchers used an alternating treatment design in order to compare the effects of each condition on student learning. The main dependent variables in the study were a measure of instructional effectiveness and a measure of instructional efficiency.
The measure of instructional effectiveness was the cumulative number of target words learned across conditions, and learning rate was a measure of instructional efficiency (number of words learned per minute of instruction).

Student performance was measured and graphed in two ways, cumulative learning (does not consider the amount of instructional time) and student learning rate (measurement does consider instructional time). The results of the study indicated that each student learned about the same number of words in each of the conditions. However, when considering learning rate, the researchers found that the students learned more words under the traditional drill and practice condition. Maintenance was high, ranging from 85% to 100%. The lowest learning rates occurred under the high-p-sequencing condition, although, one student demonstrated a higher learning rate under the interspersal condition (Cates et al., 2003).

Joseph and Nist (in press) extended the research by Cates and colleagues (2003) to determine if instructional conditions produced similar findings for cumulative word reading acquisition and learning rate. Joseph and Nist extended their investigation and included modeling and corrective feedback, and also examined word reading as opposed to spelling. Two fifth grade students and one sixth grade student participated in the study. In order to establish word reading levels, the students were administered the Letter-Word Identification subtest of the Woodcock-Johnson Tests of Achievement-Third Edition (WJ-III).

Both known and unknown words were included in the study. Before beginning the study, students were assessed in order to develop a bank of known and unknown words. There were a total of 100 words that were included in the initial assessment.
Words were taken from the teachers’ graded word lists derived from informal reading inventory materials used in the classroom. The words contained three to five syllables.

Each student was presented with 3-inch x 5-inch index cards with words printed on them. The students were given three seconds to read the words. During the initial assessment, words read incorrectly were ignored, and no corrective feedback was given. The experimenter provided verbal praise (“That’s Right,” “Good,” “That’s Correct”) for all correct responses. For each student, words read correctly were used as known words, and words read incorrectly were used as unknown words. Known words were used in two of the three experimental conditions. For each student, all unknown words were randomly selected and taught in one of three conditions. Six unknown words were taught per condition.

Students participated in three different conditions, each with a different set of six randomly selected words. One condition consisted of a less challenging ratio of unknown to known words (6 unknown to 18 known) and called the high-p sequencing (HPS). In this condition, three known words were presented prior to each unknown word. Interspersal training (IST) consisted of presenting three known words interspersed following the presentation of every third unknown word. The traditional drill and practice (TDP) condition consisted of presenting only the six unknown words.

In each condition, modeling was provided, which consisted of the experimenter reading an unknown word when it appeared for the first time in the stack of index cards for High-P, IST, and TDP. Verbal praise was given for correct responses, and corrective feedback was given immediately following an incorrect response. After all the words in each instructional condition were presented once, the index cards were shuffled and a
second trial with corrective feedback only was provided. Unknown words were considered mastered when the student correctly read the word on both trials. Maintenance was measured the day after the eighth session.

An alternating treatment design was used to compare the effects of each condition on student learning. Experimental sessions were conducted on 8 consecutive school days. The experimenter used a stopwatch to measure the number of seconds to complete each instructional condition. The dependent variables were a measure of instructional effectiveness and a measure of instructional efficiency. The results yielded some variability across participants in regards to cumulative learning to read unknown words across instructional conditions, however, all participants demonstrated higher cumulative rates of learning to read unknown words under the TDP condition, which is consistent with the findings in the Cates et al. (2003) study. In addition, cumulative learning rate was also greater under the TDP condition in both the studies.

**Incremental rehearsal.** Incremental rehearsal is an interspersing procedure that has been used to facilitate learning. Incremental rehearsal uses a high repetition of words and a slow introduction of unknown items. Numerous repetitions of new words are reached by presenting the new word, pronouncing it, defining it, and using the word in a sentence (MacQuarrie, Tucker, Burns, & Hartman, 2002).

Roberts and Shapiro (1996) examined how differentially fixed instructional ratios of known to unknown vocabulary words affected students’ reading progress. They indicated that rehearsal procedures that consisted of a high percentage of known words may lead to a lower number of words initially learned, but better retention.
MacQuarrie et al. (2002) conducted a study in order to compare the retention of words learned through Drill Sandwich, Incremental Rehearsal, and a traditional approach to flashcard instruction of 100% unknown words. Participants were taught words from the Esperanto International Language. Twenty-five third-grade students and 26 seventh-grade students participated in the study. Each student was taught 27 unknown words in three sessions of 9 words each. One randomly selected condition was administered each day. In addition, retention checks were conducted prior to the instructional conditions.

The control condition consisted of a traditional approach to using flashcards. Words were presented individually on flashcards, and the child had to pronounce the word and recall the English translation. The students were not told if the word was correct, nor did they receive any reinforcement. Words were presented until they were all mastered (correctly pronouncing and recalling the translation 3 times).

Drill Sandwich was the second condition. The 9 words were presented to students in sets of 3. The first 3 unknown words were included with 6 known words. All 9 unknown words were practiced three times, with the 6 known words interspersed. Following 3 repetitions, 3 of the known words were removed from the set and replaced by 3 previous unknown words, which were then treated as the first three known words. New words were also introduced on flashcards during the incremental rehearsal condition. During this condition, the unknown words were introduced one at a time.

The results of the study indicated that the incremental rehearsal condition produced better retention than drill sandwich or the traditional flashcard approach. The researchers noted that incremental rehearsal may be more successful for retention when rehearsing drill tasks (2002). Also, the study indicated that incremental rehearsal could
be a useful way for students to rehearse rote-learning material in an individual drill setting (MacQuarrie et al., 2002). In addition to instructional effectiveness, instructional efficiency should also be considered. This refers to the length of time needed to administer the intervention. Although incremental rehearsal sessions took twice as long as the drill sandwich sessions to administer, they produced far better results. (MacQuarrie et al., 2002).

**Statement of the problem.** There have been sets of studies that indicate that Incremental Rehearsal (IR) is a type of interspersal technique that leads to better retention due to repeated exposures of the target words. In addition, recent studies comparing Traditional Drill and Practice and an Interspersal Technique have found Traditional Drill and Practice to be more efficient but not more effective than Interspersal. However, what we don’t know is whether Incremental Rehearsal would be more effective and efficient in producing greater retention over the other two procedures. The study will also determine if children maintained mastered words that were taught in the Incremental Rehearsal Condition.

**Purpose of the study.** The current study is an extension of the research conducted by Cates et al. (2003). The main purpose of the study was to examine the instructional effectiveness and efficiency of three word reading interventions on students’ cumulative number of words read accurately and cumulative learning rate. Specifically, the study examined whether the Incremental Rehearsal approach is more effective and efficient over time because it embeds repeated opportunities to read the same word nine times. In other words, does the IR condition yield greater durability or longer lasting effects? The
study also examined the maintenance and generalization of words that were taught under the three instructional conditions. Social validity of the three instructional methods was also assessed.

Like the Cates study, the current study focused on intervention effectiveness and efficiency. School psychologists are often asked to provide interventions to teachers and staff for students with reading difficulty. Because the amount of time teachers have to spend on interventions is limited, it is important to consider interventions that are not only effective but also efficient. While many interventions are evaluated on their effectiveness, few are evaluated for both effectiveness and efficiency.

The high-P sequencing (HPS) condition was not implemented in the current study. The main reason is that Cates and colleagues found that the HPS condition, with high ratios of known items to unknown items, might reduce learning rates (Cates et al., 2003). Instead, the incremental rehearsal technique was added to the current study.

The current study also extended the Cates et al. (2003) study by centering on word reading instead of spelling. The current study also included a generalization measure, one measuring transfer of the same skill in a different context, and the other measuring transfer to a different skill (i.e. spelling). In order to further contribute to the body of research, a social validity measure was also added. Finally, the current study controlled for the number of seconds that passed between the presentations of notecards.
Research Questions for Study 1.

For the purpose of this investigation, the following questions were posed:

1. Based on the number of cumulative words read, which of the following three methods: (a) Traditional Drill and Practice (TDP), (b) Interspersal Technique (IST), or (c) Incremental Rehearsal (IR) is the most effective on the number of cumulative words read accurately on a next day retention probe for individual students as well as for students as a group?

2. Which of the following methods: (a) TDP, (b) IST, or (c) IR is the most efficient, as measured by learning rate, on the number of cumulative words read accurately on a next day retention probe for individual students as well as for students as a group?

3. Which of the following methods: (a) TDP, (b) IST, or (c) IR is the most effective for maintaining recognition of mastered words?

4. Which of the following methods: (a) TDP, (b) IST, or (c) IR is the most efficient for maintaining recognition of mastered words?

5. Which of the following methods: (a) TDP, (b) IST, or (c) IR is the most effective on students’ ability to generalize mastered words to spelling?

6. Which of the following methods: (a) TDP, (b) IST, or (c) IR is the most effective on students’ ability to correctly read the mastered word in a sentence?

7. Are the three instructional approaches a socially valid way to assess and teach word reading skills to students with reading difficulties?
Significance of the Study

This study is particularly significant in that it assessed the instructional effectiveness and efficiency of interspersal training, traditional drill and practice, and incremental rehearsal. Therefore, it provided a more in-depth analysis of the overall effects of the three different approaches for students with reading difficulties.

The research findings in the current study will assist classroom teachers in determining which interventions are most effective and efficient in terms of increasing word reading performance. This research will provide information to the school district about the effectiveness of these instructional methods with students who are in need of word reading intervention. Lastly, the information may also provide evidence of an effective early intervention that can be used with students experiencing word reading difficulty.

Study 2

Statement of the Problem

There has been a set of studies that indicate that Incremental Rehearsal (IR) is a type of interspersal technique that leads to better retention due to repeated exposures of the target words. However, what we don’t know is whether Incremental Rehearsal will lead to greater effectiveness and better retention when the number of trials of both Traditional Drill (TDP) and Interspersing (IST) is increased to nine.

Purpose of the Study

This study examined the relative effectiveness and efficiency of (a) Traditional Drill and Practice, (b) Interspersing, and (c) Incremental Rehearsal technique (IST) when
the number of trials for traditional and practice (TDP) and interspersal technique (IST) was controlled for. Incremental Rehearsal (IR) provides repeated exposure to read the unknown words nine times throughout each session. Therefore, in Study 2, students were presented nine trials of both the interspersing instructional condition and the traditional drill and practice instructional condition.

Research Questions for Study 2

For the purpose of this investigation, the following questions were posed:

1. Based on the number of cumulative words read and the number of trials students were exposed to, which of the following three methods: (a) Traditional Drill and Practice (TDP), (b) Interspersal Technique (IST), or (c) Incremental Rehearsal (IR) is the most effective on the number of cumulative words read accurately on a next day retention probe for individual students as well as for students as a group?

2. Which of the following methods: (a) TDP, (b) IST, or (c) IR is the most efficient, as measured by learning rate, on the number of cumulative words read accurately on a next day retention probe for individual students as well as for students as a group when the number of trials of IST and TDP is controlled for?

3. Which of the following methods: (a) TDP, (b) IST, or (c) IR is the most effective for maintaining recognition of mastered words when the number of trials of TDP and IST is controlled for?

4. Which of the following methods: (a) TDP, (b) IST, or (c) IR is the most efficient for maintaining recognition of mastered words when the number of trials of TDP and IST is controlled for?
5. Which of the following methods: (a) TDP, (b) IST, or (c) IR is the most effective on students’ ability to generalize mastered words to spelling when the number of trials of TDP and IST is controlled for?

6. Which of the following methods: (a) TDP, (b) IST, or (c) IR is the most effective on students’ ability to correctly read the mastered word in a sentence when the number of trials of TDP and IST is controlled for?

Significance of the Study

This study is particularly significant in that it will assess the instructional effectiveness and efficiency of interspersal training, traditional drill and practice, and incremental rehearsal, when the number of trials under the traditional drill and interspersing instructional conditions is increased to nine. The research findings in the current study will help determine if the effectiveness of the incremental rehearsal technique is due to the incremental presentation of words or the repetitiveness of the unknown words.
CHAPTER 2

REVIEW OF LITERATURE

This chapter will provide a discussion of word identification and word recognition and their importance in the reading process. The chapter will conclude with a discussion of the use of traditional drill and practice procedures, interspersing procedures, and the incremental rehearsal approach as specific instructional approaches to supplement classroom reading instruction for students identified as having poor word identification skills, as well as a discussion of instructional effectiveness/efficiency and opportunity to respond.

Word Identification

Word identification skills are strategies a reader uses when he or she does not recognize a word automatically. Such skills have been found to be highly related to reading performance (McCormick, 1999). Successful reading acquisition necessitates that children develop efficient ways for identifying unfamiliar words in text. Efficient word identification strategies are important in the development of rapid word recognition ability (Tunmer & Chapman, 2002). High levels of automaticity in word recognition free up cognitive resources for allowance to comprehend text, which is essential for learning to read (Perfetti, 1985). Once a student becomes competent in the use of word
identification strategies, they can usually read unfamiliar words independently (McCormick, 1999). In addition, once a student employs these strategies, major progress is made in the number of words they can read (Juel, 1991). Therefore, developing word identification strategies facilitates comprehension because students are able to read more (Daneman, 1991).

There are two common strategies that beginning readers commonly implement to identify unfamiliar words in text, and they are text-based strategies and word-based strategies (Tunmer & Chapman, 2002). Tunmer and Chapman described text-based strategies as the use of picture cues, semantic cues (which indicate whether the attempted response satisfies the semantic constraints of the sentence; e.g., “The ball at the sandwich”), syntactic cues (which indicate whether the attempted response satisfies the grammatical constraints of the sentence; e.g., “The boy slept the door”), preceding passage content, and prior knowledge activated by the developing meaning of the text. Word based strategies reportedly contain the use of correspondences between single letters or digraphs and single phonemes, correspondences between groups of graphemes (e.g., tion) and groups of phonemes (e.g., /shun/), orthographic analogies (i.e., reading an unknown word like that by an analogy to a known word like hat), and polyphonic letter patterns (e.g., ear as in bear and hear, where children produce alternative pronunciations of the word until one is produced that matches a word in their listening vocabulary).

Tunmer and Chapman (2002) recently examined beginning readers’ reported word identification strategies for identifying unfamiliar words in text in relation to reading achievement, reading-related skills, and academic self-perceptions. The results indicated that children who reported using word-based strategies showed superior reading
and reading-related performance, and reported more positive self-efficacy beliefs in reading and more positive academic self-concepts than children who indicated using text-based strategies.

Hammill, Mather, Allen, and Roberts (2002) also evaluated the relative importance of semantic, grammatical, phonological, and rapid naming abilities in predicting word identification in a sample of 200 students enrolled in the first through sixth grade. Composite measures of these abilities indicated significant correlation with word identification. Multiple regression analyses showed that among younger children in the beginning stages of learning to read and children whose word identification skills were below average, the phonology and rapid naming composites accounted for the greatest variance in predicting word identification skills. The semantics composite resulted in the most variance among older children and those proficient in word identification skills.

The most significant analysis of this study assessed the practical value of using the composites to predict poor word identification skills in children. In order to be considered practically useful, the authors reported that all predictive outcome values had to be .75 or greater. None of the composites that were studied met this standard. Therefore, the results of this study reportedly question the accuracy and usefulness of using any of the abilities studied to predict which students are at risk for or have poor word identification skills (Hammill, et al., 2002). It is imperative that children develop reliable word identification skills in order to be successful in the reading process. Word identification skills accelerate reading acquisition and are necessary for the development of rapid word recognition ability (Tunmer & Chapman, 2002).
In order to develop reading fluency, readers must obtain both word identification strategies and sight word recognition strategies (McCormick, 1999). Stanovich (1991) refers to word recognition as linking the printed representation of a word with its meaning. It is the process of seeing a word and accessing its meaning. Word recognition is important because higher order reading skills such as comprehension, vocabulary development, enjoyable reading, and writing are dependent on word recognition (Stanovich, 1991). In addition, word recognition is fundamental to reading acquisition (Daneman, 1991; Juel, 1991). Students at the beginning stages of word learning must often read words by sight because they do not yet have sufficient concepts and skills for reading words through phonological recoding systems, in other words, they have not yet internalized the prerequisites to word identification strategies (Ehri, 1991). Sight word reading, sometimes referred to as whole word reading, can be successfully taught with systematic instruction (Browder & Snell, 2000; Slaton, Schuster, Collins, & Camine, 1994). With practice, all words can be read automatically by sight, which is the most resourceful way to read words in text (Ehri, 2005).

Accuracy and fluency in reading improve through practice. Standard practice interventions for increasing word accuracy usually include strategies such as prompting and modeling during sight word drills (Espin & Deno, 1989). Rinaldi, Sells, and McLaughlin (1997) conducted a study in order to determine the effectiveness of using the “reading racetrack” practice procedure and precision teaching techniques to increase the fluency of reading isolated Dolch Sight words by elementary students. Ten students
receiving special education services participated in the study. There were two different racetracks, each contained 28 cells. The words read on the racetracks were taken from the lists of Dolch Sight Words sets 1-4 that were often used in the school district. The first type of racetrack contained seven target words that were repeated in random order. Every fifth racetrack was a review racetrack that contained the accumulation of the 28 different words introduced in the four previous racetracks. There were two dependent variables in the study. The first was the number of words read correctly from the reading racetrack during a one minute timing, and the second was the frequency of errors during the same one minute timed reading (Rinaldi, Sells, & McLaughlin, 1997).

During baseline, the participants read the lists of Dolch Sight Words orally as they normally appeared, and no instruction was provided. The participants were told to read the lists of words as quickly as they could, and after one minute they were told to stop. The procedures used during the reading racetracks were similar to those during the baseline condition. However, the reading racetracks were used in place of the Dolch Sight Word lists. Participants were given the reading racetrack that he or she was working on.

The participants read the words on the racetrack for one minute. Following each one minute timing, the participant counted the number of words that he or she read. The instructor tallied the number of errors and provided feedback to the participant. Participants remained on a given racetrack until they reached the criterion of 90 words read correctly per minute with zero errors. Rinaldi and colleagues found that with the
implementation of the reading racetrack, there was an immediate increase in the number of words read correctly by each participant. In addition, the reading racetrack procedure also eliminated nearly all errors (1997).

In a later study conducted by Valleley, Evans, and Allen (2002), a parent was trained to implement a sight word flash card drill and an overcorrection reading procedure to provide additional reading opportunity for her son. A seven-year-old male diagnosed with a learning disability participated in the case study. The two dependent variables in the study were sight word knowledge and reading fluency. Sight word knowledge was measured using the Dolch Basic Sight Word List at the pre-primer level. Reading fluency was defined as words per minute correct during brief reading assessments.

During the initial assessment, the participant correctly identified 22 out of a possible 86 pre-primer Dolch Sight Words. Children in second grade would usually be expected to correctly identify all 86 words. The participant also read out loud a beginning first grade passage, and correctly read 8 words per minute. A typical second student would be expected to read at least 40 words per minute (Fuchs & Deno, 1982).

Following the baseline assessment, the parent began the implementation of a sight word flashcard procedure that involved modeling, feedback, and adding new words. The parent was instructed to present 14 words from the Dolch Sight Words to the participant each day, with 8 words being known. When the student incorrectly read a word, the parent modeled the correct version before placing it in the incorrect pile. Incorrect words
were reviewed until the student read them correctly. Words read correctly on three consecutive days were replaced with new unknown words (Valleley, Evans, & Allen, 2002).

