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A Publication of
The Standard Celeration Society
The *Journal of Precision Teaching* (ISSN 0271-8200) is a multidisciplinary journal that is dedicated to a science of human behavior which includes direct, continuous and standard measurement. This measurement includes a standard unit of behavior, *frequency*; a standard scale on which successive frequencies are displayed, the *Standard Celeration Chart*; a standard measure of behavior change between two frequencies, *frequency multiplier*, and a standard, straight-line measure of behavior change across seven or more frequencies, *celeration*. Frequencies, frequency multipliers, and celerations displayed on the Standard Celeration Chart form the basis for Chart-based decision-making and for evaluating the effects of independent variables.

The purpose of the *Journal of Precision Teaching* is to accelerate the sharing of scientific and practical information among its readers. To this end, both formal manuscripts and informal, Chart-sharing articles are to be considered for publication. Materials submitted for publication should meet the following criteria:

* be written in plain English
* contain a narrative that is brief, to the point, and easy to read
* use the *Journal of Precision Teaching* Standard Glossary and Charting Conventions (See Volume X, Number 2, Spring, 1993, pp. 79 - 82.)
* format references according to the *Publication Manual of the American Psychological Association*
* contain data displayed or displayable on the Standard Celeration Chart to justify conclusions made
* direct data points may be submitted, so the Charting Macro program (Slocum, 1990) may produce an electronic version of the Chart
* original charts may also be submitted.

Articles which are not data-based and do not include data displayed on Standard Celeration Charts may be included. These articles should substantially contribute to the development or dissemination of Precision Teaching/Learning. “About PT” is a column for shorter notes.

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Claudia E. McDade, Editor
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Editor's Comments

Claudia E. McDade

Fall, 1993 brings us to an issue of the Journal of Precision Teaching which describes the use of Precision in acquiring, improving, and retaining skills in handwriting, letter recognition, basic mathematics, reading, writing, studying, and reasoning. Subjects ranged from kindergarten through entering college freshmen. Two articles generated by faculty and students from the Department of Special Education at Gonzaga University indicate that Precision Teaching is alive and thriving in Washington under the mentoring of Bill Sweeney. Mary Brunner co-authored an article with T. F. McLaughlin and Bill to report the results of her work with her son to improve his handwriting. Kelly Whalen, Robert Willis, and Bill Sweeney assisted a high school student with behavior disorders in improving his fraction problem-solving fluency. Important considerations between fluency building and endurance are addressed in this article.

Retention of skill over time is addressed in an article by Dan Bullara, John Kimball, and John Cooper who assisted an elementary school student in developing his addition skills and verified his maintenance of the skill level three months later. A Chart-Share by Ann Poe describes application of the Morningside model of math fluency to two children of the Center for Individualized Instruction's faculty. Changes resulted in more fluent performances.

Electronic presentation of instruction and monitoring of performance are addressed in an article by Colleen Stump, Randall Boone, Kyle Higgins, and Angela Notari. They used hypermedia to assist kindergarten students in developing letter recognition. Entering college freshmen used computer-assisted instructional packages, as well as small group instruction, to develop their basic skills as described in a Chart-Share about a program piloted at Jacksonville State University.

A note about the Standard Celeration Society: dues for the 1993-94 academic year are payable now through January 31, 1994. Please send them with the application/renewal form on page 52 of this issue to Peggy (Albrecht/Gaylor) Anderson. These funds are critical for the Journal's continuation and for planning the next International Precision Teaching Conference in Seattle, WA in Spring, 1995.

Manuscripts are still needed!! For consideration in the Spring, 1994 issue, get your manuscripts and Chart-Shares to us by February 1, 1994.
Using 1-Minute Time Trials and 4-Minute Practice Sessions to Improve a Student's Performance of Fraction Problems

Kelly P. Whalen, Robert J. Willis, and William J. Sweeney

This study examined the use of time trials with a high school student with behavior disorders for improving his math fluency in fraction problems. The target behavior was the number of correctly executed steps on mixed subtraction of fraction worksheet problems, while the intervention was the amount of time allotted during each time trial or practice session. A time series analysis (Cambell & Stanley, 1966) was used to evaluate the effects of different timing periods on the student's performance from 1-minute time trials to 4-minute practice sessions. During baseline, 10-minute practice sessions were used to establish the number of fraction problem steps completed per minute by the student. Data from this baseline were then compared to a two phased intervention using time trials and timed practice sessions. The first phase compared the number of correct fraction problem steps completed per minute by the student during the 1-minute, 2-minute, 3-minute, and 4-minute time trials. The variability in the data during this phase made it difficult to discern any meaningful differences from the four timing conditions. The second intervention phase compared the results of 1-minute time trials and 4-minute practice sessions to each other, as well as the phase one intervention results. The results showed an increase in the participant's math fluency, especially under the 1-minute timing condition. The data suggest a possible relationship between the student's performance and the length of the timings or fatigue factors. Implications regarding the length of timings and fatigue as related to performance were discussed.

When students progress through math curricula, they may not learn the necessary prerequisite skills fluently before moving onto more difficult math problems and concepts (Miller, Hall, & Heward, 1992). Accuracy measures alone do not reflect learning mastery of skills. All students who perform at the same level of accuracy are not equally skilled (Miller & Heward, 1992). The combination of the two dimensions of responding—accuracy and number of responses over time—gives a more complete picture of learning (West, Young, & Spooner, 1990). Haughton (1972) found that students who could calculate math problems at 30 or more digits per minute progressed easily to more complex mathematical skills. This combination of accuracy and speed of performance has been defined in terms of fluency or fluent responding. For example, two students working on the same math assignment both complete the assignment with 100 percent accuracy; however, one student completes the assignment in half the time of the second student. It is obvious that the first student is more fluent, demonstrating both accuracy and speed. This example illustrates the importance of emphasizing fluency in our classrooms rather than just focusing on accuracy.

Effective teaching of math skills must start with the concept that it is important for students to experience success (Mercer & Mercer, 1993). Various traditional and common approaches are employed in classrooms that attempt to promote successful acquisition of math concepts. Using traditional worksheets, working at the blackboard paired, and using manipulatives are but a few examples (Jacobsen, Eggen, & Kauchak, 1989; Callahan & Clark, 1988). Although many of these instructional strategies are commonly employed in the classroom, Lindsley (1992) pointed out that many of these procedures have not been empirically verified; thus, their effectiveness in terms of instruction appears questionable.

In terms of optimizing student performance in the classroom, Binder and Watkins (1990) advocated for the adoption and implementation of data-based instructional strategies which have long histories of success with students in a variety of settings. Examples of such data-based procedures include Direct Instruction (Carnine, Granzin, & Becker, 1988; Binder & Watkins, 1990), peer tutoring (McKenzie & Budd, 1981), criterion-referenced curriculums (Joseph & Cooper, 1991), Precision Teaching strategies (Sweeney, Omness, Janusz, & Cooper, 1992), and time trials (Miller &
Heward, 1992). In one investigation, Joseph and Cooper (1991) increased the math performance in multiplication, subtraction, and division of fourth-grade students through the use of data-based instructional procedures that included a criterion-referenced curriculum. In another study, Wilson and Sindelar (1991) increased the performance of students with learning disabilities in math word problems through the use of a Direct Instruction strategy. The search for effective, efficient, and innovative data-based procedures to develop students' fluency in math facts needs to be an ongoing quest in our schools.

Using time trials is another way to increase fluency of math skills within the community and in schools (Miller & Heward, 1992). As Howell and Lorson-Howell (1990) pointed out, rate per minute is a more sensitive measure of changes in performance than accuracy measures alone. Daily time trials provide students with the opportunities to improve their fluency, while at the same time, provide teachers with direct, frequent measures of each student's progress (Miller & Heward, 1992). Time trials help students improve their fluency by providing many opportunities to respond at a fast rate (Greenwood, Delquadri, & Hall, 1984). For example, Miller et al. (1992) showed dramatic academic and fluency improvements in math using time trials in a fourth-grade regular education classroom. Many educators may think that when someone is being timed or set under time constraints, performance would decrease. However, accuracy typically does not suffer, but usually improves, and existing data suggest that students enjoy being timed (Allyon, Garber, & Pisor, 1976). In fact, in a study conducted by Miller et al. (1992), 26 of 34 students indicated they liked time trials better than the untimed work period.

One of the biggest obstacles to mastery and fluency of math concepts is related to the maintenance and generalizability of the results across other curricula, other settings, and other response classes. As Cooper, Heron, and Heward (1987) and Stokes and Baer (1977) pointed out, one of the most frequent criticisms of behavior analytic research is the lack of attention to the need for programming for generalized behavior change. Several studies have shown the importance of programming maintenance and generalizability into intervention procedures (Koegel & Rincover, 1977; Sweeney, Salva, Cooper, & Talbert-Johnson, 1993; Van den Pol, Iwata, Ivanic, Page, Neef, & Whitley, 1981).

Binder, Haughton, and Van Eyk (1990) discussed the importance of developing instructional procedures for improving the performance duration or endurance of students in the classroom. It is probable that students with low attention spans may have difficulty generalizing academic behaviors because of the length of instruction (e.g., math seat-work) or fatigue factors related to the lack of programming for endurance within the classroom. This is true of generic classroom procedures, such as: seat-work, lectures, and small group activities, as well as many Precision Teaching strategies that emphasize short 1-minute timings to assess fluency. Students need to work intensely for short as well as long periods of time in the classroom. Strategies need to be developed that will build upon measurably effective instructional procedures, such as 1-minute time trails, to improve the duration and performance of students on a given task. Therefore, it is important that endurance considerations be taken into account for improving the duration of performance and to decrease the effects of academic fatigue and boredom when teachers are programming for generalized behavior change. This is the first study on the use of math time trials, that the authors could find, that investigates the possible effects of endurance programming on math performance of a high school student with severe behavior disorders.

The purpose of this study was to evaluate and improve the math performance, through the use of time trials, of a high school student with behavior disorders who expressed a dislike for math calculations, especially fractions. Fluency levels of 1-minute, 2-minute, 3-minute, and 4-minute time trials were combined with visual feedback from the Standard Celeration Chart, in an effort to improve the student's math performance. A secondary purpose of the study was to evaluate the student's repeated performance on 4-minute practice sessions that were immediately followed by a 1-minute time trial over the same material. This was conducted to assess the possible endurance effects as related to the increased performance
Method

Participant and Setting
Bob was a 15 year old sophomore in high school who received special education services for students labeled as behavior disordered with severe social and emotional problems. Placed in a self-contained classroom at a hospital psychiatric unit, he received special education services due to academic and conduct-related problems in the regular classroom. Easily distracted by other students, Bob disliked doing math problems and had poor adaptive and social skills. Bob used profanity frequently; he also had difficulties when approaching his peers to request them for something.

