ABSTRACT

COMPREHENSIVE EVALUATION OF A
DATA-BASED PROBLEM SOLVING READING MODEL

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The purpose of this study was to provide a comprehensive evaluation of a data-based problem solving model for the assessment and intervention of reading problems. The research design was a multiple baseline across ten participants. The length of the baseline varied before the treatment phase was applied to indicate if the change in performance corresponded with the introduction of treatment. This design allowed the researcher to determine if the application of treatment was truly influencing the change in reading performance. First, the study examined if an individualized, data-based problem solving model leads to increased oral reading fluency for children at risk for poor reading outcomes. Second, the study examined if an individualized data-based problem solving model leads to generalized effects on comprehension, prosody, academic engagement, and self-efficacy. Third, the study examined if self-efficacy is a significant predictor to response to intervention.

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Introduction

Reading difficulties have always been an area of concern for children during development and education. Twenty percent of children have some type of reading challenges during their lifetime (Therrien, 2004). The National Assessment of Educational Progress reported that 36% of fourth graders and 27% of eighth graders were below basic reading achievement levels in 2005. The effects of those reading struggles can negatively influence an individuals' life as a child and throughout adulthood (Lyon & Moats, 1997).

The National Association of School Psychologists (NASP) advocates for a problem solving approach to serving the needs of children with various learning challenges. Problem solving includes decisions related to identifying the problem, analyzing the problem, and monitoring progress in response to intervention. Research in the area of reading has identified "best practices" in data-based decision making, but there are currently few examples of cases in which these practices have been integrated into a single service delivery model. The first purpose of this study was to evaluate the impact of a comprehensive data-based problem solving model on oral reading fluency, which was the primary target concern for all participants. The second purpose was to evaluate the widespread positive consequences of this model on behaviors that would be expected to improve as reading skills are further developed, including comprehension, prosody, on-task behavior, and self-efficacy. The third and final purpose of the study was to identify factors that predict positive response to intervention, including the child's educational history, mental health protective factors, self-efficacy, and psychopathology.

Literature Review

There are many components related to achieving successful reading skills. The National Reading Panel (NRP, 2000) has recognized the importance of alphabetic principles, fluency (including prosody), comprehension, teacher education, computer technology, and reading instruction. The components discussed and included in this data-based problem solving model are reading fluency, comprehension, prosody, on-task engagement and reading self-efficacy levels. Each of these components was found to have a significant influence on academic achievement in reading. Using a data-based problem solving reading model that includes all of these components strengthens a child's reading skills. In the following sections, each component will be described, as well as the most valid measures for assessing this component, followed by a review of instructional variables that impact the development of this component skill.

Fluency

Reading fluency has a substantial impact on reading processing and comprehension (Kuhn & Stahl, 2003). Children with reading disabilities and poor readers appear to have great difficulty reading fluently (Chafouleas, Martens, Dobson, Weinstein, & Gardner, 2004). Reading fluency is defined as rapid reading of text with accuracy (Chafouleas et al., 2004). Reading fluency is found to be positively correlated with the amount of time spent engaged in reading activities (Anderson, Wilson, & Fielding, 1988; Taylor, Frye, & Maruyama, 1990; Cunningham & Stanovich, 1991, 1998).

Measurement of fluency. One way to measure reading fluency is by using curriculum-based measurements in reading (CBM-R). CBM-R consists of oral reading fluency tests developed from curriculum materials. CBM-R seems to be the most valid measure available for monitoring reading competence (Fuchs & Fuchs, 1999; Hintze, Owen, Shapiro, & Daly, 2000).

CBM-R literature-based benchmarks are available for oral reading fluency. For example, fourth grade students' oral reading fluency criteria placement for instructional level is 70-100 CWPM with six errors or less (Fuchs & Deno 1982). This goal is the minimal level benchmark to be confident that student is on the right track to positive reading outcomes (Good et al., 2002).

Strategies that impact fluency. Repeated reading, listening passage preview/phrase drill, incentives, and easier material are proven approaches to increase reading fluency skills. In repeated reading, children reread a selected passage three to four times or until a criterion is met (Kuhn & Stahl, 2003). Repeated reading leads to gains in reading fluency for both students with or without learning problems, and can lead to gains in other areas of reading skills as well (Adams, 1990; National Reading Panel, 2000; Therrien, 2004). According to Chafouleas, et al. (2004), children with low error rates are more likely to succeed with repeated reading than other strategies.

Listening passage preview/phrase drill (LPP/PD) uses aspects of modeling, rehearsal, and corrective feedback, which are all strong variables in academic interventions (Lentz, Allen, & Ehrhardt, 1996). Listening passage preview/phrase drill begins with the child reading the passage once, while the examiner marks the child's errors. Next, the examiner reads the passage aloud while the child follows the passage. The examiner identifies each error and reads the word aloud to the child. The child then reads the phrase(s) containing each error three times, as the examiner provides immediate corrective feedback. Kuhn & Stahl (2003) established this strategy, of modeling and assisted reading, as having positive effects on reading fluency for students with reading difficulties. Chafouleas, et al. (2004) indicated that children who read with high error rates improve more with a combination of repeated reading and performance feedback, including phase drill.

Incentives can be used as an intervention to increase reading fluency. Incentives involve the use of goal setting and rewards to impact the child's performance. This strategy impacts the child's motivation level. The use of rewards is a strong element of an effective academic intervention (Lentz, et al., 1996***;*** Martens & Witt, 2004). Walberg's (1992) meta-analysis concluded that the largest effects on reading fluency for slow and inaccurate readers were obtained by incentives.

Easier material is a strategy used to adapt the reading difficulty level of instructional materials for the student. Studies suggest that the difficulty of a reading level can negatively impact reading performance. Gickling and Armstrong (1978) found that by adapting the difficulty level, reading performance will improve. To get the largest reading gains, students must use the most appropriate instructional material that is matched to their skill level (Daly, Martens, Kilmer, & Massie, 1996).

Reading Comprehension

Reading comprehension is another important component to reading achievement. Understanding what is read is the ultimate goal of reading. Howell and Nolet (2000) suggest there are four main enabling skills taught in school that impact reading comprehension: decoding, semantics, syntax, and prior knowledge. Each of these areas can be improved through different techniques. Practice, difficulty level, and error correction are all strategies that can strengthen reading comprehension (Howell & Nolet, 2000).

Measurement of comprehension. Reading comprehension is difficult to measure. While many strategies have uncertain psychometric properties, two strategies shown to have adequate reliability and validity are maze tasks and questioning. The maze task is a form of CBM and uses a passage with every 7^{th} word deleted within the reading. The child must choose one word out of

three supplied words to complete the sentence. This measure has been shown to predict comprehension for school-aged students (Brown-Chidsey, Johnson, & Fernstrom, 2003; Espin & Foegen, 1996; Shin, Deno, & Espin, 2000). Maze passages are scored by counting the number of correct words selected in a passage. Howell and Nolet (2000) indicate the appropriate benchmark for maze passages is 60% to 80% correct. Students scoring above 80% indicate passing levels, below 60% is considered not passing, and scoring in the range of 60% to 80%, the student is considered to be at instructional level.