An overcorrection procedure was put in place after the sight word drill had been implemented over several weeks. While reading a passage, any word errors or hesitations of more than 5 seconds resulted in the parent reading the word out loud, followed by the student repeating the word three times. The student was then required to reread the sentence and continue reading the passage. The results revealed improvements in the student’s sight word knowledge. At a three-month follow-up, improvements in sight word knowledge and reading fluency had maintained (Valleley, Evans, & Allen, 2002).

Fluency and Acquisition.

When sight words are known well enough, readers can identify their pronunciations and meanings automatically without any attention or effort at sounding out letters (LaBerge & Samuels, 1974). Quick and natural recognition of words presented in isolation is essential for successful reading (Carmine, Silbert, Kameenui, & Tarver, 2004). Reading fluency is important because fluent reading has often been linked to comprehension (Fuchs, Fuchs, Hosp, & Jenkins, 2001). Fluency is important for comprehension and quick and effortless word recognition is imperative for fluency. Therefore, success at improving word recognition could improve fluency, which would likely improve comprehension (Burns, 2002).

McCormick indicated that when a reader is able to recognize a word, and can say the word without hesitation, he or she has developed automaticity. High levels of
automaticity in word recognition free up cognitive resources for distribution to
comprehension and text integration processes, which are both critical in learning to read
(Perfetti, 1985).

Unitization is another important component of sight word reading. Unitization
refers to words being read as single units with no pauses between word parts (Ehri &
Wilce, 1983). Ehri and Wilce (1993) had students read familiar object words, such as
book, man, car, and tree, read consonant-vowel-consonant (CVC) nonwords, and name
single digits. Younger skilled and older less skilled readers who were reading at a second
and fourth grade equivalent levels were studied. The researchers measured their latencies
to read each type of stimulus. The results indicated that both groups read the familiar
words much faster than the unfamiliar nonwords. However, the skilled readers at both
grade levels read the words as quickly as they named the single digits. This indicates that
the words were read as single, whole units instead of as letters processed sequentially.
Those readers who were less skilled did not show unitization until the fourth grade,
which is consistent with other findings showing that poor readers have difficulty with
sight word reading (Ehri & Saltmarsh, 1995).

Chard, Simmons, and Kameenui (1989) reviewed the word recognition research.
They identified four prerequisite conditions to strong word recognition. The first two
conditions dealt with children recognizing the existence of words in print and in speech,
and understanding that speech maps into print. Most children are able to develop both of
these prerequisite conditions by being read to and observing others reading (Chard &
Osborn, 1999).
Modeling has been shown to be an effective intervention for increasing reading accuracy (Skinner, Logan, Robinson, & Robinson, 1997). Modeling is frequently used for increasing academic performance (Hendrickson & Gable, 1981). Most definitions of modeling involve the learner observing the active demonstration of a particular response or response pattern when presented with academic stimuli. Some researchers have found that students can increase their reading accuracy by observing someone else reading accurately (McCurdy, Cundari, & Lentz, 1990). Teachers instructing students in basic phonetic skills, word attack skills, and sight word learning often utilize modeling as part of their instructional interventions.

Phonological awareness is the third prerequisite for word recognition. Phonological awareness has been defined as being aware and operating on the speech sounds in words (Blachman, Ball, Black, and Tangel, 1994). Despite the importance of phonological awareness, it remains questionable as to whether phonological awareness is a prerequisite to word recognition, or whether it is more interactive, and therefore improved by word recognition (Chard, Simmons, & Kameenui, 1998).

Chard and colleagues (1998) identified alphabetic understanding as the fourth prerequisite condition. Alphabetic understanding refers to both an understanding that words are made up of letters that are paired with sounds (e.g., knowing what sound the “l” makes), and the ability to use letter-sound relationships to pronounce words and to spell (Simmons & Kameenui, 1998). Alphabetic understanding is important because in order for students to examine and reliably and accurately read words, they must understand that written words are constructed of individual letters and apply their letter-sound knowledge to these letters (Chard & Osborn, 1999).
When readers acquire adequate knowledge of the alphabetic system, they are able to learn sight words quickly and retain them. Reitsma (1983) taught Dutch first graders to read a set of words. The results indicated that a minimum of four practice trials was enough to enable students to read the words automatically. Share (2004) indicated that only one exposure to words enabled Israeli third graders to retain the spellings of specific words a month later.

Word Recognition Phases

The pre-alphabetic phase is the phase in which word recognition begins (Ehri & McCormick, 1998). The following behaviors are characteristic of this phase:  (1). The student can read a small number of words in isolation. (2). The student only needs minimal clues to read the word, such as its length or shape to remember it. (3). Letters are often not used as cues to recognize a word. (4). If the student does consider letters, attention is directed only to certain ones. (5). Letter-sound correspondences are not used. (6). The student learns best when only a few words are presented at a time. (7). Students remember a word only after numerous exposures to it.

The next phase is referred to as the partial-alphabetic phase by Ehri and McCormick (1998). During this phase the following behaviors are evident:  (1). The student identifies more words in context-free conditions than in the initial phase. (2). Fewer exposures are needed to remember and learn words. (3). There is an analysis of words into letters. (4). Dependable recall of some letter clues is evident. (5). Beginning and ending sounds are sometimes used to help with word recognition. (6). Words are primarily read by sight instead of through application of sounds.
The word learning characteristics of Phases 1 and 2 are often seen in preschool or kindergarten children, or in students in early first grade reading instruction. Older students with reading disabilities may also display those characteristics (McCormick, 1999).

The third phase has been termed the *full alphabetic* phase. The following characteristics are seen in this phase: (1). Students start to employ more letter-sound relationships. (2). When students first start to utilize more sound-related cues, they may decode words slowly by each letter. (3). Gradually, students move on to a phase where words are decoded quicker. (4). Many words are identified through sound-symbol decoding, but are also learned by sight. (5). The number of words a reader can learn in a given amount of time significantly increases. (6). Word recognition and identification are more consistently correct than in the previous phases. (7). More real-word substitutions occur than do nonsense words when errors do occur.

Phase four is referred to as the *consolidated alphabetic* phase. During this phase, students start to see regular sequences or spelling patterns, which aid them in reading words. Such word learning typically develops in normally achieving readers during the second grade. The final phase is the *automatic* stage (Chall, 1983). During this phase, most words are recognized by sight. The reader has developed numerous ways to learn and recognize words, which can be used when a word is unknown (McCormick, 1999).

After reviewing the literature on word recognition and word identification, it is evident that there are many different ways in which these important reading skills can develop. Next, several instructional approaches to enhance word reading performance will be discussed.
Traditional Drill and Practice

Chase and Symonds (1992) indicated that “the most effective device that can be applied to learning is to increase the amount of drill and practice (p. 289).” Many researchers have indicated that for students to develop complex skills such as solving math problems, writing compositions, or comprehending, it is imperative that they develop fluency with the tool skills involved (e.g., decoding words and spelling words) (Cooke & Guzaukas, 1993). Standard drill and practice techniques consist of new material being presented over and over in isolation and/or in context for the learner to practice until the response is automatic (Cooke & Guzaukas, 1993). Drill tasks are important in academic remediation for children who do not have prerequisite skills and are not able to perform higher order tasks, but must first learn the basic information in order to move to that level (Burns, 2004).

Researchers have often analyzed different drill models as a way to increase the overall instructional effectiveness of repetition (MacQuarrie-Klender, Tucker, Burns, & Hartman, 2002). Skinner, Belfiore, and Watson (1995) suggested that in order to prevent and remedy academic skill deficits, school personnel should determine which interventions are most efficient by measuring students’ learning rates under different instructional conditions.

Drill Ratios

There has been overwhelming support for drill tasks, however, finding an appropriate level of challenge or optimal ratio of known to unknown items for drill tasks has been a topic of great discussion (Burns, 2004). Burns (2004) conducted an empirical meta-analysis of drill ratios. He examined the following groupings: <50% known, 50%
to 69% known, 70% to 85% known, and 90% known. The 90% known group had the highest median effect size coefficient and the second highest (behind the 70% to 85% group) mean effect size. The most challenging (<50% known) ratio produced a small to moderate effect. Cooke and Guzaukas (1993) indicated that while some empirical support for interspersing new and known items has been found, no studies have established any particular ratio as optimal.

Gickling and Rosenfield (1995) suggested an optimal ratio of 70% to 85% known items and 15% to 30% unknown items when practicing drill tasks. The original data suggested that children taught at these drill ratios exhibited higher rates of task completion, comprehension, and time on task. Gickling and Havertape (1981) suggested three levels of instruction that signify the degree of instructional match or mismatch between the student’s skills and the learning demands of the instructional task. An assignment that is too challenging or at a frustrational level for a student would have a ratio of 0% known items to 100% unknown items. An assignment that is very easy or at an independent level would approach a ratio of 100% known to 0% unknown items. The daily performance of students is based on a continuum between these two extremes. Gickling and Havertape indicated that an instructional ratio of level in reading consists of 93-97% known items with a 3-7% margin in challenge (unknown items), at which comprehension should be about 75% higher. Although, under conditions of drill and practice, an increased margin of challenge should be used with an instructional ratio of 70-85% known items to 15-30% unknown (Gickling & Thompson, 1985).

Cooke, Guzaukas, Pressley, and Kerr (1993) extended the research on instructional ratios and learning rates by looking at the differential effects between a 30%
acquisition-70% maintenance drill ratio and a traditional 100% acquisition. They examined the relative effects of the two conditions on acquisition of spelling words with four adolescents with emotional/behavioral disorders. The order in which the words were presented was based on suggestions made by Coulter and Coulter (1989). Data were collected for (a) the percentage of words spelled correctly on single daily probes, (b) number of words learned per session minute, (c) percentage correct on a maintenance probe every fifth session and (d) participants preference for conditions. Results indicated that accuracy levels were similar between the two conditions across daily probes. In addition, the 100% condition allowed for more words to be learned per minute across all students. The results of the five day probe indicated that the maintenance of the mastered words was also similar.

Several other studies have been conducted on different ratios of known to unknown words in order to determine the most favorable condition for retention. However, no one ratio has been found to be superior over others in leading to improved recall, and differential effectiveness has been noted across content areas being learned (MacQuarrie et al., 2002). One reason why research on instructional ratios has been so inconclusive may be due to the way in which interspersing is carried out. While some research has been carried out with complex patterns of interspersing maintenance items among acquisition items (i.e., Coulter & Coulter, 1989), other research has implemented interspersing by simply alternating maintenance and acquisition items (i.e., Neef et al., 1977, 1980). Although numerous ways of interspersing and task variation within academic learning sessions have been proposed, the degree to which these methods are time efficient and effective for increasing learning rates continues to be debated. It is
evident that research on instructional ratios has provided varied results and indicates a
need for additional research examining various optimal structures of known to unknown
items for drill tasks.

Interspersal Techniques

Researchers have investigated the notion of student choice behavior. Research
has suggested that when individuals are given the choice of two behaviors, and
everything else is held constant, individuals are more likely to engage in the behavior that
requires the least amount of effort (Billington & Skinner, 2002). Choice behavior is of
significant importance in the classroom because when students choose to engage in
assigned tasks, more than likely they will increase their skill acquisition, fluency,
generalization, and maintenance (Binder, 1996; Skinner, Fletcher, & Henington, 1996).
Techniques intended to increase the probability of students choosing to engage in
academic tasks can increase the rate of learning and decrease inappropriate behavior
(Skinner, 2002).

Neef, Iwata, and Page (1977) were among the first to study the effects of
interspersing on student achievement and retention of spelling words. Six mentally
retarded adolescents participated in the study. The interspersal training sessions
consisted of 10 known words from the pretest presented alternately with each of 10 test
words that were incorrect on the pretest. In the control condition, students were
presented with 10 unknown words. The results indicated that the students acquired and
maintained more words in the interspersing condition than in the control condition, where
the students were presented with 10 unknown words only.
In a later study by Neef, Iwata, and Page (1980), they examined the effects of interspersing on student achievement and retention of spelling words. Three mentally retarded students participated in the study. During the experimental condition, 10 known words from the pretest were presented alternately with 10 test words. Correct responses were praised, while incorrect responses were corrected by the examiner. The student was then required to write the words correctly 3 times. Following baseline, a high density reinforcement condition was implemented, where the student received social reinforcement (noncontingent on correct responses) for behaviors such as: paying attention, writing neatly, and trying hard. The results indicated that the interspersal training was effective in facilitating acquisition and retention. These findings replicate the findings of Neef, Iwata, and Page (1977).

Cooke and Gazaukas (1993) conducted a study in order to compare the effects of 2 ratios on multiplication fact fluency. Three students diagnosed with learning disabilities participated in the study. The main dependent variable was the number of correctly written digits per minute on daily generalization probes, and the second dependent variable was the number of correct answers to oral maintenance tests of mastered facts. An alternating treatment design was also used in this study. The results of this study indicated that the students were more fluent in their math facts during the 30/70% ratio condition, as compared to the 100% condition.

Browder and Shear (1996) examined the effectiveness of interspersing known items in a treatment package to teach sight words. Three middle school students with moderate mental retardation and severe behavior disorders participated in the study. The dependent variable was the number of unknown words read correctly on a sight word
test. A second dependent variable was the percentage of error responses for unknown words. Finally, a third dependent variable was the generalization of sight word reading to the newspaper report of the weather. A multiple probe across participants was used to examine the effectiveness of the treatment package. Ten known and 10 unknown words were presented to the students (50/50 ratio). The results indicated that the interspersal of known items positively influenced the rate of student learning. Skinner and colleagues also demonstrated that the interspersing of known items within an assignment increased student preference for the assignment (Cates & Skinner, 2000; Skinner, Fletcher, Wildmon, & Belfiore, 1996; Wildmon, Skinner, & McDade, 1998) along with the probability of students choosing to engage in assigned work (McCurdy, Skinner, Grantham, Watson, & Hindman, 2001).

Roberts and Shapiro (1996) examined how differentially fixed instructional ratios of known to unknown vocabulary words affected students’ reading progress. They indicated that rehearsal procedures that consisted of a high percentage of known words may lead to a lower number of words initially learned, but better retention. In the MacQuarrie study (2002), a ratio of 10% unknown to 90% known led to more words being retained and less words being forgotten.

In addition to using interspersal techniques for word reading and spelling, Robinson and Skinner (2002) extended the research using standardized mathematics subtests with different task demands. Thirty seventh-grade students participated in the study. The students were given Forms A and B of the Mental Computation and Multiplication subtests of the KeyMath-Revised. The students were given a control subtest and an experimental subtest that included additional easier items interspersed
among standard items. Results indicated that the interspersal procedure improved academic performance on the Mental Computation subtest, but not the Multiplication subtest. The findings are consistent with Neef et al. (1977, 1980) who hypothesized that the interspersal technique may increase rates of reinforcement and improve attention to academic tasks and performance.

In an additional study related to mathematics, Skinner, Hurst, Teeple, and Meadows (2002) implemented an alternating treatments design in order to compare on-task levels in four students diagnosed with an emotional disturbance while working on control and experimental independent seat work mathematics assignments. The control and experimental assignments were similar except the experimental assignments contained additional briefer mathematics problems interspersed following every third problem. Skinner and colleagues reported greater on-task levels while working on experimental assignments in three of the four students.

Cates, Skinner, Watson, and Meadows et al. (2003) also conducted a study that examined instructional effectiveness and instructional efficiency. The purpose of the study was to examine the extent to which taking into account instructional time and student learning rate affected academic treatment decisions. Five second grade students that had difficulties in spelling participated in the study. The students were exposed to three spelling interventions: traditional drill and practice, interspersal training, and high-p-sequencing.

During the traditional drill and practice sessions, students were presented with the 6 target words only. The high-p-sequencing condition consisted of presenting the 6 target words to the students and 18 known words. During this condition, 3 known words were
presented before each of the target words. Finally, the interspersal condition consisted of 3 known words being added and interspersed following every third target word. The first word was a known word (2003).

The researchers used an alternating treatment design in order to compare the effects of each condition on student learning. The conditions were randomly selected and counterbalanced across school days. The main dependent variables in the study were a measure of instructional effectiveness and a measure of instructional efficiency. The measure of instructional effectiveness was the cumulative number of target words learned across conditions, and learning rate was a measure of instructional efficiency (number of words learned per minute of instruction).

The results of the study indicated that each student learned about the same number of words in each of the conditions. However, when considering learning rate, the researchers found that the students learned more words under the traditional drill and practice condition. The lowest learning rates occurred under the high-p-sequencing condition, although, one student demonstrated a higher learning rate under the interspersal condition.

Schmidgall (2005) conducted a later study that extended the research of Cates and colleagues (2003). She examined the instructional effectiveness and efficiency of three word reading interventions on student’s cumulative number of words read accurately and cumulative learning rate. Alternating treatments designs were used to compare the effects of interspersal drill and practice training (presenting one known word prior to every third unknown word), the phonic analysis method of word boxes (presenting only unknown words), and a traditional drill and practice (presenting only unknown words) on
word reading mastery. Schmidgall’s study also examined the acquisition, maintenance, and generalization of words that were taught under the three instructional conditions.

Six first grade students identified as deficient in word identification skills as measured by their performance on the Dynamic Indicators of Basic Early Literacy Skills (DIBELS) participated in Schmidgall’s study (2005). The results indicated positive effects for all three conditions in regards to enhancing the word reading performance of students in the study. The results showed that the word boxes approach was the most effective, and the traditional drill and practice approach was the most efficient in terms of increasing word reading performance. Results of the study also indicated that none of the three instructional approaches was statistically more effective in terms of student’s ability to “maintain” and “generalize” newly learned words. In addition, students demonstrated a preference for the word boxes approach as compared to the traditional drill and interspersing methods.

Several limitations were associated with the study conducted by Schmidgall (2005). Random sampling of students was not conducted; rather, students were selected for the intervention. Therefore, the study cannot be generalized beyond the sample population. Due to the small sample size of six students, it is unclear as to the extent to which other students would perform similarly under the various instructional conditions. Finally, word reading was the only academic area investigated in Schmidgall’s study. Therefore, it is unclear as to whether the findings would generalize across other academic settings.

Joseph and Nist (in press) also extended the research by Cates and colleagues (2003) to determine if instructional conditions produced similar findings for cumulative
word reading acquisition and learning rate. Joseph and Nist extended their investigation and included modeling and corrective feedback, and also examined word reading as opposed to spelling. Two fifth grade students and one sixth grade student participated in the study. In order to establish word reading levels, the students were administered the Letter-Word Identification subtest of the Woodcock-Johnson Tests of Achievement-Third Edition (WJ-III).

Both known and unknown words were included in the study. Before beginning the study, students were assessed in order to develop a bank of known and unknown words. There were a total of 100 words that were included in the initial assessment. Words were taken from the teachers’ graded word lists derived from informal reading inventory materials used in the classroom. The words contained three to five syllables.