The study took place in an enclosed office room between 1:00 and 2:00 p.m. Monday through Thursday when the student was present at school. Within the office room were a desk and chair, a portable tape-recorder and headphones, a copy machine, a file cabinet, and a telephone. The enclosed office was also used to eliminate any external stimuli in order for the subject to have maximum concentration. He liked to have all of the lights off except for one desk lamp when working on math problems. Bob also listened to his portable tape-recorder and headphones during the time trials to eliminate any additional audio stimuli.

Movement Cycle
The movement cycle was defined as the number of correctly written individual steps within a given five-step, mixed-number subtraction problem, completed per fraction, during a given counting period. The fraction problems were developed by the first author to ensure a consistent difficulty level. The first step to be counted was finding and writing down the common denominator. The second step was finding the number that needed to be multiplied to obtain that common denominator and writing it in both the numerator and the denominator places. The third step was multiplying and writing down the correct number in the numerator place. The fourth step was subtracting correctly. The final step was determined if the answer was completely reduced. The five steps necessary to correctly complete each mixed number subtraction of the fraction problem were then multiplied by the total number of problems per probe sample. This means that on a 12 problem probe sheet, with 5 steps each per problem, the student has the possibility of completing 60 individual steps correctly. The author decided on 12 problems (i.e., 60 individual steps) after an informal assessment of the student's work production prior to the beginning of the study. The number problems were chosen for two reasons: 12 practice problems were consistent with the math homework that was often assigned to this student and rarely completed on time; and to ensure that the student would not complete all the problems during a given timing and ceiling out prematurely. Although it could be argued that if the student made an error on one of the early steps of a given problem, he would probably continue to err on subsequent steps due to the linear nature of the fraction problems. The first author did not observe this phenomena occurring during his pre-baseline and subsequent observations and is thus confident in the measurement procedures. The number of correct steps completed were totaled at the end of each session and charted by the first author.

Experimental Design
A time series analysis (Cambell & Stanley, 1966) was employed to evaluate the frequency of correct completion of steps in calculating fractions across different timing periods. The independent variable was the amount of time in each trial, and the dependent variable was the number of steps correctly completed while calculating fractions. This design allowed for a comparison of the fluency levels across time interval variances. The first phase of the intervention condition assessed the differential fluency levels of 1-minute, 2-minute, 3-minute, and 4-minute time trials. The second phase compared trends in fluency levels between the 1-minute time trials with the 4-minute practice sessions.

Baseline. During baseline the student was given a mathematics sheet with 12 mixed subtraction fraction problems and was shown each individual step. Bob was then asked to repeat the steps to ensure that he understood and was
able to perform each step. The experimenter gave the instructions by saying, "Complete as many problems as possible, and then stop when told."

**Intervention.** Two phases were implemented during the intervention. The first included alternating time trials in sequence from 1-minute, 2-minute, 3-minute, and then 4-minute trials. This sequence from 1 to 4-minute time trials was repeated three times. This phase was implemented to determine which timing period resulted in the highest number of correct fraction problem steps completed per minute. During the time trials the kitchen timer was set at the designated time and was visible to Bob throughout the interval. Bob was told the amount of time available for completion prior to beginning each set of problems. The experimenter would set the timer and say, "go," and the student would begin working on the fraction problems until the timer sounded. These timing procedures were consistent throughout the alternating treatment phase of the intervention.

A break was provided for Bob while the experimenter corrected the mixed number fraction worksheet. Praise was given for his correct responses, and his current scores were compared to his previous performance as shown by the data on the Standard Celeration Chart. Corrective feedback was provided for incorrect responses, through modeling correct responses, before moving on to the next learning trial.

During phase two of the time trials, a 4-minute practice session was followed by a 1-minute time trial. These two intervals would always be paired together. If a 4-minute practice session were conducted, then a 1-minute time trial immediately followed. As many 4-minute practice sessions and 1-minute time trials were completed as time allowed during the hour tutoring sessions in the afternoons. Each 4-minute practice session and 1-minute time trial combination represented a separate session. An average of two or three pairings was conducted daily with a minimum of zero and a maximum of four. Factors influencing how many pairings could be conducted daily depended on Bob's activity level, lack of attention, and absence from class. Noncompliance required behavioral consequences by the experimenter which disrupted the flow and productivity of the session. If Bob asked any questions not pertaining to the fractions, he was ignored or told that he was "off-task."

**Practice sessions.** The 4-minute practice session consisted of six steps. (1) The kitchen timer was set and remained visible for four minutes. (2) The student attempted to calculate the fraction problems. (3) The participant was allowed to ask any questions or ask for any help pertaining to the fraction problems during the 4-minute practice session. (4) The experimenter provided immediate corrective feedback when errors were made. For example, noting that the student had made an error, the experimenter would say, "What is the common denominator?" or "What is the answer to 18 divided by 3?" If Bob did not answer correctly after one verbal prompt, the experimenter would assist him in figuring the answer out correctly or model the correct response for the student if the assistance was not effective. (5) If he was "off-task" (i.e., not doing the fraction problems or engaging in activities other than those assigned), the timer would be stopped by the experimenter until work on the fraction problems resumed. Time off-task was not subtracted from the total time engaged in the instructional activity. (6) When a 4-minute practice session followed a 1-minute time trial, previous errors were reviewed and corrected at the beginning of the practice session. These procedures for the 4-minute practice sessions were consistently applied throughout the study.

**Time trials.** A 1-minute time trial consisted of four steps. (1) The student had to show readiness by having a pencil in his hand with the fraction worksheet on the desk in front of him. (2) The experimenter said, "When you begin, I will start the clock for a 1-minute time trial." (3) As soon as Bob began his work, the teacher started the count-down timer. Bob worked on his fraction problems and stopped his work when the count-down timer sounded. Unlike the 4-minute practice session, where feedback was provided while the student worked, no feedback was given during the actual 1-minute timing. Because feedback could detract or interfere with the student's ability to respond in a fluent manner during the 1-minute timing period, the teacher decided to wait until after this time trial to provide feedback and praise related to the student's work. (4) The student received a break while the author corrected the
worksheet and counted the number of correct steps completed. After counting the number of correct steps completed, the experimenter told Bob how many correct steps he completed, praised him for his effort, and compared the scores to his previous performance during the 1-minute timings. During the feedback sessions, the teacher and the student would negotiate a short- and long-term instructional aim related to the number of mixed subtraction fraction problems completed during the 1-minute time trials. Between trials and practice sessions, the student was often asked by the author, "How many steps do you think you can get this time?" or "What is your current record for the practice session?"

Reliability
Intergrader reliability was carried out by comparing the first author's recording to that of an outside observer. The fraction practice sheets were used as a permanent product recording. Reliability checks were carried out once during baseline and four times during intervention by an independent observer who regraded the worksheets. Reliability was calculated by summing the total number of correct step agreements and dividing them by combining the total number of correct step agreements and disagreements and then multiplying the quotient by 100. The reliability of the data of number of steps completed correctly was 100%.

Results

The overall outcomes indicated improvement in completing calculation steps with math fractions with the use of 1-minute time trials. Further, an endurance appears to have occurred during the 4-minute practice sessions over the duration of the study when compared to the fluency levels in the 1-minute time trials.

Baseline data showed that Bob completed only an average of 1.27 fraction calculations correctly per minute during a 10-minute session. This compares with average scores, during the alternating treatments phase, for the 1, 2, 3 and 4-minute time trials of 8.33, 6.33, 3.11, and 4.0 respectively, for fraction calculations steps correctly completed per minute. Results from Phase II of the Intervention condition generated an average of 11.39 calculation steps correctly completed per minute during the 1-minute time trials, and 6.85 steps correctly completed per minute during the 4-minute practice session.

Although only three sessions of data were collected during baseline, the celerations of the number of correct steps completed appeared to be either decelerating significantly or showing no change (e.g., x1.0). Due to the large variability evident during the alternating treatment sessions of Phase I, it was difficult to determine appropriate celerations for the 1 and 3-minute timings. The celerations for the 2 and 4-minute time trials appeared to remain stable at a x1.0 celeration. Data from Phase II of the intervention condition appeared to initially jump-up during the first three sessions with celerations of x2.0 and x3.0 for the 1-minute time trials and the 4-minute practice sessions respectively. The overall data paths for both the 1-minute time trials and the 4-minute practice sessions showed accelerating trends with celerations of x1.25 and x1.40 respectively. The improvement in the celerations during the 4-minute practice session appears to indicate a possible endurance effect from the 1-minute time trials.

Discussion

Data from the present study suggests that the time trials in both Phase I and Phase II were effective for increasing overall, the performance of the student's fluency in subtraction fraction problems. Unfortunately, the data paths in the time series analysis in Phase I showed a great deal of overlap, and it was difficult to determine the differential effects of the levels of performance from the 1, 2, 3, and 4-minute timings. This process could be implemented in a regular education classroom with all students if teachers had the skills to implement the procedures correctly. Financially, this is an extremely practical procedure to implement and requires little effort by the teacher during instruction.

The time trials and practice sessions in Phase II of the intervention were chosen at 1 and 4-minute intervals since they differed most in terms of time. The student's performance dramatically improved initially with a jump up
at the 1-minute time trial during Phase II, and then Bob also began to set goals for himself during the 4-minute practice sessions. It was anecdotally observed that Bob was setting goals during the 1-minute time trials, as well as during the 4-minute practice sessions. This endurance effect from the 4-minute practice sessions to the 1-minute time trials showed increased performance and motivation when under time limitations. These time trials appeared to be effective at increasing the number of steps completed correctly since the student knew his aims during the time trial or practice session. Bob's performance appeared to support the claim that, "If you do not have a goal, there is nothing to shoot for!" By telling students about their best score and setting a new goal or instructional aim, the teacher is providing some incentive or setting the occasion for them to substantially improve their own performance. Further, when data are charted for the student to provide visual feedback, it may provide even more motivation to improve students' performance.

There were several limitations that must be considered when interpreting the results of this study. It was difficult to infer the existence of a functional relationship with this design because the researchers failed to return to baseline. Future studies using this type of experimental design could be strengthened by extending withdrawing the 1-minute time trials and extending the 4-minute practice sessions. This would help to determine whether the 1-minute time trials functioned as a means of improving the endurance of the 4-minute practice session or whether the sheer aspect of practice may have been more influential in the improvements with this student. Therefore, the results should be interpreted with caution.

