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STATEMENT OF PURPOSE: As the official journal of the Standard Celeration Society the Journal of Precision Teaching and Celeration has dedicated itself to a science of human behavior founded on a technology of direct, continuous and standard measurement. This measurement technology includes: a standard unit of behavior measurement – frequency; a standard measure of change in behavior frequencies – celeration; a standard measure of the variability of behavior frequencies – bounce; and a Standard Celeration Chart to display frequency, celeration and bounce data. The Standard Celeration Chart enables chart based statistical procedures to determine changes in frequency-frequency jumps, changes in celeration – celeration turns and changes in bounce – bounce verge.

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This book belongs to Michael Fabrizio.
Please enjoy it thoroughly, treat it gently, and return it promptly.
EDITORIAL

Since becoming the editor of the Journal of Precision Teaching and Celeration in 2002, I have had the opportunity review all types of Precision Teaching research. True to the definition of Precision Teaching, an approach that systematically measures instruction and facilitates decision making, Precision Teaching continues to evolve. The current issue has a number of articles that highlight how Precision Teaching stays true to its form but adapts to the changing needs of the current educational system.

Through the application of an intervention method called repeated reading, Sweeney, Ring, Malanga and Lambert show celeration and learning pictures of elementary aged students who improved their reading. Berens, Boyce, Berens, Doney and Kenzer show how Precision Teaching can evaluate retention, endurance and application, three critical learning outcomes associated with fluency. The two articles both demonstrate that Precision Teaching’s strong measurement system allows a view of behavior not otherwise available. Additionally, the articles show how the orderly application of Precision Teaching over many years has resulted in a technology of learning born of thousands of standard celeration charted data.

A tradition that has its roots in a respect for standard displays of behavior, chart shares have continued to appear in the Journal of Precision Teaching and Celeration as well as at conferences and informal gatherings. The charts in this issue show the diversity of those that use Precision Teaching. Anderson and Alber share a chart showing how a 15-year old student learned to read better and changed his behavior when it came time for his reading instruction. King, Moors, and Fabrizio share a chart that displays a child with autism learning difficult prepositions. Fabrizio, Schirmer, Vu, Diakite and Yao present standard celeration charted data detailing how two variables affect the joint attention of a child with autism. And last, Stevens chart share examines efficient ways of monitoring a learner’s progress.

Richard M. Kubina Jr.
Editor, The Journal of Precision Teaching and Celeration
Using Curriculum-Based Assessment and Repeated Practice Instructional Procedures Combined with Daily Goal Setting to Improve Elementary Students Oral Reading Fluency: A Preservice Teacher Training Approach*

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This demonstration project evaluates the effectiveness of repeated reading techniques combined with daily goal setting to build oral reading fluency with fourth-grade students. This reading fluency demonstration project was a combined effort of the School of Education at The University of South Dakota with the teachers in the Sioux City Community Schools. This project was designed to address some of the reading needs of students enrolled in one of its elementary schools with a large population of academically at-risk students. Thirty-nine fourth-grade students, from two general education classes, worked with 8 undergraduate practicum tutors from the university. The practicum tutors worked with the students in groups of 1 to 4 for approximately 45 minutes focusing on basic reading skills. The tutors met with their groups two to three days a week on average for approximately five weeks. The experimental design used was an analysis of fluency celerations and learning pictures common to Precision Teaching programs. Precision Teaching measurement procedures were employed to evaluate the repeated readings procedures. Results showed substantial fluency improvements with multiplying learning pictures for oral reading passages. The implementation of these procedures were effective at improving the students’ reading fluency, were cost effective in terms of time and resources, and took little time to administer. Implications for classroom instruction and adoption of repeated reading procedures for both students academically at-risk and teacher training are discussed.

DESCRIPTORS: Precision Teaching, reading fluency, repeated reading

Many authorities point out the importance of structured, repeated practice for students to assure proficiency with any skill taught in the classroom (Samuels, 2002). High performance athletes, musicians, artisans, and accomplished writers all understand the importance of prolonged, structured, daily practice routines to assure mastery of the skills required in their profession. In fact, a concert violinist or an accomplished baseball pitcher would not think of playing a formal concert or pitching in a competitive baseball game without ensuring that they engaged in sufficient daily practice to ensure mastery of their instrument or of their fastball. In fact, many adults fondly, and sometimes not so fondly, reminisce about the hours they spent as a youth practicing their flute, drawing sketches of a tree, or practicing their wrist shots in hockey. Most of these adults will also readily acknowledge the importance of these practice opportunities to their ability to excel in a recital, concert, formal art exhibit, or a competitive athletic activity (i.e., game, meet, or race). Unfortunately, as Samuels (2002) points out in relation to fluency development: "Although there is universal recognition that fluency (i.e., practice) is important, too little is done in the classroom to develop this important skill level" (p. 166).

The National Reading Panel (NRP) reaffirmed the importance of practice and fluency building procedures in its final seminal report, Teaching Children to Read (2002). The NRP report not only discussed the importance of daily practice in learning to read the alphabetic and phonemic code as well as building fluency in reading textual material, but it also addressed the need for fluency building procedures based on research.

*Special thanks is extended to Mr. Doug Robbins, Principal, and Jenny Wetz and Laurie Powell, Fourth-Grade Teachers, at Smith Elementary School in the Sioux City Community Schools for their support, hospitality, and willingness to allow us to work within their school’s on this project.

*Requests for reprints should be addressed to William J. Sweeney, Ph.D., The University of South Dakota, Division of Curriculum & Instruction, Special Education Program, 414 E. Clark Street, Vermillion, SD 57069.
findings for adequate understand and comprehension of the reading text. Further, the NRP report emphasized the need for regular assessment of reading fluency in the classroom to assure that students are making adequate progress and to assure that if reading problems are exhibited that "timely and effective instructional response" or remediation is implemented to ameliorate said difficulties (p. 7). Even though reading fluency procedures are largely overlooked during regular reading instruction according to Reutzel and Hollingsworth (1993), they are an essential component of good reading instruction. Good reading instruction assures that students not only correctly identify the words within the text but are able to do this decoding automatically, therefore, allowing the student to divert their attention to the meaning of the text rather than concentrating on the sounding out of individual words. Thus, the introduction of fluency building procedures into reading instruction is an essential aspect for good teaching in this area as well as a necessity for improving the reading performance of students in the classroom.

Samuels (1979) advocated for the incorporation of reading fluency (i.e., speed and accuracy) procedures during reading instruction. Unfortunately, as was pointed out earlier, reading quickly and accurately are often overlooked outcomes of good reading instruction. Authorities say that (a) oral fluency is a necessary feature of good reading, (b) readers can acquire fluency with instruction, and (c) fluent reading improves overall reading ability (Howell & Lorson-Howell, 1990; Sweeney, Omness, Janusz, & Cooper, 1992; Teigen, Malanga, & Sweeney, 2001). Fluency is a means for quickly and easily mastering new skills (Lindsay, 1992; Kameunu, Simmons, Baker, Chard, Dickson, Gunn, Smith, Sprick, & Lin, 1998; Sweeney, 1992; Sweeney, Sweeney, & Malanga, 2001). Fluent readers become experts because they are more proficient at incorporating complex skills, assimilating large amounts of content, understanding knowledge structures, and problem representation (Sweeney, 1992; Mastropieri, Leinart, & Scruggs, 1999). In addition, fluency is related to the eventual generalization and maintenance of reading skills (Levy, Nichols, & Kohen, 1993; Max & Caruso, 1998; Sweeney et al., 1992; Teigen et al., 2001).

The purpose of repeated readings is to build fluency (Samuels, 1979; Rashotte & Torgesen, 1985). Three components have been emphasized in research on oral reading fluency: (a) decoding, (b) overall reading speed and accuracy, (c) and the relationship between reading fluency and comprehension. Research documents the effectiveness of reciprocal peer tutoring and a Precision Teaching measurement system with repeated readings to improve the reading fluency of elementary and severe behavior handicapped learners (Downhower, 1989; Downs & Morin, 1990; Daly & Guldswog, 1992; Lee, 1990; Sweeney, 1992; Sweeney et al., 1992; Teigen et al., 2001). Additional research on potential classroom applications of repeated readings reaffirm the robust nature of this instructional method (Bolich & Sweeney, 1996; Durgunoglu, Mir, & Arino-Marti, 1993; Homan, Klesuis, & Hite, 1993; Sweeney et al, 1992).

For example, Teigen et al. (2001) implemented a combined repeated readings procedure with an error correction package to improve the reading performance of a 10-year-old boy who was participating in a summer reading clinic. The combination of the repeated readings and the error correction procedures was successful at increasing the number of words read correctly while simultaneously decreasing the words read incorrectly across a 10 day instructional period. Additionally, Sweeney et al. (1992) showed that repeated readings combined with Precision Teaching measurement approaches were responsible for the reading improvements of a 43-year-old male who was diagnosed as functionally illiterate. Not only did the repeated readings improve his ability to read and understand textual material, but the reading instruction was also responsible for his reported improvement in self-confidence as it related to reading tasks. Further, repeated readings were successfully implemented on a classwide basis with third- and fourth-grade students while working with undergraduate tutors from a local university (Robbins, Sweeney, Ring, & Sweeney, 1999).

Although the focus of this project was to improve the reading performance of the students with mild disabilities who were in an inclusive setting, the results indicated improvements in oral reading fluency all of the students in the classroom. The importance of this study was that repeated readings and fluency building procedures are effective for improving reading performance regardless of whether a student is experiencing reading difficulties or are already reading at appropriate levels. Thus, teachers who incorporate repeated reading procedures and fluency building strategies as a component of their reading instruction are going to improve the reading skills of students who are exhibiting reading difficulties, while enhancing the reading performance of those students who are achieving adequately in the classroom. One of the important difficulties in the integration of repeated reading procedures is the need to ensure effectiveness of the fluency building strate-
Integrating Precision Teaching measurement systems with repeated readings instruction as a method to build reading fluency is frequently advocated by authorities in the area of curriculum-based measurement (Binder, 1990) and curriculum-based assessment (Sweeney, Ring, Robbins, Larsen, & Schnetzer, 1998). Precision Teaching measurement provides a frequency of responses over time and across days as its measurement unit. For example, a teacher can count the number of words read correctly or incorrectly and divide that number by the time allocated for assessment (e.g., one-minute) and come up with a count per minute measure. This count per minute measure is then charted on the Standard Celeration Chart across a series of days, thus providing the teacher with a quantifiable visual analysis mechanism that is sensitive to daily changes in reading performance. The teacher then possesses the information necessary to determine the effectiveness of the strategies, curriculum, and time required to improve a student’s reading performance. Likewise, if the data from the chart indicates deteriorating or stagnate performance, the teacher possesses the immediate feedback from the student’s performance that suggest that changes, modifications, or accommodations in the instruction are required. Precision Teaching measurement approaches provide the teacher with a powerful tool for assessing student’s reading performance as well as providing a feedback mechanism to ensure the effectiveness and appropriateness of the instruction.