Each student was presented with 3-inch x 5-inch index cards with words printed on them. The students were given three seconds to read the words. During the initial assessment, words read incorrectly were ignored, and no corrective feedback was given. The experimenter provided verbal praise (“That’s Right,” “Good,” “That’s Correct”) for all correct responses. For each student, words read correctly were used as known words, and words read incorrectly were used as unknown words. Known words were used in two of the three experimental conditions. For each student, all unknown words were randomly selected and taught in one of three conditions. Six unknown words were taught per condition.

Students participated in three different conditions, each with a different set of six randomly selected words. One condition consisted of a less challenging ratio of unknown to known words (6 unknown to 18 known) and called the high-p sequencing (HPS). In
this condition, three known words were presented prior to each unknown word. Interspersal training (IST) consisted of presenting three known words interspersed following the presentation of every third unknown word. The traditional drill and practice (TDP) condition consisted of presenting only the six unknown words.

In each condition, modeling was provided, which consisted of the experimenter reading an unknown word when it appeared for the first time in the stack of index cards for High-P, IST, and TDP. Verbal praise was given for correct responses, and corrective feedback was given immediately following an incorrect response. After all the words in each instructional condition were presented once, the index cards were shuffled and a second trial with corrective feedback only was provided. Unknown words were considered mastered when the student correctly read the word on both trials. Maintenance was measured the day after the eighth session.

An alternating treatment design was used to compare the effects of each condition on student learning. Experimental sessions were conducted on 8 consecutive school days. The experimenter used a stopwatch to measure the number of seconds to complete each instructional condition. The dependent variables were a measure of instructional effectiveness and a measure of instructional efficiency. The results yielded some variability across participants in regards to cumulative learning to read unknown words across instructional conditions, however, all participants demonstrated higher cumulative rates of learning to read unknown words under the TDP condition, which is consistent with the findings in the Cates et al. (2003) study. In addition, cumulative learning rate was also greater under the TDP condition in both the studies.
Several limitations exist in the study conducted by Joseph and Nist (in press). First, only three students participated in the study, therefore making it difficult to determine whether other students would perform similarly under the three instructional conditions. Second, the study was conducted over a period of only eight consecutive school days, allowing for only one maintenance session to be conducted. If the sessions would have been implemented over a longer period of time, perhaps an additional maintenance session could have taken place midway through the sessions. As in the Schmidgall (2005) study, this study assessed word reading. It would be useful to compare interspersal procedures with traditional reading approaches across curricula. Finally, the study only examined whole word reading approaches. It would be interesting to extend this research by assessing phonic analysis approaches using measures of instructional effectiveness and instructional efficiency.

**Instructional Efficiency and Effectiveness**

Research on interspersal techniques has yielded different results for instructional efficiency and instructional effectiveness. Neef et al. (1977, 1980) found that interspersing easy, known, or mastered items enhanced learning effectiveness and learning efficiency. However, Cooke and Gazaukas (1993) found that the most rapid learning rates occurred during the 100% condition, where none of the words had been mastered. Cates, Skinner, and Watson, et al. (2003) also found that the most rapid learning rates occurred during the traditional drill and practice condition, where only the 6 target words were presented to the students.

Often, learning rates are measured by increases in accuracy over time. Learning rates can be improved by increasing the quality and/or quantity of learning trials in a set
period of time (Skinner et al., 1996). Quality refers to the amount of learning during trials. Learning trials that are qualitatively stronger require fewer trials to meet a standard. Likewise, the quantity of learning trials can also enhance learning. This can be done by increasing the time allowed for participating in learning trials (Skinner et al., 1996).

In order to avoid academic difficulties, school psychologists should determine which interventions are most efficient by measuring students’ learning rates under different instructional conditions (Skinner, Belfiore, & Watson, 1995). In a study that demonstrated the importance of instructional efficiency, Skinner et al. (1995) compared the effects of two taped-words interventions on student learning. Two different dependent variables were used. During the slow taped-words intervention, words were presented every 5 seconds. During the fast taped-words intervention, words were presented one immediately after the other. The results indicated that the students learned more words under the slow taped-words intervention. When the number of words learned per minute of instructional time was graphed, results showed that the rapid taped-words intervention was superior.

Other studies have also demonstrated the importance of instructional efficiency (Skinner, Belfiore, Mace, Williams-Wilson, & Johns, 1997; Skinner, Ford, & Yunker, 1991). The interventions used in these studies were associated with respect to the number of chances to respond, but made more efficient (i.e., the time it took to complete each intervention session was reduced) by changing response topographies. The students were encouraged to give verbal responses that took relatively less time to perform, rather
than have the students write responses. The results indicated that enhancing response efficiency increased rates of active responding, and in turn, increased learning rates.

**Incremental Rehearsal**

Incremental rehearsal is an interspersing procedure that has been used to facilitate learning. Incremental Rehearsal is designed to teach new words by interspersing them among previously mastered words at a ratio of 10% unknown words to 90% known. Incremental Rehearsal is based on the techniques of errorless learning (Browder & Shear, 1996), spaced repetition (Dempster, 1991; Glenberg & Smith, 1981), the introduction of small pieces of material (Schnorr, 1989), teaching to automaticity (Dehaene & Akhavein, 1995; Jones & Christensen, 1999), and increased opportunities to respond (Greenwood, Delquadri, & Hall, 1984). Incremental rehearsal uses a high repetition of words and a slow introduction of unknown items. Numerous repetitions of new words are reached by presenting the new word, pronouncing it, defining it, and using the word in a sentence (MacQuarrie, Tucker, Burns, & Hartman, 2002). The first unknown word is presented to the child. Before the child has a chance to respond, the examiner says the word to the child. Then the first known word is presented for the child to read. Next, the first unknown word is presented again, followed by the first known word, and then a second known word for the child to read. Again, the first unknown word is presented, and the pattern is continued until all nine words are exposed to the child. Upon completion of the first unknown word, a second unknown word is introduced by treating the previous unknown word as the first known, removing the previous ninth known word, and starting the sequence over again. The ratio of unknown words to known words remains 10% unknown to 90% known (Burns, Dean, & Foley, 2004).
MacQuarrie et al. (2002) conducted a study in order to compare the retention of words learned through Drill Sandwich, Incremental Rehearsal, and a traditional approach to flashcard instruction of 100% unknown words. Participants were taught words from the Esperanto International Language. Twenty-five third-grade students and 26 seventh-grade students participated in the study. Each student was taught 27 unknown words in three sessions of 9 words each. One randomly selected condition was administered each day. In addition, retention checks were conducted prior to the instructional conditions.

The control condition consisted of a traditional approach to using flashcards. Words were presented individually on flashcards, and the child had to pronounce the word and recall the English translation. The students were not told if the word was correct, nor did they receive any reinforcement. Words were presented until they were all mastered (correctly pronouncing and recalling the translation 3 times).

Drill Sandwich was the second condition. The 9 words were presented to students in sets of 3. The first 3 unknown words were included with 6 known words. All 9 unknown words were practiced three times, with the 6 known words interspersed. Following 3 repetitions, 3 of the known words were removed from the set and replaced by 3 previous unknown words, which were then treated as the first three known words. New words were also introduced on flashcards during the incremental rehearsal condition. During this condition, the unknown words were introduced one at a time.

The results of the study indicated that the incremental rehearsal condition produced better retention than drill sandwich or the traditional flashcard approach. The researchers noted that incremental rehearsal might be more successful for retention when
rehearsing drill tasks (2002). Also, the study indicated that incremental rehearsal could be a useful way for students to rehearse rote-learning material in an individual drill setting (MacQuarrie et al., 2000).

Several limitations were noted with the MacQuarrie et al. study. First, the study did not examine time to complete each model, which is an important factor when selecting interventions. Treatment integrity or interobserver data were not collected in the study. Finally, additional research is needed to make a distinction between the effects of increased repetition and different drill ratios, and among grades and curricula not represented in the study (MacQuarrie et al., 2000).

In a later study, Burns, Dean, and Foley (2004) used the Incremental Rehearsal technique in order to improve both contextual reading fluency and comprehension. Twenty students identified with a Specific Learning Disability participated in the study. Both a control condition and an experimental condition were used in the study. In the control condition, no intervention occurred prior to the student reading the passage and answering comprehension questions. The experimental condition consisted of key words being taught to the student before reading the passage and answering comprehension questions. Words were considered “key” if they were critical to understanding the meaning of the reading passage. Twenty additional words were randomly selected from the second grade word list to serve as known words for the study. Each student was presented the key words in order to see if they could read them out loud within two seconds of presentation. Words that were not correctly identified were considered unknown and were taught to the child.
Unknown key words from one passage were taught to the students using the Incremental Rehearsal technique. The unknown words were presented in the same order as they appeared in the passage. An error occurred if the child could not read the word within two seconds of presentation or was unable to correctly read the word. The results indicated increased reading fluency, an average of 8.0 words per minute. In addition, the mean number of comprehension questions answered correctly increased by 2.4 questions (Burns, Dean, & Foley, 2004).

Burns and colleagues noted several limitations to their investigation. First, their sample was 85% male, which was an overrepresentation of males. Further, the sample size was small, meaning that it could not be determined whether other individuals would perform similarly. Finally, the students in the study were school-identified with a learning disability using state criteria. However, discrepancy models lack a universally accepted definition. Therefore, one must exhibit caution when making assumptions about generalization.

In addition to using Incremental Rehearsal for word recognition, Burns (2005) used Incremental Rehearsal to teach single-digit multiplication facts to three elementary students identified as learning disabled in math calculation. Student progress in the study was monitored with weekly curriculum-based measurement fluency probes. Once a week, students were given 35 randomly selected single-digit multiplication facts to complete. Students were given two minutes to complete the probes. The number of digits correct was counted and converted to a digits correct/minute metric by dividing the number by two.
The students were taught unknown single-digit multiplication facts. Each classroom was assigned a student researcher who taught the unknown facts to the students in the experimental condition one-on-one. Single-digit multiplication facts were identified as known and unknown by writing each of the 100 single-digit facts on index cards. The answer for the fact was not included. The cards were then shuffled and presented to the student one at a time. Correct answers given within 2 seconds were counted as known, and incorrect answers were counted as unknown. Multiplication facts were taught using Incremental Rehearsal. The first unknown fact was presented to the student, and the experimenter verbally gave the correct answer. Next, the student was asked to restate the fact and provide the correct answer. Then a known fact was provided, followed by the unknown fact, unknown fact until the sequence was repeated nine times. After completing the sequence, the first unknown fact was treated as the first known, the previous ninth known fact was removed, and a new unknown fact was introduced. The number of cards always remained 10, and ratio of unknown to known in the 9th step for each new item was 10% unknown to 90% known. Incremental rehearsal was found to be an effective intervention for increasing fluency of single-digit multiplication facts among the third-grade children who participated in the study (Burns, 2005).

Opportunity to Respond

Incremental Rehearsal is based on the practice of increased opportunity to respond. High repetition of new words is achieved by presenting the unknown word, pronouncing it, and using the word in a sentence, and practicing it nine times while showing an increasing number of known words between repetitions of the unknown word.
Research has shown that fluency and maintenance are enhanced when students engage in high rates of active accurate academic responding (Greenwood, Delquadri, & Hall, 1984; Skinner, Belfiore, Mace, Williams, & Johns, 1997).

Greenwood, Delquadri, and Hall (1984) defined opportunity to respond as “the interaction between (a) teacher-formulated instructional antecedent stimuli and (b) their success in establishing the academic responding desired or implied by the material (p. 64).” Opportunity to respond requires the teacher to arrange antecedent stimuli so that all children can give the desired responses (Cooper, Heron, & Heward, 1987). Another implication of opportunity to respond requires students to be placed in learning environments where they can emit high rates of correct responses. Cooper, Heron, and Heward (1987) reported that often students are required to respond to antecedent stimuli that set the chance for incorrect responses. The students have not obtained enough prerequisite skills to respond correctly. A final implication of opportunity to respond is the significance of active responding rather than passive responding. Active academic responding refers to behaviors such as calculating math facts, reading orally, pointing to a word, and asking questions. Passive responding includes watching a teacher present a lecture, raising hand, and waiting for teacher help. Greenwood and colleagues (1984) indicated that passive responding represented as much as 45% of instructional time during the school day. This suggests that active responding to antecedent stimuli may be a significant correlate of academic achievement.

Carnine (1976) evaluated the effect of increased opportunity to respond on the percentage of correct reading responses by two first-grade students who exhibited high rates of off-task behaviors. In addition, the students also had significant academic
deficits. Opportunities to respond were elevated by increasing the presentation rate of academic requests. During the fast presentation condition, the teacher gave a new task right after a student’s correct response. In the slow presentation condition, the teacher waited five seconds after a correct response before presenting the next task. The results showed that the teacher was able to exhibit control over the presentation rate of the academic requests. The faster presentation rate led to increased percentages of correct responses across students.

West and Sloane (1986) also investigated the effect of increased opportunity to respond. Five students identified with an Emotional Behavioral Disorder (EBD) were observed each day for four separate 15-minute sessions (reading, math, spelling, and functional skills). Increased opportunity to respond was manipulated through presentation rate. All combinations of fast (20 second) and slow (60 second) presentation rates were examined. The results showed a slight difference between fast and slow presentation rates for accuracy, but students had 2.4 correct responses per minute during the fast condition, compared to .9 per minute during the slow presentation rate condition. Although having increased opportunity to respond led to slightly more errors, the rate of correct responding during this condition was higher than during the slow presentation rate (West & Sloane, 1986).

Skinner and Shapiro (1989) evaluated the effect of increased opportunity to respond using taped words and drill interventions (2 opportunities to respond) and continuous and intermittent assessment (1 opportunity to respond). Five high school students participated in the study. Results of the study indicated that having more opportunities to respond led to increased rates of words read correctly and decreased rates
of words read incorrectly. The mean number of words read correctly per minute was 78 for the conditions offering two opportunities to respond, and the mean number read correctly for the conditions offering one opportunity to respond was 54 (Skinner & Shapiro, 1989).

In addition, Skinner, Ford, and Yunker (1991) examined the effects of increased opportunity to respond on two students with EBD by using a verbal cover, copy, and compare intervention (VCCC); a written cover, copy, and compare (WCCC); and no treatment. Students were trained in the WCCC intervention to look at the math problem, cover the problem and answer, write the problem and answer, uncover the problem and answer, and evaluate what was written. The VCCC intervention required the students to verbally state the problem and answer. Data showed that the VCCC intervention led to approximately 2.5 times as many opportunities to respond as the WCCC intervention during the same amount of time. The mean percentage of problems correct was 74 for the VCCC intervention and 68 for the WCCC intervention and no treatment combined. The VCCC intervention also resulted in 28 digits correct per minute, 20 digits correct per minute for the WCCC intervention and no treatment condition combined (Skinner et al., 1991).

Finally, Skinner, Smith, and McClean (1994) increased the opportunity to respond by increasing the presentation rate, in addition to requiring increased responses from participants during two intervention conditions. An alternating treatment design was used to evaluate the effect of two interventions, 1-second and 5-second presentation rates on the number of reading words mastered by three elementary students. Students were given three opportunities to respond per target word during each of the interventions,
compared to one opportunity to respond per target reading word during the no-treatment condition. The results indicated that both interventions led to increased mastery of words across all students. The presentation rates of 1 and 5 seconds did not differ. Across students, the 5 second presentation rate took an average of 103 seconds longer per session than the 1 second presentation rate and may have characterized a somewhat more efficient use of instructional time (Skinner et al., 1994).

Summary

Early identification and intervention for students at risk of reading failure is a significant factor in preventing reading difficulties. Instructional approaches that emphasize word identification have been found to significantly improve the reading performance of students with word reading difficulties. The purpose of the following study is to determine the effectiveness and efficiency of three different instructional approaches (traditional drill and practice, interspersing, and incremental rehearsal) on study word reading performance.
CHAPTER 3

METHODOLOGY

This chapter describes the methods of the study. The following sections are discussed: subject selection, setting, role of the researcher, materials, and definition and measurement of the dependent variables. Procedures including initial assessment, experimental conditions, random sampling, experimental design, experimental procedures, maintenance assessment, generality, social validity, interscorer agreement, and treatment integrity will be discussed.

Subject Selection

Participants were 6 first grade students from a suburban elementary school in Central Ohio. The school district is the second largest in the county and the sixth largest in Ohio. It consists of seventeen elementary schools, five intermediate schools, five middle schools, and four high schools. There are approximately 21,000 students in the district.

Students were recruited by first obtaining approval to conduct the study from school administrators and the university’s Institutional Review Board. Students with reading difficulty were selected through teacher referral to the school’s Care Team, which meets weekly to provide interventions to those students having difficulty in the
classroom. Those students were referred based on their performance on the Developmental Reading Assessment (DRA). The DRA provides a method of assessing and documenting primary students’ development as readers over time within a literature based instructional reading program (Beaver, 1997).

Once the students were identified, parents of the students were contacted by the experimenter. The experimenter explained the purpose of the study, issues of confidentiality, and the reporting of results. Parents also received an informational form explaining the nature of the study as well as a consent form for permitting their child to participate in the study.

Setting

The instructional interventions were conducted in an office at the elementary school. The intervention took place at a circular table that comfortably sat the experimenter and the student. Lighting in the room was adequate for the implementation of the three interventions.

Role of the Researcher

The researcher is a female, doctoral candidate in the School Psychology program at the Ohio State University. The researcher is a full-time School Psychologist serving a public school district in Central Ohio. She has obtained National Certification through the National Association of School Psychologists. In the study, the researcher administered, scored, and interpreted the results of all assessments during the screening, treatment, and maintenance phases of the study.
Materials

Materials used in the study were paper and pencils, a stopwatch, and 4-inch by 6-inch index cards with words printed on them.

Definition and Measurement of the Dependent Variables

The primary dependent variables in the study included a measure of instructional effectiveness and a measure of instructional efficiency. Instructional effectiveness was measured by the number of words read correctly, and the number of words read correctly on maintenance probes. In order for a word to be considered correct, the student was required to read the word as a whole on the retention probe that was administered the day after the instructional conditions were presented. For example, the word “dog” would need to be read as a whole word, not as “d” or “do,” etc. The cumulative number of target/unknown words mastered across conditions served as a measure of instructional effectiveness. For example, if 3 words were read correctly during the first session and 5 words were read correctly during the second session, then the cumulative number of words read correctly would be 8.

Instructional efficiency was defined as the rate of accurate responding, relative to time. In this study, rate refers to the number of words read per minute of instruction. The experimenter began timing the session as soon as the first index card was presented, and stopped timing the session after the last word in the session was read out loud by the student. Words were considered mastered when a correct response was provided the next day on the retention measure. In addition, a weekly probe was administered during the last day of the week. Retention rates were calculated by multiplying the number of words mastered during the session by 60 seconds and then dividing by the amount of
instructional time (in seconds) spent under each respective condition during the session. For each condition, the number of words mastered per minute was added across sessions to gain a measure of cumulative learning rates across sessions that could be compared to the instructional effectiveness data. For example, if a rate of 2 words per minute was read during the first session and a rate of 4 words per minute during the second session, a cumulative learning rate of 6 words per minute would be recorded for the two sessions. The number of words read correctly was recorded for the maintenance assessment. Maintenance rate was calculated in a similar fashion; the number of mastered words maintained was multiplied by 60 and divided by the cumulative amount of instructional time (in seconds) spent in each respective condition (Incremental Rehearsal, Traditional Drill and Practice, and Interspersal).