Questioning is generating questions about the reading to measure the students' comprehension. Questioning sometimes relies on the students' prior knowledge, which can make it harder to interpret, but when combined with another measure such as maze, interpreting comprehension is much easier (Nolte & Singer, 1985). Fuchs and Deno, (1982) have indicated this form of assessment to be an effective way to measure reading comprehension when using questions within an easier reading level. Questioning may be scored by counting the percentage of correct answers out of ten questions derived from a reading passage. Glickling and Thompson's (1985) criteria for instructional level suggests that 70% or above is an adequate benchmark for comprehension questions.

Strategies that impact comprehension. Fluency has been established as a predictor for reading comprehension (Fuchs, Fuchs, Hosp, & Jenkins, 2001). Increasing reading fluency impacts automaticity in word recognition (Kuhn & Stahl, 2003). Literature suggests that increasing accurate word recognition (John, 1993) increases reading comprehension by allowing the child to expend more cognitive resources on comprehension rather than decoding words (Kuhn & Stahl, 2003). Repeated reading strategies have lead to significant improvements in reading comprehension (Dowhower, 1987). Therefore, using repeated reading strategies may lead to multiple benefits for the students' reading performance.

Howell and Nolet (2000) address that error correction (phrase drill) and attaining difficulty level (easier material) can contribute to gains in reading comprehension. Listening passage preview/phrase drill includes modeling, which has been found to be an important instructional component in learning to read (Collins, Brown, & Newman, 1989). Studies have shown that by using easier material and matching it to the student's appropriate skill level, reading gains will increase (Gickling & Armstrong, 1978; Daly, et al., 1996).

Prosody

Many theorists believe the contribution of prosody plays a large role in reading comprehension. Prosody addresses the rhythmic and tonal parts of language such as phrasing, structural pauses, expression, and patterns in oral reading (Kuhn & Stahl, 2003; Schwanenflugel, Hamilton, Wisenbaker, Kuhn, & Stahl, 2004). Prosody can impact a student's ability to read words accurately at an appropriate rate (Kuhn & Stahl). Many children who do not have sufficient reading fluency usually group their words or read word-for-word in a manner that does not communicate the author's intent (Kuhn & Stahl; Schwanenflugel, et al.), and thus reading comprehension may be compromised.

Measurement of prosody. Prosody is measured by using rubrics or rating scales. The National Center for Education Statistics developed a four-level fluency scale that measures the grouping of words read in a phrase and how well a student reads the text with expression. The Ohio Department of Education indicates prosody benchmarks for fourth grade students to be at level 40 (1995). According to Clay and Imlach (1971), skillful readers make few short pauses in their reading indicating prosodic awareness, which is one component that impacts reading fluency, comprehension, and on-task engagement.

Strategies that impact prosody. Repeated reading has been shown to increase the development of prosody in oral reading (Herman, 1985; Dowhower, 1987; Schwanenflugel et al., 2004). Herman found that by increasing students' reading fluency to a rate of 85 correct words per minute, there was a decrease in the number of pauses. Dowhower concluded that repeated reading also contributed to the fall of final pitch and vowel lengthening. Consequently, by gaining fluency rates, prosody strengthens which enhances reading comprehension (Kuhn & Stahl, 2003).

Listening Passage Preview/Phrase drill's use of modeling and rehearsal is an important assisted reading component that helps with the development of reading prosody (Schwanenflugel, et al., 2004). Empirical research has found that listening passage preview helps students read with prosody (Chomsky, 1976; Hoffman, 1987) while giving students an advantage over others who do not have listening passage previews. As well, Dowhower (1987) indicated students who have been exposed to auditory modeling pause fewer times when they read, and lower their pitch at the end of sentences.

On-task

Another important component for students is generalizing reading skills into the classroom. A students' on-task engagement during reading-related classroom exercises can impact reading achievement. The amount of time engaged in reading is positively correlated with reading fluency (Anderson, Wilson, & Fielding, 1988; Taylor, Frye, & Maruyama, 1990; Cunningham & Stanovich, 1991, 1998) and reading fluency can affect all other components to reading such as comprehension and prosody. By helping a child build solid reading skills with fluency, comprehension and prosody, the child may be able to generalize these skills to the classroom and increase their on-task engagement during reading exercises.

Measurement of on-task. One way to measure these on-task related behaviors is the Behavior Observation System (BOS; Jones, Wickstrom, & Friman, 1997). The BOS is a partial interval recording system used to record the occurrence or nonoccurrence of off-task behaviors during a series of consecutive 10-second intervals. Local norms suggest fourth grade students should be on-task 69% of the time during independent seatwork (Haile-Griffey, Saudergas, Hulse-Trotter, & Zanolli, 1993)

Strategies that impact on-task. According to Gickling and Thompson, the ideal instructional range for achievement and on-task engagement is 70-85% (1985). It is important to find the appropriate instructional range for the student to have optimal success (Daly et al., 1996). The use of easier material is one strategy used to find appropriate instructional material and build stronger reading skills through repeated reading, listening passage preview/phrase drill, and incentives.

Self-efficacy

Children who experience learning difficulties in school usually have lower levels of self-efficacy. Hackett & Betz (1989) imply teachers should pay more attention to a student's self-efficacy than their actual performance, because the student's perceptions may be a better predictor of student motivation and performance. Self-efficacy could be a factor in why the same academic interventions are successful for some students while unsuccessful for other students. Self-efficacy influences important components to learning such as effort, persistence, learning and motivation (Bandura, 1982; Schunk, 1989b; Zimmerman, Bandura, and Martinez-Pons, 1992). It is clear that self-efficacy can influence whether a child takes an interest in reading or if a child avoids reading in fear of failure.

Measurement of self-efficacy. There are many scales available to measure self-efficacy level but most are broadly focused on academics in general. The Reader Self-Perception Scale (RSPS), developed by Henk and Melnick, measures how intermediate level students feel about their reading progress, observational comparison, social feedback, and physiological state (Henk & Melnick, 1992;1995). This scale was based upon the four factors in Bandura's self-efficacy model (Bandura, 1977). Henk & Melick demonstrated that the scale reliability ranges from .81 to .84 on all items (1992; 1995). Average normed-benchmark scores for readers' self-perception are: 39 for academic progress; 21 for observational comparison; 33 social feedback; and 31 for physiological state.

Strategies that impact self-efficacy. According to Bandura's self-efficacy theory, self-efficacy can be increased in a few ways. One common way to change self-efficacy is through positive attribution statements. Positive attribution statements can encourage and empower students' self-beliefs while negative attributions can weaken individual's self-beliefs (Pajares, 2003). Attributional feedback (Nicholls, 1978) can motivate students to work harder. Self-efficacy can be strengthened when good performance is acknowledged with the assurance that success is possible (Schunk, 1989a).