Research shows that the immediacy and frequency of teacher delivered feedback, such as that provided by Precision Teaching measurement approaches, is functionally related to improvements in students’ academic achievement (Cooper, Heron, & Heward, 1990; Van Houten, 1980). Public posting systems are one measurably effective means that are recommended to assist teachers in providing students with effective and meaningful feedback on their classroom reading performance (Lambert, Sweeney, & McLaughlin, 1996). An important component of many public posting systems is academic goal setting or setting instructional aims. Unfortunately, few studies or projects have appeared in the literature over the past 10 years documenting the effectiveness of daily goal setting for the improvement of reading fluency skills in the classroom.

Cooper, Kubina, and Malanga (1998) provided a set of guidelines for chart collections or frequency collections by teachers as a means of displaying individual student performance on the Standard Celeration Chart for the purposes of summative evaluation. Although integrating repeated readings and daily goal setting combined with Precision Teaching measurement approaches was shown as an effective means of improving student’s oral reading fluency (Robbins et al., 1999), few recent articles in the literature display classwide summaries of improvements in reading fluency. Even though the monitoring of individual reading performance is at the heart of Precision Teaching, an important gap appears to exist in relationship to displaying a visual summary analysis of classwide improvements in reading fluency performance.

**Purpose.** This demonstration project evaluated the effectiveness of repeated reading techniques on oral reading fluency for students academically at-risk on a classwide basis. A concurrent goal of this demonstration was to document the importance and effectiveness of integrating procedures for daily goal setting, as part of an overall treatment package, for assisting students at improving their reading skills. Finally, this demonstration project shows the efficacy of using chart collections as a means of summative, classwide evaluation of the reading fluency instruction.

**METHOD**

**Participants.** Thirty-nine fourth-grade students, from two general education classes, worked with 8 practicum tutors from the university. The practicum tutors worked with the students in groups of 1 to 4 for approximately 45 minutes focusing on basic reading skills. Over half of the students from both of these classes had been identified with reading problems and were enrolled in classes for students in special education, English as a Second Language, or Title 1 reading. Further, the classroom teachers identified several students that were not currently enrolled in these remedial programs who were at-risk for academic problems due to social behavior, attendance, or other behavioral concerns.

**Setting.** This demonstration project took place at Smith Elementary School in Sioux City, Iowa during the spring of 2002. The school that participated in this project is located in a racially and ethnically diverse section of the community. Roughly 61% of the students come from minority backgrounds (i.e., Hispanic, Native American, African American, Vietnamese, etc.) with an unusually high percentage enrolled in English as Second Language programs. Based upon the school district’s measure of socio-economic status (i.e., free or reduced school lunch programs), close to 68% of the students could be considered from economically deprived backgrounds (i.e., below what could be considered the poverty line).

Two integrated classrooms of students took
part in a combined repeated readings and goal setting instructional intervention. The repeated readings were conducted in the students' respective classrooms or in the hallway adjacent to the classrooms. Tutors utilized the hallway because of limited space for the small groups and to eliminate as many auditory distractions as possible. Students from these classes worked in groups of 1 to 4 students with trained undergraduate special education practicum tutors. A university supervisor and the classroom teachers served as mentors/coaches for the practicum tutors. These tutors used a combined repeated reading procedure with daily goal setting as well as Precision Teaching evaluation approaches to document the students' progress at building oral reading fluency. The practicum tutors sat across or perpendicular to the students in their respective tutoring groups.

Movement Cycle/Movement Procedure. The movement cycle for oral reading was the number of words orally read during an one-minute timing. The learning channels for oral reading were see/say (see word/say word). The corrects were the number of words read correctly during the one-minute timing. The incorrects were the number of words read incorrectly (i.e., omissions, substitutions, additions, and mispronunciations) during the same period.

The practicum tutor provided a retelling procedure for the student following oral reading timings. The retelling consisted of a free recall for the student in which they would tell all the information and details that they could remember from the reading passage. During the oral retell, the tutors counted key points related to the characters, facts, and specific action verbs from the passage. Although the oral retells were counted, recorded, and charted, they are presented in this article due to space limitations.

PROCEDURE

General Procedures. Prior to the beginning of the instruction, the classroom teacher filled out a brief survey on each student providing an approximation of the students' overall reading level, vocabulary and sight word recognition level, decoding problems, and any other information necessary to help the practicum tutor get started with instruction. Based upon this information the practicum tutor selected three reading passages of approximately 150 to 220 words in length (one passage below the reported reading level, one passage at the reported reading level, and one passage slightly above the reported reading level). These three passages were used during the initial assessment to determine the most appropriate passage for instruction using the repeated reading procedure. Additional curriculum-based measures were taken during the initial tutoring session to get a better understanding of each student's sight word recognition skills, decoding skills, and response patterns, and structural analysis skills.

After the initial assessment, the practicum tutor selected the passage he or she believed would challenge the student but could also be used to improve their oral reading fluency. Instruction consisted of a variety of different decoding, sight word recognition, and reading exercises (e.g., paired readings, neurological impress, chained reading, and specific error correction), which culminated with a one-minute timing for oral fluency on the selected passages. After the repeated readings timing, the practicum tutor conducted an one-minute retelling comprehension probe.

Goal Setting. The practicum tutor selected the most appropriate passage (i.e., approximately 150 to 220 words) from the initial oral reading fluency assessment. Prior to the timing, the tutor asked the student what his previous best score was and then asked the student what his goal was for today's reading fluency timing. The practicum tutor prompted and cued the students during the goal setting to ensure that they were selecting a reasonable goal for their repeated readings one-minute timing. A minimum improvement goal from the last session of at least one more word per minute was used during the goal setting procedures. Maximum improvement goals were based upon the tutor's judgment of what was a reasonable goal for the students' to attain, thus ensuring continued intermittent success towards the ultimate fluency aim range of between 180 to 210 correctly read words orally per minute. At the conclusion of the repeated readings, the practicum tutor and the student(s) reviewed, recorded, and charted their best repeated readings score from the day. The tutors celebrated the student(s) accomplishments by rewarding them with stickers or other tokens when they met or exceeded their daily reading goals. The chart and daily goal setting provided an important source of feedback related to the student(s) success in meeting their ultimate instructional aim of reading 180 to 210 words per minute on a selected reading passage (Liberty, 1972; Liberty, 1975; McGreevey, 1983; White & Liberty, 1976).

Repeated Readings. The practicum tutors began the fluency training by reviewing the passage with the student prior to implementing the one-minute repeated readings time trial. During this review, the tutor corrected any errors and provided additional instruction on portions of the passage that appeared especially difficult for the
When the tutor believed that the student had mastered the passage sufficiently and was ready for the one-minute timing, the tutor provided a specific cue, such as "Ready? Five seconds, Go!," to let the student know when to start reading. While the student read aloud, the instructor followed the passage on his or her own sheet marking any errors that needed to be corrected following the one-minute timing. Previously, the tutor told the student to read out loud as fast as he or she could and if he or she did not know a word to skip it and go on to the next word. When the beep of the watch sounded the student stopped reading. Following the conclusion of the one-minute timing, the practicum tutor recorded the student’s best score for the day. The data indicated accelerating data paths for the number of words read correctly as well as decreceling data or celerations below the record floor related to incorrectly read words during the one-minute timings.

RESULTS

Data from the students’ summary charts showed substantial improvements in all of the student(s) oral reading fluency performance through the use of repeated readings and goal setting procedures across multiple reading passages. The upward celerations that related to the increasing number of correctly read words were indicative of climb learning pictures for the students. Also, many of the student(s) oral reading performance more than doubled per week, multiplying generally at a X2.0 or greater. Some of the students exhibited periodic celerations multiplying at X10.0 or more per week. Data also indicated that the error correction procedures were successful for most of the students. Error responses for most students after the initial sessions remained below 5 per minute or less for most students. Additionally, the overall performance change for most students multiplied by X3.0 to X6.0 in most cases. Finally, many of the students met or exceeded the terminal instructional aim of 180 to 210 words read correctly per minute on not just one passage, but often on two or more passages during the five week period. Because the chart collections are meant to display the individual student improvements in an easy to differentiate and assess format, the individual student improvements may appear difficult to differentiate. Therefore, three representative student’s charts are also provided to show the effectiveness of the instruction on individual students. Charts 7-9 display the individual performance of three students across reading passages. Table 1 shows the relative celeration for correct and incorrect responses for each student across multiple reading passages. The data indicated accelerating data paths for the number of errors read correctly as well as decelerating data or celerations below the record floor related to incorrectly read words during the one-minute timings.