Procedures

Initial Assessment. The current study included both “known” and “target” or “unknown” words. Before beginning the study, students were assessed with a screener in order to obtain a list of “known” and “unknown” words for each student. The researcher randomly selected 100 words consisting of an equal number of CVC, CVCV, CVVC, and CVCC consonant (C) and vowel (V) patterns from various instructional reading texts. The researcher then created the presentation order of words for the screener by writing the words on index cards and then shuffling the cards for random ordering. Each student was presented with the same initial 100 randomly selected words printed on flashcards. The words were presented twice to each student, and were presented to each student in the same order. Correct responses were followed by verbal praise from the experimenter (e.g., “Good job!”). All incorrect responses were ignored. Words recognized incorrectly
on both trials were considered “unknown,” and were randomly chosen to be taught in one of the three experimental conditions. Words recognized correctly on both trials were considered “known” and used in the interspersing of known items and the incremental rehearsal experimental condition.

**Pretest.** A pretest was conducted prior to implementing the three instructional conditions. Words that were incorrectly read on both trials of the screener (unknown words) were presented to the students in the form of a spelling test. In addition, the unknown words were also presented in sentences to the students.

**Random Selection.** In order to control for word difficulty levels, initial lists were constructed for each student by randomly assigning six target/unknown words from the screener to each condition. Words were randomly selected from each of the four consonant-vowel patterns (CVC, CVCV, CVVC, and CVCC) for the first session as well as each additional treatment session by rotating through the order of patterns. For example, the first list of six words would consist of CVC, CVCV, CVVC, CVCC, CVC, and CVCV patterns. The second list of six words would consist of CVVC, CVCC, CVC, CVCV, CVVC and CVCC patterns. Therefore, the same word would not appear in more than one instructional condition throughout the sessions. After the initial lists were established for each condition, the remaining target words were randomly assigned to each list after students mastered a target word in that list. Therefore, each list always contained six target words, but those words changed as a student mastered words.
Known words were also randomly selected for both the interspersal and incremental rehearsal conditions, following the same procedures as above so as to ensure that the same known word would not appear in more than one instructional condition throughout the sessions.

**Experimental Conditions**

During each session, the students were exposed to three different conditions, each with a different set of randomly selected words. These conditions included interspersal training (IST), traditional drill and practice (TDP), and incremental rehearsal (IR).

**Experimental Design**

Alternating treatment designs were implemented to compare the effects of each instructional condition on student learning and learning rate. Alternating treatment designs require the rapid alteration of two or more conditions. This design was chosen because it is suitable for comparing the effects of two or more interventions over brief periods of time (Barlow & Hersen, 1984). With an alternating treatment design, an equal number of observation days usually occur for each of the interventions being compared (Barlow & Hayes, 1979). This design requires that the experimental procedures be carefully analyzed to make certain that all conditions will be identical, except for the independent variables that are being examined (Holcombe & Wolery, 1994). One intervention is judged to be more effective than another when a consistent difference occurs in the level of the respective data patterns (Tawney & Gast, 1984).
Study 1

Experimental Procedures

During each session, students were exposed to all three conditions (IST, TDP, and IR). Conditions were randomly selected and presented in counterbalanced order across school days to control for sequence effects. For instance, the order for the first session would be IST, IR, TDP, and IR, TDP, IST, for the second, etc. The experimenter used a stopwatch to measure the number of seconds it took to complete each condition. Timing began as soon as the first word in the condition was presented and ended after the student read the last word. On the following day, students were presented with a retention probe, where they had to read the 6 target words from each instructional condition one time. In addition, weekly probes were also presented on the last day of the week. The weekly probes included all the unknown words that were taught in the three instructional conditions for that particular week. Words that were not read correctly were counted as unknown and continued to be taught in the respective instructional condition. Corrective feedback for incorrect responses was given.

Traditional drill and practice. In the traditional drill and practice (TDP) condition, six unknown words were presented on index cards to the students in a drill type format. The experimenter first went through the index cards and pronounced each word aloud one time and asked the student to repeat the word before moving to the next word. Correct responses were followed by verbal praise (i.e. “Good Job” or “Very Good!”). The examiner then administered the words one time, and the student read the word aloud on his own. Correct responses were again followed by verbal praise. Corrective feedback was given for words that were read incorrectly. The examiner shuffled the index cards
after the instructional phase for random ordering. Words were considered mastered when
the student correctly read the word on the next day’s retention probe. Words not read
correctly continued to be taught during the instructional condition.

**Interspersal training.** With the interspersal training (IST) condition, six unknown
and three known words were presented on index cards to the students in a drill type
fashion. The examiner first went through the index cards, pronouncing each of the
unknown words aloud one time and asking the student to repeat the word before moving
to the next word. Correct responses were followed by verbal praise (i.e. “Good Job” or
“Very Good”). Incorrect responses were followed by corrective feedback. The student
was administered one trial of the words (both known and unknown) without help from
the examiner. Again, correct responses were followed by verbal praise, and incorrect
responses were followed with corrective feedback. The index cards were shuffled after
the instructional phase for random ordering. However, known words remained in the
first, fifth, and ninth presentation spots. Words were considered mastered when the
student correctly read the target word on the next day’s retention probe. The word was
then used as a known word in the instructional condition. Words not read correctly
continued to be taught during the instructional condition.

**Incremental Rehearsal.** For the IR condition, nine known words and the 6
unknown words were used. The first unknown word was presented to the child. Before
the child had a chance to respond, the examiner said the word to the child. Then the first
known word was presented for the child to read. Next, the first unknown word was
presented again, followed by the first known word, and then a second known word for the
child to read. Again, the first unknown word was presented, and the pattern was
continued until all nine words were exposed to the child. After each unknown word was interspersed nine times with the known words, the 9th known word was removed and the first unknown word was treated as a known word. Corrective feedback was given to the child any time a word was missed or he did not respond after 3 seconds. Words were considered mastered when the student correctly read the 6 target words during the next day’s retention probe. The newly learned word was used as a known word in the instructional condition. Words not read correctly were included in the instructional condition.

In each of the three conditions, unknown words were considered mastered when the student correctly read the target word on the next day retention probe. All newly mastered words were removed from the respective list and replaced with a new randomly chosen target word and included in the next day’s procedures. Words not mastered were included as target words in the next session.

**Maintenance assessment.** Maintenance was measured twice throughout the intervention sessions (after the 5th session and the 10th session). Students were presented with all the words that he or she “mastered” during the weekly probes. The words were presented one time in random order. Verbal praise was presented for correct pronunciations.

**Generalization.** In order to determine whether the students could generalize the words recognized correctly in the maintenance phases to a different context, sentences containing the mastered words were created. Generalization occurred after the 10th session. For each student, the mastered words were presented in the sentences that were used in the pretest. Students were asked to read each sentence in order to determine
whether or not the mastered word was correctly recognized. Target words were considered generalized when a student correctly recognized the word within the sentence. A correct response required the student to only identify the target word.

In addition to the sentences, a spelling test was also given to assess generality. The spelling test was presented in the same way it was presented during the pretest. For each student, the experimenter presented a mastered word, used it in a sentence, and repeated the word again. The student then wrote the word on a piece of paper, numbered from 1-10. Target words were considered generalized when a student could correctly spell the word.

**Interscorer Agreement.** Reliability of correct and incorrect response measurement was checked by having an undergraduate female student majoring in Psychology trained in the three conditions independently score 50% of the responses across subjects. Each item was compared in order to determine if the experimenter and the aide agreed on the student’s response. An agreement was defined as both the experimenter and the aide correctly scoring the student’s response for an item. Interscorer agreement was calculated by dividing the number of agreements by the number of agreements plus disagreements, and multiplying by 100%.

In addition, occurrence agreement and nonoccurrence agreement were assessed. Occurrence and nonoccurrence agreement were calculated because interscorer agreement can often be inflated by extremes or have high variability. The Occurrence Agreement Formula is as follows: \( \frac{A\text{ occ}}{A\text{ occ} + D\text{ occ}} \times 100 \). Agreement was scored for each time in which both observers recorded that the word was read correctly. Disagreement was scored for each time in which only one of the observers recorded that the word was
read correctly. The Nonoccurrence Agreement Formula is as follows: $A_{\text{nonocc}} / (A_{\text{nonocc}} + D_{\text{nonocc}}) \times 100$. Agreement was scored for each time both observers recorded that the word was read incorrectly. Disagreement was scored for each time in which only one of the observers recorded that the word was read incorrectly.

**Treatment Integrity.** Treatment integrity data was collected on each of the researcher’s implementations of the three conditions across 50% of the sessions. Treatment integrity data was collected by the same female undergraduate student, majoring in Psychology. A treatment integrity checklist was used to assist in the process. The checklist consisted of the procedures used to implement each instructional condition. The observer checked “yes” if the researcher correctly implemented the step or “no” if the researcher did not correctly implement the step (See Appendix F). This data was collected in order to determine if the researcher was implementing the procedures correctly.

**Study 2**

**Experimental Procedures**

During each session, students were exposed to all three conditions (IST, TDP, and IR). However, in this study, students received nine trials of the IST and TDP conditions each session. Conditions were randomly selected and presented in counterbalanced order across school days to control for sequence effects. For instance, the order for the first session would be IST, IR, TDP, and IR, TDP, IST, for the second, etc. The experimenter used a stopwatch to measure the number of seconds it took to complete each condition.
Timing began as soon as the first word in the condition was presented and ended after the student read the last word. On the following day, students were presented with a retention probe, where they had to read the 6 target words from each instructional condition one time. In addition, weekly probes were also presented on the last day of the week. The weekly probes included all the unknown words that were taught in the three instructional conditions for that particular week. Words that were not read correctly were counted as unknown and continued to be taught in the respective instructional condition. Corrective feedback for incorrect responses was given.

**Traditional drill and practice.** In the traditional drill and practice (TDP) condition, six unknown words were presented on index cards to the students in a drill type format. The experimenter first went through the index cards and pronounced each word aloud one time, and asked the student to repeat the word before moving to the next word. Correct responses were followed by verbal praise (i.e. “Good Job” or “Very Good!”). The examiner then administered the words nine times, and the student read the word aloud on his own. Correct responses were again followed by verbal praise. Corrective feedback was given for words that were read incorrectly. The examiner shuffled the index cards after the instructional phase for random ordering, and repeated the condition eight more trials. Words were considered mastered when the student correctly read the word on the next day’s retention probe. Words not read correctly continued to be taught during the instructional condition.

**Interspersal training.** With the interspersal training (IST) condition, six unknown and three known words were presented on index cards to the students in a drill type fashion. The students were exposed to nine trials of the interspersing technique. The
examiner first went through the index cards, pronouncing each of the unknown words aloud one time and asking the student to repeat the word before moving to the next word. Correct responses were followed by verbal praise (i.e. “Good Job” or “Very Good”). Incorrect responses were followed by corrective feedback. The student was administered nine trials of the words (both known and unknown) without help from the examiner. Again, correct responses were followed by verbal praise, and incorrect responses were followed with corrective feedback. The index cards were shuffled between trials for random ordering. However, known words remained in the first, fifth, and ninth presentation spots. Words were considered mastered when the student correctly read the target word on the next day’s retention probe. The word was then used as a known word in the instructional condition. Words not read correctly continued to be taught during the instructional condition.

**Incremental Rehearsal.** For the IR condition, nine known words and the 6 unknown words were used. The first unknown word was presented to the child. Before the child had a chance to respond, the examiner said the word to the child. Then the first known word was presented for the child to read. Next, the first unknown word was presented again, followed by the first known word, and then a second known word for the child to read. Again, the first unknown word was presented, and the pattern was continued until all nine words were exposed to the child. After each unknown word was interspersed nine times with the known words, the 9th known word was removed and the first unknown word was treated as a known word. Corrective feedback was given to the child any time a word was missed or he did not respond after 3 seconds. Words were considered mastered when the student correctly read the 6 target words during the next
day’s retention probe. The newly learned word was used as a known word in the instructional condition. Words not read correctly were included in the instructional condition.

In each of the three conditions, unknown words were considered mastered when the student correctly read the target word on the next day retention probe. All newly mastered words were removed from the respective list and replaced with a new randomly chosen target word and included in the next day’s procedures. Words not mastered were included as target words in the next session.

**Maintenance assessment.** Maintenance was measured after the 6th session in Study 2. Students were presented with all the words that he or she “mastered” during the weekly probes. The words were presented one time in random order. Verbal praise was presented for correct pronunciations.

**Generalization.** In order to determine whether the students could generalize the words recognized correctly in the maintenance phases to a different context, sentences containing the mastered words were created. Generalization occurred after the 6th session. For each student, the mastered words were presented in the sentences that were used in the pretest. Students were asked to read each sentence in order to determine whether or not the mastered word was correctly recognized. Target words were considered generalized when a student correctly recognized the word within the sentence. A correct response required the student to only identify the target word.

In addition to the sentences, a spelling test was also given to assess generality. The spelling test was presented in the same way it was presented during the pretest. For each student, the experimenter presented a mastered word, used it in a sentence, and
repeated the word again. The student then wrote the word on a piece of paper, numbered from 1-10. Target words were considered generalized when a student could correctly spell the word.

**Social Validity.** Researchers assess social validity through the use of interviews, questionnaires, or rating scales. In addition to the subject, additional individuals such as parents, teachers, and other staff members may also be considered when examining social validity. This study included a teacher questionnaire in order to assess the social validity of the three instructional methods. The questionnaires were handed to the teachers after the final maintenance session of Study 2. In addition to the teacher questionnaire, the students were given the opportunity to choose which intervention they perceived to be the one they learned the most, and which one they enjoyed the most. Following the completion of the experimental sessions, the experimenter presented the students with the three experimental conditions: Traditional Drill and Practice (TDP), Interspersal Training (IST), and Incremental Rehearsal (IR). The students were able to choose which intervention he or she wanted to receive. Each instructional condition consisted of different colored notecards. The students were able to choose the color of notecard (experimental condition) that they wanted to receive. The experimenter then presented the instructional condition to the student. This procedure occurred 3 times in order to determine if one intervention was consistently favored over another.

**Interscorer Agreement.** Reliability of correct and incorrect response measurement was checked by having an undergraduate female student majoring in Psychology trained in the three conditions independently score 50% of the responses across subjects. Each item was compared in order to determine if the experimenter and the aide agreed on the
student’s response. An agreement was defined as both the experimenter and the aide correctly scoring the student’s response for an item. Interscorer agreement was calculated by dividing the number of agreements by the number of agreements plus disagreements, and multiplying by 100%.

In addition, occurrence agreement and nonoccurrence agreement were assessed. Occurrence and nonoccurrence agreement were calculated because interscorer agreement can often be inflated by extremes or have high variability. The Occurrence Agreement Formula is as follows: \( \frac{A_{occ}}{A_{occ} + D_{occ}} \times 100 \). Agreement was scored for each time in which both observers recorded that the word was read correctly. Disagreement was scored for each time in which only one of the observers recorded that the word was read correctly. The Nonoccurrence Agreement Formula is as follows: \( \frac{A_{nonocc}}{A_{nonocc} + D_{nonocc}} \times 100 \). Agreement was scored for each time both observers recorded that the word was read incorrectly. Disagreement was scored for each time in which only one of the observers recorded that the word was read incorrectly.

**Treatment Integrity.** Treatment integrity data was collected on each of the researcher’s implementations of the three conditions across 50% of the sessions. Treatment integrity data was collected by the same female undergraduate student, majoring in Psychology. A treatment integrity checklist was used to assist in the process. The checklist consisted of the procedures used to implement each instructional condition. The observer checked “yes” if the researcher correctly implemented the step or “no” if the researcher did not correctly implement the step (See Appendix F). This data was collected in order to determine if the researcher was implementing the procedures correctly.
CHAPTER 4

RESULTS

This chapter presents the results of the research questions for Study 1 and 2. The chapter begins with interobserver agreement and treatment integrity results. The research questions were examined using visual inspection of graphed data. Descriptive statistics are typically used to evaluate single subject research data. Therefore, graphed data was the means of data analysis in the present studies.

Study 1

Interobserver Agreement

An independent observer scored 50% of the responses across all participants. Observer agreement on the scoring of the responses was calculated by using the following formula:

\[
\frac{\text{Agreements}}{\text{Agreements} + \text{Disagreements}} \times 100
\]
Interobserver agreement between the observer and independent observer was 100% for daily intervention sessions and 100% for the maintenance sessions. In addition, occurrence agreement and nonoccurrence agreement were calculated due to the fact that interscorer agreement can often be inflated by extremes or have high variability. Occurrence agreement was calculated using the following formula:

\[ \frac{A_{\text{occurrence}}}{A_{\text{occurrence}} + D_{\text{occurrence}}} \times 100 \]

Agreement was scored for each time in which both observers recorded that the word was read correctly. Disagreement was scored for each time in which only one of the observers recorded that the word was read correctly. Occurrence agreement between the observer and independent observer was 100% for the daily intervention sessions and 100% for the maintenance sessions. Nonoccurrence agreement was calculated using the following formula:

\[ \frac{A_{\text{nonoccurrence}}}{A_{\text{nonoccurrence}} + D_{\text{nonoccurrence}}} \times 100 \]

Agreement was scored for each time both observers recorded that the word was read incorrectly. Disagreement was scored for each time in which only one of the observers recorded that the word was read incorrectly. Nonoccurrence agreement between the
observer and independent observer was 100% for the daily intervention sessions and 100% for the maintenance sessions.

Treatment Integrity

Treatment integrity data were collected by each of the researcher’s implementation of the three conditions across 5 randomly selected sessions (50% of the sessions). A treatment integrity checklist (see Appendix F) was used to assist in the process. These data were collected in order to ensure that the researcher was implementing the procedures correctly. Treatment integrity was 100% across all 5 sessions. Specifically, words were printed on 4 x 6 index cards, the examiner timed each session, notecards were presented within 4 seconds of each other, appropriate feedback was provided contingent upon response accuracy for correct responses, and corrective feedback was provided for words read incorrectly or words not read within 3 seconds. The results suggest that the procedures were implemented with high accuracy and reliability.

Research Question Number One

Based on the number of cumulative words read, which of the following three methods: (a) Traditional Drill and Practice (TDP), (b) Interspersal Technique (IST), or (c) Incremental Rehearsal (IR) is the most effective on the number of cumulative words read accurately on a next day retention probe for individual students as well as for students as a group?

Table 4.1 includes the final cumulative number of words learned on next day retention probes for all six students across the traditional drill and practice, interspersing, and incremental rehearsal procedures. Table 4.1 also provides a total number of words
learned across all students for the three instructional approaches. The data shows that the students as a group learned a total of 513 words with some variability in the number of words learned across the three conditions. It appears as though the students learned a greater number of words under the Incremental Rehearsal condition as compared to the Traditional Drill and Interspersing conditions. The data also show minimal variability between the Traditional Drill and Interspersing conditions in terms of the cumulative number of words learned. Table 4.2 includes the final cumulative number of words learned on the two weekly probes for Study 1. Similar to the cumulative number of words learned on the next day retention probes, students retained a greater number of words on the weekly probes under the Incremental Rehearsal instructional condition.