The student's behavior and disability may also have limited the overall effectiveness of the intervention. The participant's erratic, oppositional, and off-task behavior may have contributed to a lack of overall experimental control as shown by the variability in Phase I of the intervention. It was evident that the student was often engaging in behaviors incompatible with those intended, expected, and implemented by the experimenter. For example, Bob would repeatedly strike the underside of the desk with his knee while sitting in his chair when he was supposed to be doing the math problems. A further analysis should be conducted to isolate and provide alternate reinforcers that may exert a greater amount of control over the student's behavior.

Another potential limitation was the lack of a literature base that has explored the relationship between endurance effects and students' performance in math during time trials. It is evident from this study that further research needs to be conducted to verify the performance endurance demonstrated in this study and to determine the efficacy and social validity of this intervention with other populations. Further replication of these procedures should also examine, in more depth, the potential functional relations that may exist between students' math performance and the adoption of time trials in the classroom.

This study suggests some interesting effects on performance during seat-work activities when followed by a short 1-minute assessment of the skills being taught. The initial time series analysis, as shown in the baseline and Phase I of the intervention, seems to support the commonly held assumption by many Precision Teachers that the longer the duration of assigned work, the less produced by students. This would imply that endurance and fatigue may be important variables that need to be addressed during instructional programming for students. Further consideration may need to be given to developing interventions that can extend the duration of student performance without sacrificing speed, accuracy, and quality of the work production. Phase II of the intervention may provide one possible means of effectively programming to increase the duration or endurance of work performance while decreasing fatigue during instruction. For example, the data seemed to indicate that the student was becoming more fluent in correctly completing the number of mixed subtraction problems during the 1-minute time trials, as shown by the celerating learning patterns in Phase II of the intervention. At the same time a concurrent celeration was also evident during the 4-minute practice sessions. Although it would be premature to say that the improvements in the 4-minute practice sessions are a function of the concurrent 1-minute time trials, it does generate some interesting questions related to the
sequencing of instruction and the interval success of current instructional time intervals employed in many classrooms. Future research is needed to help determine the optimal time intervals necessary for sustained work performance and endurance in the classroom.

Time trials and timed practice sessions could be effective and efficient means for improving the overall math performance of students in the classroom. Further research should continue to explore the possible factors related to performance endurance from a given intervention across students, stimulus conditions, and response classes. Hopefully, a greater consideration of endurance and fatigue factors related to programming for generalized outcomes will improve the adoption and maintenance of measurably effective procedures for instruction, therefore resulting in the accelerated performance of students in our schools and communities.

This study should prompt other researchers to evaluate the effectiveness and efficacy of time trials and possible endurance effects during instruction. These procedures will hopefully be adopted and implemented in our schools to increase fluency of students and to maximize measurably superior instruction in the classroom.

References


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The authors would like to give special thanks to the three teachers at Sacred Heart Medical Center for allowing us to work in their respective classrooms.
An Assessment of Beginning Addition Skills Following Three Months Without Instruction or Practice

Daniel T. Bullara, Jonathan W. Kimball, and John O. Cooper

This case study reports the effects of Precision Teaching on strengthening and retaining basic computational skills of an elementary student in an urban city school district. The learner attended a university clinic for instruction in arithmetic using repeated practice, review of math rules, guided practice, sprints, and assessments for accuracy. Within 4 weeks, the student demonstrated fluency on the math facts, sums to 10. Fluency with sums to 10 maintained with a slight jump down and no turns more than three months during which no instruction or practice took place. We discuss implications of fluency building for retention of skill acquisition.

The development of basic math skills is a major concern to parents and teachers. Horton, according to White (1986), estimated that 98% of all adult Americans "do not compute." Most Americans know basic arithmetic facts, but they are unable to perform computations fluently (White, 1986). Binder (1988) defined fluency, the true measure of mastery of arithmetic or any other skill, as accuracy plus speed.

There are at least three reasons why arithmetic instruction should include instructional aims for fluency, as opposed to simply accuracy (i.e., most typically, percentage correct). First, accuracy is just one dimension of competent performance. Accuracy measures do not provide complete information about how well a learner can perform a given skill. Skill assessments that measure performance with frequency (i.e., count per unit of time) of response are the only means of gaining an account of how well a skill is performed.

Second, learning should endure over time, but students who acquire new knowledge and skills but do not learn them well are unlikely to retain them over time. Retention of knowledge and skills correlates positively with behavior fluency.

Third, an emphasis on fluency may reduce distractibility during academic instruction. Binder, Haughton, and Van Eyk (1990) suggest that there is a vicious circle between distractibility and ever-diminishing academic performance, but that teacher intervention addressing academic endurance will break that circle. A skill practiced to fluency systematically improves academic endurance and often reduces distractibility.

Only practice produces fluent performances. Precision Teaching is an assessment system that properly used can lead to effective practice because it requires continuous and systematic assessment of progress toward instructional (fluency) aims (Lindsley, 1990). Precision teachers and their students count behaviors during assessments of student performance and learning; thus, they gain direct information regarding the effectiveness of an instructional program. They use these data to make instructional decisions (White, 1986). An additional benefit of this information is that it can also increase student motivation (Van Houten, 1980).

It is well to assert that fluency is important, but the question then becomes, how quickly must students perform a skill? The answer depends upon the skill and the use of that skill. Haughton (1972) found that students who wrote answers to math problems at 70 to 90 correct digits per minute advanced more easily to more complex mathematical skills than students who wrote fewer digits per minute (e.g., from single digit multiplication to multi-digit multiplication).

This research was supported in part by a leadership training grant (#H029D10054) from the Office of Special Education Programs, U.S. Department of Education.
The primary purpose of our initial instruction was to help one student become fluent in math facts, sums to 10. Following Haughton's recommendation, we set instructional aims at 70 to 90 correctly written digits per minute. We then wondered whether the student would maintain fluency with sums to 10: (a) after a prolonged time without instruction or practice, and (b) while receiving instruction on different math skills. Our purpose in presenting this case study is to share the convincing answers to our questions.

Method

Student and Setting
Shamus, an African-American male, was 11-years-old and in the fourth grade at a parochial school when instruction began. He was in a fifth grade public classroom when we assessed retention. In both settings, Shamus spent a portion of his school day in a resource room for specific learning disabilities. Shamus was enthusiastic and cooperative, though his intake evaluation for The Ohio State University Psychoeducational Clinic stated that he had difficulty staying on task in the regular classroom.

Shamus was referred to The Ohio State Clinic in the Spring of 1992 for instruction in reading and math. We gave instructional priority to the development of math skills after doing informal assessments in math and reading. Shamus, who had no prior experience with Precision Teaching, attended one-hour sessions at the Clinic, twice a week for 10 weeks. In Autumn 1992 (after summer vacation), Shamus returned to the Clinic for 10 weeks of instruction and long-term retention assessment. Tutoring took place in a 12 by 20 ft room furnished with instructional carrels for up to 12 teacher-learner pairs.

Materials
We used addition practice sheets with sums to 10, flash cards with corresponding sums to 10 problems, an addition facts wheel with sums to 10, and a timer that counted both up and down. For see-write exercises during instruction and counting periods, we placed the practice sheet in an open manila folder under a sheet of clear acetate (an 8 1/2" by 11" overhead transparency); we used dry erase markers to write the answers on the acetate.

Movement Cycle
Our movement cycle was sums to 10 addition problems. The learning channel set was see-write. The correct-incorrect pair was number of correct addition facts per one-minute counting period, and number of learning opportunities per one-minute counting period. Learning opportunities were the incorrect answers; we did not count skipped problems incorrect. During instruction (i.e., the 10 weeks in the Spring of 1992), Shamus' instructional aim for sums to 10 was 70 to 90 correct written responses in one minute, with no learning opportunities.
as such phrases as "zero plus any number equals that number." Our rationale for permitting finger counting during acquisition was that Shamus' school teacher used finger counting to teach addition. As instruction continued, we discouraged Shamus from depending on his fingers to compute math facts, and as fluency improved, Shamus abandoned the use of his fingers to compute sums to 10. Again, we celebrated correct answers with Shamus, and we corrected learning opportunities.

Initially, Shamus wrote 20 digits correctly in 30 seconds, but he had difficulty keeping up this pace during 60-second counting periods. To build endurance, each session we used several see-write 15, 30, or 45 seconds sprints, and a minimum of two 30-second counting periods each lesson. The sprints were identical in form and materials to the regular counting periods except for the duration of time that became progressively longer throughout a session.

**Long-term Retention**

Shamus returned to the Clinic following a summer break with no instruction or practice. Before further instruction, we assessed retention of see-write sums to 10 facts, using a one-minute counting period. Shamus retained acceptable fluency with these math facts. We therefore chose to instruct subtraction facts (numerals 1 to 10 subtracted from 10) because the operation of subtraction is logically consistent with the skills Shamus had practiced in the clinic the previous spring. It included the same numbers that were involved in the reciprocal operation (i.e., sums to 10). We reasoned that it would provide Shamus with additional opportunities to recognize relationships between the numbers that we worked on during formal instruction (e.g., \(2+8=10\), but also \(10-8=2\), and \(10-2=8\)). Further, during instruction that took place in the spring, we observed that Shamus seemed to confuse the operation he was to perform (i.e., subtraction rather than addition). We thought that because the same numbers were involved in both movement cycles, it might serve to incidentally strengthen Shamus' discrimination between operations: (whether this is indeed the case remains an empirical question).

**Results**

**See-write addition (Spring, 1992).** During instruction with sums to 10, Shamus' median number of correctly written digits per one-minute counting period was 67, with a spread from 23 to 74. His median number of learning opportunities per minute was 0, with a spread from 6 to 0. As Chart 1 shows, Shamus' performance change (i.e., the distance between the lowest and highest data points for a given movement cycle) multiplied by 3.2 for corrects and divided by 6 for learning opportunities. Shamus' weekly celeration for correctly written digits per minute multiplied by 1.4 and the weekly celeration for learning opportunities divided by 1.4.

After instruction with sums to 10 had ended, Shamus maintained fluency with that skill. His weekly celeration for correctly written digits per minute multiplied by 1, and his celeration for learning opportunities divided by 1.

**Long-term retention.** As Chart 2 shows, Shamus' median number of correctly written digits for sums to 10, in a one-minute counting period, was 53, with a spread from 50 to 59. His median number of learning opportunities per minute was 0, with a spread from 2 to 0. During assessment for retention, following three months without instruction or practice, Shamus' performance showed a slight jump down (from 74 to 56) with no turns (celeration x 1.0) while learning opportunities remained near zero.