Effort attributions rather than ability attributions can lead to better gains for younger children (Nicholls, 1978) and for children with learning problems who usually do not place enough emphasis on effort in achievement performance (Torgesen, 1988). Effort attributions increase the students' focus on strengthening skills even if mistakes are made in the process (Mueller & Dweck, 1989). A student with learning problems may require effort feedback for early success and ability feedback as their skills strengthen. Positive attribution statements include: effort statements "I can tell you are trying you best," "I can tell all of your practice has really helped you," or "You must have worked hard on these problems" and ability statements "You're good at this," or "You're a natural."

Data-based Problem Solving Model

Using a comprehensive data-based problem solving model can lead to a successful reading outcomes for students suffering from reading difficulties. This model can lead to larger reading gains as well as give students the basic foundations for being successful students. The purpose of this study is to provide a comprehensive evaluation of a data-based problem solving model for the assessment and intervention of reading problems.

A thorough review of the literature indicates that "best practices" in data-based decision making exist for each sequence within a problem solving framework. For problem identification, the goal is to identify a functional discrepancy between child performance and expected performance. Noell et al. (2005) proposed a model for problem identification called the Screening to Enhance Equitable Placement (STEEP). The STEEP includes many components, but the one most useful for problem identification is the class-wide assessment, which involves a comparison of the child's performance on curriculum-based measures and a brief observation of on-task behavior to those of his or her classroom peers, as well as literature-based standards. The ultimate outcome of this approach to problem identification is to verify those areas in which the child's performance levels are discrepant from expected performance levels.

The second step in problem solving is problem analysis. It is a functional analysis of intervention effects under analogue conditions (Daly et al., 1997). A brief assessment compares the students' baseline data against the students' performance during four different instructional strategies by calculating the effects of each treatment using CWPM. A 30% increase above baseline indicated that it was an effective strategy. The brief assessment goal is to match the

appropriate intervention to a child's specific needs to identify treatment content. The brief assessment leads to effective treatment designs (Daly, Martens, Dool, & Hintze, 1998) that address the selection of intervention goals, content, and processes (Shinn & Bamonto, 1998).

The third step is progress monitoring**.** It measures the outcome of the intervention based on the brief assessment. The goal is formative evaluation – frequent measurement of progress toward a benchmark, procedures involve data-based decisions (e.g., when to add treatment) and outcome is a defensible data set displaying child progress across baseline and treatment phases. Progress monitoring entailed monitoring the students' academic growth and whether the students' performance score discrepancy decreased between the student and literature-based standards. Using the CBM-R is an effective way to monitor progress (Fuchs and Fuchs, 1998). It has been used to develop growth standards (Deno, Fuchs, Marston, & Shin, 2001) and is able to track small changes in instruction. To assess the slopes of improvement, it was necessary to calculate the mean weekly increase in CWPM for participants.

The National Association of School Psychology (NASP) advocates for a "comprehensive evaluation" of learning difficulties (2003). NASP recommendations were aligned with Shinn and Bamonto (1998) organized sequentially steps in problem solving. The steps were problem identification, problem analysis, and progress monitoring. Problem identification addresses whether there is a problem. Problem analysis focuses on what the solution might look like, and progress monitoring assesses if the problem has been solved. This model dictated that appropriate information be collected at each stage (Shinn & Bamonto). The specific procedures and decision rules used in each step were derived from empirically based, "best practices" examples from the school psychology literature. To date, however, no studies have illustrated how these components can be linked.

Purpose of Study

The purpose of this study was to provide a comprehensive evaluation of a data-based problem solving model for the assessment and intervention of reading problem.

Hypothesis 1: An individualized, data-based problem solving model leads to increased oral reading fluency for children at risk for poor reading outcomes.

Hypothesis 2: An individualized data-based problem solving model leads to generalized effects on comprehension, prosody, academic engagement, and self-efficacy.

Hypothesis 3: Self-efficacy is a significant predictor to response to intervention.

Method

Participants

Seven 4th grade students and three 3rd grade students served as participants in this study. The ten children were diagnosed at risk for reading failure (i.e., referrals from teachers on students who do not meet DIBELS benchmarks for oral reading fluency meaning students who scored between 'At Risk' or 'Some Risk' for reading failure for their grade level). Students were enrolled in a rural middle-class school district located in the Southwest Ohio.

All individualized assessment and intervention procedures were implemented by graduate students. The graduate students were enrolled in a NASP-approved school psychology program

at Miami University, Oxford, Ohio. Training foundations were provided within coursework that corresponded to field experience during their second year of graduate training.

Dependent Variables

Fluency. Curriculum-based measurement in reading (CBM-R) was used to measure fluency, twice per week throughout all experimental phases. CBM-R was calculated as the mean number of words read correctly per minute on 1-3 novel passages during a biweekly session. CBM-R is a reliable and valid measure offered for monitoring reading competence (Fuchs & Fuchs, 1999) with a test-retest reliability of .92-.97 and concurrent validity coefficients of .80 (Good et al., 2002-2003).

To calculate CBM-R, each child was presented with a grade level passage. The student was asked to start reading aloud to the best of their ability at the beginning of the story, while the examiner followed along on a separate copy of the passage. After 60 seconds, the examiner placed a slash mark after the final word attempted (although the child was allowed to continue reading). If the child came to a word he or she did not know, the child was directed to skip it and continue reading. The same procedure was followed for two or three additional passages during each session. Oral reading fluency was collected during baseline and during treatment phases on a weekly basis to monitor the slope of performance growth.

Comprehension. Maze techniques measured reading comprehension. The student read a selected reading passage where every seventh word is missing. The first and last sentence was left intact. The student chose the original word from three words provided. Maze resembled a multiple-choice assignment. Students' instructional level goal ranged from 60 to 80 percent correct (Howell & Nolet, 2000).

The three word choices included the exact original word, a syntactically correct word but semantically incorrect and a semantically and syntactically incorrect word. The child was asked to start at the beginning and read across the page; when he/she came to a blank, circle the word that fits in the passage best. This task was un-timed, to get a more reliable measure of comprehension. Maze was scored by calculating the percentage of correct choices for the total passage. The maze was administered to collect a pre and posttest measure of comprehension, using a separate passage at each interval.

Questioning. Questioning was used in conjunction with maze techniques. A new reading passage was used during the questioning technique. Questioning was generating questions about the reading passage to measure reading comprehension. Questions included four literal questions that could be found directly in the text, three inter-sentential questions that could be found by combining two parts of the passage, and three inferential questions that could not be found in the text. The child was asked to silently read the generated passages and answer questions given to the child after he/she finishes. The calculations were derived from the total percentage of correct responses and the percentage of correct responses per type (literal, inter-sentential, and inferential). Comprehension was collected as a pre and posttest measure, using a separate passage at each interval.

On-task. The Behavioral Observation System (BOS) was a direct observation procedure to measure on-task engagement. The BOS measured the percentage of 10-second intervals of the student's on-task engagement for reading-related activities. The students were observed during a 20-minute time period recommended by the teacher that would most likely display off-task engagement. The on-task engagement was defined as the absence of motor, verbal or off-task behaviors during the 10-s interval. The students were observed for two consecutive intervals followed by an observation of three random peers. A peer observation was observed during

every third interval to compare on-task engagement with other students in the classroom. The BOS score was calculated as the percentage of intervals containing on-task. The BOS was given as a pre and posttest to measure on-task engagement.