DISCUSSION

This study has remained consistent with previous research involving repeated readings for the development of oral reading fluency (Biemiller, 1977; Dowhower, 1987; O’Shea, Sindelar & O’Shea, 1985; Robbins et al., 1999; Sweeney, 1992; Sweeney et al., 1992). Although it cannot be said that daily goal setting was solely responsible for the improvements of these students in their oral reading fluency, it can be said that the daily goal setting was an important component of the treatment package which was responsible for these reading improvements. Comments made by the elementary students and the affective enthusiasm showed by these students about both their tutors and the practicum were returning to work with them. From a teacher training perspective, this demonstration project provided an excellent opportunity for undergraduate practicum tutors to gain valuable instructional and curriculum-based assessment opportunities in a structured, highly supervised, real world setting. The relatively simple to follow instructional strategies and the straight forward Precision Teaching evaluation system provided the undergraduate tutors the basic instructional foundations for success when working with students with disabilities or who were academically at-risk. In fact, comments made from graduating students’ teachers, who had completed a similar experience two to three years before, reported that the tutoring practicum was largely responsible for their understanding and...
### Table 1

Celeration Values for Correct and Incorrect Responses Across Reading Passages for Individual Sample Students

<table>
<thead>
<tr>
<th>Passage</th>
<th>Raven Corrects</th>
<th>Raven Incorrects</th>
<th>Grayson Corrects</th>
<th>Grayson Incorrects</th>
<th>Geoffrey Corrects</th>
<th>Geoffrey Incorrects</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>X 1.5</td>
<td>+ 5.0</td>
<td>X 3.5</td>
<td>+ 25.0</td>
<td>X 2.0</td>
<td>Below 5</td>
</tr>
<tr>
<td>#2</td>
<td>X 1.6</td>
<td>+ 6.0</td>
<td>X 5.0</td>
<td>+ 60.0</td>
<td>X 2.5</td>
<td>X 9.0</td>
</tr>
<tr>
<td>#3</td>
<td></td>
<td></td>
<td>X 1.4</td>
<td>+ 7.0</td>
<td>X 1.8</td>
<td>+ 2.8</td>
</tr>
<tr>
<td>#4</td>
<td>Celer. Corrects</td>
<td>At Aim</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#5</td>
<td>Celer. Incorrects</td>
<td>Below 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#6</td>
<td>Celer. Corrects</td>
<td>X 5.0</td>
<td></td>
<td></td>
<td></td>
<td>+ 25.0</td>
</tr>
</tbody>
</table>

Integration of specific curriculum, instructional materials, and strategies as they progressed through their teacher preparation program. In short, the opportunity to employ these procedures with real students in a supervised setting assisted these practicum tutors to gain a greater mastery and fluency of important instructional teaching behaviors.

Several important limitations need to be considered when evaluating the results of this study. First, the demonstration project met on average twice a week for only 5 weeks. Had the practicum tutors been able to continue the intensive tutoring for a longer period of time, such as a year, it is probable that much more substantial results may have been obtained. Secondly, the tutors worked in small groups of 2 to 3 students. Working intensively, with highly trained tutors, in small groups is often not practical or feasible for most general education teachers. Additional training and support may enable these teachers to develop peer tutoring or cooperative grouping strategies that could adopt or modify these fluency building and daily goal setting strategies in the regular classroom (Maheady, Michielli-Pendel, Mallette, & Harper, 2002; Smith, Tyler, Easterling, Smith-Davis, Clarke, & Mims, 2002). Unfortunately, training in developing peer tutoring or cooperative grouping strategies are too often only the auspices of those in special education and are not contained or satisfactorily taught in general education teacher training programs (Greenwood & Maheady, 1997). Further, by utilizing summary chart collections as a potential decision making tool, practitioners run the risk of masking or inadvertently missing the fine grained nuances of individual daily performance by students related to improvements or potential deterioration of oral reading fluency. If summary chart collections are employed as the sole decision making tool by teachers and other educational leaders, without an additional analysis of the individual student's performance, they must interpret these results with caution due to the same threat posed by statistical analysis, i.e., masking the true variability across time of the individual student's reading performance (Johnston & Pennypacker, 1993). Educational practitioners need to combine the analysis of both the summary chart collections with a thorough analysis of individual student's
charts to avoid making erroneous conclusion related to the effective reading fluency instruction on student’s actual reading performance. Finally, further research needs to be conducted related to long term gains of reading fluency instruction, generalization of fluency skills into other curriculum areas, and ways to increase adoption and implementation of fluency building and goal setting procedures by more classroom teachers.

Repeated readings and oral reading fluency procedures hold great promise for improving the overall reading performance of many students. Through the adoption of repeated reading and fluency building approaches, teachers are providing students with the tools so that they can automatically recognize and decode words within the text. When students are able to automatically decode words with in a text, they are provided with a greater opportunity to focus more of their time, attention, and effort in developing adequate reading comprehension skills (Allington, 1977; LaBerge & Samuels, 1974). Although the outcomes of this project for building reading fluency with elementary students are very promising, additional planning and resources are necessary for implementation on a classwide or school wide basis. Through effective collaboration between the local public schools and universities, the opportunity to increase available resources for instructional purposes may be realized. Further, the actual in school teaching experience in a structured and supervised setting provides invaluable experience for preservice teachers and optimizes feedback and resources related to effective instructional practices provided by teacher training programs.

REFERENCES


A Technology for Evaluating Relations between Response Frequency and Academic Performance Outcomes*

Kimberly Nix Berens, Thomas E. Boyce, Nicholas M. Berens, Janice K. Doney, and Amy L. Kenzer

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Since the 1970's, proponents of Precision Teaching have cited the relation between fluent performance and various long-term academic performance outcomes. Unfortunately, clinical work has mainly been used to demonstrate the importance of high correct response frequencies in education. The current paper describes a technology currently being used in a university-based Precision Teaching center to systematically evaluate relations between response frequency and academic performance outcomes with school children. Specifically, three studies are reported which evaluate retention, endurance, and application as a function of response rate during training. Results indicate that higher rates of responding during training yielded better performance during tests of retention, endurance, and application. The studies are discussed in terms of technological innovations for educational reform and directions for future research.

DESCRIPTORS: Precision Teaching, fluency, retention, endurance, application

In the Precision Teaching (PT) literature, Retention Endurance Application Performance Standards (REAPS) have been described as the positive outcomes to fluent performance. From this perspective, fluency is defined as a mastery criterion that requires both accuracy and speed (i.e., high correct response frequencies). Proponents of fluency-based instruction suggest that fluent performers are more likely to maintain their accurate, high-rate performances over periods of time without practice (retention) and over long durations in the presence of distractions (endurance/stability), as well as acquire complex skills more quickly and easily (application/adduction) (Binder, 1996; Bloom, 1986; Johnson & Layng, 1992; Lindsley, 1971).

As described above, REAPS could have great significance for learners in traditional education settings. First, increased skill retention following extended school absences (e.g., summer break) would require that less time be spent reviewing skill objectives from the previous school year. Second, behavioral endurance during standardized tests could enhance student performance by decreasing distractibility and fatigue. Finally, application outcomes could increase the likelihood that learners would continue to excel in and pursue advanced coursework during their secondary or post-secondary educations. Overall, it appears that if fluency leads to REAPS, fluency-building strategies may be used to complement more traditional methods of instruction as a means of producing better learning gains.

The notion of fluency extends beyond the PT literature. Proponents of curriculum-based measurement (CBM) also use behavior frequency as a basic unit of measurement for evaluating academic proficiency (Deno, 1985; Fuchs, Deno, & Mirkin, 1984; Marston, Mirkin, & Deno, 1984). CBM maintains similarities to PT in that count per time per time, or responses per minute per week, serves as the basic datum from which educational decisions are made. Additionally, from both perspectives, the higher the response frequency the more proficient the learner is considered to be. Research in CBM indicates frequency of correct response is as reliable a measure of academic proficiency as commercially available standardized test scores, and tends to provide educators with more information regarding the specific nature of skill deficits (Elliot & Fuchs, 1997; Fuchs & Deno, 1996).

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Although there are differences between how PT and CBM use fluency as a measure of learning, it is generally agreed upon that fluent performances result in long-term benefits to the learner. Unfortunately, much of the evidence for REAPS has been obtained clinically (Binder, 1996). Although clinical evidence is important and should not be overlooked, it appears that more rigorous empirical work evaluating the relation between increasing response frequencies and REAPS is sorely needed. In order to influence a shift in traditional educational practices in favor of behavior analytic approaches that emphasize frequent measurement and true skill mastery, outcome data across large numbers of learners is needed.

The current paper describes a technology currently being used to examine relations between response frequency and REAPS within a university-based PT center. The primary mission of the center is to design effective instructional strategies for improving the academic performances of students in grades K-12. The center is also committed to the use of a scientist-practitioner model of psychological practice where data are systematically collected for use in: (a) making educational decisions, (b) conducting general program evaluation, and (c) disseminating scientific information regarding relations between response frequency and academic performance outcomes.

GENERAL CENTER OVERVIEW

Students

Twenty-five students in grades one through 10 currently attend the Center for Advanced Learning (CAL) for 2 to 6 hours per week and receive tutoring in mathematics and reading. Each student's curriculum is tailored to meet his/her specific needs and is established from performance on a comprehensive basic skills assessment. Each skills assessment is curriculum-based, such that tests are generated from local grade-level curriculum. However, these curricula are broken down into basic components so that only finite skills are being assessed. Learners' correct responses per minute are initially evaluated for grade-level curriculum. However, if a learner's correct responding falls below the established fluency aims for any grade-level skills, their performances on skills from previous grade levels are evaluated until fluent performances are obtained. Skills at the next level are then targeted for fluency training.

Curricula

Similar to the basic skills assessment, the CAL math and reading curricula are composed of various programs that represent overall skill objectives for grades one through 12. These programs are broken down into the basic component skills required for performance of the overall skill objective, or composite skill. For example, the phonetic reading program is broken down into (a) identifying letters, (b) identifying phonics sounds, (c) identifying vowel blends, (d) identifying consonant blends, (e) identifying three-letter words, and (f) identifying words for grade levels 1-12 (all words can be identified through word-attack skills). The stimuli associated with a particular level in a program are presented on various worksheets or sets of flashcards. This levels system applies for all math and reading programs included in the curriculum, with various worksheets and flashcards associated with each level.

A session book is generated for each student. The book includes: (a) a curriculum checklist identifying the component skills and overall composite skill objectives to be mastered during the student's tutoring sessions, (b) paper copies of each skill level in a program to be conducted during tutoring sessions, (c) standard celeration charts (Pennypacker, Koenig, & Lindsley, 1972) for recording correct and incorrect response frequencies obtained during each program, and (d) a log for communicating program changes, directing questions to the Case Managers/Advisors, and describing problems or highlighting achievements that occur during a student's session. Additionally, during fluency training sessions, tutors are equipped with: (a) digital timers for the accurate monitoring of various timing periods, (b) hand-held counters for tallying rapid response frequencies, (c) pencils, erasers, and rulers for charting, and (d) boxes of highly preferred stimuli for use as rewards.