**Discussion**

When Shamus first came to The Ohio State University Psychoeducational Clinic, he wrote 23 correct digits to sums to 10, and had 6 learning opportunities in a one-minute counting period. Within six weeks (12 one-hour lessons), Shamus achieved his instructional aim (i.e., 70 to 90 correct digits in one minute, with no learning opportunities) for sums to 10.

We assessed the retention of sums to 10 at the end of the first 10 weeks of instruction, and again following 9 weeks of summer break with no instruction or practice. In the Autumn, Shamus consistently performed near aim, even
though he no longer practiced sums to 10 and while he practiced subtraction skills.

The Precision Teaching experience that we shared with Shamus seems to support the three purposes for incorporating fluency aims into arithmetic instruction. First, Shamus' performance improved not only with accuracy, but with competence as well. Second, he was able to fluently perform skills he had learned in the Spring, three months after we stopped teaching them. Finally, given these first two points, Shamus' "distractibility" became a nonissue for him. It may be unfortunate that we were unable to determine how the components of our intervention contributed to Shamus' success. We think it is reasonable, however, given the degree of fluency that Shamus achieved in a short time and the extent to which he maintained his skills, to make one conclusion. For Shamus, Precision Teaching was both effective and efficient.

References


Hypermedia CAI and Precision Teaching: An Exploratory Study
Colleen Shea Stump, Randall Boone, Kyle Higgins, and Angela Notari

The purpose of this study was to monitor the effect of a hypermedia computer-assisted instruction (CAI) software program on the development of letter recognition skills of kindergarten students. Experimental (n = 18) and control (n = 19) students participated in the ABC study and received group instruction on three target letters, one letter presented per week. In addition, experimental students worked with the hypermedia computer software letter recognition lessons. Student letter recognition performance was monitored through probe sheets administered across three phases. During baseline (A), students completed probes of animal figures and a letter previously taught. During intervention (B), students completed probes of the letter presented each week, and during maintenance (C), students were retested on probes presented during intervention. Although overlap in performance among experimental and control students existed, (a) experimental students demonstrated improved levels of letter recognition as compared to their control peers, (b) low performing students in the experimental classroom demonstrated greater gains in overall performance levels from intervention to maintenance as compared to their control peers, and (c) student and group changes in celeration rates were similar in degree across experimental and control classrooms.

Knowledge of letter names has been identified as a predictor of first year reading achievement (Bond & Dystra, 1967; Chall, 1983; Tunmer, Herriman, & Nesdale, 1988). Moreover, fluency in letter recognition skills has been cited as a predictor of the acquisition of reading skills among beginning readers (Blachman, 1984; Ehri & Wilce, 1979; Speer & Lamb, 1976). Students who are slow to recognize and name letters experience difficulty in learning letter sounds (Ehri & Wilce, 1979) and have difficulty in recognizing words (Mason, 1980).

One instructional approach that is receiving increased attention is computer-assisted instruction (CAI). CAI has been found to enhance literacy and prereading skills (Fein, 1987; Gore, Morrison, Maas & Anderson, 1989) and self-confidence (Hyson, 1985) in normally developing preschool and kindergarten children. Additionally, CAI offers the flexibility to individualize and pace instruction as needed and the ability to provide opportunities for repetitive practice in challenging formats (Allen-Watson, Chadwick, & Brinkley, 1986).

Hypermedia, a specially designed computer environment, provides a flexible format for adapting materials and allows children to access information by means of a simple selection process. When working with a program developed through a hypermedia environment, children can select images or buttons on a screen to expose additional information in the form of pictures, letters, words, and sounds. (See Higgins & Boone, 1990, for a description of the hypermedia environment and its application to instructional practice.)

This study investigated the effect of the use of hypermedia CAI on the acquisition of letter recognition skills of kindergarten students. This study was part of an investigation centered on the development and testing of state of the art microcomputer software designed to aid students with disabilities and other students considered at-risk, in the acquisition of successful pre-reading skills in general education kindergarten settings. (See Higgins, Boone, Notari, and Stump (under review), for a complete description of that investigative study.) The purpose of this study was to monitor and compare experimental and control students’ letter identification skills through the application of hypermedia software lessons and Precision Teaching techniques.

Method

Subjects
Students enrolled in two general education kindergarten classrooms located in a suburb of Seattle, Washington, were involved in the study:

The research reported in this paper was supported in part by Grant #H02J80015 from the U.S. Department of Education, Office of Special Education to Thomas C. Lovitt. Statements should not be interpreted as official agency positions.
18 students in an experimental classroom and 19 in a control classroom. There were 10 boys and 8 girls in the experimental classroom and 10 boys and 9 girls in the control classroom. Most children were Caucasian, except for four students, two in each classroom, who were African-American. Socio-economic status and IQ information were not available from the school district.

Teachers classified students as high, medium, and low performers based on classroom observations. Additionally, the experimental teacher indicated that two of her students were considered at risk for referral to special education. The district defined students considered at risk for referral to special education, as those who scored at or below the 25th percentile on a district-developed prereading test. The teachers in both the experimental and control classrooms had been teaching kindergarten for five years.

Materials

Basal Reader
The Macmillan Basal Reader Series-R (1983) was the adopted text for the participating school district. This series provided a comprehensive curriculum in kindergarten for the instruction of letter identification. Hypermedia CAI lessons were developed for each letter of the alphabet based on the curriculum presented through the basal series. The hypermedia lessons made use of the same pictures and examples that were presented by the teacher using the Macmillan instructional materials.

Computer Equipment
Two Apple Macintosh Plus computers with external 3.5 inch disk drives were used in the experimental kindergarten classroom. Students operated all computer functions through the mouse, a hand-held input device. Keyboards were not attached to the computer.

HyperCard
HyperCard (Atkinson, 1987) from Apple Computer is a combination operating system and authoring environment for the Macintosh computer. It was the development system for the software used in this research.

Hypermedia CAI Lessons
Hypermedia allows students to access information through the selection or clicking on images or buttons on the screen. Through selection, additional information may be presented as digitized speech, graphic representations, animated sequences, text or a combination of these modes.

Baseline Probe Sheets
Two sets of baseline probe sheets were created. One set consisted of an average of 100 drawings of animal figures familiar to the children randomly placed on a page. The target animal was a mouse, with pigs, giraffes, bears, and squirrels serving as distractors. Five forms of this sheet were created, one for each experimental day.

The second set of baseline probe sheets was composed of upper and lower case H. The letter H had been previously presented to students. These sheets were similar to a worksheet with which the students were already familiar and that was used regularly in the classroom. An average of 60 target letters and 70 distractor letters were randomly presented on a page. Distractor letters were selected using the following guidelines: one letter which looked like the target (e.g., K for target H), one that was less similar in appearance (e.g., E for target H), and one that was shaped significantly different from that of the target (e.g., S for target H). Five sheets, one per experimental day, were created.

Intervention and Maintenance Probe Sheets
Probe sheets similar to those used in baseline were created for the target letters (i.e., R, S, and T) introduced during intervention, one letter per week. Three forms of the probe sheets were created for each of these letters. The distractors letters were: (a) P, N, and A for R, (b) C, F, and M for S, and (c) B, C, and M for T. These same sheets were also used during the maintenance phase.

Design and Procedure
A single-subject ABC design was selected. The study began with a baseline phase (A), which
lasted two weeks. During the first week of baseline (A1), students responded to the animal probe sheets, and during the second (A2), students completed probe sheets presenting the letter H. Next, the intervention phase (B) was in effect for a period of three weeks, with one target letter introduced each week. Each week, students completed three probe sheets of the week's letter. The maintenance phase (C) lasted three weeks and reassessed the three letters that were introduced during the intervention phase. Students completed three probe sheets per letter, one letter per week. There was a one week break between the intervention and maintenance phases due to spring vacation at the school. In all, the study lasted for a period of nine weeks.

**Baseline (A1): Animals**
The objectives of this first week of baseline were to evaluate students' skill in identifying and circling a familiar image (i.e., a mouse), to assess motor ability, and to familiarize students with the probe activity. Students were shown an enlarged picture of the mouse figure and told that they had a short time (30 seconds) to circle as many as they could on their probe sheets. Papers were collected, with the number of correct and incorrect circled items counted and recorded. This activity was repeated each day, for a one-week period.

**Baseline (A2): H**
The objective of this second week of baseline was to assess students' skill in identifying and circling the letter H. The letter H had been previously presented to students. Administration and scoring procedures matched Baseline A1: Animals. This phase lasted five days with a different form of the probe sheet completed each day.

**Intervention (B)**
**General procedures.** During the next three weeks, the letters R, S, and T were introduced and presented by the control and experimental teachers, one letter per week. The purpose of this phase was to monitor students' skill in identifying and circling target letters before and after instruction. The teachers' existing instructional schedules were not altered during this phase. The letter of the week was introduced on Monday during group instruction which lasted approximately 10 to 20 minutes. Teachers introduced the letter on the chalkboard and made its sound, followed by students naming words that contained that letter sound. These student-generated words were written on the board and the target letter highlighted. A chalkboard task, mirroring the format of the probe sheets, was completed with individual students circling the target letters found on the chalkboard. Worksheets of this same format were then completed individually by the students. During two days of the week, students worked at centers, one of which presented a letter-of-the-week activity. The letter probe sheets were added to this existing instructional sequence in the following manner.

**Control classroom.** In the control classroom, students completed a probe sheet on Friday for the letter that was to be presented during the upcoming week. On Monday before group instruction, another probe sheet was completed. Following group instruction, students completed the third and final probe of the week. Thirty seconds was provided each time for completing the probe sheets.

**Experimental classroom.** Students in the experimental classroom completed the same three probe sheets per letter. In addition, they worked on the hypermedia CAI lesson designed for each letter. Experimental students were assigned to two groups: before-instruction and after-instruction. The before-instruction group worked with the CAI lesson prior to group instruction and completed: (a) a probe before working on the computer (Friday), (b) another probe following work on the computer (Friday), and (c) the final probe following group instruction (Monday). The after-instruction group observed the following schedule: (a) a probe before instruction (Friday), (b) another probe following group instruction (Monday), and (c) the final probe after working with the computer (Monday).

**Maintenance (C)**
The maintenance phase was designed to assess any changes in fluency that occurred following a three-week lapse of instruction on the target letters. This phase began one week following the last intervention week due to spring break at the school. During the maintenance phase, teachers introduced new letters with no review
of the target letters. During the first week of maintenance, probes for the target letter R were re-administered in random order on Monday, Wednesday, and Friday, one probe per day. Students were allowed 30 seconds to complete the activity. Papers were collected and scored for the number of correct and incorrect responses. During the second week of maintenance, the probes for the target letter S were re-administered, and the probes for the target letter T were used on the third week of this phase.