Prosody. The National Center for Education Statistics (1995) developed a prosody scale. The scale consists of a four-level fluency rating (1.0, 2.0, 3.0, and 4.0). The four levels reflected two components of reading prosody. The first component measured the grouping of words read in a phrase with pauses. The second feature measured how well students read the text with expression. The instructor marked each item that describes the child's reading performance and circled the level indicating the majority of the child's reading characteristics. Prosody was assessed as a pre and posttest, using audio-taped recording of the child's performance during 1-3 oral reading probes.

Self-efficacy. The Reader Self-Perception Scale (RSPS) consisted of 33 questions representing overall reading ability, progress, observational comparison, social feedback, and physiological states. The RSPS was made up of a 5-point likert scale (1=strongly disagree, 2=disagree, 3=undecided, 4=agree, and 5=strongly agree). The total scale reliability ranged from .81 to .84. The original scale was modified for use of this study: the text size was enlarged; the font was changed to a less formal font; and smiley faces and sad faces were added to the 1-5 point scale to illustrate the pictures that correspond with the likert scale. The instructor began by reading the instructions to the child. The instructor and the child would both look at the same scale as the instructor reads the questions and answers. The child would be directed to circle the answer that best described his/her feelings. The Reader Self-Perception Scale was administered as a pre and posttest.

Reliability

Reliability was assessed for the curriculum-based measurement scores by having a second examiner independently score of an average of 25% readings (range, 18 to 41%). The reliability of the two observers was calculated by dividing the lower estimate by the higher estimate, and multiplying by 100. The mean reliability was an average of 97% (range, 90 to 99%).

Experimental Conditions

The experimental conditions included baseline and treatment.

Baseline. Baseline data were assessed in the absence of any supplemental treatment. The number of baseline data collected varied from three to six points for the multiple baseline design. Three grade level passages were given to the student to read for one minute. After one minute the student's correct words per minute was calculated while subtracting the errors. The median oral reading fluency score and the median errors per session were recorded. Two sessions per week were administered.

Data-based problem solving. The data-based problem solving model was made up of three sequential steps: problem identification, problem analysis, and progress monitoring. The first component addressed problem identification. Problem identification involved the administration of CBM-R, maze, questioning, prosody scale (based on CBM-R readings), BOS, and self-perception scale to gather pre-test performance on each component. These scores were compared to the literature-based benchmarks to determine which academic areas the student was discrepant from expectations.

Problem analysis involved the administration of a brief experimental analysis of oral reading fluency. The model directly assessed the relative impact on various instructional variables (e.g., incentives, practice) on oral reading performance. During brief instructional

trials, reading performance across four conditions was evaluated using a multi-element design. Each instructional strategy was evaluated using a single reading passage (Daly, et al., 1998). The goal of the brief assessment was to identify the least intrusive, yet effective instructional strategy. The order was hierarchical, beginning with the least intrusive (e.g., motivational strategies), followed by more intrusive (e.g., instructional strategies). The specific strategies tested during the brief assessment were incentive, repeated reading, listening passage preview/phrase drill and easier material. Table 1 describes each strategy used during the brief experimental analysis. Once the student was assessed on each strategy, a mini-reversal was completed to confirm the most effective intervention. The mini-reversal consisted of a single replication of the effects of the least intrusive yet most effective condition.

Progress monitoring was the third component, and involved plotting the child's oral reading fluency twice per week, before any intervention was administered. During this phase, biweekly progress was monitored in response to a treatment based on the most effective condition identified during the brief assessment. Twice per week, the child was administered the strategy one to three times, each with a new passage, during a 30-minute intervention session. Scores were plotted twice per week, and a goal-line was established for reading fluency that corresponded to +1.5 per week increase. If the child's progress fell below goal-line for three consecutive data points, an additional second instructional treatment component was added. The second instructional treatment was always incentive (e.g., repeated reading + incentive), as this strategy represented the least intrusive component.

A self-efficacy strategy was included with all fluency interventions. Self-efficacy was added to each strategy through positive attribution statements. This consisted of non-contingent effort-based statements and contingent ability statements. Verbal attribution statements were given three times per intervention script. Examples of effort attribution statements are: "You seem to be working really hard", "You seem to be trying your best", or "You are doing great because you are working hard". When the student achieves his/her performance goal, an ability-based statement was given such as, "You made your goal, you are good at this" or "You are talented. You did really well".

Design and Procedures

The research design was a multiple baseline across participants. This design allowed the researcher to determine if the application of treatment was truly influencing the change in reading performance. Baseline was the natural classroom conditions, while treatment was the data-based problem solving model. The length of baseline varied before the treatment phase was applied to indicate if the change in performance corresponded with the introduction of treatment. Stoiber & Kratochwill (2000) suggest that single-case designs are a valid methodology for establishing evidence-based interventions.

Procedures in the study included subject recruitment, training in data-based problem solving (DBPS), and administration of DBPS. A school district in southwest Ohio referred a group of ten students who were struggling in oral reading fluency. Consent forms were sent home and signed by each student's parents in order to participate in our research study. Ten graduate students received DBPS model training during the Fall 2006. The graduate students were trained on the DBPS model for three weeks. Data collection began in October. The first two to four sessions were devoted to all pre-test measures on reading fluency, comprehension, prosody, on-task engagement in the classroom during reading-related tasks and self-efficacy levels. All DBPS model activities were delivered during two 30-minute sessions per week. Posttest measures were administered during the final week (across two sessions).

The intervention was conducted in a one-on-one pull out setting twice a week for ten weeks. Students were be given a pretest using the CBM-R to get baselines in oral reading fluency, maze and questioning to assess reading comprehension, prosody scale to assess reading prosody, BOS to get on-task percentage of engagement and RSPS to get self-efficacy baselines. The brief assessment was used to further assess the student on the different reading strategies mentioned above and evaluated on the strategy that gave the student the most gains.

Over the next ten weeks, each student began with the treatment derived from the brief assessment. A goal-line was established for reading fluency that corresponded to +1.5 per week increase. If the child's progress fell below goal-line for three consecutive data points, an additional second instructional treatment component was added. The second treatment was based on their initial brief assessment. The students were given CBM-R, maze and questioning, prosody scale, BOS, and RSPS posttest to evaluate if this data-based problem solving model helped students achieve reading gains during progress monitoring.

The final step for all cases was to calculate summary statistics. Summary statistics included effect size, percentage of non-overlapping data (PND), and growth rates. Effect size was calculated by subtracting the median score of the final three baseline data points by the median score of the final three treatment data points divided by the mean of the baseline standard deviation plus the treatment standard deviation. To adjust for the effects of repeated reading measures, this number was then multiplied by the square root of 2(1 - .84), with .84 being the average correlation between two CMB-R administrations (Swanson & Saches-Lee, 2000). PND was calculated as the percentage of treatment scores over the highest baseline score (Scruggs et al., 1987). Growth rate per week was calculated by subtracting the median final three baseline points by the median final three treatment point divided by the number of treatment weeks.