<table>
<thead>
<tr>
<th></th>
<th>TDP</th>
<th>IST</th>
<th>IR</th>
<th>Student Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sarah</td>
<td>27</td>
<td>30</td>
<td>44</td>
<td>99</td>
</tr>
<tr>
<td>Lori</td>
<td>26</td>
<td>26</td>
<td>35</td>
<td>87</td>
</tr>
<tr>
<td>Marie</td>
<td>18</td>
<td>20</td>
<td>29</td>
<td>67</td>
</tr>
<tr>
<td>Danny</td>
<td>27</td>
<td>21</td>
<td>42</td>
<td>93</td>
</tr>
<tr>
<td>Chris</td>
<td>22</td>
<td>21</td>
<td>28</td>
<td>71</td>
</tr>
<tr>
<td>Brooke</td>
<td>26</td>
<td>29</td>
<td>42</td>
<td>97</td>
</tr>
<tr>
<td>Group Total</td>
<td>146</td>
<td>147</td>
<td>220</td>
<td>513</td>
</tr>
</tbody>
</table>

Table 4.1
*Cumulative Number of Words Learned by Student on Next Day Retention Probes*
<table>
<thead>
<tr>
<th></th>
<th>TDP</th>
<th>IST</th>
<th>IR</th>
<th>Student Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sarah</td>
<td>24</td>
<td>26</td>
<td>42</td>
<td>92</td>
</tr>
<tr>
<td>Lori</td>
<td>25</td>
<td>23</td>
<td>34</td>
<td>82</td>
</tr>
<tr>
<td>Marie</td>
<td>16</td>
<td>19</td>
<td>33</td>
<td>68</td>
</tr>
<tr>
<td>Danny</td>
<td>28</td>
<td>21</td>
<td>43</td>
<td>92</td>
</tr>
<tr>
<td>Chris</td>
<td>24</td>
<td>20</td>
<td>27</td>
<td>71</td>
</tr>
<tr>
<td>Brooke</td>
<td>24</td>
<td>26</td>
<td>40</td>
<td>90</td>
</tr>
<tr>
<td>Group Total</td>
<td>141</td>
<td>135</td>
<td>219</td>
<td>495</td>
</tr>
</tbody>
</table>

Table 4.2
*Cumulative Number of Words Learned by Student on Weekly Retention Probes*

Figures 4.1 through 4.6 provide the cumulative number of words learned across all sessions for Sarah, Lori, Marie, Danny, Chris, and Brooke respectively. The data from these figures show consistent patterns of word acquisition across the three instructional conditions.

Sarah

Figure 4.1 represents the cumulative number of words learned for Sarah. Sarah participated in all 10 sessions for Study 1. The data show an increasing trend with little variability between the IST and TDP instructional conditions. It appears as though the incremental rehearsal (IR) condition was more effective in terms of the cumulative number of words read correctly on the next day retention probe.
Figure 4.1
*Cumulative Words Read Correctly on Next Day Retention Probe by Instructional Condition for Sarah*

Figure 4.2 shows the cumulative number of words learned across all sessions by Lori. Lori participated in all 10 sessions of Study 1. Lori also showed an increasing trend in word acquisition across all three instructional conditions. The incremental rehearsal (IR) instructional condition appeared to be the most effective on the number of cumulative words read accurately on the next day retention probes. Furthermore, it appears that Lori learned approximately the same number of words in the interspersing instructional condition (IST) and the traditional drill and practice condition (TDP).
Marie

Figure 4.3 shows the cumulative number of words learned across all sessions by Marie. Marie participated in all 10 sessions of Study 1. The data show a similar pattern to the previous two figures. Marie also showed an increasing trend in word acquisition across all three instructional conditions. The incremental rehearsal (IR) instructional condition appeared to be the most effective on the number of cumulative words read accurately on the next day retention probes as compared to the traditional drill and practice (TDP) or interspersing (IST) procedures. Marie’s data showed a slight amount of variability between conditions and little variability within any specific condition. Finally, it appears as though Marie may have learned slightly more words in the interspersing condition as compared to the traditional drill and practice condition.
Danny

Figure 4.4 shows the cumulative number of words learned across all sessions by Danny. Danny was able to participate in all 10 sessions. Similar to the previous data, Danny also showed an increasing trend in word acquisition across all three treatment conditions with little variability within conditions. It appears as though Danny demonstrated a clear increase in the number of words learned in the incremental rehearsal (IR) condition as compared to the traditional drill and practice (TDP) and interspersing (IST) conditions.

Also, the data suggest that Danny learned more words in the traditional drill and practice (TDP) condition as opposed to the interspersal (IST) condition.
Chris

Figure 4.5 shows the cumulative number of words learned across all sessions by Chris. Chris was able to participate in all 10 sessions. Similar to the previous data, Chris also showed an increasing trend in word acquisition across all three treatment conditions with little variability within conditions. The data suggest that Chris may have shown a marked increase in the number of words learned in the incremental rehearsal (IR) condition as compared to the traditional drill and practice (TDP) and interspersing (IST) conditions. Finally, it appears as though Chris was able to learn slightly more words in the traditional drill condition as opposed to the interspersing condition.
Figure 4.5
*Cumulative Words Read Correctly on Next Day Retention Probe by Instructional Condition for Chris*

Brooke

Figure 4.6 shows the cumulative number of words learned across all sessions by Brooke. Brooke was able to participate in all 10 sessions. Similar to the previous data, Brooke also showed an increasing trend in word acquisition across all three treatment conditions with little variability within conditions. The data suggest that Brooke may have shown a marked increase in the number of words learned in the incremental rehearsal (IR) condition as compared to the traditional drill and practice (TDP) and interspersing (IST) conditions. In addition, the data suggests that Brooke learned more words under the interspersing condition as opposed to the traditional drill and practice condition.
The data were collapsed into group data in order to test which treatment condition was more effective in terms of the number of cumulative words learned among students as a group. Figure 4.7 shows the data collapsed across individuals for the three instructional conditions. The data suggest a marked increase in the number of words learned in the incremental rehearsal (IR) condition as compared to the traditional drill and practice (TDP) and interspersing (IST) conditions. In other words, students tended to learn more words under the incremental rehearsal condition over the course of study 1. There also appears to be only minimal variability between the traditional drill and practice and interspersing conditions, which suggests a similar number of words learned for the two conditions among students as a group.
The data from the above graphical displays show regular patterns of word acquisition across the three conditions. The data show an increasing trend with little variability within conditions. The figures suggest that the incremental rehearsal (IR) condition was more effective at increasing students’ word acquisition. Therefore, the results suggest that the incremental rehearsal condition is a more effective method of teaching words to students with word recognition difficulties.

Research Question Number Two

Which of the following methods: (a) TDP, (b) IST, or (c) IR is the most efficient, as measured by learning rate, on the number of cumulative words read accurately on a next day retention probe for individual students as well as for students as a group?
Table 4.3 provides a summary of the cumulative number of words learned, total time engaged in each of the three conditions, and the rate (i.e., number of words learned per minute of instruction) of word acquisition under all three instructional conditions by each participant, and total across all participants.

<table>
<thead>
<tr>
<th></th>
<th>Drill</th>
<th>Interspersing</th>
<th>Incremental Rehearsal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Words</td>
<td>Time&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Rate&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Sarah</td>
<td>27</td>
<td>3.54</td>
<td>6.92</td>
</tr>
<tr>
<td>Lori</td>
<td>26</td>
<td>6.46</td>
<td>3.84</td>
</tr>
<tr>
<td>Marie</td>
<td>18</td>
<td>5.72</td>
<td>2.90</td>
</tr>
<tr>
<td>Danny</td>
<td>27</td>
<td>5.75</td>
<td>4.32</td>
</tr>
<tr>
<td>Chris</td>
<td>22</td>
<td>6.50</td>
<td>3.22</td>
</tr>
<tr>
<td>Brooke</td>
<td>26</td>
<td>5.68</td>
<td>4.24</td>
</tr>
<tr>
<td>Group</td>
<td>146</td>
<td>33.65</td>
<td>25.44</td>
</tr>
</tbody>
</table>

<sup>a</sup> = number of minutes
<sup>b</sup> = number of words learned/time

Table 4.3
Total Number of Words Learned, Number of Minutes Spent in Each Condition, Learning Rates by Student and Group Totals by Condition

Data analysis can also be seen in Figures 4.8, 4.9, 4.10, 4.11, 4.12, and 4.13 which allow for a visual analysis of the data for Sarah, Lori, Marie, Danny, Chris, and Brooke.

Sarah

In figure 4.8, Sarah’s learning rate is highest under the traditional drill and practice (TDP) condition followed by the interspersing condition (IST). All three of the instructional conditions appear to have stable increasing trends, however, the incremental rehearsal (IR) condition shows a slower increasing trend and lower levels of progress. These data differ from what was found when only examining the number of cumulative words learned in Figure 4.1. Previous data showed only a slight difference in
performance across the three instructional conditions, with the incremental rehearsal condition being the most effective for word acquisition. However, when time is factored into the analysis, there seems to be an advantage to using traditional drill or interspersing over incremental rehearsal to increase word acquisition rates for Sarah.

Figure 4.8
Cumulative Learning Rates Across All Sessions and Conditions by Sarah

Lori

Lori’s cumulative learning rate data are presented in Figure 4.9. An increasing trend is visible among all three conditions, however, traditional drill and practice (TDP) resulted in a greater number of words learned per minute of instruction than the interspersing (IST) and incremental (IR) instructional conditions. Similar to Sarah’s data, Lori’s data differ from what was found when only examining the number of cumulative words learned in Figure 4.2. Previous data showed only a slight difference in performance across the three instructional conditions, with the incremental rehearsal
condition being the most effective for word acquisition. However, when time is factored into the analysis, there seems to be an advantage to using traditional drill or interspersing over incremental rehearsal to increase word acquisition rates for Lori.

![Cumulative Learning Rates Across All Sessions and Conditions by Lori](image)

**Figure 4.9**
*Cumulative Learning Rates Across All Sessions and Conditions by Lori*

**Marie**

Figure 4.10 shows the cumulative learning rate data for Marie. The data also suggest that the traditional drill and practice (TDP) instructional condition may be more efficient in terms of increasing word acquisition as compared to the interspersing or incremental rehearsal instructional conditions. These data differ from those presented in Figure 4.3 which found the incremental rehearsal instructional condition to be more effective than traditional drill or interspersing. However, when factoring in time, it appears as though traditional drill is a more efficient technique when considering rates of word acquisition.
Figure 4.10
*Cumulative Learning Rates Across All Sessions and Conditions by Marie*

Danny

Figure 4.11 shows the cumulative learning rate for Danny. The data suggests that all three instructional conditions resulted in the acquisition of words. The increasing trend for traditional drill and practice is much steeper than the trends for the interspersing and incremental rehearsal instructional conditions, which suggests slower rates of word acquisition for the interspersing and incremental rehearsal conditions. The data in Figure 4.4 indicate that the incremental rehearsal instructional condition was more effective for increasing word acquisition for Danny. However, when time is factored into the analysis, it appears that the rates of word acquisition under the incremental rehearsal condition are much lower than the traditional drill and practice technique.
Chris

Chris’ cumulative learning rate is presented in 4.12. The data show an increasing trend across all three instructional conditions and suggests that all conditions resulted in the acquisition of words. The data also suggest that the traditional drill and practice (TDP) instructional condition may result in more efficient learning for Chris. The data differ from those presented in Figure 4.5 which indicated that the incremental rehearsal (IR) instructional condition resulted in greater word acquisition. However, when time is considered, it appears that rates of word acquisition under the incremental rehearsal condition are lower than the traditional drill and interspersing instructional conditions.
Figure 4.12
Cumulative Learning Rates Across All Sessions and Conditions by Chris

Brooke

Figure 4.13 displays the cumulative learning rate data for Brooke. The data show increasing trends for all three conditions. The data also indicate that the traditional drill and practice technique may be more efficient in terms of increasing word acquisition with Brooke. The data differ from those shown in Figure 4.6 which suggest the incremental rehearsal condition to be a more effective technique for increasing word recognition. However, when time is factored into the analysis, it seems that rates of word acquisition are lower when words are presented under the incremental rehearsal technique.
The above graphs suggest that all six students demonstrated more efficient learning rates under the traditional drill and practice (TDP) instructional condition as opposed to the interspersing (IST) or incremental rehearsal (IR) instructional conditions. In addition, none of the students displayed the greatest efficiency for the acquisition of words under the incremental rehearsal instructional condition. Therefore, the results may suggest that the traditional drill and practice technique is most efficient for learning new words among individual students identified as having word identification difficulties.

Data were collapsed in order to examine which method is most efficient for learning new words among students as a group. Figure 4.14 shows the cumulative learning rates collapsed across all six participants across all three instructional conditions. Upon examining the data, the graph suggests a minimal degree of variability within the conditions and a considerable degree of variability across conditions. The data suggest
that when time is factored into the analysis, the traditional drill and practice (TDP) instructional condition resulted in greater rates of word acquisition followed by the interspersing (IST) and incremental rehearsal (IR) instructional conditions respectively. Students tended to learn more words per minute of instruction under the traditional drill and practice condition over the course of Study 1.

Figure 4.14

*Cumulative Learning Rates Across All Students Across All Three Conditions*

Research Question Number Three

Which of the following methods: a.) TDP, b.) IST, or c.) IR is the most effective for maintaining recognition of mastered words?

Research Question Number Four

Which of the following methods: a.) TDP, b.) IST, or c.) IR is the most efficient for maintaining recognition of mastered words?
Data were collapsed across the two maintenance sessions in order to examine both research questions. Table 4.4 represents the cumulative number of words mastered, total time engaged in each of the three conditions, the rate (i.e., cumulative number of words mastered per minute of instruction) of word acquisition under all three conditions by each participant, number of words maintained, rate of mastered words maintained, and totals across all participants for all variables. Overall, maintenance ranged from 73% to 95%. All six students maintained the highest percentage of words under the incremental rehearsal condition (IR). For all six of the six students, the traditional drill and practice (TDP) condition was the most efficient for maintaining recognition of mastered words.
<table>
<thead>
<tr>
<th></th>
<th>Drill</th>
<th>Interspersing</th>
<th>Incremental Rehearsal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>W</td>
<td>Time&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Rate&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Sarah</td>
<td>27</td>
<td>3.54</td>
<td>6.92</td>
</tr>
<tr>
<td>Lori</td>
<td>26</td>
<td>6.46</td>
<td>3.84</td>
</tr>
<tr>
<td>Marie</td>
<td>18</td>
<td>5.72</td>
<td>2.90</td>
</tr>
<tr>
<td>Danny</td>
<td>27</td>
<td>5.75</td>
<td>4.32</td>
</tr>
<tr>
<td>Chris</td>
<td>22</td>
<td>6.50</td>
<td>3.22</td>
</tr>
<tr>
<td>Brooke</td>
<td>26</td>
<td>5.68</td>
<td>4.24</td>
</tr>
</tbody>
</table>

<sup>a</sup> number of minutes  
<sup>b</sup> number of words mastered/time  
<sup>c</sup> number of mastered words maintained/time

Table 4.4
Number of Words Learned (WL), Number of Words Maintained (WM), Percentage of Learned Words Maintained (%WM), and Rate of Mastered Words Maintained (MR) for Each Student and Condition Totals
Research Question Number Five

Which of the following methods: a.) TDP, b.) IST, or c.) IR is the most effective on students’ ability to generalize mastered words to spelling?

Data were collected from the generalization student sessions in order to examine this research question. Specifically, all mastered words from each instructional condition were administered to the students in the form of a spelling test, as in the pretest. The results of the pretest yielded the following: Sarah correctly spelled 3/80 unknown words on the pretest, Lori was unable to correctly spell any of the unknown words on the pretest, Marie correctly spelled 7/60 unknown words, Danny correctly spelled 13/76 unknown words, Chris correctly spelled 6/80, and Brooke correctly spelled 3/68. Target words were considered to be “generalized” when a student correctly spelled the word. Generalization data was collected following the 10th session. Table 4.5 represents the number of words correctly generalized (WG), percentage of words generalized (PWG) for each student across all three instructional conditions, and group total for all of the variables across each condition. Overall, generalization to spelling was considered low, ranging from 16% to 29%.
<table>
<thead>
<tr>
<th></th>
<th>Drill</th>
<th></th>
<th>Interspersing</th>
<th></th>
<th>Incremental Rehearsal</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>WG</td>
<td>PWG</td>
<td>WG</td>
<td>PWG</td>
<td>WG</td>
<td>PWG</td>
</tr>
<tr>
<td>Sarah</td>
<td>6</td>
<td>27%</td>
<td>7</td>
<td>28%</td>
<td>11</td>
<td>28%</td>
</tr>
<tr>
<td>Lori</td>
<td>4</td>
<td>25%</td>
<td>5</td>
<td>26%</td>
<td>7</td>
<td>22%</td>
</tr>
<tr>
<td>Marie</td>
<td>4</td>
<td>29%</td>
<td>3</td>
<td>20%</td>
<td>6</td>
<td>23%</td>
</tr>
<tr>
<td>Danny</td>
<td>5</td>
<td>22%</td>
<td>6</td>
<td>33%</td>
<td>8</td>
<td>20%</td>
</tr>
<tr>
<td>Chris</td>
<td>4</td>
<td>22%</td>
<td>5</td>
<td>29%</td>
<td>7</td>
<td>28%</td>
</tr>
<tr>
<td>Brooke</td>
<td>5</td>
<td>25%</td>
<td>4</td>
<td>16%</td>
<td>8</td>
<td>21%</td>
</tr>
<tr>
<td>Group</td>
<td>28</td>
<td>25%</td>
<td>30</td>
<td>25%</td>
<td>47</td>
<td>23%</td>
</tr>
</tbody>
</table>

Table 4.5
*Number of Words Generalized (WG) and Percentage of Words Generalized (PWG) for Each Student, and Condition Totals*

**Research Question Number Six**

Which of the following methods: a.) TDP, b.) IST, or c.) IR is the most effective on students’ ability to correctly read the mastered word in a sentence?

Data were collected from the generalization student sessions in order to examine this research question. Specifically, all mastered words from each instructional condition were included in sentences that the students read during the pre-test. During the pre-test, all six students were unable to correctly read the unknown words in the sentences. The results of the pre-test yielded the following: Sarah correctly read 2/80 unknown words in sentences, Lori correctly read 1/86, Marie read 2/60, Danny read 10/76, Chris read 3/80, and Brooke read 7/68. Target words were considered to be “generalized” when a student was able to correctly read the word in the sentence. Generalization data was collected following the 10th session. Table 4.6 represents the number of words correctly
generalized (WG), percentage of words generalized (PWG) for each student across all three instructional conditions, and group total for all of the variables across each condition. Overall, generalization to reading the target words in sentences was moderate to high, ranging from 75% to 100%.