Results

Outcomes from this intervention were analyzed in primarily three ways: visual inspection, level of performance, and celeration rates. Incorrect frequency data were dropped from all analyses because more than 90% of the students made zero errors when completing the probe sheets.

Visual Inspection

All student data were plotted on Standard Celeration Charts and inspected. Visual inspection of the Charts revealed: (a) great overlap between the performance of the two experimental groups (e.g., before-instruction and after-instruction), preventing drawing of conclusions associated with instructional sequences, and (b) variability in performance within and across letters in control and experimental groups. To illustrate these patterns, charts of the two experimental low performers identified as at-risk for special education referral and the charts of two randomly selected low-control group students are displayed in student Charts (4).

Control Student 1 demonstrated similar median levels of performance on the baseline probe sets and her greatest intervention change when working with the letter S. She demonstrated higher median levels during maintenance for letters S and T as compared to intervention levels. Control Student 2 demonstrated the overall lowest levels of performance of the group of students whose Charts are displayed. His performance during the maintenance phase revealed more upward trends as compared to his intervention phase, although his median levels of performance during both the intervention and maintenance phases did not exceed those of the baseline phases.

Experimental Student 1 generally demonstrated accelerating performance patterns across all phases. Her median intervention performance level for letter S and for all maintenance phases surpassed her baseline performance levels. This student also demonstrated improved median performance for intervention to maintenance. Experimental Student 2 demonstrated low levels of performance during the baseline phases and "bouncy" performance during the remaining phases. However, all of his maintenance median levels surpassed baseline levels of performance.

In order to discern patterns related to group performance, overall comparisons were made. Levels of performance and celeration rates were calculated and compared.

Level of Performance

Performance levels compared to baseline.

Median levels of performance were calculated for each student for each phase of the study. The median levels for the classes, and then for the three ability groups (i.e., high, medium, and low performers) were calculated per phase. Further, the mean of the median performance levels for the baseline phase components was found by averaging the levels indicated for A1 and A2. This average baseline performance level was used as a comparison point. As shown in Table 1, average group performances of 22 (experimental) and 25 (control) correct responses were indicated for baseline.

During intervention, the overall experimental group surpassed its average baseline level of performance for the letters S and T; the control group failed to reach or surpass its baseline level during intervention. As for maintenance, the overall experimental group reached or exceeded its baseline level for the letters S and T, as did the control group.
Subgroup performance also indicated changes in level. Medium and low group experimental students surpassed their baseline performance during intervention and maintenance phases: medium group for letters S and T during both phases, and the low group for letter S during intervention and R, S, and T during maintenance. Low performers reached or surpassed their baseline performance levels for letters S and T during maintenance.

Table 1

**Median (Range) Performance Levels per Phase**

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Baseline</th>
<th>Intervention</th>
<th>Maintenance</th>
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<tr>
<td></td>
<td></td>
<td>A1</td>
<td>A2</td>
<td>R</td>
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<tr>
<td><strong>Experimental</strong></td>
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<tr>
<td>Overall</td>
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<td>20</td>
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<tr>
<td>High</td>
<td></td>
<td>28</td>
<td>25</td>
<td>21</td>
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<td>Medium</td>
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<td>Low</td>
<td></td>
<td>22</td>
<td>17</td>
<td>16</td>
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<tr>
<td><strong>Control</strong></td>
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<tr>
<td>Overall</td>
<td></td>
<td>26</td>
<td>23</td>
<td>19</td>
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<td>N=19</td>
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<td>(13-32)</td>
<td>(8-26)</td>
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<td>High</td>
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<td>Low</td>
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</table>
Performance levels: Intervention to maintenance. Experimental and control group gain scores across intervention and maintenance phases were calculated for each letter to evaluate the level of letter recognition students maintained three weeks following instruction. This was completed by first determining the gain score of individual students for each letter from intervention to maintenance phases. This was found by subtracting the median intervention level of a letter from the median level for that letter during maintenance. For example, the median rate for letter R for an experimental student during intervention was 21 and 24 during maintenance. This resulted in a gain score of 3 for the letter R for that student. These individual gain scores per letter were then averaged for experimental and control groups and for the three subgroups within each classroom setting. Analyses for the medium-control group were limited due to lack of data for the letter T during the maintenance phase; only 1 of the 4 students completed the maintenance probe sheets. Gain scores are reported in Table 2.

Group gain scores were: (a) 2.94 for experimental and 1.95 for control for the letter R, (b) 2.00 for experimental and 2.26 for control for the letter S, and (c) 3.56 for experimental and 1.64 for control for the letter T. For two of the three letters, the experimental group demonstrated greater gains from intervention to maintenance.

Differences were noted in subgroup performance. The most notable differences in gains were indicated for the low performing groups. Experimental low group students demonstrated greater gains for all three letters as compared to control students. Gain scores for the low performers were: (a) 3.60 for experimental and 0.80 for control for the letter R, (b) 2.40 for experimental and 0.50 for control for the letter S, and (c) 3.40 for experimental and 0.25 for control for the letter T.

<table>
<thead>
<tr>
<th>Performance Level Gain Scores</th>
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<tbody>
<tr>
<td>Experimental</td>
</tr>
<tr>
<td>R</td>
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<tr>
<td>Overall</td>
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<tr>
<td>High</td>
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<td>Low</td>
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Celeration Rates

Celeration rates compared to baseline. As with performance levels, celeration rates were calculated for each phase (i.e., last correct data point divided by the first correct data point for A1 and A2, and for each letter during intervention and maintenance phases) for each student. Next, these were averaged across groups. Finally, mean celeration rates for the baseline phase were found by averaging performance across A1 and A2. These average celeration rates were then used as a comparison point. One outlier (x24.00) was noted in the medium performing control group for letter S and resulted in analysis including and excluding the data point. Outcomes are presented in Table 3.

The baseline rate for the overall experimental group was not surpassed during any other phase of the study. The baseline rates for the overall control group were surpassed during the intervention phase for letter S when the outlier was included; when the outlier was removed, the overall celeration was x1.11 and therefore,
did not surpass the baseline average. For the subgroups, the experimental students surpassed their baseline rates during the intervention phase for letters R and S, and the medium group surpassed their baseline performance during intervention for letter T. The medium control group students surpassed their baseline performance during intervention for letter S when the outlier was included, but when the outlier was removed, the students achieved an average rate of x1.19 and did not surpass their baseline average. Low performing students surpassed their baseline performance during the intervention for letter S.

Celeration rates: Intervention to maintenance. Individual student celeration rates between intervention and maintenance were calculated for each letter (i.e., last correct data point for the letter during intervention). These rates were then averaged across total groups and subgroups for experimental and control classrooms. As reported in Table 4, celeration rates per letter were: (a) x1.41 for experimental and x1.19 for control for letter R, (b) x1.25 for experimental and x2.43 (x1.23 excluding the one data point) for control for letter S, and (c) x1.35 for experimental and x1.30 for control for letter T.

Subgroup celeration rates per letter varied greatly among letters and performance groups. For high performers, the experimental group demonstrated similar, but somewhat higher rates for all three letters as compared to their control peers. Medium control performers achieved greater rates for the letter S as compared to their experimental peers. When excluding the outlier data point, however, the medium performing control group demonstrated a celeration rate of +1.16 for the letter S from intervention to maintenance, which was lower than the experimental group's rate of x1.28.

In an attempt to more clearly understand the patterns of celeration performance across intervention to maintenance, individual students' performance rates per letter were classified as indicating improved, same, or worsened performance. A celeration rate between +1.24 and x1.24 was considered as same, celeration rates of +1.25 or less as worsened, and celeration rates of x1.25 or greater as improved. Student performance status classification is reported in Table 4.

Overall, (a) 56% of the experimental and 37% of the control students were classified as improved for the letter R, (b) 44% of the experimental and 32% of the control were classified as improved for the letter S, and (c) 50% of each of the experimental and control groups were classified as improved for the letter T. A greater percentage of control students were classified as worsened for letters R and S as compared to the experimental students.

As for subgroups, one student in the high-experimental group was classified as worsened for the letter R; all other students were classified as either improved or as same for all letters. A range of 11 to 40% of control medium and low performing students were classified as worsened for the letters R and S. However, results indicated that the majority of students maintained or improved their fluency performance from intervention to maintenance.

Discussion

Outcomes from these analyses suggest that, although there was overlap in graphed patterns, there were differences in performance among experimental and control students. Differences were noted for both levels of performance and celeration rates.

Level of Performance

During the baseline phase, the control group demonstrated slightly higher levels compared to the experimental students. However, during intervention, the experimental students demonstrated similar or higher levels of performance as compared to the control students. Additionally, experimental students surpassed their baseline performance level in more instances than the control students.

In terms of overall gains in performance levels from intervention to maintenance, the experimental students generally demonstrated greater gains in performance as compared to their control peers. The most dramatic difference was noted for the low performing subgroups.
Table 3