Treatment Integrity

Treatment integrity was assessed by the examiner daily. During each session the examiner completed a checklist of intervention steps. A separate checklist was created for sequential steps included the data-based problem solving model. The first checklist was problem identification (Figure 1). This checklist was designed for the pretest and posttest components by having the examiner check each step as the examiner assesses oral reading fluency, on-task behavior, comprehension, prosody and self-efficacy. The second checklist completed was used for the collection of multiple baseline data for oral reading fluency (Figure 2). The checklist addressed session number, date, phase, selected passage, instructions read, words read correct per minute and the number of errors. The third checklist was used to measure the treatment integrity of the brief assessment indicating the completion of each reading strategy, instructions given, and performance scores on oral reading fluency and a mini-reversal if needed (Figure 3). The final checklist was used to affirm the actual treatment (Figure 4). Each reading strategy had a specific checklist that corresponded with the appropriate steps in that treatment. All treatment checklists included a section to check for providing positive affirmation statements. Analysis of self-reported fidelity sheets revealed an adherence to intervention steps 100% of the time.

Results

Results were organized in terms of the three study hypotheses.

Hypothesis 1: An individualized, data-based problem solving model leads to increased oral reading fluency for children at risk for poor reading outcomes.

To test this hypothesis, visual inspection was used to analyze each child's oral reading fluency using a multiple baseline design. Visual inspection illustrated the treatment effects of single-participant data compared to the participant's baseline (Morgan & Morgan, 2001). Each child's oral reading fluency during treatment was compared to baseline performance. To ensure that this improvement was due solely to the independent variable, a between-subjects comparison was conducted. Because improved growth occurred at the time when treatment was introduced for each participant, internal validity was strengthened.

Figure 5 displays the results for Von, Brie, and Krissy using a visual inspection on a multiple baseline design across participants. Each graph indicates the participant's data with varying baselines. Von (top panel) displayed a consistent upward growth trend indicating an effective treatment for this child. Brie (middle panel) also displayed a consistent upward growth trend indicating an effective treatment for this child. Krissy (bottom panel) displayed an upward growth pattern with some variability indicating the students performance fluctuated some during treatment. Although some variability, the upward growth trend still supports an effective treatment for this child. This suggests that the treatment (e.g., data-based problem solving model) was effective in strengthening reading fluency for each of these three children.

Figure 6 displays the results for Patti, Shelly, and Mick; the second group of student's data points on a multiple baseline design across participants. Patti (top panel) appeared to display a consistent growth slope which indicated an effective treatment for this child. Shelly (middle panel) appeared to have no growth during treatment indicating an ineffective treatment for this child. Mick (bottom panel) appeared to have some growth but inconsistent performance levels indicating an ineffective treatment for this child. The results in Figure 6 suggest that treatment (e.g., data-based problem solving model) was a moderately effective one of the three students.

Figure 7 displays the results for Nat, Zarah, Dave, and Maggie. Figure 7 displays four participant's data with varying baselines. Nate (top panel) displayed a consistent upward growth slope over time indicating an effective treatment for this child. Zarah (second panel) displayed a significant upward growth slope with no variability. Zarah's performance data indicates an effective treatment for this child. Dave (third panel) displayed a upward growth slope with slight variability. These data indicated an effective treatment for this child. Maggie (bottom panel) displayed a consistent upward growth pattern in response to treatment. Through visual inspection, the data indicated Nat (top panel) showed moderate growth while the bottom three students showed a strong consistent growth slope across participants regardless of the varied baseline. This suggests that the treatment (e.g., data-based problem solving model) was an effective for strengthening reading fluency for all four children.

Table 2 displays each student's average correct words per minute during the baseline and treatment phrase. The treatment growth rate was calculated and organized from greatest response to least response. Overall, the data demonstrate that the majority of the students, regardless of baseline reading mean, improved their correct words per minute on average during the treatment conditions using a multiple baseline design. The students appear to fall into three categories: high responders, moderate responders and poor responders. Through visual inspection, four students appeared to respond the highest: Zara, Maggie, Dave, and Brie. All four highest responders' final treatment status was repeated reading (RR), although two of them required incentives (IN) to be added to RR. Four students responded moderately: Patti, Von, Nate and Krissy. Three of the moderate responders' final treatment status included listen passage

preview/phrase drill (PD), either alone or combined with IN. The final two students, Shelley and Mick, were considered poor responders. Shelly's final treatment status including three conditions RR, PD, and IN. Mick's treatment status was a repeated reading condition.

Table 3 displays summary statistics for each case including effect size, percentage of non-overlapping data, and treatment growth rate. The bottom line indicates the literature based standards for each summary statistics. The summary statistics (effect size and treatment growth rate) suggest that 80% of the students made substantial gains in oral reading fluency, indicating that the treatment used was effective.

Therefore, using all of the data collected, the hypothesis of an individualized, data-based problem solving model leads to increased oral reading fluency for children at risk for poor reading outcomes was supported.

Hypothesis 2: An individualized data-based problem solving model leads to generalized effects on comprehension, prosody, academic engagement, and self-efficacy.

Table 4 illustrates each participant's scores across measures at pretest and posttest for oral reading fluency (ORF), reading comprehension using the MAZE and questioning, on-task behavior, and prosody. The mean score for participant's comprehension using MAZE increased on average from 55% on the pretest to 79% on the posttest (scores ranging from 74% to 100%). Five out of the ten students made gains. The overall average pretest for questioning was 63% while posttest scores increased to 84% (scores ranging from 60% to 100%). Seven out of the nine students made gains. For on-task behavior, collected during routine classroom instruction, the average pretest score of 64% increased to 77% during posttest (scores ranging from 52% to 100%). Seven out of the ten students made gains. The total prosody score averages increased from 1.9 on pretest to 2.6 on posttest (scores ranging from 1.0 to 3.0). Seven out of the ten students made gains. The data indicates that overall gains were made in each area illustrating that an individualized, data-based problem solving model leads to generalized effects on comprehension, academic engagement, and prosody.

Therefore, using all of the data collected, the hypothesis of an individualized data-based problem solving model leads to generalized effects on comprehension, prosody, academic engagement, and self-efficacy was supported.

Hypothesis 3: Self-efficacy is a significant predictor of response to intervention.

Table 5 displays each participant's scores across measures at pretest and posttest for self-efficacy: academic progress, observational comparison, social feedback and physiological state. The mean score for participant's academic progress using the RSPS increased on average from 35 on the pretest to 36 on the posttest (scores ranging from 22 to 45). The overall average pretest for observational comparison was 14 while posttest scores increased to 17 (scores ranging from 6 to 28). For social feedback, the average pretest was 31 increasing to 34 during posttest (scores ranging from 16 to 44). The total physiological state average scores increased from 30 on pretest to 31 on posttest (scores ranging from 10 to 40). The averages indicate that there was an overall gain among the four self-efficacy measures. The average highest gains were in observational comparison and social feedback.