<table>
<thead>
<tr>
<th></th>
<th>Drill</th>
<th>Interspersing</th>
<th>Incremental Rehearsal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>WG</td>
<td>PWG</td>
<td>WG</td>
</tr>
<tr>
<td>Sarah</td>
<td>19</td>
<td>86%</td>
<td>22</td>
</tr>
<tr>
<td>Lori</td>
<td>12</td>
<td>75%</td>
<td>17</td>
</tr>
<tr>
<td>Marie</td>
<td>11</td>
<td>79%</td>
<td>12</td>
</tr>
<tr>
<td>Danny</td>
<td>18</td>
<td>82%</td>
<td>15</td>
</tr>
<tr>
<td>Chris</td>
<td>15</td>
<td>83%</td>
<td>15</td>
</tr>
<tr>
<td>Brooke</td>
<td>16</td>
<td>80%</td>
<td>21</td>
</tr>
<tr>
<td>Group</td>
<td>91</td>
<td>81%</td>
<td>102</td>
</tr>
</tbody>
</table>

Table 4.6
*Number of Words Generalized (WG) and Percentage of Words Generalized (PWG) for Each Student, and Condition Totals*

Research Question Number Seven

Are the three instructional approaches a socially valid way to assess and teach word reading skills to students with reading difficulties?

The six students in this study completed a social validity interview following the completion of the final intervention session (See Appendix H). The interview consisted of five short questions. All questions were verbally read to the students. Questions such as, “Did you enjoy working together,” “Did working together help with learning new
words,” and “Did working together help you with reading” were asked in order to examine the social validity of the three instructional approaches.

The results indicated that all six students enjoyed working together on the reading intervention activities. The students were given the opportunity to choose which intervention they liked the best. The students were able to choose the color of notecard (experimental condition) that they wanted to receive. The experimenter then presented the instructional condition to the student. This procedure occurred 3 times in order to determine if one intervention was consistently favored over another. All six of the students chose the traditional and practice technique because it was the shortest. However, all six students reported that all three activities would be helpful for teaching students new words.

The two classroom teachers participated in filling out a social validity questionnaire following the completion of the final intervention session (See Appendix I). The questionnaire consisted of seven short response questions. Responses to questions such as, “Did you notice any difference in the student’s word reading performance while he or she was participating in the study,” and “Do you feel as though the three instructional approaches appear to be appropriate approaches for teaching words to students with word identification difficulties” were assessed in order to evaluate the social validity of three instructional approaches. Both teachers indicated that four out of the six students expanded their core of words. In addition, the teachers felt that the instructional approaches appeared to be valid approaches for teaching words to students with word identification difficulties.
Study 2

Interobserver Agreement

An independent observer scored 50% of the responses across all participants. Observer agreement on the scoring of the responses was calculated by using the following formula:

\[
\text{Agreements} \times 100 \over \text{Agreements + Disagreements}
\]

Interobserver agreement between the observer and independent observer was 100% for daily intervention sessions and 100% for the maintenance sessions. In addition, occurrence agreement and nonoccurrence agreement were calculated due to the fact that interscorer agreement can often be inflated by extremes or have high variability. Occurrence agreement was calculated using the following formula:

\[
\text{A occurrence} \times 100 \over \text{A occurrence + D occurrence}
\]

Agreement was scored for each time in which both observers recorded that the word was read correctly. Disagreement was scored for each time in which only one of the observers recorded that the word was read correctly. Occurrence agreement between the observer
and independent observer was 100% for the daily intervention sessions and 100% for the maintenance sessions. Nonoccurrence agreement was calculated using the following formula:

\[
\frac{A_{\text{nonocc}}}{A_{\text{nonocc}} + D_{\text{nonocc}}} \times 100
\]

Agreement was scored for each time both observers recorded that the word was read incorrectly. Disagreement was scored for each time in which only one of the observers recorded that the word was read incorrectly. Nonoccurrence agreement between the observer and independent observer was 100% for the daily intervention sessions and 100% for the maintenance sessions.

**Treatment Integrity**

Treatment integrity data was collected on each of the researcher’s implementation of the three conditions across 3 randomly selected sessions (50% of the sessions). A treatment integrity checklist (see Appendix C) was utilized to assist in the process. These data were collected in order to ensure that the researcher was implementing the procedures correctly. Treatment integrity was 100% across all 3 sessions. Specifically, words were printed on 4 x 6 index cards, the examiner timed each session, notecards were presented within 4 seconds of each other, appropriate feedback was provided contingent upon response accuracy for correct responses, corrective feedback was provided for words read incorrectly or words not read within 3 seconds, and the students
received 9 trials under the traditional drill and interspersing instructional conditions. The results suggest that the procedures were implemented with high accuracy and reliability.

**Research Question Number One**

Based on the number of cumulative words read and the number of trials students were exposed to, which of the following three methods: a.) Traditional Drill and Practice (TDP), b.) Interspersal Technique (IST), or c.) Incremental Rehearsal (IR) is the most effective on the number of cumulative words read accurately on a next day retention probe for individual students as well as for students as a group?

Table 4.7 includes the final cumulative number of words learned on next day retention probes for all six students across the traditional drill and practice, interspersing, and incremental rehearsal procedures. Table 4.7 also provides a total number of words learned across all students for the three instructional approaches. The data shows that the students as a group learned a total of 389 words with some variability in the number of words learned across the three conditions. It appears as though the students learned a greater number of words under the Incremental Rehearsal condition as compared to the Traditional Drill and Interspersing conditions. The data also show minimal variability between the Traditional Drill and Interspersing conditions in terms of the cumulative number of words learned.
<table>
<thead>
<tr>
<th></th>
<th>TDP</th>
<th>IST</th>
<th>IR</th>
<th>Student Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sarah</td>
<td>24</td>
<td>21</td>
<td>24</td>
<td>69</td>
</tr>
<tr>
<td>Lori</td>
<td>20</td>
<td>21</td>
<td>26</td>
<td>67</td>
</tr>
<tr>
<td>Marie</td>
<td>19</td>
<td>21</td>
<td>24</td>
<td>64</td>
</tr>
<tr>
<td>Danny</td>
<td>18</td>
<td>24</td>
<td>27</td>
<td>69</td>
</tr>
<tr>
<td>Chris</td>
<td>16</td>
<td>20</td>
<td>21</td>
<td>57</td>
</tr>
<tr>
<td>Brooke</td>
<td>15</td>
<td>20</td>
<td>28</td>
<td>63</td>
</tr>
<tr>
<td>Group Total</td>
<td>112</td>
<td>127</td>
<td>150</td>
<td>389</td>
</tr>
</tbody>
</table>

Table 4.7
Cumulative Number of Words Learned by Student on Next Day Retention Probes

Table 4.8 includes the final cumulative number of words learned on the weekly retention probe for all six students across the traditional drill and practice, interspersing, and incremental rehearsal procedures. Table 4.8 also provides a total number of words retained on the weekly probe across all students for the three instructional approaches. The data shows that the students as a group retained a total of 347 words with some variability in the number of words learned across the three conditions. It appears as though the students retained a greater number of words under the Incremental Rehearsal condition as compared to the Traditional Drill and Interspersing conditions.
Table 4.8
*Cumulative Number of Words Learned by Student on Weekly Retention Probe*

Figures 4.15 through 4.21 provide the cumulative number of words learned across all sessions for Sarah, Lori, Marie, Danny, Chris, and Brooke respectively. The data from these figures show consistent patterns of word acquisition across the three instructional conditions.

**Sarah**

Figure 4.15 represents the cumulative number of words learned for Sarah. Sarah participated in all 6 sessions for Study 2. The data show an increasing trend for all three instructional conditions. It appears as though there was some overlap between the incremental rehearsal (IR) condition and the traditional drill and practice (TDP) condition, with IR being slightly more effective in terms of the cumulative number of words read correctly on the next day retention probe.
Figure 4.15
Cumulative Words Read Correctly on Next Day Retention Probe by Instructional Condition for Sarah

Lori

Figure 4.16 represents the cumulative number of words learned for Lori. Lori participated in all 6 sessions for Study 2. The data show an increasing trend for all three instructional conditions with slight variability among the three instructional conditions. In this study, the number of trials for the traditional drill and practice (TDP) and interspersing (IST) instructional conditions was controlled for. Initially, there was overlap among all three instructional conditions. However, it appears as though the incremental rehearsal (IR) condition was more effective than the interspersal (IST) or traditional drill and practice (TDP) instructional conditions in terms of the cumulative number of words read correctly on the next day retention probe. Traditional drill and practice resulted in a
slightly lower number of words read correctly on the next day retention probe, as compared to the incremental rehearsal and interspersing instructional conditions.

Figure 4.16
*Cumulative Words Read Correctly on Next Day Retention Probe by Instructional Condition for Lori*

Marie

Figure 4.17 shows the cumulative number of words learned across all sessions by Marie. Marie participated in all 6 sessions of Study 2. The data show a similar pattern to the previous two figures with respect to an increasing trend in word acquisition across all three instructional conditions. However, Marie showed some overlapping among the conditions during the first three sessions. The incremental rehearsal (IR) instructional condition appeared to be the most effective on the number of cumulative words read accurately on the next day retention probes as compared to the traditional drill and practice (TDP) or interspersing (IST) procedures.
Danny

Figure 4.18 shows the cumulative number of words learned across all sessions by Danny. Danny participated in all 6 sessions of Study 2. Danny also showed an increasing trend in word acquisition across all three instructional conditions. It appears as though Danny demonstrated a clear increase in the number of words learned in the incremental rehearsal (IR) condition as compared to the traditional drill and practice (TDP) and interspersing (IST) conditions even when the number of trials was controlled. Danny’s data showed a slight amount of variability between conditions and little variability within any specific condition.
Figure 4.18  
*Cumulative Words Read Correctly on Next Day Retention Probe by Instructional Condition for Danny*

Chris  

Figure 4.19 shows the cumulative number of words learned across all sessions by Chris. Chris was able to participate in all 6 sessions. Similar to the previous data, Chris also showed an increasing trend in word acquisition across all three treatment conditions. However, he did show some overlap between the incremental rehearsal and interspersing instructional conditions during sessions 4 and 5. The data suggest that the incremental rehearsal instructional condition may have been slightly more effective at increasing Chris’ word acquisition than the interspersing instructional condition. Finally, it appears as though Chris was able to learn more words in the interspersing condition as opposed to the traditional drill and practice condition.
Brooke

Figure 4.20 shows the cumulative number of words learned across all sessions by Brooke. Brooke was able to participate in all 6 sessions. Similar to the previous data, Brooke also showed an increasing trend in word acquisition across all three treatment conditions with little variability within conditions. The data suggest that Brooke may have shown a marked increase in the number of words learned in the incremental rehearsal (IR) condition as compared to the traditional drill and practice (TDP) and interspersing (IST) conditions. In addition, the data suggests that Brooke learned more words under the interspersing condition as opposed to the traditional drill and practice condition.
The data were collapsed into group data in order to test which treatment condition was more effective in terms of the number of cumulative words learned among students as a group. Figure 4.21 shows the data collapsed across individuals for the three instructional conditions. The data suggest a marked increase in the number of words learned in the incremental rehearsal (IR) condition as compared to the traditional drill and practice (TDP) and interspersal (IST) conditions. In other words, students as a group tended to learn more words under the incremental rehearsal condition over the course of Study 2, even when the number of trials was controlled for in both the traditional drill and practice and interspersal instructional conditions. However, the effects of the instructional conditions showed greater differentiation for each student over the course of Study 1, whereas in Study 2, the differentiation is not as pronounced.
Research Question Number Two

Which of the following methods: a.) TDP, b.) IST, or c.) IR is the most efficient, as measured by learning rate, on the number of cumulative words read accurately on a next day retention probe for individual students as well as for students as a group when the number of trials of IST and TDP are controlled for?

Table 4.9 provides a summary of the cumulative number of words learned, total time engaged in each of the three conditions, and the rate (i.e., number of words learned per minute of instruction) of word acquisition under all three instructional conditions by each participant, and total across all participants.
<table>
<thead>
<tr>
<th></th>
<th>Drill</th>
<th></th>
<th></th>
<th>Interspersing</th>
<th></th>
<th></th>
<th>Incremental Rehearsal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Words</td>
<td>Time&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Rate&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Words</td>
<td>Time&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Rate&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Words</td>
</tr>
<tr>
<td>Sarah</td>
<td>24</td>
<td>22.35</td>
<td>1.06</td>
<td>21</td>
<td>31.35</td>
<td>.66</td>
<td>24</td>
</tr>
<tr>
<td>Lori</td>
<td>20</td>
<td>19.58</td>
<td>1.00</td>
<td>21</td>
<td>29.64</td>
<td>.70</td>
<td>26</td>
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<tr>
<td>Marie</td>
<td>19</td>
<td>16.38</td>
<td>1.14</td>
<td>21</td>
<td>31.17</td>
<td>.67</td>
<td>24</td>
</tr>
<tr>
<td>Danny</td>
<td>18</td>
<td>13.71</td>
<td>1.27</td>
<td>24</td>
<td>28.32</td>
<td>.84</td>
<td>27</td>
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<tr>
<td>Chris</td>
<td>16</td>
<td>13.59</td>
<td>1.14</td>
<td>20</td>
<td>27.63</td>
<td>.71</td>
<td>21</td>
</tr>
<tr>
<td>Brooke</td>
<td>15</td>
<td>13.31</td>
<td>1.11</td>
<td>20</td>
<td>30.91</td>
<td>.63</td>
<td>28</td>
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<tr>
<td>Group</td>
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<td>1.13</td>
<td>127</td>
<td>179.02</td>
<td>.71</td>
<td>150</td>
</tr>
</tbody>
</table>

<sup>a</sup> = number of minutes  
<sup>b</sup> = number of words learned/time

Table 4.9  
*Total Number of Words Learned, Number of Minutes Spent in Each Condition, Learning Rates by Student and Group Totals by Condition*

Data analysis can also be seen in Figures 4.22, 4.23, 4.24, 4.25, 4.26, and 4.27 which allow for a visual analysis of the data for Sarah, Lori, Marie, Danny, Chris, and Brooke.

**Sarah**

In figure 4.22, Sarah’s learning rate is highest under the traditional drill and practice (TDP) condition followed by the interspersing condition (IST). All three of the instructional conditions appear to have stable increasing trends, however, the incremental rehearsal (IR) condition shows a slower increasing trend and lower levels of progress. These data differ from what was found when only examining the number of cumulative words learned in Figure 4.22. Previous data showed only a slight difference in performance across the three instructional conditions, with the incremental rehearsal condition being slightly more effective than traditional drill and practice for word
acquisition. However, when time is factored into the analysis and the number of trials is controlled, there continues to be an advantage to using traditional drill over interspersing or incremental rehearsal to increase word acquisition rates for Sarah.

Figure 4.22
Cumulative Learning Rates Across All Sessions and Conditions by Sarah

Lori

Lori’s cumulative learning rate data are presented in Figure 4.23. An increasing trend is visible among all three conditions, however, traditional drill and practice (TDP) resulted in a greater number of words learned per minute of instruction than the interspersing (IST) and incremental (IR) instructional conditions. Similar to Sarah’s data, Lori’s data differ from what was found when only examining the number of cumulative words learned in Figure 4.16. Previous data showed only a slight difference in
performance across the three instructional conditions, with the incremental rehearsal condition being the most effective for word acquisition. However, when time is factored into the analysis and the number of trials is controlled, there continues to be an advantage to using traditional drill or interspersing over incremental rehearsal to increase word acquisition rates for Lori.

Figure 4.23
Cumulative Learning Rates Across All Sessions and Conditions by Lori

Figure 4.24 shows the cumulative learning rate data for Marie. The data also suggest that the traditional drill and practice (TDP) instructional condition may be more efficient in terms of increasing word acquisition as compared to the interspersing or incremental rehearsal instructional conditions. These data differ from those presented in Figure 4.17 which found the incremental rehearsal instructional condition to be more
effective than traditional drill or interspersing. However, when factoring in time and the number of trials, it appears as though traditional drill is a more efficient technique when considering rates of word acquisition.

Figure 4.24
_Cumulative Learning Rates Across All Sessions and Conditions by Marie_

**Danny**

Figure 4.25 shows the cumulative learning rate for Danny. The data suggests that all three instructional conditions resulted in the acquisition of words. The increasing trend for traditional drill and practice is much steeper than the trends for the interspersing and incremental rehearsal instructional conditions, which suggests slower rates of word acquisition for the interspersing and incremental rehearsal conditions. The data in Figure 4.18 indicate that the incremental rehearsal instructional condition was more effective for increasing word acquisition for Danny. However, when time is factored into the analysis
and the number of trials is controlled, it appears that the rates of word acquisition under the incremental rehearsal condition are much lower than the traditional drill and practice technique.

Figure 4.25
*Cumulative Learning Rates Across All Sessions and Conditions by Danny*

*Chris*

Chris’ cumulative learning rate is presented in 4.26. The data show an increasing trend across all three instructional conditions and suggests that all conditions resulted in the acquisition of words. The data also suggest that the traditional drill and practice (TDP) instructional condition may result in more efficient learning for Chris even when the number of trials is controlled. The data differ from those presented in Figure 4.19 which indicated that the incremental rehearsal (IR) instructional condition resulted in slightly more words acquired.
However, when time is considered, it appears that rates of word acquisition under the incremental rehearsal condition are lower than the traditional drill and interspersing instructional conditions.

![Graph showing cumulative learning rates across all sessions and conditions by Chris Brooke](image)

**Figure 4.26**
*Cumulative Learning Rates Across All Sessions and Conditions by Chris*

**Brooke**

Figure 4.27 displays the cumulative learning rate data for Brooke. The data show increasing trends for all three conditions. The data also indicate that the traditional drill and practice technique may be more efficient in terms of increasing word acquisition with Brooke, even when the number of trials of both traditional drill and practice and the interspersing instructional conditions was increased. The data differ from those shown in Figure 4.20 which suggest the incremental rehearsal condition to be a more effective technique for increasing word recognition.
However, when time is factored into the analysis, it seems that rates of word acquisition are lower when words are presented under the incremental rehearsal technique.

The above graphs suggest that all six students demonstrated more efficient learning rates under the traditional drill and practice (TDP) instructional condition as opposed to the interspersing (IST) or incremental rehearsal (IR) instructional conditions. Of particular relevance, is the fact that the number of trials of both the traditional drill and practice and interspersal instructional conditions was increased to nine. In addition, none of the students displayed the greatest efficiency for the acquisition of words under the incremental rehearsal instructional condition. Therefore, the results might possibly suggest that the traditional drill and practice technique is most efficient for learning new words among individual students identified as having word identification difficulties.
Data were collapsed in order to examine which method is most efficient for learning new words among students as a group. Figure 4.28 shows the cumulative learning rates collapsed across all six participants across all three instructional conditions. Upon examining the data, the graph suggests a minimal degree of variability within the conditions and a considerable degree of variability across conditions. The data suggest that when time is factored into the analysis, the traditional drill and practice (TDP) instructional condition resulted in greater rates of word acquisition followed by the interspersing (IST) and incremental rehearsal (IR) instructional conditions respectively for students as a group. Students tended to learn more words per minute of instruction under the traditional drill and practice condition over the course of Study 2.

![Cumulative Learning Rates Across All Students Across All Three Conditions](image-url)
Research Question Number Three

Which of the following methods: a.) TDP, b.) IST, or c.) IR is the most effective for maintaining recognition of mastered words when the number of trials of TDP and IST is controlled for?

Research Question Number Four

Which of the following methods: a.) TDP, b.) IST, or c.) IR is the most efficient for maintaining recognition of mastered words when the number of trials of TDP and IST is controlled for?