GENERAL TRAINING PROCEDURES

Fluency Training

Skill introduction. Skill introduction is the first step in fluency training. Specifically, each student's correct response frequency on an academic task is evaluated during 15-s, 30-s, and 1-min timings. The timing length that produces response frequencies closest to the fluency range determines the interval used for initial training.
For example, if a student engages in higher frequencies on a task during a 15-s timing versus a 30-s or 1-min timing, then frequency building during 15-s timings is introduced. Thirty-second timings are introduced after fluent responding is achieved at 15-s and so on until the learner is performing fluently during 1-min timings.

**Frequency building.** Following skill introduction, frequency building during the previously selected timing length commences. During frequency building, each student is instructed to perform the skill as quickly as possible. Students are periodically prompted during the timing to respond more rapidly (e.g., "Go faster" or "Hurry"), if pausing or decrements in frequency are observed during the interval.

Tutors deliver verbal praise during the course of a timing when a student makes significant improvements in accuracy or frequency as compared to his/her previous timing (e.g., "Awesome" or "Great"). Errors are noted, but corrective feedback is withheld until the end of the timing. At that time, the tutor initiates correction trials for all incorrect items.

A correction trial consists of the tutor instructing the student to respond to the incorrect item again, providing immediate praise for a correct response or immediate corrective feedback for an additional incorrect response. Corrective feedback entails the tutor providing the student with the correct response (i.e., modeling), and then requiring that the student repeat the correct response. The tutor then requires that the student respond to the item again, and provides immediate praise for the correct response. Correction trials of this sort are repeated until the student can emit independent correct responses to all incorrect items.

Throughout the course of the training session, students are eligible to receive verbal, tangible, or edible rewards contingent upon various response requirements. The specific contingency implemented with each student depends upon nuances specific to that individual. For example, some students show rapid increases in response frequencies across days (i.e., high accelerations). As a result, these students receive reinforcement for doublings in performance (i.e., X2.0 celeration) throughout the week. However, some students require that reinforcement be made contingent upon accurate responding before increases in frequency can be targeted. Other students require that reinforcement be made contingent upon on-task or compliant behavior.

In addition, it is standard practice in CAL to reinforce a student's performance if fluency is achieved during a given timing length and he/she proceeds to a longer timing length (i.e., increases in endurance). In order for a student to proceed to a longer timing length, his/her response frequency per minute must fall within the fluency range (i.e., divided by .25 and .5 for a 15-s and 30-s timing, respectively). Finally, performance is reinforced for Phase 1 and Phase 2 mastery of a skill.

Phase 1 mastery is achieved when a correct response frequency falls within the fluency range for two consecutive 1-min timings during a session. Phase 2 mastery is achieved when a correct response frequency falls within the fluency range during the first timing conducted on that skill during the first session after Phase 1 mastery has been achieved (generally 2 days apart). If the student fails to achieve Phase 2 mastery, then he/she must restart the mastery sequence (i.e., achieve Phase 1 and Phase 2 mastery on consecutive sessions).

Since individualized programs of instruction are implemented with all students as a means of enhancing learning, the numbers of timings conducted on each skill during each session depend upon individual performance characteristics. Therefore, response opportunities vary across students as a function of their individual performance during sessions, and are evaluated as part of the data analysis in each of studies reported below.

**General Data Collection Procedures and Calculation of IOA**

For all students, frequency of correct responses, incorrect responses, and skipped items are recorded during sessions using standard celeration charts. A standard timings chart is used to record the response frequencies obtained during all timings conducted on a particular skill during a session. After all timings have been conducted on that skill, the highest correct response frequency obtained for that skill area is then plotted on a standard daily chart. Figure 1 shows an actual daily chart from one of our learners, who is also included in the analyses reported below.

Secondary observers obtain point-by-point agreement measures during a portion of all tutoring sessions. At the completion of the analyses reported below, secondary observers had obtained agreement measures for 782 timings conducted throughout the 2001-2002 school year and 2002-summer session. Exact agreement scores were calculated from these measures by first identifying the total number of agreements and disagreements obtained during the timing. Agreement scores included total number of correct items, incorrect items, and skipped items in which the two observers reported the same score. Disagreements included the num-
number of correct, incorrect, or skipped items for which conflicting scores were reported. Exact agreement coefficients were then calculated for each timing by dividing the number of agreements by the number of agreements plus disagreements and multiplying by 100%. An overall agreement score across all timings was then calculated. The average agreement score across the 782 timings was 96.87% and ranged from a low of 78% to a high of 100%.

**STUDY 1: RETENTION**

**Method**

**Participants**

Five students enrolled in CAL were selected for inclusion in the retention analysis. These 5 participants were included due to their having curricula with at least two programs within a similar academic domain having the same fluency aim (65 or more responses/min), thus allowing for appropriate within and between subject comparisons.

Jack (7th grade), Emily (6th grade), Larry (7th grade), and Josie (10th grade) were typically developing students receiving instruction in general education classrooms at private schools in northern Nevada. Jack and Emily were enrolled in CAL to receive skill building in mathematics. Larry and Josie were enrolled to receive skill building in reading and mathematics.

Karen was a 4th grade female with mild Downs Syndrome in special education at a public school in northern Nevada. Karen was enrolled in CAL to receive skill building in reading, mathematics, and fine motor skills. She was also receiving intervention through CAL for disruptive classroom behavior (e.g., out-of-seat behavior, noncompliance, etc.).

**Responses**

For all participants, correct responses per minute on basic computation flashcards were included in the retention analysis. Basic computation included: (a) addition facts (0-18), (b) subtraction facts (0-18), (c) multiplication facts (0-12), (d) division facts (0-12), (e) reducing fractions, and (f) converting improper fractions to proper fractions. All basic computation flashcard tasks entailed the same fluency aim of 65 or more correct responses per minute. The fluency aim for this skill was established through normative sampling (Binder, 1996), where the number of computation flashcards completed per minute was evaluated across a series of timings conducted with exemplary learners, undergraduate tutors, and graduate students affiliated with our center. The distribution of scores obtained on this skill area across individuals was evaluated to produce a range of optimal frequencies, with 65 facts spoken per minute serving as the low-end of the range.

**Reinforcers**

All 5 participants received edible rewards (i.e., candy or snacks) for: (a) any increase in response frequency over the previous session, (b) achievement of fluent performance during shortened timing lengths (e.g., 15-s. or 30-s. timings), (c) achievement of Phase 1 mastery, and (d) achievement of Phase 2 mastery. Karen also received edible rewards for staying on-task and following instructions throughout her sessions (these were delivered randomly at the discretion of her tutor).

**Retention Probes**

Retention probes were conducted on mastered and unmastered skills following a naturally occurring 1-month break between semesters (i.e., winter break). During probes for retention, participants were given up to four opportunities to perform the skill as a means of controlling for warm-up effects. A probe session could involve fewer than four timings if the participant responded fluently for two consecutive timings. For those participants who had achieved Phase 2 mastery of a skill prior to the retention period, failure to perform fluently during two consecutive probe timings resulted in that skill being reintroduced during training.

**Data Analysis**

Data for the 5 participants were analyzed in terms of median training frequency and total number of responses emitted during training. The relation of these measures to the percentage of retention was explored.

**Median training frequency.** The median training frequency was calculated from all of the participants’ training data for each separate skill. To calculate the median frequency for a skill, each score obtained on that skill prior to the retention period was entered into a computer database that automatically calculated the median measure for the distribution of values. This median served as a summary measure of the participant’s training performance for use in comparing training performance with the percentage of retention.

**Total responses emitted.** A total responses emitted score was calculated from each participant’s training data to serve as a measure of practice. This score was calculated for each participant by summing all of the response frequencies obtained across all timings prior to the
retention period. The total responses emitted calculation reflected actual responses. Therefore, the numbers of responses obtained during shortened time periods (i.e., 15-s or 30-s) were not reported as count per minute for this calculation.

Percentage of retention. Percentage of retention was calculated for each participant's performance of a skill during retention probes. To obtain a more comprehensive measure of performance before and during the probe, the percentage of retention calculation involved dividing the average frequency obtained during the retention probe (i.e., summing each frequency obtained during the probe and dividing by the total number included in the sum) by the average of the last two training points obtained before the probe. This computation yielded a percentage of each participant's previous response frequency that was maintained following a period without instruction or practice.

RESULTS

The relation between each participant's median training frequency and the percentage of their previous performance retained during the probe is reflected in the top panel of Figure 2. These data indicate a positive relation between median training frequencies and the proportion of previous performance retained after a 1-month period without practice. In general, it appears that those participants emitting response frequencies closer to the fluency range on particular skills prior to the retention period (Josie, Larry, & Emily), performed better during the retention probes (over 100% retention) than participants responding at lower frequencies on particular skills. In other words, those participants who rapidly progressed towards fluency on a particular skill during practice, and thus achieved higher overall median training frequencies, appeared to retain more of their performance following the retention period than those who progressed more slowly during training. This relation appears to hold true across participants and, with the exception of Emily, within participants across different basic computation programs.

The relation between each participant's practice opportunities, measured as total responses emitted, and the percentage of their previous performance retained during the probes is reflected in the bottom panel of Figure 2. In contrast to the results obtained for median response frequencies and percentage of retention, these data suggest a negative relation between total responses emitted and percentage of retention across participants. That is, it appears that those participants (Karen and Josie) who engaged in the most cumulative practice (3300 and 4300 responses respectively) on a particular skill retained less of their previous performance. Conversely, those students (Josie and Larry) with the least amount of practice (less than 100 responses) on a particular skill retained as much or more of their performance. This negative relation holds true across participants and, with the exception of Larry and Karen, within participants across the different computation skills. The results for Larry and Karen indicate no relation between amount of practice and skill retention.

DISCUSSION

The current results indicate a positive relation between response frequencies emitted during practice trials and retention of academic performances by school children. It appears that the higher the frequency of correct responding during practice, the greater the amount of previous performance retained following a 1-month period without instruction or practice. The current findings also indicate a somewhat negative relation between amount of practice (i.e., total responses emitted) and retention of previous performance. It appears that additional practice opportunities will not enhance skill retention unless response frequencies are fairly close to the fluency range. Put differently, engaging in additional practice of a skill at low frequencies did not appear to enhance retention following a 1-month period without practice. These findings suggest that response frequencies emitted during practice, rather than simply the overall amount of practice, is a more critical predictor of skill retention.