These pre-post changes in self-efficacy indicate a possible correlation between improved fluency and reading self-efficacy progress. The strength of this association, however, is more

obvious when examining the correlation between pre-test performance and response to intervention (see Table 6). Self-efficacy progress was the only component that indicated a significant correlation ($p<.01$) in regards to the percentage of non-overlapping data (percentage of treatment scores over the highest baseline score). This correlation indicates as oral reading fluency scores increased (based on PND), students' self-efficacy progress increased. Based on these data, it appears that for this small group of children, reading self-efficacy progress was a strong predictor of response to intervention. Therefore using all of the data collected, the hypothesis that self-efficacy progress is a significant predictor of response to intervention was supported.

Discussion

The primary finding of this study was that an individualized, data-based problem solving model leads to increased oral reading fluency for children at risk for poor reading outcomes. The findings are congruent with the National Association of School Psychology recommendations for best practices. In addition to other research that indicates using a organized sequential problem solving model including problem identification (Novell et al., 2005), problem analysis (Daly, Martens, Dool, & Hintze, 1998) and progress monitoring can lead to effective gains (Shinn and Bamonto, 1998; NASP, 2003). However, the present study contributes to the previous literature by demonstrating how these problems solving elements can be combined into an integrated model to address oral reading fluency problems.

The second finding revealed that the data-based problem solving model lead to increased performance on comprehension using the MAZE and questioning, increased performance on-task behavior in school, and increased prosody or reading with expression. The findings were illustrated through pretest posttest data. The findings are consistent with previous research that indicates oral reading fluency has an impact on reading processing and comprehension (Kuhn & Stahl, 2003), as well as research supporting that oral reading fluency is found to be positively correlated with the amount of time spent engaged in reading activities (Anderson, Wilson, & Fielding, 1988; Taylor, Frye, & Maruyama, 1990; Cunningham & Stanovich, 1991, 1998). The findings are also congruent with Kuhn and Stahl research indicating prosody can impact a student's ability to read words accurately at an appropriate rate. In addition to previous research, the present study continues to reveal the positive effects on oral reading fluency within the framework of using a data-based problem solving model for identification, analysis, and progress monitoring.

The third finding revealed that the data -based problem solving model leads to increased self-efficacy in academic progress, observational comparison, social feedback and physiological state. The findings were revealed through student pretest performance on each Reader Self Perception Scale factor compared to posttest performance. Overall, the students average scores on the RSPS pretest increased during the posttest. There was a strong correlation ($p < .01$) which indicated a significant relationship between self-efficacy and percentage of non-overlapping data for participants.

Despite the positive findings from the present study, several limitations should be noted. While many pretest and posttest findings revealed significant student gains, the multiple baseline design did not include a reversal or return to baseline. Adding a reversal would have provided more certain evidence that effects were due to treatment. Future studies may include this to strengthen their findings.

While the study revealed a strong correlation between self-efficacy and one index of treatment response (PND), the correlation does not reveal whether self-efficacy levels predict treatment success or if treatment success determines self-efficacy levels. Future research may explore the direction of the relationship between self-efficacy and oral reading fluency. As well as continue to evaluate the significant effects of self-efficacy as a predictor for response to intervention.

There are at least two additional areas for future research that may seriously impact response to intervention services. First, there is a need to comprehensively evaluate the degree to which a brief assessment improves student outcomes. While research suggests that reading fluency interventions are more effective based on brief assessments (Daly, Martens, Dool, & Hintze, 1998, Daly et al., 1999), the current study was limited to ten 3rd and 4th graders. Additional research should replicate the study across more children and grade ranges to evaluate outcomes on a variety of students.

A second area for future research should focus on how well skills generalize using brief experimental analysis. To date many studies employing a brief experimental analysis have been limited to elementary aged students with reading deficits (Daly, Martens, Dool, & Hintze, 1998, Daly et al., 1999). It is not clear if the same generalized effects established in this study would also be observed for brief experimental analysis derived treatments in math or writing. (Grossen, 1997). Future research is needed to evaluate the degree to which a brief assessment improves student outcomes in math or writing. Future studies will strengthen the findings of this study that support using a brief experimental analysis leads to generalized effects in other academic domains.

Overall, the findings from the study suggest that using a data-based problem solving model will lead to successful gains. Eight out of ten students had performance gains in oral reading fluency using visual inspection. The majority of the students had generalized effects in reading comprehension, on-task behavior, prosody, and self-efficacy. Using an organized sequential model will lead to individualized plans that will be effective for the majority of students.

Implication to Practice

The findings suggest that a data-base problem solving (DBPS) model will lead to individualized plans that will be effective for the majority of students. As schools continue to proceed with a Response to Intervention model (RTI), the DBPS model would be an effective way to increase student success. School psychologist, special education teachers and general education teachers could be trained on administering the DBPS for ‘at risk’ students needing intervention. Once the training is conducted, there would be a vast amount of school personnel who could administer the DBPS when needed. The DBPS model may be most appropriate to use for Tier 3, intense interventions. By using an individualized plan at the Tier 3 level, the intervention should lead to increased gains for that student instead of randomly picking an intervention. In practice many times student interventions are conducted in groups. Once the DBPS model is administered to a child, it might be possible to actually conduct the intervention in a group setting if the students respond positively to the same interventions. Regardless, by incorporating the DBPS model into RTI, the majority of the students will make effective gains.

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Table 1

Brief Experimental Analysis Reading Components

Incentive (IN)	The student is awarded an incentive once an established reading goal is reached.
Repeated Reading (RR)	The student reads the same passage three consecutive times.
Phrase Drill (PD)	The student reads a passage once. The instructor then reads the passage aloud while the child follows along the passage. The child's first 15 errors are then identified and read to the child. The child reads the corrected phrases three times. The child then rereads the entire passage.
Easier Material (EM)	The student reads a passage one grade level below his/her actual grade level, decreasing the difficulty level of the student reading passage.
All Components: Self-Efficacy (SE) **Attributions**	Each reading intervention included 3 non-contingent effort attribution statements. An additional ability attribution statement was given if the participant reached his/her goal.