Average Celeration Rates (Range) per Phase

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>Intervention</th>
<th>Maintenance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>A1</td>
<td>A2</td>
</tr>
<tr>
<td><strong>Experimental</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Overall</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N=18</td>
<td>x1.33</td>
<td>(+1.47/</td>
<td>(+1.35/</td>
</tr>
<tr>
<td></td>
<td></td>
<td>x2.17)</td>
<td>x2.63)</td>
</tr>
<tr>
<td><strong>High</strong></td>
<td>x1.41</td>
<td>+1.03</td>
<td>x1.27</td>
</tr>
<tr>
<td>N=6</td>
<td>x1.19</td>
<td>(+1.12/</td>
<td>(+1.35/</td>
</tr>
<tr>
<td></td>
<td></td>
<td>x1.63)</td>
<td>x1.41)</td>
</tr>
<tr>
<td><strong>Medium</strong></td>
<td>x1.32</td>
<td>x1.47</td>
<td>x1.17</td>
</tr>
<tr>
<td>N=7</td>
<td></td>
<td>(+1.47/</td>
<td>(+1.05/</td>
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<tr>
<td></td>
<td></td>
<td>x2.17)</td>
<td>x1.65)</td>
</tr>
<tr>
<td><strong>Low</strong></td>
<td>x1.56</td>
<td>x1.51</td>
<td>x1.65</td>
</tr>
<tr>
<td>N=5</td>
<td></td>
<td>(+1.38/</td>
<td>(+1.06/</td>
</tr>
<tr>
<td></td>
<td></td>
<td>x1.73)</td>
<td>x2.63)</td>
</tr>
<tr>
<td><strong>Control</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Overall</strong></td>
<td>x1.42</td>
<td>x1.13</td>
<td>x1.71</td>
</tr>
<tr>
<td>N=19</td>
<td></td>
<td>(+2.63/</td>
<td>(+2.22/</td>
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<tr>
<td></td>
<td></td>
<td>x1.70)</td>
<td>x3.00)</td>
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<tr>
<td><strong>High</strong></td>
<td>x1.37</td>
<td>x1.18</td>
<td>1.55</td>
</tr>
<tr>
<td>N=9</td>
<td></td>
<td>(+1.00/</td>
<td>(+1.23/</td>
</tr>
<tr>
<td></td>
<td></td>
<td>x1.52)</td>
<td>x2.16)</td>
</tr>
<tr>
<td><strong>Medium</strong></td>
<td>x1.39</td>
<td>+1.06</td>
<td>x1.93</td>
</tr>
<tr>
<td>N=5</td>
<td></td>
<td>(+2.63/</td>
<td>(+2.22/</td>
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<tr>
<td></td>
<td></td>
<td>x1.33)</td>
<td>x3.00)</td>
</tr>
<tr>
<td><strong>Low</strong></td>
<td>x1.52</td>
<td>x1.22</td>
<td>x1.77</td>
</tr>
<tr>
<td>N=5</td>
<td></td>
<td>(+1.08/</td>
<td>(x1.05/</td>
</tr>
<tr>
<td></td>
<td></td>
<td>x1.70)</td>
<td>x2.16)</td>
</tr>
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Table 4
Celeration Rates and Status

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<tr>
<th>Experimental</th>
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<th></th>
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<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Rate</td>
<td>I S W</td>
<td>Rate</td>
<td>I S W</td>
<td>Rate</td>
<td>I S W</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall N=18</td>
<td>x1.41</td>
<td>10 7 1</td>
<td>x1.25</td>
<td>8 10 0</td>
<td>x1.35</td>
<td>9 9 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>High N=6</td>
<td>x1.46</td>
<td>4 1 1</td>
<td>x1.18</td>
<td>1 5 0</td>
<td>x1.22</td>
<td>2 4 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medium N=7</td>
<td>x1.25</td>
<td>3 4 0</td>
<td>x1.28</td>
<td>4 3 0</td>
<td>x1.50</td>
<td>4 3 0</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Low N=5</td>
<td>x1.57</td>
<td>3 2 0</td>
<td>x1.31</td>
<td>3 2 0</td>
<td>x1.30</td>
<td>3 2 0</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Control</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Rate</td>
<td>I S W</td>
<td>Rate</td>
</tr>
<tr>
<td>Overall N=19</td>
<td>x1.19</td>
<td>7 10 2</td>
<td>x2.43</td>
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<tr>
<td>High N=9</td>
<td>x1.34</td>
<td>5 4 0</td>
<td>x1.10</td>
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<tr>
<td>Medium N=5</td>
<td>x1.03</td>
<td>1 3 1</td>
<td>x4.57</td>
</tr>
<tr>
<td>Low N=5</td>
<td>x1.09</td>
<td>1 3 1</td>
<td>x1.77</td>
</tr>
</tbody>
</table>

Note: I=Improved; S=Same; W=Worsened
Celeration Rates
Generally, celeration rates for the two groups of students failed to reach those levels established during baseline. This outcome may be linked with the fact that baseline data were collected on five consecutive days for each probe set (i.e., A1 and A2) and that the baseline probes presented familiar animal figures and a letter previously presented to students. It may be that students required more opportunities to work with the target letters and their related probe sheets to develop fluency; the students may have been at the acquisition level of learning during the study.

Comparisons across intervention and maintenance celeration rates were less clear than for levels of performance. The experimental students demonstrated greater, although modest, positive changes in celeration rates across intervention and maintenance for the individual letters as compared to their control peers.

Classification of celeration rates as improved, same, or worsened performance indicated that the majority of students in both classrooms either improved or maintained their performance rates from intervention to maintenance. However, a greater number of medium and low performing students in the control group were classified as worsening, when compared with their experimental peers.

Together, these outcomes provide support for the use of hypermedia CAI software lessons with students striving to gain letter recognition skills. Students who worked with the software lessons demonstrated similar or enhanced performance patterns compared with their control peers. Use of the CAI lessons appeared to most positively impact the level of performance achieved by students, especially that of the low performers. Low performing experimental group students demonstrated gains from intervention to maintenance, and the majority demonstrated improved performance patterns for letters S and T.

One unique feature of the arrangement of the CAI intervention was that student work with the computer did not require the teacher to restructure her existing instructional sequence or schedule. Students independently took turns working on the computer during station time. The computer lessons provided students with one additional, and novel, means for interacting with the target letters. It may be that additional opportunities to work with the computer lessons would result in enhanced student performance; time was only allowed for experimental students to work through the computer lesson one time for each letter.

This study offers a beginning point for investigating the application of hypermedia CAI with students developing reading-readiness skills. The providing of CAI in the general education classroom may prove to be another viable tool is supporting low performing students and students with disabilities in general education settings. Data from this study indicate that the software lessons most dramatically impacted the performance of low performers.

Further research is needed to investigate the impact of the availability of technology on the performance patterns of young children. The inclusion of computer technology, and in this case, hypermedia CAI, offers a new avenue for assisting students in developing beginning reading skills.

References


We greatly acknowledge the participation of the following individuals of the Renton School District, Renton, Washington: Kathryn Fantasia, Program Administrator, Vera Risdon, principal, Hazelwood Elementary, and Kathryn Davis, Anne Marie Zahradnik, Molly Wilberg, and Judy Bush, teachers at Hazelwood Elementary. We also acknowledge the efforts of James Thurston, research assistant.

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Employing Error Drill and Feedback to Improve the Legibility of Manuscript and Cursive Handwriting

Mary Brunner, T. F. McLaughlin, and William J. Sweeney

The effects of an error drill and feedback procedure for improving the legibility of both manuscript and cursive handwriting were evaluated with a 14 year old, ninth grade male. The criteria provided for judgment of readability/legibility were based on size and formation of each upper and lower case letter for manuscript writing samples, and size, slants, and letter formation of lower and upper case letters for the cursive handwriting samples. Precision Teaching techniques were used to count, record, chart, and make instructional decisions about the legibility of the student's handwriting. Results showed an increase in the frequency of correct individual letters written and a dramatic decrease in the learning opportunities (i.e., incorrect size, slants, and letter formation) for both manuscript and cursive handwriting samples. Important instructional implications of adopting measurably superior data-based procedures for improving the legibility of manuscript and cursive handwriting are discussed.

Language is indeed our most distinctive feature as human beings (Vander Zanden, 1987). "Written language," Vander Zanden stated, "is secondary and developed in imitation of the spoken word." At all levels the ability to convey thought through language enables us to communicate. Business people, teachers of all levels, and the general public realize that this ability to communicate is essential. Byram, Manning, & Reiter, 1987). During the past several decades, Manning asserts, "teachers have neglected to teach proper handwriting techniques."

Handwriting is a communication skill in literacy (Hansen, 1978; Sweeney, Salva, Cooper, & Talbert-Johnson, 1992, in press). Teachers have lowered handwriting standards either because of lack of knowledge, improper instructional techniques, or the attitude that this instruction should only take place in the lower grades (Manning, 1986). The dominant concern in the handwriting area has been focused on the elementary level (Peck, Askov, & Fairchild, 1980; Manning, 1986; Sweeney et al., 1992, in press). Little teaching of handwriting traditionally occurs at the middle and secondary levels (Manning, 1986).

The major objective in handwriting instruction is legibility (Hansen, 1978; McLaughlin, 1980; Mercer & Mercer, 1989; Talbert-Johnson, Salva, Sweeney, & Cooper, 1991). Various procedures have been implemented to improve the legibility of handwriting and have ranged from complex token reinforcement programs (McLaughlin, 1980) to academic positive practice and response cost (McLaughlin, Mabee, Byram, & Reiter, 1987).

The purpose of this research was to evaluate the effects of remediation, error drill and feedback on handwriting. The investigation focused on both manuscript and cursive writing with a secondary student. The primary setting for the intervention was in the home.

Method

Student and Setting
The student, Paul, was a 14 year old male, enrolled in the ninth grade. He attended a small rural junior high, and earned above average grades at the time of the research. The student expressed a desire to improve the legibility of his handwriting. The parent and teachers also felt that the student's handwriting was illegible.
and therefore difficult to read. This was a concern because this could interfere with the student's academic success in the classroom.

Data collection took place in the home between 7:00 p.m. and 9:00 p.m. Instruction occurred in a quiet area of the home, at a full size desk.

Collection of Writing Samples and Development of Probe Sheets

A sample of manuscript and cursive handwriting was produced by the student and collected by the first author. The student viewed the correct formation of individual letters from the sample of his school work, and these were then placed on a probe sheet (i.e., see to write letters in isolation). The student's school work also provided letters that were placed on probe sheets for remediation. Similar probe sheets were used for cursive handwriting samples. The frequency of letters placed on the probe sheets ranged from 100 to 135.

Rating and Grading

The criteria provided for judgment of readability/legibility involved size and formation of each upper and lower case letter for manuscript writing samples (Hansen, 1978; McLaughlin et al., 1986). Samples for manuscript writing came from home generated samples, as well as having the student fill out job applications. Size and formation (two movements) defined legibility. For cursive handwriting, the criteria involved size, slants, and formation (three movements per letter) for both upper and lower case letters.

The student and first author used a transparency with the correct model to judge the legibility for both individual manuscript and cursive letters. The first author explained [to the student] the criteria for corrects in manuscript with respect to size and formation. The criteria used for cursive letters for corrects and incorrects involved size, slants, and formation.

Experimental Design and Conditions

An AB single subject replication design (Kazdin, 1980) was employed to assess the effectiveness of the error drill and feedback procedure.

Baseline. Letters to practice and target for remediation came from random school generated work samples. This procedure generated a sample of 75 small and capital cursive letters and 150 small and capital cursive letters. Many of the targeted and repeated isolated letters occurred on the probe sheets. The student was timed for one-minute to determine the frequency of corrects and learning opportunities (i.e., error rate). The student received no feedback or instruction. Baseline data collection lasted for 3 sessions.

Error drill + feedback. The student was given a prepared sample of manuscript to serve as a model for both upper and lower case letters. The student would then write two pages of manuscript in a non-timed manner. The student then completed a one-minute self-timed writing sample of both upper and lower case letters. Legibility was assessed by the first author with respect to size, slants, and formation.