There are some limitations to the current study. Firstly, retention probes involved assessing performance on basic computation skills following a 1-month absence from instruction or practice. Future research should focus on an examination of additional skill areas and longer retention periods so that the generality of the current findings can be assessed. Additionally, whether students were actually practicing some skills during the retention period is unknown. Therefore, it is difficult to determine the effect that extraneous practice may have had on the current findings.

The current results contradict previous research that has been conducted investigating relations between practice and retention of academic skills. Overlearning, or exposure to varying numbers of practice trials beyond an initial learning criterion, has been shown to produce retention when measured only as accurate responding (i.e., percent correct). In their metaanalysis, Driskell, Willis, and Copper (1992) indicate that larger de-
Figure 2

Median Training Frequency Across All Practice Timings

- Josie
- Jack
- Emily
- Karen
- Larry

Total Responses Emitted During Training

Percentage of Retention
grees of overlearning yield greater amounts of retention at various follow-up periods. In other words, learners exposed to more additional practice trials during training tend to perform more accurately after a retention period. Thus, a positive correlation appears to exist between amount of practice and skill retention, when retention is measured as accuracy-only. Our results suggest that this relationship does not hold up when frequency is included in the measure of retention.

STUDY 2: ENDURANCE

Method

Participants
According to the criteria described previously, seven students enrolled in CAL were selected for inclusion in the endurance analysis. Billy (6th grade), Krissi (4th grade), Joey (2nd grade), and Jim (5th grade) were typically developing students receiving instruction in general education classrooms at public or private schools in northern Nevada. Jack (7th grade), Josie (10th grade), and Karen (4th grade), who were included in the retention analysis, were also included in the endurance analysis.

Responses
For all participants, vocally identifying Arabic numerals was included in the endurance analysis. This program requires that students correctly name a series of numbers presented on sheets, with six columns of 16 numbers on each sheet. The numbers presented on each sheet range from the one's to the million's place (depending upon level of difficulty). In other words, the lowest level of the number identification program requires that students name single digit numerals (e.g., 5) and the highest level requires that students name numerals to the millions place (e.g., 1,345,005). Regardless of level, we established the fluency aim for this program according to the recommendation of at least 100 movements (i.e., digits) per minute (Haughton, 1971).

Reinforcers
The reinforcement contingencies were the same as those described for the retention analysis, with one exception. In addition to rewards delivered contingent upon training performance, participants also received highly preferred edible rewards for meeting certain performance requirements during endurance probes. These requirements are described in detail below.

Endurance Probes
Endurance probes were conducted following mastery of a skill level. In other words, when a participant achieved Phase 1 and Phase 2 mastery, his/her endurance across a 5-min timing on that skill was evaluated during the next subsequent session. A 5-min timing length was selected for the endurance analysis so that count per min for each minute of the timing could be plotted on a timings chart and within-timing celeration evaluated. Standard charting convention suggests that at least five data points are required for an accurate measure of celeration (Pennypacker et al., 1972). In addition, relative to 1-min training timings, 5-min timings seemed appropriately lengthy for an evaluation of endurance performance.

Prior to conducting an endurance timing, the tutor informed the participant that he/she would be eligible to choose a prize out of the "endurance box" for engaging in responses per minute that fell at or above the fluency aim (total responses/5). The "endurance box" contained candy bars and other treats much larger in size or value than those items typically earned during sessions. Due to the length of the timing requirement, the aim of these rewards was to motivate participants to try their best during the 5-min timing.

The participant was then presented with five different sheets of stimuli (i.e., Arabic numerals from their current level) placed across the table in a row, with one sheet of stimuli associated with each minute of the timing. Once the timing commenced, the tutor followed along while the participant responded, using identical sheets of stimuli for scoring purposes. At the end of each minute, the tutor prompted the participant to "switch" and respond on the sheet of stimuli associated with the next minute. Throughout the timing, the tutor recorded the correct, incorrect, and skipped response frequencies for each minute. At the end of the timing period, the tutor calculated an overall count per minute for the five minutes (total response frequency/5). If the participant's count per minute for the timing was at or above the fluency aim, then the participant was allowed access to the "endurance box."

Data Analysis
As in the retention analysis, data for the 7 participants were analyzed in terms of median training frequencies and total number of responses emitted during training. The median training frequency and total number of responses emitted were calculated in the same manner as described in the retention analysis. The relation of these measures to frequency per minute across the 5-min endurance timing was explored. The
frequency per minute for the 5-min endurance timing was calculated by dividing the total number of responses emitted during the entire timing by five.

Results

The relation between each participant’s median training frequency and their frequency per minute during the 5-min endurance probe is reflected in the top panel of Figure 3. These data indicate a positive relation between median training frequencies and frequency of responding during a 5-min endurance probe. In general, it appears that participants emitting response frequencies close to or within the fluency range during training, performed at higher frequencies during the endurance probes. The lowest frequency per minute during the endurance probes was obtained with Karen on a skill where her median training frequency was also below the aim. Josie engaged in the highest median training frequency on a skill and also performed at the highest frequency on that skill during the endurance timing. This relation appears to hold true across participants and, with the exception of Billy and Krissi, within participants across different levels of the numeral identification program.

The relation between each participant’s practice opportunities, measured as total responses emitted, and their frequency per minute during a 5-min endurance probe is reflected on the bottom panel of Figure 3. In contrast to the results obtained for median response frequencies and frequency per minute during endurance probes, these data suggest a negative relation between total responses emitted and endurance frequency when results are analyzed across participants. When results are analyzed within participants across the different skill areas there does not appear to be a relation between these two measures. In other words, as with the results for the retention analysis, it does not appear that practice alone is a good predictor of performance across long timing durations. For example, Krissi performed just as well during the endurance probe on a skill with over 3,000 total responses emitted during training as she did on a skill with less than 1,000 total responses emitted during training. Additionally, Karen showed the best endurance performance on a skill with less than 500 total responses emitted during training.

Discussion

The results for the endurance analysis are similar to those obtained for the retention analysis. It appears that participants were better able to maintain stable, high frequencies of correct responses across long timing durations when their median training performance was within the fluency range. It also appears that practice alone was not a good predictor of endurance. In other words, when frequency is not included in the analysis, amount of practice does not predict how well a student will perform over a long timing duration. Engaging in high frequencies of responding during practice appears to enhance a student’s endurance, or ability to maintain high correct response frequencies over long timing durations.

Some definitions of endurance include resistance to distractions as well as resistance to fatigue. The current study only evaluated resistance to fatigue through an examination of response stability across a timing duration that was five times as long as the typical practice timing duration. Distractions were not included in the current analysis. However, future research should examine the effects of distracters on performance during endurance timings using frequencies of correct responding as a dependent measure. Future research should also examine performance across increasingly long timing durations as a means of evaluating whether there is a point at which endurance breaks down regardless of median training performance. In this way, educators could better understand how to arrange testing or assessment conditions that encourage a learner’s best performance.

STUDY 3: APPLICATION

Method

Participants

Eight students enrolled in CAL were selected as participants for the application analysis. Participants were selected if they had multiple application probes conducted across multiple skill levels within the composite skill objective defined as Identifying Place Value. Mike (4th grade), Daryl (4th grade), Emma (4th grade) and Nathan (3rd grade) were typically developing students receiving instruction in general education classrooms at public or private schools in northern Nevada. Billy, Krissi, Joey, and Jim, who were included in the endurance analysis, were also included in the application analysis.

Responses

For all participants, vocally identifying place value was included in the application analysis. This program requires that students correctly
Figure 3
identify the place values for a series of numerals presented on sheets, with six columns of 10 numerals on each sheet. On each sheet, one digit in a numeral is printed in a larger font than the others, indicating to the student that they are to name the place value for that digit (e.g., 5, 263 would require a response of "thousands"). The numerals presented on each sheet range from the one's to the million's place (depending upon level of difficulty). In other words, the lowest level requires that students identify numbers in the ones and tens places. The highest level requires that students identify numbers in the ones through one millions places. Regardless of level, we established the fluency aim of at least 90 movements per minute (i.e., correct place values) according to the recommendations of The Haughton Learning Center, who also provided us with the program.

Reinforcers

The reinforcement contingencies were the same as those described in the retention analysis.

Application Probes

Application probes were conducted at the following training milestones: (a) introduction of a skill level and (b) achievement of fluent performance during the various timing lengths (i.e., 15-s, 30-s, and 1-min timings, respectively). During application probes, participants were required to perform the next level of a skill beyond their current training level during a 1-min timing. For example, if a participant's current training level entailed identifying place values through the ten's place, then his/her application probe level entailed identifying place values through the hundred's place. Therefore, when participants reached one of the milestones described above during their current training level, an application probe was conducted at the next subsequent level. Data were collected during application probe timings in the same manner as during training. However, tutors did not provide feedback on or reinforcement for performance during application probes.

Results

Figure 4 depicts response frequencies across application probes for all participants. In general, it appears that response frequencies during application skill levels increased from the initial probe to the final probe. In other words, as participants achieved fluency at the various milestones on skills targeted during training, their performance on higher-level, untargeted skills also increased. There were a few exceptions to this finding.

Nathan, Billy, and Jim each showed no change or a decrease in response frequency between two probe timings on a skill. However, for these students, probes were not conducted at every milestone and, therefore, a complete data stream was not available. For those participants where probe data were missing for a particular milestone, fluent performance was obtained at shorter timing lengths when the target skill level was introduced. Thus, frequency building initially commenced during longer timing lengths (i.e., 30-s or 1-min), which prevented application probes from being conducted at earlier milestones. Therefore, some of the data streams depicted on the figure appear incomplete.