Table 2

Oral Reading Fluency Responders

Name	*Baseline Mean*	*Treatment Mean*	*Treatment Growth Rate*	*Final Treatment Status*
Zara	61	95	9.7	IN+RR
Maggie	70	95	5.6	RR
Dave	85	107	4.89	RR
Brie	30	51	4.7	IN+RR
Patti	43	54	2.4	PD
Von	87	98	2	PD
Nate	46.5	60	2	IN+PD
Krissy	51	60.5	1.6	RR
Shelly	10	11	0.18	IN+RR+PD
Mick	99	90	-2	RR

Note: IN = incentives; RR = repeated reading; PD = listening passage preview/phrase drill

Table 3

Summary Statistics for Each Case

Name	*Effect Size*	*Percentage of Non-Overlapping Data*	*Treatment Growth Rate*
Zara	.80	33%	9.7
Maggie	1.60	67%	5.6
Dave	2.0	38%	4.89
Brie	11	88%	4.7
Patti	1.70	67%	2.4
Von	1.10	60%	2
Nate	1.40	54%	2
Krissy	.55	25%	1.6
Shelly	-.26	0%	0.18
Mick	.99	33%	-2
Literature Based Standards	.80 large .50-.79 moderate .49 small	85% highly effective 65%-85% moderate 64% questionable	+1.0

Table 4

Generalized Effects on Reading Comprehension, On-Task Behavior and Prosody
Pre- and Posttest Scores for Each Student

Name	*MAZE*		*Questioning*		*On-Task*		*Prosody*	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Zara	97	89	90	90	63	72.2	25	30
Maggie	90	100	80	100	100	100	25	30
Dave	86	77	65	100	53	94	20	20
Brie	63	95	40	90	35	81	10	30
Patti	45	74	50	60	74	67	20	30
Von	68	77	70	70	72	89	30	30
Nat	89	89	50	70	46.2	55	10	20
Krissy	86	86	50	80	39	52	20	30
Shelly	70	86	*	*	76	67	10	10
Mick	87	84	75	100	85.7	91	20	30

Note: Shelly was unable to complete the questioning assessment due to her low oral reading performance

Table 5

Self-Efficacy Pre- and Posttest Scores for Each Student

Name	*Academic Progress*		*Observational Comparison*		*Social Feedback*		*Physiological Sate*	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Zara	33	25	10	n/a	24	n/a	36	n/a
Maggie	42	39	24	15	43	36	39	36
Dave	31	39	19	20	37	31	33	33
Brie	44	45	14	19	39	41	40	38
Patti	44	45	10	11	37	43	36	40
Von	38	44	15	28	27	44	34	40
Nat	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Krissy	21	36	12	17	25	32	30	35
Shelly	25	22	6	6	23	28	12	10
Mick	33	29	12	20	22	16	13	17
Averages	35	36	14	17	31	34	30	31

Table 6

Correlation Between Pretest Measures and Treatment Summary Statistics

Name	*Effect Size*	*Percentage of Non-Overlapping Data*	*Treatment Growth Rate*
ORF	-.29	.08	.20
MAZE	-.32	-.28	.33
Questioning	-.57	-.49	.42
BOS	-.51	-.18	-.09
Prosody	-.41	-.04	.26
Self-Efficacy	.53	.88**	.33

Note: * $p < 0.05$; ** $p < .01$

Figure 1

Fidelity Checklist for Problem Identification
COMPONENT READING SKILLS (PRE-TEST)

On-Task

Date: _____

Observe child during 10-15 min reading-related independent seatwork activity.
Mark each 10-s interval as "ON" if no verbal, motor, or passive off-task occurs.
Use every third interval to mark peer on-task. I suggest alternating between 3 randomly selected peers.

_____ overall percentage of ON (child)
_____ overall percentage of ON (peers)

Oral Reading Fluency

Session No. _____ Date: _____

Selected a new reading assessment passage. Title: _____

Recite standardized CBM administration instructions.

Assessed general performance CWPM:_____ Errors _____

IOA: _____

Notes
This reading should be included when calculating the half-week score for progress monitoring

Maze

Session No. _____ Date: _____

Selected a new reading assessment passage. Title: _____

Assess maze performance, untimed. Allow child to finish.
Use maze scoring sheet to determine: _____ percentage correct
_____ percentage semantically incorrect
_____ percentage syntactically (and semantically) incorrect.

Questioning

Session No. _____ Date: _____

Selected a new reading assessment passage. Title: _____

Assess question answering. Allow child to review passage for answers.
Use questioning scoring sheet to determine: _____ overall percentage correct
_____ percentage of literal questions correct (1-4)
_____ percentage intersential questions correct (5-7)
_____ percentage of inferential questions correct (8-10)

Prosody

Session No. _____ Date: _____ .

Proceed with baseline administration of new passages, beginning with Book 1 at child's current grade level. Always take a short, 3-4 min break between readings. Audiotape one reading and label it "Prosody _____." Save this audiotape.

Administer Reading Self Perception Scale. Continue to administer ORF passages during each visit, 3- 6 per session, while completing the baseline fidelity checklists.

Figure 2

Fidelity Checklist for BASELINE

Baseline

Session No. _____ Date: _____ Phase _____

Selected passage. Code _____

___Instructions

Assessed general performance CWPM:_____ Errors _____ *IOA:* _____

Baseline

Session No. _____ Date: _____ Phase _____

Selected passage. Code _____

___Instructions

Assessed general performance CWPM:_____ Errors _____ *IOA:* _____

Baseline

Session No. _____ Date: _____ Phase _____

Selected passage. Code _____

___Instructions

Assessed general performance CWPM:_____ Errors _____ *IOA:* _____

Figure 3

Fidelity Checklist for BRIEF ASSESSMENT

Incentive

Session No. _____ Date: _____ Phase _____

Selected passage. Code _____

Goal set: 1.30 X baseline = _____

Reward coupon selected: _____

___Instructions (make reference to goal)

Assessed instructional performance CWPM:_____ Errors _____*IOA:* _____

___Incentive provided if earned, or consolation reward if score exceeds previous high score, or no reward

[Plot CWPM and errors.]

Repeated Reading

Session No. _____ Date: _____ Phase _____

Selected passage. Code _____

___ Student read instructional passage 1 time with no error correction. Score for CWPM: _____ Errors: _____

___Student read instructional passage 2 more times with no error correction

___Instructions

Final reading: Assessed instructional performance CWPM:_____ Errors _____*IOA:* _____

[Plot final reading CWPM and errors.]

LPP/Phrase Drill

Session No. _____ Date: _____ Phase _____

Selected passage. Code _____

___ Student read aloud passage while examiner highlighted errors. Score for CWPM: _____ Errors: _____

___Examiner read story once aloud while child follows along on copy.

___Student read *phrase* containing error three times each, with immediate correction **MAX. 15 PHRASES**

___Instructions

Final reading: Assessed instructional performance CWPM:_____ Errors _____ *IOA:* _____

[Plot final reading CWPM and errors.]

Easier Material

Session No. _____ Date: _____ Phase _____

Selected lower grade level passage. Grade: _____ Code _____

__Instructions

Student read lower grade passage CWPM:_____ Errors _____*IOA:* _____[Plot CWPM and errors.]

Replication Phase

Complete necessary conditions using a second Fidelity Checklist for Brief Assessment:

1. Reversal (if necessary): If effects of least intrusive, most effective condition are not reversed by EM, administer the least effective previous condition. AReversed@ = 30% decrease
2. Replication: Considering errors, administer the least intrusive, most effective condition. AReplication@ = approximately 30% increase over prior (reversal) condition score.
3. If replication fails, administer the next least intrusive, effective condition.