Data were collapsed across the two maintenance sessions in order to examine both research questions. Table 4.10 represents the cumulative number of words mastered, total time engaged in each of the three conditions, the rate (i.e., cumulative number of words mastered per minute of instruction) of word acquisition under all three conditions by each participant, number of words maintained, rate of mastered words maintained, and totals across all participants for all variables. Overall, maintenance ranged from 78% to 96%. Five out of the six students maintained the highest percentage of words under the incremental rehearsal condition (IR), and one student maintained the highest percentage of words under the interspersing (IST) instructional condition. For all six students, the traditional drill and practice (TDP) condition was the most efficient for maintaining recognition of mastered words, followed by the interspersing (IST) instructional condition.
<table>
<thead>
<tr>
<th>Drill</th>
<th>Interspersing</th>
<th>Incremental Rehearsal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>W</td>
<td>Time</td>
</tr>
<tr>
<td>Sarah</td>
<td>24</td>
<td>22.35</td>
</tr>
<tr>
<td>Lori</td>
<td>20</td>
<td>19.58</td>
</tr>
<tr>
<td>Marie</td>
<td>19</td>
<td>16.38</td>
</tr>
<tr>
<td>Danny</td>
<td>18</td>
<td>13.71</td>
</tr>
<tr>
<td>Chris</td>
<td>16</td>
<td>13.59</td>
</tr>
<tr>
<td>Brooke</td>
<td>15</td>
<td>13.31</td>
</tr>
</tbody>
</table>

*a number of minutes

*b number of words mastered/time

*c number of mastered words maintained/time

Table 4.10

Number of Words Learned (WL), Number of Words Maintained (WM), Percentage of Learned Words Maintained (%WM), and Rate of Mastered Words Maintained (MR) for Each Student and Condition Totals
Research Question Number Five

Which of the following methods: a.) TDP, b.) IST, or c.) IR is the most effective on students’ ability to generalize mastered words to spelling when the number of trials of TDP and IST is controlled for?

Data were collected from the generalization student sessions in order to examine this research question. Specifically, all mastered words from each instructional condition were administered to the students in the form of a spelling test. Target words were considered to be “generalized” when a student correctly spelled the word. Generalization data was collected following the 6th session. Table 4.11 represents the number of words correctly generalized (WG), percentage of words generalized (PWG) for each student across all three instructional conditions, and group total for all of the variables across each condition. Overall, generalization to spelling was considered low, ranging from 38% to 58%.

<table>
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<tr>
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<th>Incremental Rehearsal</th>
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</thead>
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<tr>
<td></td>
<td>WG</td>
<td>PWG</td>
<td>WG</td>
<td>PWG</td>
<td>WG</td>
<td>PWG</td>
</tr>
<tr>
<td>Sarah</td>
<td>7</td>
<td>44%</td>
<td>14</td>
<td>54%</td>
<td>18</td>
<td>44%</td>
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<tr>
<td>Lori</td>
<td>8</td>
<td>47%</td>
<td>12</td>
<td>52%</td>
<td>14</td>
<td>44%</td>
</tr>
<tr>
<td>Marie</td>
<td>6</td>
<td>38%</td>
<td>9</td>
<td>53%</td>
<td>13</td>
<td>48%</td>
</tr>
<tr>
<td>Danny</td>
<td>7</td>
<td>47%</td>
<td>10</td>
<td>56%</td>
<td>16</td>
<td>39%</td>
</tr>
<tr>
<td>Chris</td>
<td>6</td>
<td>46%</td>
<td>9</td>
<td>53%</td>
<td>11</td>
<td>44%</td>
</tr>
<tr>
<td>Brooke</td>
<td>7</td>
<td>58%</td>
<td>12</td>
<td>46%</td>
<td>20</td>
<td>51%</td>
</tr>
<tr>
<td>Group</td>
<td>41</td>
<td>46%</td>
<td>66</td>
<td>52%</td>
<td>92</td>
<td>45%</td>
</tr>
</tbody>
</table>

Table 4.11
Number of Words Generalized (WG) and Percentage of Words Generalized (PWG) for Each Student, and Condition Totals
Research Question Number Six

Which of the following methods: a.) TDP, b.) IST, or c.) IR is the most effective on students’ ability to correctly read the mastered word in a sentence when the number of trials of TDP and IST is controlled for?

Data were collected from the generalization student sessions in order to examine this research question. Specifically, all mastered words from each instructional condition were included in sentences that the students read during the pre-test. Target words were considered to be “generalized” when a student was able to correctly read the word in the sentence. Generalization data was collected following the 6th session. Table 4.12 represents the number of words correctly generalized (WG), percentage of words generalized (PWG) for each student across all three instructional conditions, and group total for all of the variables across each condition. Overall, generalization to reading the target words in sentences was moderate to high, ranging from 75% to 98%.

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<th></th>
<th>Incremental Rehearsal</th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
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<td>PWG</td>
<td>WG</td>
<td>PWG</td>
<td>WG</td>
<td>PWG</td>
<td>Group</td>
<td>PWG</td>
</tr>
<tr>
<td>Sarah</td>
<td>14</td>
<td>88%</td>
<td>24</td>
<td>92%</td>
<td>40</td>
<td>98%</td>
<td>73</td>
<td>82%</td>
</tr>
<tr>
<td>Lori</td>
<td>13</td>
<td>76%</td>
<td>19</td>
<td>83%</td>
<td>29</td>
<td>91%</td>
<td>111</td>
<td>92%</td>
</tr>
<tr>
<td>Marie</td>
<td>12</td>
<td>75%</td>
<td>15</td>
<td>88%</td>
<td>25</td>
<td>93%</td>
<td>38</td>
<td>97%</td>
</tr>
<tr>
<td>Danny</td>
<td>12</td>
<td>80%</td>
<td>14</td>
<td>78%</td>
<td>39</td>
<td>95%</td>
<td>194</td>
<td>95%</td>
</tr>
<tr>
<td>Chris</td>
<td>12</td>
<td>92%</td>
<td>15</td>
<td>88%</td>
<td>23</td>
<td>92%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brooke</td>
<td>10</td>
<td>83%</td>
<td>24</td>
<td>92%</td>
<td>38</td>
<td>97%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group</td>
<td>73</td>
<td>82%</td>
<td>111</td>
<td>87%</td>
<td>194</td>
<td>95%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.12
*Number of Words Generalized (WG) and Percentage of Words Generalized (PWG) for Each Student, and Condition Totals*
CHAPTER 5

DISCUSSION

This chapter discusses the results of the study, which looked at the effectiveness and efficiency of three instructional techniques on word reading performance. Comparisons to previous research studies, implications for practitioners, limitations, and directions for future research are also discussed.

Study 1

The current study is an extension of the research conducted by Cates et al. (2003). The main purpose of Study 1 was to examine the instructional effectiveness and efficiency of three word reading interventions on students’ cumulative number of words read accurately and cumulative learning rate on next day retention measures. Specifically, the study examined whether the Incremental Rehearsal (IR) approach is more effective and efficient over time because it embeds repeated opportunities to read the same word nine
The study also examined the maintenance and generalization of words that were taught under the three instructional conditions. Social validity of the three instructional methods was also assessed.

**Instructional Effectiveness**

Results showed that all 6 students enhanced their word acquisition under all three instructional conditions. However, the results found a substantial difference between the three instructional conditions in terms of instructional effectiveness and efficiency. Students as a group learned the most words under the incremental rehearsal condition.

There are several possible explanations as to why students performed substantially better in the incremental rehearsal condition, in terms of the number of words learned. One reason could be due to the repetitive nature of the intervention. Specifically, the student saw the unknown word nine times throughout the instructional condition, giving the student increased opportunities to respond. Research has shown that fluency and maintenance are enhanced when students engage in high rates of active accurate academic responding (Greenwood, Delquadri, & Hall, 1984; Skinner, Belfiore, Mace, Williams, & Johns, 1997).

Another possible explanation could be due to the incremental fashion in which the words were presented to the students. Incremental Rehearsal is designed to teach new words by interspersing them among previously mastered words at a ratio of 10% unknown words to 90% known. Incremental rehearsal uses a high repetition of known words and a slow introduction of unknown items. Numerous repetitions of new words are reached by presenting the new word, pronouncing it, defining it, and using the word in a sentence (MacQuarrie, Tucker, Burns, & Hartman, 2002). Upon completion of the first
unknown word, a second unknown word is introduced by treating the previous unknown word as the first known, removing the previous ninth known word, and starting the sequence over again. The ratio of unknown words to known words remains 10% unknown to 90% known (Burns, Dean, & Foley, 2004).

In addition to the high repetition of unknown words and the incremental presentation of the words, the amount of time spent in the incremental rehearsal instructional condition was significantly greater than the time spent in the traditional drill and practice or interspersing conditions. Therefore, the amount of time students were exposed to the incremental rehearsal instructional condition could have increased the chance that a greater number of words would be correctly identified. The results of the effectiveness data suggest that educators may want to consider the incremental rehearsal technique for students with word identification difficulties. Although, students learned the greatest number of words under the incremental rehearsal instructional condition, it was not found to be the most efficient approach. In other words, students did not learn as many words per minute of instruction as they did in the traditional drill instructional condition.

**Instructional Efficiency**

Upon examination of the efficiency data, in Study 1 traditional drill and practice was found to be more efficient than either the incremental rehearsal or interspersing instructional techniques. All six students displayed higher learning rates under the traditional drill and practice instructional condition. The results indicated that the traditional drill and practice technique resulted in greater instructional efficiency, followed by the interspersing technique and incremental rehearsal technique.
Standard drill and practice techniques consist of new material being presented over and over in isolation and/or in context for the learner to practice until the response is automatic (Cooke & Guzaukas, 1993). Drill tasks are important in academic remediation for children who do not have prerequisite skills and are not able to perform higher order tasks, but must first learn the basic information in order to move to that level (Burns, 2004). Researchers have often analyzed different drill models as a way to increase the overall instructional effectiveness of repetition (MacQuarrie-Klender, Tucker, Burns, & Hartman, 2002). Skinner, Belfiore, and Watson (1995) suggested that in order to prevent and remedy academic skill deficits, school personnel should determine which interventions are most efficient by measuring students’ learning rates under different instructional conditions. In order to determine instructional efficiency, the number of words learned under a specific condition was divided by the amount of time engaged in the condition. The greater the number of words learned per minute of instruction, the greater the instructional efficiency.

**Maintenance**

Maintenance is essential for determining the overall effectiveness of an intervention. In Study 1, maintenance was measured after the 5th and 10th sessions. Students were presented with index cards consisting of all the words mastered on the weekly probes. Maintenance was considered to be moderate to high. The results indicated that all 6 students maintained a greater number of words that were taught under the incremental rehearsal condition. Previous research has also found that Incremental Rehearsal led to better retention of words than did other approaches (Tucker, 1989; MacQuarrie, Tucker, Burns, & Hartman, 2002). Roberts and colleagues (1991) and
Roberts and Shapiro (1996) suggested that rehearsal models that contained a high percentage of known material might lead to a lower number of words initially learned, but better retention. Maintenance rate was highest under the traditional drill and practice instructional condition.

Generalization

In order to determine whether the students could generalize the words recognized correctly in the maintenance phases to a different context, sentences containing the mastered words were created. Baer, Wolf, and Risley (1968) defined generality of behavior change as a behavior change that “proves durable over time, if it appears in a wide variety to possible environments, or if it spreads to a wide variety of related behaviors” (p. 96).

Generalization rates were considered to be moderate to high. The findings indicate that generalization rates were somewhat higher in the incremental rehearsal condition as compared to the traditional drill and interspersing instructional conditions. This finding is similar to the results found in the maintenance data, where the incremental rehearsal condition resulted in greater maintenance.

One explanation for students generalizing a greater number of words that were taught in the incremental rehearsal instructional condition may be due to the amount of time spent in this condition. Overall, students spent the largest amount of time under the incremental rehearsal instructional condition. In addition, the students had more opportunities to respond under this condition. Finally, generalization may be related to instructional effectiveness and maintenance, both of which found incremental rehearsal to be superior.
In addition to looking at generalization to reading the mastered words in sentences, generalization to spelling was also assessed. Students were required to spell all the words that were maintained. Generalization to spelling was low. The data did not reveal one instructional technique to be superior over another at correctly spelling the mastered words. A possible explanation may be that students were not directly taught to pay attention to spelling patterns in words. In addition, as first grade students, they had not yet learned the rules for spelling. Perhaps, if a phonics-based intervention was used, where the students were taught the individual sounds in each word, they could have used these strategies to help them correctly spell the word.

Comparison to Previous Research Studies

Incremental rehearsal procedures have been found to be effective through numerous investigations (Burns, Dean, & Foley, 2004; and MacQuarrie, Tucker, Burns, & Hartman, 2002). The results of this study extended upon Cates, et al. by evaluating interspersal, traditional drill and practice, and incremental rehearsal procedures on word recognition performance, and with a sample of 6 first grade students who were referred for intervention assistance due to delayed word reading performance. The current study assessed word acquisition on next day and weekly probes, whereas the Cates study assessed word acquisition on the same day. Cates and colleagues (2003) found no superior benefits to any of the three interventions in terms of effectiveness, or the number of words learned. However, the current study found the incremental rehearsal technique to be superior in terms of instructional effectiveness.

All 6 of the students demonstrated higher cumulative learning rates of learning to read unknown words under the traditional drill and practice condition, a finding
consistent with Cates and colleagues (2003). Therefore, one could conclude that students learn to read more words per minute of instructional time under the traditional drill and practice condition. The current study yielded similar findings to Cates et al. (2003) and Joseph and Nist (in press) with regard to instructional efficiency. All three studies suggest that traditional drill and practice techniques may be more efficient for learning to read unknown words when academic instructional time is a significant factor in achieving word reading mastery.

Cates et al. (2003) found the maintenance of mastered words to be closely related to intervention efficiency, just as the current study found the rate of maintaining words consistent with intervention efficiency data. Cates argued that their research findings show how basing decisions on effectiveness data may be an incomplete educational practice that fails to maximize student learning rates. However, the current study also found that maintenance of mastered words was closely related to intervention effectiveness, as all 6 students maintained a greater number of words under the Incremental Rehearsal instructional condition.

Several significant differences in methodology exist between the current study and the Cates et al. (2003) study. First, the current study looked at word reading performance, whereas the Cates et al. (2003) study examined spelling performance. Second, in the current study, an initial assessment was conducted to identify known and unknown words for each student. In the Cates et al. (2003) study, an initial assessment was conducted to identify known words only. In the current study, 100 words of various consonant vowel patterns were selected for the initial assessment. Words were counted as known if a student correctly read the word on both trials. Third, the current study
examined the incremental rehearsal technique instead of the high-p-sequencing technique that was implemented in the Cates et al. study. Cates et al. found that the HPS condition, with high ratios of known items to unknown items, may reduce learning rates. Fourth, the current study was broken down into Study 1 and Study 2, for a total of 16 sessions. The students in the Cates et al. study participated in 12 sessions. Finally, unlike the Cates et al. study, the current study included two generalization measures, generalization to spelling and generalization to reading the target word in a sentence.

Study 2

The main purpose of Study 1 was to examine the instructional effectiveness and efficiency of three word reading interventions on students’ cumulative number of words read accurately and cumulative learning rate on next day retention measures. Specifically, the study examined whether the Incremental Rehearsal (IR) approach is more effective and efficient over time because it embeds repeated opportunities to read the same word nine times. The study also examined the maintenance and generalization of words that were taught under the three instructional conditions.

The main purpose of Study 2 was to examine the instructional effectiveness and efficiency of three word reading interventions on students’ cumulative number of words read accurately and cumulative learning rate on next day retention measures. Specifically, the study examined the effectiveness of the incremental rehearsal technique when the number of trials students were exposed to under the traditional drill and interspersing conditions was increased to match the number of times students were
exposed to the target words under the incremental rehearsal condition. The study also examined the maintenance and generalization of words that were taught under the three instructional conditions.

**Instructional Effectiveness**

Results showed that all six students enhanced their word acquisition under all three instructional conditions. The results were generally found to be consistent with those derived in Study 1. Students as a group learned to read the most words in the incremental rehearsal condition.

An explanation for this outcome may not be solely due to the repeated exposures of the words, but may be due to a combination of the incremental presentation and repeated exposure of the words. Incremental Rehearsal is designed to teach new words by interspersing them among previously mastered words at a ratio of 10% unknown words to 90% known. Incremental rehearsal uses a high repetition of known words and a slow introduction of unknown items. Upon completion of the first unknown word, a second unknown word is introduced by treating the previous unknown word as the first known, removing the previous ninth know word, and starting the sequence over again. The ratio of unknown words to known words remains 10% unknown to 90% known (Burns, Dean, & Foley, 2004).

In addition to the high repetition of unknown words and the incremental presentation of the words, the amount of time spent in the incremental rehearsal instructional condition was significantly greater than the time spent in the traditional drill and practice or interspersing conditions, even when the number of trials was increased to nine under both instructional conditions. Therefore, the amount of time students were
exposed to the incremental rehearsal instructional condition could have increased the chance that a greater number of words would be correctly identified. The results of the effectiveness data suggest that educators may want to consider the incremental rehearsal technique for students with word identification difficulties. Although students learned the greatest number of words under the incremental rehearsal instructional condition, it was not found to be the most efficient approach. In other words, more time was required to learn words in this condition.

**Instructional Efficiency**

Upon examination of the efficiency data, in Study 2 traditional drill and practice was again found to be more efficient than either the incremental rehearsal or interspersing instructional techniques. All six students displayed higher learning rates in the traditional drill and practice instructional condition, followed by the interspersing technique and incremental rehearsal technique, consistent with the findings in Study 1.

**Maintenance**

Maintenance is essential for determining the overall effectiveness of an intervention. In Study 2, maintenance was measured after the 6th session. Students were presented with index cards consisting of all the words mastered on the weekly probes. Maintenance was considered to be moderate to high. The results indicated that five out of the six students maintained a greater number of words under the incremental rehearsal condition, and one student maintained a greater number of words under the interspersing instructional condition. Maintenance rate was highest under the Traditional Drill instructional condition.
Generalization

In order to determine whether the students could generalize the words recognized correctly in the maintenance phases to a different context, sentences containing the mastered words were created. Generalization rates were considered to be moderate to high. The findings indicate that generalization rates were somewhat higher in the incremental rehearsal condition as compared to the traditional drill and interspersing instructional conditions, similar to the findings of Study 1.

One explanation for students generalizing a greater number of words in the incremental rehearsal instructional condition may be due to the amount of time spent in this condition. Overall, students spent the largest amount of time under the incremental rehearsal instructional condition. Another explanation could be due to the incremental presentation of the words under the incremental rehearsal technique, along with the repeated exposures of the words.