Figure 5 depicts the relation between Krissi's training performance on targeted skills and her performance during application probes on untargeted skills. The figure indicates that as Krissi's frequencies of responding on targeted skills increased, her frequencies of responding on untargeted skills during application probe timings increased as well. It is also appears that her time to skill mastery (i.e., fluency) for each subsequent skill level decreased. For example, she required approximately 50 timings to achieve fluency on the first skill level (i.e., 1's-100's), whereas she required only 9 timings to achieve fluency on the fourth level (1's-100,000's). In this way, it appears as though she was able to achieve skill mastery at higher levels more quickly following component skill mastery. This pattern seemed typical when individual performances were analyzed.

Discussion

The current results indicate that increases in response frequencies on targeted skills may lead to decreases in frequencies on untargeted skills within the same composite skill objective. In other words, as participants' performances improved on targeted skill levels, corresponding improvements were obtained on higher-level skills prior to the use of specific frequency-building strategies.

These data lend support to the notion of "curriculum leaping," or acquiring upper level skills without direct instruction on those skills (Johnson & Layng, 1992). Given this, requiring more stringent mastery of component skills (i.e., fluency criteria combining accuracy plus speed), might lead to greater overall academic proficiency and critical thinking skills. As many educators have theorized, establishing skills to high frequencies of correct responding might enable those skills to be more readily available for selection by the natural environment. Basic tool skills that occur at high frequencies are more likely to occur on
novel occasions and recombine with other skills to form novel and more complex academic repertoires (Johnson and Layng, 1992).

The current study serves as a stepping-stone for more research in this area. Future research should include analyses of different skill areas across larger numbers of participants as a means of evaluating the generality of the findings. Additionally, unlike the two studies reported previously, practice was not included as a variable in the application analysis. As such, it is difficult to conclude that increases in response frequency on targeted skills were solely responsible for performance improvements on untargeted skills. It may be the case that practice alone improves performance on untargeted skills within the same composite skill objective. Future research examining the role of practice on skill application is needed.

**GENERAL DISCUSSION**

Overall, the results of the three studies reported have important implications for general education. If frequency of responding is a critical predictor of academic performance outcomes (i.e., REAPS), and speed plus accuracy is a more sensitive measure of academic proficiency than accuracy alone, then fluency-enhancing methods and frequency-based measurement systems within traditional classrooms might lead to greater learner gains. Because accuracy-only measures are most commonly used in education, teachers may be less able to effectively evaluate their students' proficiency in basic skill areas. That is, with an emphasis solely on accuracy, response rate and time required to achieve fluency are overlooked as critical predictors of academic proficiency. As a result, students may be advanced to higher-level skill areas before true mastery is achieved on prerequisite skills. Although some students can perform skills to an accuracy criterion, they may be unable to perform these skills at a rapid pace. This deficit may impede their performance on standardized tests or in more complex skill areas, and lead to academic difficulties at higher-grade levels. The current findings suggest that a more comprehensive picture of academic proficiency requires the inclusion of frequency and accuracy measures.

As mentioned previously, educators adopting CBM methods depend upon the use of frequency measures rather than accuracy measures alone. However, mastery criteria continue to be based upon class norms or averages rather than upon the direct assessment of academic performance outcomes with each learner. In this way, fluency is defined as average performance rather than exemplary performance. Increasing overall academic achievement remains a strong commitment in this country. However, such a goal cannot be achieved when class averages remain the standard in education.

In contrast, PT holds exemplary performance as the standard. However, along with holding students to higher standards of achievement comes the task of devising instructional strategies that will enable all students to reach those standards. As such, educators at the primary grade levels must begin requiring true mastery (i.e., fluency) of basic component skills before allowing advancement to higher-level skills. True mastery must be measured in terms of accuracy plus speed requirements and defined in relation to specific performance standards obtained with individual learners (e.g., REAPS). Additionally, complex skills must be broken down into very basic component units and practiced until true mastery is achieved.

The current results offer a starting point for an effective measurement and analysis tool to use in general education classrooms. Firstly, frequency measures and standard charting practices lead to timely and effective decision-making by educators. Additionally, by collecting frequent (i.e., daily) frequency measures during skill acquisition, educators could compare training performance with other outcome measures so that learning patterns across students and skill areas could be discovered. Thus, more information regarding the instructional conditions that produce the greatest academic proficiency could be identified.

One general limitation of the studies reported above involves each participant's differential progression through the curriculum. For example, some participants had progressed through a significant proportion of the curriculum and thus possessed a large repertoire of basic skills in which fluency had been achieved. As a result, those participants engaged in naturally higher baseline rates of responding during the introduction of novel skill areas than participants who were not as far along in the curriculum. That is, the more experienced students were initially responding at frequencies closer to the fluency range and thus did not have to make as significant an increase to achieve fluency. It may be the case that baseline rates of responding prior to fluency training can predict REAPS. The relationship of base rates to academic performance standards is an area for future research we are currently pursuing.

The current results expand upon clinical and empirical work conducted in the areas of PT and CBM that emphasize direct measurement of behavior (i.e., frequency) as a basic assessment tool. In order for educators to better understand the conditions necessary for establishing and
maintaining overall academic proficiency, more research needs to be conducted in the areas of PT and fluency-based instruction. With more frequent and rigorous investigation, it may be possible to identify educational technologies where academic excellence is the norm rather than the exception. We hope that these studies will set the occasion for more research in this area.

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Lara L. Anderson and Sheila R. Alber*
The University of Southern Mississippi

Red is a 15-year-old boy who is receiving services for severe emotional and behavioral problems in an outpatient day treatment facility in south Mississippi. He has been diagnosed with Bipolar Disorder and Oppositional Defiance Disorder. In addition to his therapy, he also receives academic instruction for reading, math, and English in a self-contained classroom in this facility. Red was placed in the 8th grade because of his chronological age, however his academic performance ranged from the second to third grade level. His academic deficiencies can be attributed to his truancy throughout his educational history.

Upon initial placement in the day treatment facility, Red's reading deficits were so severe that he was unable to identify letter sounds. A corrective, direct instruction, decoding reading program was implemented for 11 nonconsecutive months prior to his participation in this precision teaching project. He attended the day treatment program for 9 months, and then he was removed from the program because he was noncompliant with his medication and his parents neglected to participate in his treatment. After a 4-month leave, he was re-admitted to the day treatment facility and continued with the corrective reading program for two more months prior to beginning this precision project.

During the course of his participation in the corrective reading program, Red's progress was astounding, and certainly alleviated any doubts of his ability to learn. He was able to decode words on approximately a 2.7 grade level, but his reading rate was very slow and he made frequent errors.

Red's teacher began implementing this precision teaching project because it was a requirement in a class she was taking towards her Master's degree. This was her first experience using precision teaching. Prior to implementing the intervention designed to increase Red's fluency and accuracy, baseline data were recorded for three consecutive days. He was instructed to read a passage while his teacher timed him for 1 minute and recorded the number of words he read correctly and incorrectly. His reading rate ranged from 12 to 14 words per minute with 5 to 9 errors. For this project, a reading error was recorded if the Red omitted, inserted, substituted, or mispronounced words. Hesitations for more than two seconds and self-corrections were also counted as errors.

After collecting Red's baseline data, his teacher decided to set the aim at 100 words per minute with fewer than 5 errors. The intervention designed to increase Red's fluency and accuracy was as follows:

1) The teacher read the reading selection to Red.
2) Red was directed to silently follow along as the teacher read, and circle with a pencil any words he did not recognize.
3) After the teacher read, she used direct instruction to teach Red the words he circled (e.g., The teacher would say, "That word is morning. What word?" and Red would say "morning.").
4) When she finished going over each word he circled, she prompted him to read the words on his own.
5) The teacher continued to review the words Red circled until he read the word correctly within one second. This usually required two to three learning trials for each word.
6) After he read each word correctly, the teacher prompted Red to read the passage as quickly as he could and timed him for one minute.
7) Red entered his own data on the logarithmic chart on the computer immediately after he was timed. His teacher guided Red to access the saved chart, insert the data points (one for correct words per minute and one for errors), and save the updated information.
8) Upon completion of this procedure Red was rewarded with time to play games on the computer.

After 4 sessions of using the above procedure, Red stated that he did not want to play on the computer as a reward. Instead, he said, he would rather spend that time practicing reading so that he could increase his speed. So, on the ninth session, a phase change was implemented. The instructional procedures the teacher implemented were the same with the following exceptions: Red's teacher rewarded his participation by allowing him and a peer to practice reading together. They took turns reading the same passage the teacher used for instruction that day. This extra practice lasted approximately 10 minutes.

On the first day of the last phase change (the 9th session), Red read 39 words per minute and continued to increase his reading rate each *Corresponding Author: Address correspondence to Sheila R. Alber, Department of Curriculum, Instruction, and Special Education, The University of Southern Mississippi, Box 5115, Hattiesburg, MS 39406; Telephone (601) 266-6636; E-mail: Sheila.Alber@usm.edu
session. By the 23rd session he surpassed his aim by reading 102 words per minute. Additionally, Red made fewer than 5 errors per minute throughout the duration of the last phase. This was a considerable leap from his first timing when he read 12 words correctly and made 7 errors.

Throughout this project, Red became increasingly more motivated to improve his reading rate and decrease his errors. He paid close attention to his teacher while she read aloud and made sure he marked each unfamiliar word. Initially the computer game time helped encourage Red’s participation and compliance to instruction. However Red’s continued success provided the needed motivation to practice reading, and external rewards became unnecessary.

Red finished this project by meeting the aim of one hundred words per minute with fewer than 5 errors. Red continues to ask for time to read aloud with his reading partner. His partner also wanted to chart his own progress, and this desire to increase reading fluency and plot data has spread to the rest of the students in his class.
Concurrently Teaching Multiple Verbal Operants Related to Preposition Use to a Child with Autism

Amy King, Alison L. Moors, and Michael A. Fabrizio
Fabrizio/Moors Consulting

Because understanding prepositions is useful to students for many skills such as following directions, requesting, and expanding expressive and receptive language, children should learn how prepositions function in language. This chart shows the progress a child with autism made in learning multiple ways of responding with and to prepositions.

Joe began timed practice on prepositions on December 9, 2002, when he was 5-years and 3-months old. Joe received approximately six hours of in-home behavior analytic intervention therapy per week. Joe also attended a half-day preschool program at a comprehensive early childhood center providing inclusive educational services for children with and without disabilities.