Figure 4

Fidelity Checklist for
INCENTIVE + REPEATED READING

Incentive + Repeated Reading

Session No. _____ Date: _____ Phase _____

Selected passage. Code _____

Assessed general performance CWPM _____ Errors _____ *IOA:* _____

Goal set: ___ 1.30 x median of previous session (half-week score)

Reward coupon selected: _____

___Student read instructional passage 2 times, without error correction

___Instructions (make reference to goal)

Assessed instructional performance CWPM:_____ Errors _____ *IOA:* _____

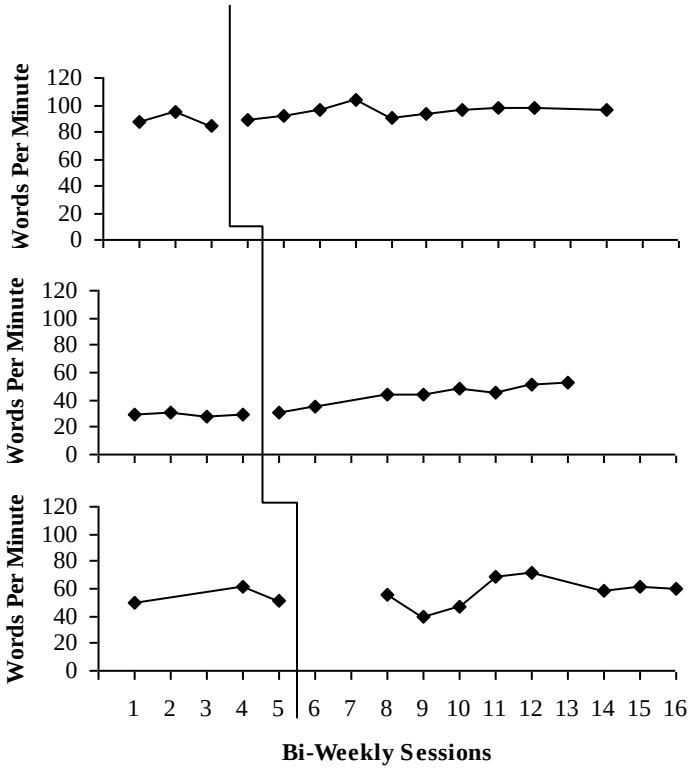
___Incentive provided if earned, or consolation reward if score exceeds previous high score, or no reward

__ Provided three (3) positive affirmation statements

___ Provided extra incentive for general CWPM score above aim-line.

Figure 5

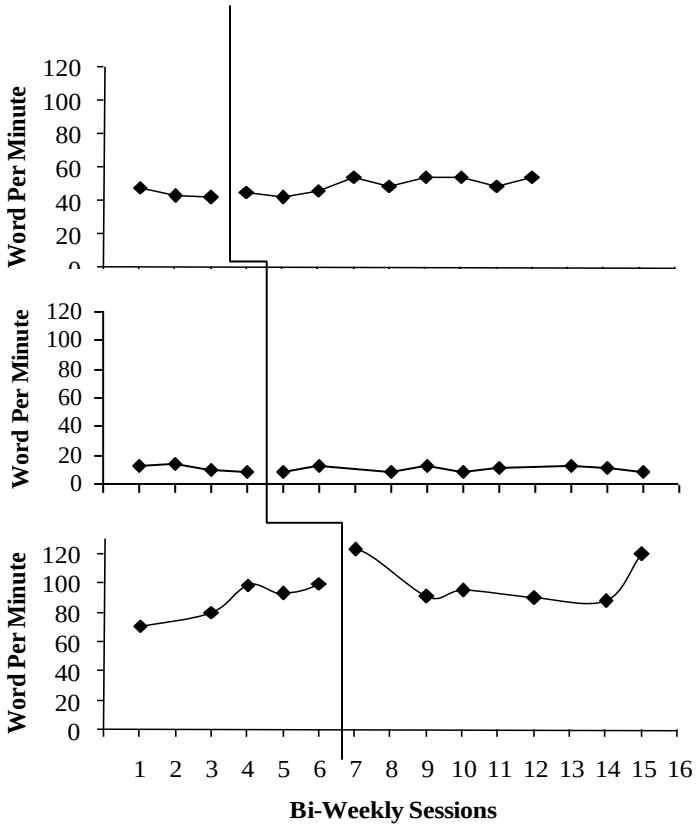
Visual Analysis of Student Data Set 1



Note: Von (Figure 1, top panel), Brie (Figure 1, middle panel), Krissy (Figure 1, bottom panel)

Figure 6

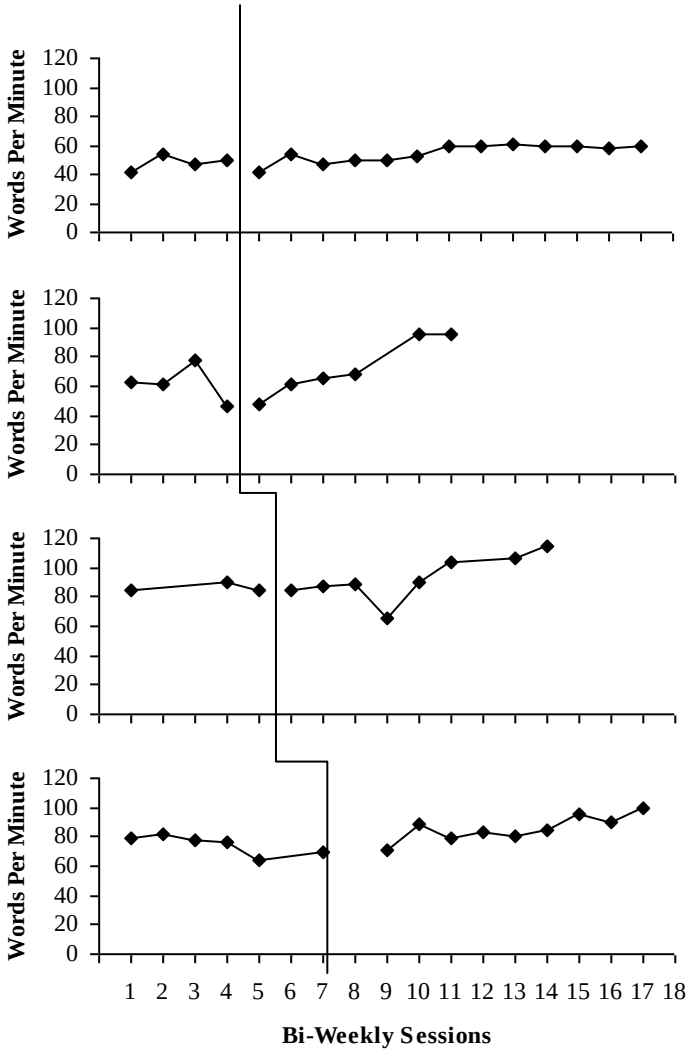
Visual Analysis of Student Data Set 2



Note: Patti (Figure 1, top panel), Shelly (Figure 1, middle panel), Mick (Figure 1, bottom panel)

Figure 7

Visual Analysis of Student Data Set 3



Note: Nat (Figure 1, top panel), Zarah (Figure 1, second panel), Dave (Figure 1, third panel), Maggie (Figure 1, bottom panel)