In addition to looking at generalization to reading the mastered words in sentences, generalization to spelling was also assessed. Students were required to spell all the words that were maintained. Generalization to spelling was low, as in Study 1. The data did not reveal one instructional technique to be superior over another at correctly spelling the mastered words. A possible explanation may be that students were not directly taught to pay attention to spelling patterns in words. In addition, as first grade students, they had not yet learned the rules for spelling. Perhaps, if a phonics-based intervention was used, where the students were taught the individual sounds in each word, they could have used such strategies to help them correctly spell the word.
Comparison to Previous Research Studies

Incremental rehearsal procedures have been found to be effective through numerous investigations (Burns, Dean, & Foley, 2004; and MacQuarrie, Tucker, Burns, & Hartman, 2002). The results of Study 2 extended upon Study 1 by evaluating interspersal, traditional drill and practice, and incremental rehearsal procedures on word recognition performance when the number of trials under the traditional drill and interspersing instructional conditions was increased to nine. The number of trials was increased to match the number of times students were exposed to the target words under the incremental rehearsal condition in order to determine what variable(s) were responsible for the greater effectiveness of the incremental rehearsal technique. Research has shown that fluency and maintenance are enhanced when students engage in high rates of active accurate academic responding (Greenwood, Delquadri, & Hall, 1984; Skinner, Belfiore, Mace, Williams, & Johns, 1997).

The findings in Study 2 were consistent with the findings in Study 1. Incremental rehearsal again led to greater instructional effectiveness, whereas traditional drill and practice led to greater instructional efficiency. However, in Study 2 the interspersing instructional condition led to greater maintenance for one student, as compared to Study 1 where all six of the students maintained the greatest number of words under the incremental rehearsal condition.

Student Choice Behavior

Research has shown that increasing students’ active academic responding promotes acquisition, maintenance, and generalization of skills (Binder, 1996; Gettinger, 1995; Skinner, Fletcher, & Henington, 1996). Procedures designed to enhance the chances
of students choosing to engage in assigned academic behavior can increase learning rates and decrease inappropriate classroom behavior (Skinner, 2002). Research on the discrete task completion hypothesis and the interspersal technique suggests that educators could possibly manipulate the schedules of reinforcement without having to deliver tangible rewards contingent upon student choice behaviors (Skinner, Robinson, Johns, Logan, & Belfiore, 1996).

The discrete task completion hypothesis suggests that while working on assignments with many discrete tasks, a completed task is a conditioned reinforcer. Academic assignments often contain discrete tasks that students complete at their own pace. Consequences are often delivered contingent upon a student’s response to assignments, and students may avoid aversive consequences that are delivered when they do not complete their work (Skinner, Hall-Johnson, Skinner, Cates, Weber, & Johns, 1999). Skinner gave the example that students who complete assignments are not likely to have to stay inside during recess. Therefore, completing assignments is negatively reinforced. Completing assignments may also be positively reinforced. For example, after completing an assignment, a student may be able to engage in a preferred activity (Logan & Skinner, 1998). If problem completion is a reinforcing event, then interspersing brief problems could be a way to increase the probability of students choosing to problems (Skinner, Hurst, Teeple, & Meadows, 2002).

**Limitations**

Several limitations exist within the current study. First, only six students participated in the study. Such a small sample size greatly reduces the external validity of the study. Therefore, it cannot be determined whether other individuals would display...
similar learning rates under the various instructional conditions. Second, only word reading was investigated in the current study. It would be interesting to examine whether similar results would be found with reading fluency, reading comprehension, or mathematics. Third, the elementary school contained very little racial diversity, consisting of a majority of Caucasian students. Therefore, in order to enhance generalization, one may want to choose a more diverse population in which to conduct the study. Fourth, generalization to spelling was poor. Researchers may want to explore a phonics-based approach, where students are taught letter-sound recognition. Finally, students participated in only six sessions during Study 2. Researchers may want to increase the number of sessions and the number of maintenance points to determine if similar results would be found.

Implications for Practice

The findings from the current study have many significant implications for educational practitioners and researchers. All three instructional techniques resulted in word acquisition for all six students. Therefore, for students who are referred to Intervention Assistance Teams (IAT) for word reading difficulties, these instructional techniques may be an effective way to help students acquire more words.

The general finding related to instructional efficiency is significant when recommending such approaches to teachers. Since time is a critical factor for teachers, when given a choice between multiple interventions, teachers may choose the intervention that generates the most learning in the least amount of instructional time (Witt, Elliott, & Martens, 1984). In the current study, the traditional drill and practice technique was found to be the most efficient, not the most effective. Incremental
rehearsal was found to be superior over traditional drill and practice and interspersing in terms of retention, maintenance, and generalization. Therefore, teachers may want to consider both instructional effectiveness and efficiency when determining which reading intervention to use with a particular child.

Response to intervention is becoming more and more prevalent in the field of school psychology. With response to intervention (RTI), students are identified with a learning disability when their response to instruction is significantly inferior to that of their peers (Fuchs, Fuchs, & Compton, 2004). It is estimated that about 80% of students are learning disabled in reading (Lyon, 1995). In the primary grades, this mostly involves word analysis and word identification. However, eventually difficulties with reading fluency and comprehension emerge. The three instructional techniques implemented in the current study could possibly be incorporated into an RTI model since all three lead to word acquisition. However, incremental rehearsal was found to be the most effective in terms of retention, maintenance, and generalization. In addition, all three instructional techniques are empirically based interventions.

**Social Validity**

The current study included interviews with the students (See Appendix H) as well as interviews with the teachers (See Appendix I) in order to assess the social validity of the three instructional techniques. Social validity examines the overall significance of an intervention to the subjects involved. The interview consisted of five short questions. All questions were verbally read to the students.
Questions such as, “Did you enjoy working together,” “Did working together help with learning new words,” and “Did working together help you with reading” were asked in order to examine the social validity of the three instructional approaches.

The results indicated that all six students enjoyed working together on the reading intervention activities. Three of the students indicated that they would choose all three of the intervention activities to do again. Two of the students indicated they would choose the traditional drill and practice intervention because it was the shortest, and one student indicated that he would not choose any of the intervention activities because they were too long. However, when given the opportunity to choose which intervention they would like to receive on three different occasions, all 6 students consistently chose the Traditional Drill and Practice instructional condition. All 6 students reported that all three activities would be helpful for teaching students new words.

The two classroom teachers participated in filling out a social validity questionnaire following the completion of the final intervention session. The questionnaire consisted of seven short response questions. Responses to questions such as, “Did you notice any difference in the student’s word reading performance while he or she was participating in the study,” and “Do you feel as though the three instructional approaches appear to be appropriate approaches for teaching words to students with word identification difficulties” were assessed in order to evaluate the social validity of three instructional approaches. Both teachers indicated that four out of the six students expanded their core of words. In addition, the teachers felt that the instructional approaches appeared to be valid approaches for teaching words to students with word identification difficulties.
Based upon the students and teachers’ responses, it appears as though all three instructional techniques could be considered a socially valid way to assess and teach word reading skills to students identified as having word identification difficulties.

**Directions for Future Research**

Since only word reading was investigated in the current study, it is inconclusive as to whether the findings would generalize across academic areas. Future research may want to examine the extent to which findings would generalize across other academic subject areas, such as mathematics, reading fluency, reading comprehension, and writing. The current study only examined whole word reading approaches. Therefore, researchers may want to evaluate phonic analysis procedures using measures of instructional effectiveness and efficiency. Researchers may also want to investigate the extent to which similar findings would be found for teaching students sounds on notecards (i.e. *ear, ee, ea*). Future research may also want to investigate the extent to which findings would generalize to older students, children with mental retardation, and ELL populations.

**Summary**

The results of both Study 1 and Study 2 indicated positive effects for all three instructional techniques in regards to increasing the students’ word reading performance. Specifically, the studies found the incremental rehearsal technique to be the most effective and the traditional drill and practice technique to be the most efficient. In Study 2, the number of trials under the traditional drill and interspersing instructional conditions was increased to nine. This was done in order to match the number of times the students were exposed to the unknown words under the incremental rehearsal instructional
condition and to determine which variable(s) were responsible for the greater
effectiveness of the incremental rehearsal condition. Since students were exposed to the
unknown words a total of nine times during all three instructional conditions, one could
possibly conclude that the incremental presentation of the words under the incremental
rehearsal technique, along with the repeated exposures of the words
could have led to the greater effectiveness.
APPENDIX A

LETTER REQUESTING PARENTAL/GUARDIAN PERMISSION
Dear Parent(s)/Guardian(s),

Your child has the opportunity to participate in a reading intervention study lead by Dr. Laurice Joseph, a professor at The Ohio State University, and Lindsay Nist, School Psychologist and doctoral student in the School Psychology Program at The Ohio State University. The study is designed to enhance your child’s learning rate in the area of word recognition. Specifically, your child is invited to participate in three word reading intervention activities: drill and practice of unknown words, interspersal training (presenting one word that your child knows prior to every third target or “unknown” word), and incremental rehearsal (presenting one unknown word prior to nine known words).

If you decide to allow your child to participate, Miss Nist will meet with your child on an individual basis four-five days a week for a period of approximately 4 weeks. The intervention activities are designed to be brief and will only require your child to miss approximately twenty-five minutes of class time each day. The primary goal of the study is to determine which of the three interventions is most effective in helping children to increase their word reading learning rate.

This study will take place in the XXXXXXXX School District. All identifying information will be kept confidential. Students will be given a code number so that names will not used on any documents. Participation in this study is completely voluntary, and you have the right to remove your child from participating at any time without prejudice. A summary of the results for your child will be provided to you upon completion of the intervention sessions.

We hope that you will find this experience valuable for your child. A letter of consent has been included and will need to be signed and returned by_____ if you are interested in participating. If you have any questions, please feel free to contact Lindsay Nist at XXX-XXXX or Dr. Laurice Joseph at XXX-XXXX. Thank you for your consideration.

Sincerely,

Laurice Joseph, Ph.D.
Lindsay Nist, M.A., NCSP
APPENDIX B

CONSENT FOR PARTICIPATION IN SOCIAL AND BEHAVIORAL RESEARCH
CONSENT FOR PARTICIPATION IN RESEARCH

I consent for my child’s participation in the study entitled: The Effectiveness and Efficiency of Three Instructional Approaches on Student Word Reading Performance.

Dr. Laurice Joseph, Principal Investigator, or her authorized representative Lindsay Nist have provided information regarding the purpose of the study, the procedures to be followed, and the expected duration of my child’s participation. Possible benefits of the study have been described, as have alternative procedures, if such procedures are applicable and available.

I acknowledge that I have had the opportunity to obtain additional information regarding the study and that any questions I have raised have been answered to my full satisfaction. Furthermore, I understand that my child is free to withdraw consent at any time and to discontinue participation in the study without prejudice.

Finally, I acknowledge that I have read and fully understand the consent form. I sign it freely and voluntarily. A copy has been given to me.

Date: ____________________  Signed: ____________________________________

Signed: ________________________________  Signed: ___________________________

(Principal Investigator or her Authorized representative)  (Person authorized to consent for participant)

Witness: ________________________________
APPENDIX C

LIST OF WORDS FOR SCREENER
<table>
<thead>
<tr>
<th>CVCC</th>
<th>CVC</th>
<th>CVCV</th>
<th>CVVC</th>
</tr>
</thead>
</table>
APPENDIX D

INTERVENTION SCRIPTS
Intervention Scripts

Traditional Drill and Practice (TDP): Examiner starts stopwatch. “I am going to read some words so listen carefully as I read each word because I’m going to ask you to read it after me.” Examiner reads aloud each of the six target words and asks the student to repeat the word by saying, “Now you read it,” before moving on to the next. If correct, “Nice work, good job.” If incorrect, “listen again…” and the examiner repeats the word. Examiner shuffles the index cards for random ordering. “Now, we’re going to go through the words again, only this time you will be reading them by yourself. “Ready?” Examiner shows each of the index cards one by one to the student. If correct, “Nice work, good job, etc.” If incorrect or no response within 3 seconds, the examiner provides corrective feedback. Examiner stops the stopwatch.

Interspersal of Known Items (IST): Examiner starts stopwatch. I am going to read some words so listen carefully as I read each word because I’m going to ask you to read it after me.” Examiner reads aloud each of the six target words and asks the student to repeat the word by saying, “Now you read it,” before moving on to the next. If correct, “Nice work, good job.” If incorrect, “listen again…” and the examiner repeats the word. Examiner adds in the three KNOWN words and shuffles the index cards for random ordering, but ensures that the KNOWN words are in the 1st, 5th, and 9th positions. “Now, we’re going to go through the words again. “Ready?” Examiner shows each of the index cards one by one to the student. If correct, “Nice work, good job, etc.” If incorrect or no response within 3 seconds, examiner provides corrective feedback. Examiner stops the stopwatch.
Incremental Rehearsal (IR): Examiner starts stopwatch. *I am going to read some words so listen carefully as I read each word because I’m going to ask you to read it after me.*” Examiner reads aloud each of the six target words and asks the student to repeat the word by saying, “*Now you read it,*” before moving on to the next. If correct, “*Nice work, good job.*” If incorrect, “*listen again. . .*” and the examiner repeats the word. Examiner adds in the nine KNOWN words and shuffles the cards for random ordering. “*Now we’re going to go through the words again. Ready?*” Examiner shows the first target word, and before the student can respond, the examiner reads the word aloud to the student. Then the first known word is presented for the child to read. Next, the first unknown word is presented again, followed by the first known word, and then a second known word for the child to read. Again, the first unknown word is presented, and the pattern is continued until all nine words have been exposed to the child. Examiner stops stopwatch. The first target word becomes a known word (placed in the 9th position), and the last known word is taken out of the pile and replaced with the second target word.
APPENDIX E

SESSION PROTOCOL FORMS
SESSION PROTOCOL

Student ID#____________________________________

Session Number________________________________

Order of Conditions_____________________________

Session Observed?________________________________

Traditional Drill and Practice (TDP):

Correct Response?
Yes
No

First Response

1.     ____  ____

2.     ____  ____

3.     ____  ____

4.     ____  ____

5.     ____  ____

6.     ____  ____

Number of seconds____________________

Number of target words read correctly_______________
Interspersing (IST):

Correct Response?

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
</table>

* K denotes a known word
* U denotes an unknown word

First Response

1. (K)  ___  ____
2. (U)  ___  ____
3. (U)  ___  ____
4. (U)  ___  ____
5. (K)  ___  ____
6. (U)  ___  ____
7. (U)  ___  ____
8. (U)  ___  ____
9. (K)  ___  ____

Number of seconds__________________________

Number of target words read correctly____________________
Student ID#________

Incremental Rehearsal (IR):

Correct Response?

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
</table>

First Response (Target Words)

1.    ___    ___
2.    ___    ___
3.    ___    ___
4.    ___    ___
5.    ___    ___
6.    ___    ___

Number of seconds_____________

Number of target words read correctly_______________
APPENDIX F

TREATMENT INTEGRITY CHECKLISTS
TRADITIONAL DRILL AND PRACTICE
Treatment Integrity Checklist

Student ID#______________________________________________

Date___________________________________________________

Observer________________________________________________

Instructional Material Used:

Yes No

1. 4 x 6 index cards were used

Procedure:
The researcher: Yes No

1. Read each word to the student and asked the student
to repeat each word before moving to the next

2. Shuffled index cards for random ordering

3. Presented the notecards within 4 seconds of each other

4. Provided appropriate feedback contingent upon
response accuracy (e.g., “Good job,” “Nice Work”) for correct responses

5. Provided corrective feedback for words read incorrectly
or words not read within 3 seconds

6. Shuffled index cards for random ordering

7. Kept a record of correct and incorrect responses

8. Timed the condition
**INTERSPERSAL TRAINING**  
Treatment Integrity Checklist

Student ID#__________________________________________

Date_______________________________________________

Observer____________________________________________

**Instructional Material Used:**

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. 4 x 6 index cards were used  

**Procedure:**

<table>
<thead>
<tr>
<th>The researcher</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Read each *unknown* word to the student and asked the student to repeat each word before moving to the next  

2. Shuffled index cards for random ordering but kept *known* words in the 1st, 5th, and 9th spots  

3. Presented the notecards within 4 seconds of each other  

4. Provided appropriate feedback contingent upon response accuracy (e.g., “Good job,” “Nice Work” for correct responses  

5. Provided corrective feedback for words read incorrectly or words not read within 3 seconds  

6. Shuffled index cards for random ordering but kept the *known* words in the 1st, 5th, and 9th spots  

7. Kept a record of correct and incorrect responses  

8. Timed the condition

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INCREMENTAL REHEARSAL
Treatment Integrity Checklist

Student ID#______________________________

Date____________________________________

Observer_________________________________

Instructional Material Used:

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. 4 x 6 index cards were used __     ___

Procedure:

The researcher: Yes No

1. Read each *unknown* word to the student and asked the student to repeat each word before moving to the next __     ___

2. Presented the notecards within 4 seconds of each other ___     ___

3. Provided appropriate feedback contingent upon response accuracy (e.g., “Good job,” “Nice Work” for correct responses ___     ___

4. Provided corrective feedback for words read incorrectly or not read within 3 seconds ___     ___

5. Took out 9th *known* word and replaced it with first previously *unknown* word ___     ___

6. Repeated the sequence with the next 5 *unknown* words ___     ___

6. Provided appropriate feedback contingent upon response accuracy for correct responses ___     ___

9. Timed the condition ___     ___
APPENDIX G

STEPS IN INCREMENTAL REHEARSAL CONDITION
Steps in Incremental Rehearsal

1. Present first unknown word.
   Present first known word.

2. Present first unknown word.
   Present first known word.
   Present second known word.

3. Present first unknown word.
   Present first known word.
   Present second known word.
   Present third known word.

4. Present first unknown word.
   Present first known word.
   Present second known word.
   Present third known word.
   Present fourth known word.

5. Present first unknown word.
   Present first known word.
   Present second known word.
   Present third known word.
   Present fourth known word.
   Present fifth known word.

6. Present first unknown word.
   Present first known word.
   Present second known word.
   Present third known word.
   Present fourth known word.
   Present fifth known word.
   Present sixth known word.

7. Present first unknown word.
   Present first known word.
   Present second known word.
   Present third known word.
   Present fourth known word.
   Present fifth known word.
   Present sixth known word.
   Present seventh known word.
Present first unknown word.
Present first known word.
Present second known word.
Present third known word.
Present fourth known word.
Present fifth known word.
Present sixth known word.
Present seventh known word.
Present eighth known word.

9. Present first unknown word.
Present first known word.
Present second known word.
Present third known word.
Present fourth known word.
Present fifth known word.
Present sixth known word.
Present seventh known word.
Present eighth known word.
Present ninth known word.
APPENDIX H

STUDENT QUESTIONS TO ASSESS SOCIAL VALIDITY
STUDENT QUESTIONS

Name______________________________

1. Did you enjoy working together?

2. Did working together help with learning new words?

3. Did working together help you with your reading?

4. Do you think that the three activities that we did together seemed to be helpful for teaching students new words?

5. Which of the three activities would you like to choose to do again?
APPENDIX I

TEACHER QUESTIONS TO ASSESS SOCIAL VALIDITY
TEACHER QUESTIONS

Name___________________________________

1. Did you notice any difference in the student’s word reading performance while he or she was participating in the study?

2. After examining the description of each intervention, which of three instructional methods used do you think students would find most enjoyable?

3. Of the three instructional methods used, which do you think would be most efficient in enhancing student word reading performance?

4. Which of the three instructional methods do you think would be most effective in enhancing student word reading performance?

5. Do you feel as though the three instructional methods appear to be valid approaches, or appropriate approaches, for teaching words to students with word identification difficulties?

6. Which methods would you consider using in the classroom as part of your instruction to teach word reading?
BIBLIOGRAPHY