Joe practiced prepositions through the See/Say, Hear/Do, and Hear/Touch learning channels on this same chart. By varying the learning channel during the timing, Joe was able to improve concurrently his expressive (See/Say) and receptive (Hear/Touch) labeling of prepositions and his following directions that included prepositions (Hear/Do). Each day of practice, Joe's tutor set for him a daily improvement goal that he needed to reach in order to obtain his choice of rewards and finish working on the skill for the day.

Because we designed this skill using three different learning channels, Joe's tutor had to do change the cues she used during each timing—she had to ask Joe to identify the location of objects relative to one another ("Where is the glass?"); to touch items ("Find the item that is under the book."), and to place objects in relation to one another ("Put the pen behind your chair."). To avoid inappropriate stimulus control, the tutor varied the objects and the placement of the objects she used during the timing. His tutor used small toy figurines and any objects that Joe could put things in, on, or under for the initial slice. For example, Joe's tutor may have used a box and the lid of the box and said to Joe, "put the dog in the box." Once Joe put the dog in the box, the tutor would then give Joe another direction and vary the object as randomly as they could to avoid any pattern.

The first slice of the chart included the prepositions "in," "on," and "under." Joe completed two to three timings per day to reach his daily improvement goal. He began the slice at 18 corrects per minute and two errors per minute. His corrects accelerated at X1.9 across the four days of timed practice to their high and ending frequency of 34 per minute, and bounced at X1.3. Joe's errors remained steady across the phase at X1.0. Because of Joe's steep acceleration in his corrects, his tutor moved to slice two, in which she added the preposition, "behind." Joe's rate of correct responding jumped down by /1.43 and turned down (/1.8). Joe met his daily improvement goal in one to two timings during this phase. Christmas break occurred for one week during this phase, but Joe's performance maintained after this break.

Joe's tutor next added three new prepositions in the next phase of the chart—"in front", "between", and "beside" or "next to." At the start of this phase, Joe's rate of correct responding did not jump, but turned up by X1.04 from the previous phase. Joe's rate of incorrect responding also did not jump with the phase change, but did turn up by X1.74 from the previous phase. Joe required three timings per day during this phase to reach his daily improvement goal. Joe's corrects reached a high and ending frequency of 36 per minute with four errors per minute in seven days of practice across five weeks.

In the next phase of the chart, Joe's tutor added the preposition "over." Here, again, his corrects did not jump with the start of the phase change, but did turn down by /1.49. Joe's errors jumped down at the start of the phase but turned up (X2.0) as the phase progressed across the four days of timed practice. Joe practiced for three days and ended with corrects at 28 per minute with two errors. He required three timings per day to reach his goal during this phase. Joe went on vacation for one week towards the end of the phase.

When Joe returned from vacation, his tutor decided to evaluate the fluency of Joe's performance because she was unsure what an appropriate frequency aim might be for this skill. If Joe's performance to date showed the features of fluent performance—retention, endurance, stability, and application—then there was no reason to continue daily timed practice on the skill.

Joe's tutor first completed an endurance check on Joe's performance. To do this, she tripled the timing interval to 90 seconds and presented Joe with the same materials. Joe maintained his rate of 34 corrects per minute and four errors per minute errors in one timing. After passing the endurance check, his tutor moved to a 30-second stability check to evaluate his performance in the presence of significant distractions. For the stability check timing, Joe's mother was in the kitchen (Joe is easily distracted from work when his mother is present), and the tutor played with one of Joe's

JOURNAL OF PRECISION TEACHING AND Celeration, Volume 19, Number 1, 2003, Pages 38-40
favorite toys during the timing. Joe passed his stability check at 30 corrects per minute and a drop down in his rate of incorrects. Next, Joe completed an application check. For the application check, his tutor asked Joe to identify prepositions in pictures within a book instead of using actual objects as they had been doing throughout the course of the chart. Joe passed his application check at 30 corrects per minute with zero errors on his first timing. Finally, to assess the skill's retention, Joe's tutor stopped all timed practice on this skill for four weeks. After four weeks, Joe's tutor presented Joe with the materials from the final slice before checks started and had him resume timed practice on all prepositions. Joe completed one 30-second timing and achieved 30 corrects per minute with two errors per minute. The chart was stopped, and we and Joe and did a cheer!
<table>
<thead>
<tr>
<th>Date</th>
<th>09-09-00</th>
<th>09-16-00</th>
<th>09-23-00</th>
<th>09-30-00</th>
<th>10-07-00</th>
<th>10-14-00</th>
<th>10-21-00</th>
<th>10-28-00</th>
<th>11-04-00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>Count per minute</td>
<td>00.0</td>
<td>01.0</td>
<td>02.0</td>
<td>03.0</td>
<td>04.0</td>
<td>05.0</td>
<td>06.0</td>
<td>07.0</td>
<td>08.0</td>
</tr>
</tbody>
</table>

Legend:
- **00.0**: indicates no activity.
- **01.0**: indicates a minor activity.
- **02.0**: indicates a moderate activity.
- **03.0**: indicates a major activity.
- **04.0**: indicates a very major activity.
- **05.0**: indicates an extreme activity.
- **06.0**: indicates a critical activity.
- **07.0**: indicates a catastrophic activity.
- **08.0**: indicates a failure.
Analog Analysis of Two Variables Related to the Joint Attention of a Toddler with Autism

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*Fabrizio/Moors Consulting*  
*Seattle, Washington*

Kristin Schirmer  
*Fabrizio/Moors Consulting*  
*Seattle, Washington*

Elizabeth Vu  
*Seattle Central Community College*

Ami Diakite and Mari Yao  
*University of Washington*

Joint attention—the ability to alternate attention between people and objects (Adamson & MacArthur, 1995)—is important to both language and social development and children with autism often show deficits in joint attending skills (Charman, T., Swettenham, J., Baron-Cohen, Cox, A., Baird, G., & Drew, A., 1997; Mundy, 1995; Dawson, Meltzoff, Osterling, Rinaldi, & Brown, 1998); as an example, children with autism may have difficulty shifting their gaze between a person and a toy with which they are playing. This chart shows the results of our analysis of the gaze shifting performance of a toddler with autism under analog conditions designed to test the effects of two variables on the child's joint attention: toy manipulation demands and the child's preference for the toy. We present this chart to document how precision teachers might display data collected during analog analyses on the Standard Celeration Chart and to describe clinical procedures for evaluating the effects of two variables on learner performance.

Diagnosed with Autism, Amir was 2-years and 9-months old when this chart began and had been receiving four hours per day of intensive in-home intervention services for one month. His in-home intervention team consisted of the authors listed above. During a language evaluation, Amir's Speech Language Pathologist noticed that he seemed to have difficulty shifting his attention (i.e., moving his head and eyes) from toys he played with to people in his immediate environment. Amir's Speech Language Pathologist suspected that Amir experienced this difficulty shifting attention because of the manipulation demands the toys presented. She hypothesized that he was unable to "break" his attention from toys to attend to adults around him when the toys required a great amount of manipulation. She suggested Amir receive daily formal intervention in shifting attention as part of his in-home intervention program because of his apparent difficulty with shifting attention and its developmental importance.

Rather than beginning intervention right away, however, we chose to examine more closely and systematically whether the amount of manipulation a toy required affected Amir's attention shifting. Because we suspected Amir's preference for various toys might also influence how frequently he shifted his eye gaze away from them, we also analyzed how his preference for a toy affected his attention shifting at the same time that we evaluated the effects of toy manipulation.

We began by generating a list of toys for which Amir showed a high preference and a list of toys for which he showed little or no preference by considering how frequently he chose to play with a given toy and how long he interacted with it. If he interacted with a toy for long periods and consistently chose to play with it, we classified the toy as Highly Preferred. If he did not play with the toy for long periods or rarely chose to play with it, we classified the toy as Less Preferred. We then classified each of the same toys according to the degree of manipulation they required by considering several factors: the number of moving parts on each toy, the number of ways he could move the parts, and the size of the toy's parts. For example, because picture books consist of a few, large parts (pages) that Amir could only turn, we classified books as requiring a low level of manipulation. A Busy Beads toy, by contrast, consists of many small moving parts that Amir could move in a variety of ways; therefore, we classified Amir's Busy Beads toy as requiring a high level of manipulation. Once we classified each toy according to manipulation requirements and perceived preference, we subdivided the toys into four categories: (1) Highly Manipulative and Highly Preferred toys, (2) Less Manipulative and Highly Preferred toys, (3) Highly Manipulative and Less Preferred toys, and (4) Less Manipulative and Less Preferred toys. We used these categories as the four experimental conditions for the project.

After we generated our toy lists, we evenly distributed four sessions, each 2.5-minutes long, throughout Amir's daily intervention schedule. During each of these 2.5-minute long sessions, we conducted the analysis. Each day, we gave Amir a toy from each list for 2.5 minutes. During those 2.5 minutes, a member of Amir's intervention team (usually the third or fourth author) said Amir's name aloud every 60 seconds. The staff member counted one attention shift if Amir looked up from the toy he was playing with within two seconds after hearing his name. If he did not look towards...
the staff member within two seconds, no attention shift was counted. The order in which the toys were given to Amir varied randomly each day to control for sequence effects. Amir received between 9 and 11 sessions overall within each condition.

Figure one below shows Amir’s rate of shifting attention plotted as cumulative frequencies by condition. Because staff members only requested that Amir look once per minute, and each session lasted only 2.5 minutes, the maximum counted shifts in attention he could emit was two. Because detecting differences between such low rates of behavior would be very difficult if plotted as per minute frequencies each day, we plotted the data cumulatively.

We employed the Quarter-Intersect procedure (Koenig, 1972 as cited in White & Haring, 1980) to calculate celeration values for each of the four experimental conditions. Amir’s attention shifting accelerated at a rate of X1.9 per week during the Highly Manipulative and Highly Preferred condition. During the Less Manipulative and Highly Preferred condition, Amir’s attention shifting changed at a rate of X1.8 per week. In the Highly Manipulative and Less Preferred condition, his attention shifting accelerated at a rate of X2.0 per week, and during the Less Manipulative and Less Preferred condition, it accelerated at a rate of X1.6 per week.