The procedure used for cursive handwriting was similar. Models of upper and lower case letters provided a visual sample for upper and lower case cursive letters. The student would practice the model, producing two pages of cursive letter writings. Then the student would take part in a one-minute timed probe sheet. The instructional aim for writing cursive letters was 125 movement per minute, while the instructional aim for writing manuscript letters was 75 movements per minute. The student would then produce two pages of practice letters in both cursive and manuscript, after which the researcher and the student would discuss error types and the corrective measures needed to remediate. Finally, the student would complete a one-minute time trial for the session. The first author conducted an assessment of legibility that evaluated size, slants, and letter formation. Error drill and feedback lasted for 15 sessions.

Reliability of Measurement

Reliability of measurement took place and reflected the frequency of letters produced. If the two observers scored the letters in the same manner, an agreement was noted. Any deviations reflected a disagreement. Agreement between the two observers for manuscript ranged from 85 and 95% (M = 90%). For cursive writing the two observers agreed.
between 87 to 97% with an overall mean of 93%.

Results

The data from Charts 1 and 2 indicate improvement in the legibility of manuscript and cursive handwriting with the use of an error drill and feedback program. The frequency of correct responses related to size, slants, and individual letter formation increased for both manuscript and cursive handwriting samples, while the frequency of learning opportunities (i.e., errors) dramatically decreased during the error drill and feedback conditions. During baseline, the median frequency of correctly written individual letters for the manuscript handwriting sample was 51 per minute, with scores ranging from 40 to 60, while the median of correctly written individual letters for the cursive handwriting sample was 60 per minute, with scores ranging from 40 to 70. The median of learning opportunities for individual letters of manuscript handwriting was 30 per minute, with scores ranging from 28 to 32, while the median learning opportunities for individual letters of cursive handwriting was 90, with scores ranging from 80 to 110. This was compared with the error drill and feedback conditions resulting in median scores for correct frequencies of individual letters written per minute of 73 and 124, with ranges from 51 to 80 and 90 to 235 for manuscript and cursive handwriting samples respectively. Further, the learning opportunities dramatically decreased during the error drill and feedback condition, with medians of 9.5 and 20 and ranges of 1 to 30 and 2 to 80 for manuscript and cursive handwriting samples.

Results from Chart 1 and 2 show an accelerating data path from the frequency of correctly written letters and a decelerating trend in learning opportunities during the error drill and feedback conditions for both manuscript and cursive handwriting respectively when compared with baseline trends. Data for the correct letters written for both manuscript and cursive handwriting appear to be accelerating at a x1.25 or x6.0 in baseline. Even though the corrects appeared to be accelerating, the learning opportunities during baseline, remained stable at a x1.00 or decreased very slowly at a +1.25. The first author believed that it was important to decrease the learning opportunities at a much greater rate, and therefore the decision was made to implement the error drill and feedback condition.

During the error drill and feedback condition, the student's celeration on correct letters written for both manuscript and cursive handwriting accelerated by x1.25 and x2.0, while learning opportunities decelerated by a +7.00 and +6.00 respectively. These resulted in a "jaws" learning picture for the manuscript handwriting samples, and a "cross-over jaws" learning picture for the cursive handwriting sample.

The overall performance change for the frequency of correct letters written during the error drill and feedback condition increased at a x1.7 and learning opportunities decreased by a +30.00 on the manuscript sample. This compares to an overall baseline performance change for the frequency of correct letters written of only a x1.5 and performance changes in learning opportunities of x1.0. Similarly, the overall performance change for the frequency of correct letters written during the error drill and feedback condition increased at a x3.0 and learning opportunities decreased by a +40.00 on the cursive handwriting sample. This compares to an overall baseline performance change for the frequency of correct letters written of only a x1.7 and performance changes in learning opportunities of +1.4.

Discussion

Many factors contribute to the legibility of handwriting--size, slants formation, position of writing implement, posture, environmental setting, topography and instructional strategies (Sweeney et al., 1992, in press; Talbert-Johnson et al., 1991; Hanson, 1976; Manting 1986; Mercer & Mercer, 1989; Peck et al., 1980). The focus of the present study was simply size, slants and formation. The data from this study indicate that with improvements in the awareness of handwriting problems, as well as with an intervention designed to remediate these deficits, student legibility can be increased. Remediation of
handwriting difficulties with secondary students has been shown to be an effective means to improve the legibility of handwriting (Manning, 1986; Peck et al., 1980; Sweeney et al., 1992, in press; Talbert-Johnson et al., 1991; Mercer & Mercer, 1989).

Overall improvements in handwriting legibility appeared to generalize to the classroom setting. However, the student's cursive handwriting still showed some difficulty with legibility. The major difficulties still experienced by the student dealt with slants and the speed with which the student wrote in school. These problems appear to be problems of fluency, and future research could address them. Other research has shown that as fluency increases, so does legibility (McLaughlin, 1980; Sweeney et al., 1992, in press). Using actual data from the student's daily work at school would provide a more powerful demonstration of the effects of the intervention. Due to time constraints this was not possible.

In an age of technical and mechanical communication, handwriting has seemingly become almost an archaic tool (Peck et al., 1980). Although mechanical means of communication has developed rapidly, handwriting remains an individual expression (Peck et al., 1980). Written expression is one way we are perceived by the world around us (McLaughlin et al., 1986). Be it a job application or personal communication, legibility in handwriting can affect others' perceptions of us (Manning, 1986). Encouragement of legibility and remediation of student handwriting is an appropriate focus for all teachers and is a functional skill which generalizes to all areas of a student's life (Hansen, 1978; McLaughlin, 1980; McLaughlin et al., 1986; Manning, 1986).

References


Mary Brunner, T. F. McLaughlin and William J. Sweeney are affiliated with Gonzaga University, Department of Special Education, School of Education, Spokane, WA. 99258-0001. Reprints may be obtained from the authors.


Precision Teaching and Success for Shawn

April D. Miller and Annie Lou Polk

Annie "Lou" Polk enrolled in graduate level courses at the University of Southern Mississippi to have an opportunity to learn new teaching methods and techniques. One of the new techniques Lou was introduced to was Precision Teaching. Lou, a teacher in a public school district in South Central Mississippi, enrolled in a graduate level course called "Diagnostic Techniques for Exceptional Children" as a part of the required coursework for a Masters degree in Special Education, Fall 1992. This course was taught by April Miller and included instruction in Precision Teaching. Students enrolled in the course were required to implement an intervention measured through the use of Precision Teaching in an applied setting and present the data to the class, in the form of a Chart share. Some students in the course complained the Chart was too hard to learn or to read, but others, like Lou, embraced Precision Teaching and used the charts to improve instructions for their students.

Subject
Shawn, a 12 year old student with learning disabilities and severe behavior problems, was placed in Lou's classroom at the beginning of the 1992-93 school year. The previous school year, with a different teacher, Shawn had "spent more time out of the classroom than in it." Most of this time, Shawn was either suspended (11 days) or was "spending the rest of the day" in the principal's office. Shawn had been suspended multiple times during the previous school year for disruptive behaviors in either the classroom or on the school bus. Lou's principal challenged her to "find something that works" with Shawn.

Shawn's cumulative folder indicated reading performance at the first grade level and math at the end of second grade level according to teacher assessments and recent evaluations on the WRAT-R and WISC-R. Lou decided to draw on Shawn's strengths, and began with mathematics. Assessment indicated that Shawn did not have the basic addition facts memorized, but recognized numbers and could effectively solve the basic facts by counting his fingers. He was embarrassed by his skill level and using his fingers, and was willing to try something new.

Procedures
Through the use of a daily time trial, Lou measured Shawn's performance on mathematics facts and encouraged him to "go fast." This form of practice was preferred by Lou because it could be completed in a very short amount of time and was less likely to create frustration for Shawn. Daily, Shawn was shown his Chart. As Shawn met his aims, Lou changed the method of calculating (i.e., no fingers) or the pinpoint.

Results
The Chart displays Shawn's see/write performance on mathematics facts during the first semester of the 1992-93 school year. In all phases, Shawn's performance increased and met the aims set. He showed enthusiasm about seeing the corrects accelerating and the learning opportunities decelerating and was motivated to make even small improvements. Another benefit of the intervention was that Shawn wanted to come to school and did not disrupt class. His behavior steadily improved, while his willingness to attempt new skills increased across the school year. Additionally, Shawn's attendance improved, and he was referred to the principal's office only 5 times during the entire school year.

Dr. April D. Miller is Assistant Professor of Special Education at the University of Southern Mississippi, SS Box 5115, Hattiesburg, MS 39406-5115. Annie Lou Polk is a teacher at East Marion Elementary School in Columbia, MS and a Masters candidate at the University of Southern Mississippi.
What We Did On Our Summer Vacation: Practice 399 Precision Competencies!

Claudia E. McDade

In an attempt to provide meaningful access to strongly motivated but poorly prepared students, Jacksonville State University is addressing the academic and nonacademic skills necessary for college success for "high-risk" students. A residential summer session, known as Experiencing Student Success: Education and Life (ExSEL), was piloted in Summer '93 as the only means of freshman level entry for students whose ACT Composite score was less than 16. Thirty-three prospective freshmen were enrolled. The 17 women and 16 men presented ACT Composites between 7 and 17 with a mean of 15.

Coursework in the eight week session included 12 credit hours, with emphasis on developing skills in studying, reading, reasoning, writing, quantifying, and adjusting to college life. All courses were competency-based with Precision criteria. Coursework was supplemented in the residence halls by workshops and discussions, such as time and stress management, realistic choice of major, cultural diversity, and personal finance. Graduate students assisted by living in the residence hall, monitoring structured study sessions and developing rapport with participants. The goal of ExSEL was to prepare students for a successful transition to college life in the fall term.

Almost thirty years of research in Precision Teaching has indicated that true competence occurs only when students are fluent at academic skills. Using the Center for Individualized Instruction model of intense, individualized approaches to learning, ExSEL ensured success by developing competence in academic skills. The Center team diagnosed each individual student's presenting skill levels. The prerequisite tool skills necessary for developing competency were pinpointed with individual prescriptions for learning activities. Individualized activities directed each student into fluent, proficient performances. Rather than classes scheduled for a set amount of time, students worked every day at developing all their competencies. Each day students began with their weakest skill. As a daily aim was reached in that area, the student progressed to aims in other areas. A total of 399 competencies were required across the five courses. Chart 1 demonstrates the group's progress on mastering these competencies across the eight weeks session. Seventy percent of grades earned in the five courses were "A" and "B". True individualized instruction provided each student consultation from the CII team and sufficient practice opportunities to develop his/her competencies. As each student experienced success, she or he strengthened both self-concept and academic preparedness. Each became more aware of how true learning through Precision was taking place, as each student became his/her own reinforcer and learning guide. There was a strong positive relationship \( r = .82 \) between number of competencies reached and improvements on the ACT Assessment. Chart 2 shows one student's competencies reached on writing and quantifying each week and her ACT subtest scores in English and Mathematics before and after ExSEL.

Students signed weekly performance contracts to keep on target for accomplishing the required competencies. Typically, a student committed to reach 15-20 competencies per week in each class. Weekly Chart Shares were held on Friday afternoons where students were encouraged to show at least one of the Charts they kept in each course. A mean of 11 Charts was shown at each session.

This program was expected to show a high degree of success because of its depth and "whole-student" approach. With the added variables of a residential setting, scheduled study sessions, team-building, self-monitoring,
and a high degree of mentoring, ExSEL students were expected to be well prepared for college success. What none of us bargained for during the two and a half years of meetings to design ExSEL was the detrimental effects of overwhelming proportion of this intensity on student feedback and performance. Students lived in the University’s nicest, newest residence hall with men on the first floor, women on the second floor, and transient groups not affiliated with ExSEL on the third floor. Mandatory Saturday excursions off-campus and Sunday night study sessions allowed students little free time to visit family or friends outside the program. Such intense closeness lead to “groupthink” and “groupact” of almost everyone being on a collective “high” or “low.” Changes in romantic involvements, fears of ghosts in the attic, fire alarms being falsely activated, illnesses, party binges and unexplained absences affected almost all participants. Faculty, who had always worked with students without obvious influence from their personal lives, were suddenly wrapped up in racial discord, fears of pregnancy, menstrual cycles, financial problems, and other extremely personal issues ExSEL students presented. Since the group was so tightly knit, students typically brought these concerns directly to the classroom, rather than the privacy of the instructor’s office. While we regret we were not farsighted enough to chart some of the concerns and their effects on performance we were so overwhelmed by ExSEL ’94 will not require residential living. Students in ExSEL ’94 will be treated as other freshmen in regards to living arrangements with no attempt to contain them in any particular location. Commuters, as well as residential students, will be welcome. While we missed the opportunity to more fully study this unexpected phenomenon, none of us is willing to recreate such havoc for the good of science!

CII staff assisted ExSEL students in planning their fall schedules, based on their post-tests in each skill. Of the 33 students who were eligible to enroll as full-time freshmen, 30 actually did (one used a scholarship at a community college, one left homesick after one day, and one could not get enough money). In the Fall Semester ’93 students meet monthly with Center staff to ease the transition to a regular semester and to keep a running check on student performance in core curriculum courses. Other indicators of adjustment to the freshman year show that nineteen have on-campus jobs, three have joined the marching band, three have pledged a fraternity/sorority, one has become a disc jockey at the campus radio station, one writes for the campus newspaper, and two have become involved in the Student Government Organization.

ExSEL was a terrific learning opportunity for all involved. We faculty are more empathetic of student concerns, while ExSEL students report they are better adjusted to the collegiate experience than their peers who entered in Fall ’93. We are readjusting our competency requirements and curricular materials on the basis of student performance. ExSEL students have reported greater academic success than their peers, although they have not yet received any course grades. They will be carefully tracked by the Office of Assessment throughout their years at JSU--both in their coursework and their satisfaction with the University. Stay tuned for further developments as this Precision intervention grows!

Claudia E. McDade is the Director of the Center for Individualized Instruction, and a Professor of Psychology at Jacksonville State University, Jacksonville, AL 36265.
In August, 1992, I joined the Center for Individualized Instruction (CII) team at Jacksonville State University and was introduced to Precision Teaching. I must admit I was skeptical of Precision Teaching and its learning benefits for students, until I attended the Precision Teaching Conference in March, 1993. Sold on Precision Teaching is an understatement! After returning from the conference, I was eager to put to work what I had learned. At the same time, the CII staff was gearing up for ExSEL, a pilot program to be totally Precision taught for students deficient in reading, writing and quantification skills. The reading and writing courses were designed to use practice sheets with computer-assisted software, while the quantification course would be using the Morningside Model for math fluency.

Connie Williams, an instructor in CII's ExSEL program, and I had talked on many occasions about our children, Katelyn and Rachel. Katelyn and Rachel had not mastered basic math skills in the second grade and were given the assignment of learning the multiplication tables to the 5's during the summer vacation, thus the implementation of "Junior ExSEL".

Subjects
Rachel Poe, my daughter, and Katelyn Williams, Connie's daughter, both 8 years old, had just completed the second grade at different schools. Both girls were "finger counters" when it came to addition and subtraction, but would not admit the need to use their fingers. They needed work on basic addition and subtraction skills, in addition to mastering their multiplication tables. Rachel and Katelyn agreed that math was their least favorite school subject. Both girls were at about the same level in basic math skills of addition and subtraction facts. Before leaving the second grade, neither Rachel nor Katelyn had begun learning the multiplication tables.

Procedures
Rachel and Katelyn attended the ExSEL program five days a week for two hours each day, Monday through Friday, for a six week period. They were included in Data Share on Fridays with the college ExSEL students and were given the opportunity to share their progress for the week. This was one of many positive reinforcers for them. Their participation also helped to motivate the regular ExSEL students, since Rachel and Katelyn would be doing various regular ExSEL practice sheets from the Morningside Model of math fact fluency.

The Standard Celeration Chart was introduced on the first day. In order to make charting easy, "Telling Time" practice sheets, a skill Rachel and Katelyn knew was used for one-minute timings. They were shown how to plot or "drop the dot," as they liked to refer to it, on the Chart. Rachel and Katelyn caught on quickly to charting. Cumulative review addition and subtraction math facts was then introduced. Chris Rosser, a fifth grade student, served as a peer tutor for Rachel and Katelyn during this learning phase. He worked through difficulties that they were having with the various practice sheets on the chalkboard with them. In addition to practice sheets, Rachel and Katelyn were introduced to Math Blaster, a computer program using four different types of games with addition and subtraction facts. They worked on the computer daily, in addition to working the practice sheets, and completed a one-minute timing per day on the addition/subtraction practice sheet. Chart 1 and 2 shows their performance on cumulative addition and subtraction math facts.

The Morningside Model teaches multiplication and division facts concurrently. Katelyn's and Rachel's school teach them as separate math facts. In order to keep them from being confused, and stay within their school's
curriculum, a deviation was made in the Morningside Model, and only multiplication table practice sheets were introduced. Jessica Matheny, a seventh grade student at Jacksonville Middle School, served as their peer tutor for the multiplication sequence. Jessica made-up multiplication practice sheets beginning with "0" to the "5's", with a cumulative review after each two digits mastered. She also devised various math games to help reinforce the multiplication facts they were working on. Chart 3 and 4 shows their performance on multiplication facts.

Results

Although Rachel and Katelyn did not complete up to "5's" in multiplication before ExSEL ended, they are no longer "finger counters." Their progress was considered phenomenal for the six week period they participated in the program. Dropping dots on the Chart was fun and challenging for them; they wanted to Chart everything they did. Sharing their progress in Data Share proved to be a good motivational tool, not only for Rachel and Katelyn, but for the ExSEL students as well. As a result of Rachel's and Katelyn's progress this past summer, plans are being made to conduct camp "Mad About Math" in the summer of 1994 for area elementary school children. Stay tuned for more exciting progress and Charts! PT and kids -- a natural learning combination!
Chart Share Guidelines

Precision Teachers wishing to share interesting Charts without writing lengthy articles are encouraged to submit a Standard Celeration Chart-share. Each Chart-share is limited to two pages in length—one Chart and a maximum of one page of explanatory text. The Chart and accompanying text will be printed on reverse sides of the same page to ensure they will not be separated if removed from the Journal for copying.

The Chart: The Chart should be as self-explanatory as possible. All the information at the bottom of the Chart (i.e., Supervisor, Adviser, Manager, etc.) should be completed as descriptively as possible. All charting conventions should be followed. If additional symbols or extensions of the conventions are required, they should be explained in an appropriate "Key." For example, if in addition to charting "words said correctly" with a + and "words said incorrectly" with an x, you wish to note "words omitted" with a λ, that should be noted on the Chart. Each phase of a multi-phase project should be clearly labeled with brief but descriptive phrases. For example, instead of labeling phases, "Phase I, Phase II," etc., the phases might be labeled, "One minute of practice; teacher charts results," and "Same practice; learner charts results." Additional notes should be provided as necessary to explain the project, unplanned events which appeared to affect performances, and other features of interest.

The Back: The back of the Chart may be used to explain the project in more detail. At a minimum, try to provide the following:

1. title for the project;
2. your name and affiliation;
3. names and affiliations of other people involved in the project (first names, initials, or pseudonyms may be used to protect privacy if necessary);
4. the purpose or goal of the project;
5. the specific measurement cycle(s) or target(s) being evaluated;
6. a brief statement of what you learned from the project.

Space permitting, you may add as much additional comment or discussion as you wish. If the submission exceeds the space available, the Journal editors will make whatever changes are necessary while trying to preserve the basic message of the Chart-share.

-- Owen R. White
Association for Precision Teaching
...a division of the Standard Celeration Society

Association for Precision Teaching
A network and support group for Precision Teachers and Precision Learners—those who use the Standard Celeration Chart in education, training, and self-directed learning.

Standard Celeration Society
A professional organization for all those who use the Standard Celeration Chart in education, therapy, economic analysis, marketing, financial planning, quality improvement, performance management or science.

Why Join?
The association for Precision Teaching provides a "home" for charting and Precision Teachers. It is a network of colleagues and friends devoted to improving teaching and learning. A variety of benefits to members includes:
* a year's subscription to the Journal of Precision Teaching
* reduced conference fees for the International Precision Teaching Conference
* periodic mailings and notices about developments in Precision Teaching

History
The Association evolved from a 25-year history, beginning with the founding of Precision Teaching by Dr. Ogden Lindsley, supported by the Precision Teaching Project in Great Falls, Montana, and maintained with ten international Precision Teaching Conferences. In 1990, PT leaders from around North America decided it was time for an organization with expanded scope—to serve a broader range of needs for communication and networking among Precision Teachers and to make PT methods available to those seeking measurably effective educational alternatives. The APT, as part of the Standard Celeration Society, will address those needs with more than a conference, including the Journal, a membership directory, and opportunities to serve on committees and special projects.

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