His attention shifting performance changed faster within both conditions where he played with highly manipulative toys (X1.9 and X2.0) than in either condition using less manipulative toys (X1.8 and X1.6). When the manipulation demands of the toy were kept constant and low (that is, during both the Less Manipulative and Highly preferred and the Less Manipulative and Less Preferred conditions), his attention shifting performance was better with highly preferred toys (X1.75) than with less preferred toys (X1.55).

Based on these differences, we concluded that the level of manipulation demand presented by a toy most influenced Amir’s attention shifting-the more manipulative the toy, the better his attention shifting performance. This conclusion refuted the hypothesis his Speech Language Pathologist originally developed during her clinical examination. We also learned that toy preference affected Amir’s attention shifting, but to a lesser degree than toy manipulation. When toys required less manipulation, toy preference did affect his performance-Amir shifted his attention more frequently with highly preferred toys than less preferred toys when the toys themselves presented lower manipulation demands.

Systematically analyzing how toy preference and toy manipulation affected Amir’s ability to shift his attention presented several advantages over immediately beginning formal intervention to change his performance. First, evaluating the variables’ effects gave us important information about how frequently Amir was actually shifting his attention without intervention. Once counted and charted, his intervention team (including his Speech Language Pathologist) agreed that his rate of attention shifting was adequate and did not warrant intervention. Having baseline data that indicated no intervention was needed saved us time, saved Amir’s family money, and most importantly, saved Amir time. Clinicians often develop impressions during informal assessment, but too often they rush to begin intervention when such may be unnecessary.

Beyond helping us decide not to intervene with Amir’s attention shifting, had we instead found that his performance did warrant intervention, having evaluated the variables’ effects on his performance would have provided another benefit: the data would have allowed us to evaluate clearly the effects of any intervention we developed.

Further, the baseline data we gathered when we evaluated the two variables separately also gave us a good deal of information about which variable exerted functional control over Amir’s attention shifting as well as interactions that existed between the two variables. We learned that the manipulation opportunities toys offered were more important than Amir’s preference for the toys in controlling his attention shifting. We also learned that this control appeared to work in an opposite way from what we originally hypothesized.

We hope clinicians working with children with autism will invest the time needed to collect baseline and functional assessment data prior to designing and implementing an intervention. Collecting the data for this project took a total of 100 minutes (40 sessions at 2.5 minutes per session). The analysis took very little time, was easy to do, and produced quite a bit of information that helped us make better decisions on Amir’s behalf.

REFERENCES


Cumulative Count per Minute

001 0 10 20 30 40 50 60 70 80 90 100 110 120 130 140

1 Highly Manipulative
2 Less Manipulative
3 Highly Preferred
4 Less Preferred

CALENDAR WEEKS

COUNTING RECORD FLOORS
Single vs. Multiple Movement Frequencies: How Many Times Should We Measure?

Dana J. Stevens
University of Washington

The purpose of this chart share is to look for more efficient ways of monitoring a learner’s progress. I decided to compare progress records based on a single opportunity to complete complicated task with a progress record based on multiple opportunities to compare the same task.

The learner, Sam, was an 8-year-old boy with autism who was fully integrated into a regular 2nd grade classroom. The goal of this intervention was to teach Sam how to put on his coat independently. To begin, a 12-step task analysis was created and the method of most-to-least prompting selected. During the course of the program, a picture script of the task analysis and peer modeling methods were also used. Instruction took place during naturally occurring school opportunities to put on his coat (e.g., preparing to go outside for recess, preparing to go home for the day). Sam’s parents also worked with him at home using the same task analysis.

Three methods of monitoring the learner’s progress (Figure 1) were implemented throughout the program: (1) Single-movement frequencies involved charting a single opportunity to complete the task each day. Time to completion was recorded and additional prompts were counted as errors.

For the Single Movement Frequency:

\[
\text{Correct Frequency} = \frac{1}{\text{Time Required to Complete the Task Once}}
\]

\[
\text{Error Frequency} = \frac{\# \text{ of Extra Prompts}}{\text{Time Required to Complete the Task Once}}
\]

For the Multiple Movement Frequency:

\[
\text{Correct Frequency} = \frac{3 \text{ (the number of times the task was completed)}}{\text{Cumulative Time Required to Complete All 3 Trials}}
\]

\[
\text{Error Frequency} = \frac{\# \text{ of Extra Prompts}}{\text{Cumulative Time Required to Complete All 3 Trials}}
\]

Figure 1: Three methods of monitoring the learner’s progress.
Journal Description

The Standard Celeration Society publishes the Journal of Precision Teaching and Celeration (JPTC) two times a year. JPTC provides a forum for research, practical applications and discussions of Precision Teaching and Celeration technology. JPTC has dedicated itself to the promotion and diffusion of Precision Teaching and Standard Celeration technologies.

Journal Sections:

Authors may submit their original contributions to one of five sections of JPTC:

I. Application Articles: “Application articles” require:
1. Use of Standard Celeration Charts;
2. Use of basic charting conventions;
(See the JPTC guidelines for guidance on the “basic charting conventions”);
3. Description of variables or procedures supporting the interpretation of the data.

“Application articles” usually represent data from applied settings such as schools, clinics, human service agencies.

II. Research Articles: “Research articles” require:
1. The use of Standard Celeration Charts;
2. Descriptions of the collection and analysis of data;
3. Use of basic and advanced charting conventions and analysis;
(See the JPTC guidelines for guidance on the “basic” and “advanced” charting conventions and analysis);
4. Description of variables or procedures supporting the interpretation of the data;
5. Control for extraneous variables or report of their influence.

III. Discussion Articles: “Discussion articles” offer explanations, reviews, and extensions of Precision Teaching and Standard Celeration concepts.

IV. Chart Shares: “Chart shares” contain data displayed on Standard Celeration Charts along with brief descriptions of the performer, what occurred, and other relevant observations.

V. Technical Notes: Brief technical descriptions clarifying, elaborating, or reporting upon Precision Teaching and Standard Celeration concepts.

Submission Guidelines:

To submit a manuscript authors must conform to the following guidelines:
1. Submit three (3) typewritten, doubled spaced copies of the manuscript without author’s names or affiliations;
2. Follow the format outlined in the Publication Manual of the American Psychological Association (5th edition, 2001);
3. Do not exceed 20 words in the article title;
4. Include an abstract and do not exceed 250 words in the abstract;
5. Select 3 to 5 key words that describe the manuscript;
6. Secure permission for use of copyrighted materials;
7. Send submissions to: Dr. Richard M. Kubina Jr., The Pennsylvania State University, Department of Educational and School Psychology and Special Education, 231 CEDAR Building, University Park, PA 16802-3109.

The Editors reserve the right to edit all material accepted for publication.
**BASIC CHARTING CONVENTIONS for the DAILY STANDARD CELEBRATION CHART**

<table>
<thead>
<tr>
<th>TERM</th>
<th>DEFINITION</th>
<th>CONVENTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. CHARTED DAY</td>
<td>A day on which the behavior is recorded and charted.</td>
<td>1. Chart the behavior frequency on the chart on the appropriate day line.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Connect charted days except across phase change lines, no chance days and ignored days.</td>
</tr>
<tr>
<td>a) ACCELERATION TARGET FREQUENCY</td>
<td>Responses of the performer intended to accelerate.</td>
<td>Chart a dot (●) on the appropriate day line.</td>
</tr>
<tr>
<td>b) DECELERATION TARGET FREQUENCY</td>
<td>Responses of the performer intended to decelerate.</td>
<td>Chart an (x) on the appropriate day line.</td>
</tr>
<tr>
<td>2. NO CHANCE DAY</td>
<td>A day on which the behavior had no chance to occur.</td>
<td>Skip day on daily chart.</td>
</tr>
<tr>
<td>3. IGNORED DAY</td>
<td>A day on which the behavior could have occurred but no one recorded it.</td>
<td>Skip day on daily chart.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Do not connect data across ignored days.)</td>
</tr>
<tr>
<td>4. COUNTING-TIME BAR</td>
<td>Designates on the chart the performer's lowest possible performance (other than zero) in a counting time. Always designated as &quot;once per counting time.&quot;</td>
<td>Draw solid horizontal line from the Tuesday to Thursday day lines on the chart at the &quot;counting-time bar.&quot;</td>
</tr>
<tr>
<td>(aka Record Floor)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. ZERO PERFORMANCE</td>
<td>No performance recorded during the recording period.</td>
<td>Chart on the line directly below the &quot;counting-time bar.&quot;</td>
</tr>
<tr>
<td>6. PHASE CHANGE LINE</td>
<td>A line drawn in the space between the last charted day of one intervention phase and the first charted day of a new intervention phase.</td>
<td>Draw a vertical line between the intervention phases. Draw the line from the top of the data to the &quot;counting-time bar.&quot;</td>
</tr>
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<td>---</td>
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<tr>
<td><strong>7. CHANGE INDICATOR</strong></td>
<td>Words, symbols or phrases written on the chart in the appropriate phase to indicate changes during that phase.</td>
<td>Write word, symbol and/or phrase. An arrow (↑) may be used to indicate the continuance of a change into a new phase.</td>
</tr>
<tr>
<td><strong>8. AIM STAR</strong></td>
<td>A symbol used to represent: (a) the desired frequency, and (b) the desired date to achieve the frequency.</td>
<td>Place the point of the caret...^ for acceleration data\v for deceleration data...on the desired aim date. Place the horizontal bar - on the desired frequency. The caret and horizontal line will create a &quot;star.&quot;</td>
</tr>
<tr>
<td><strong>9. CALENDAR SYNCHRONIZE</strong></td>
<td>A standard time for starting all charts.</td>
<td>It requires three charts to cover a full year. The Sunday before Labor Day begins the first week of the first chart. The twenty-first week after labor day begins the second chart. The forty-first week after Labor Day begins the third chart.</td>
</tr>
<tr>
<td><strong>10. CELERATION LINE</strong></td>
<td>A straight line drawn through 7-9 or more charted days. This line indicates the amount of improvement that has taken place in a given period of time. A new line is drawn for each phase for both acceleration and deceleration targets. (Note: For non-research projects it is acceptable to draw free-hand celeration lines.)</td>
<td></td>
</tr>
</tbody>
</table>

![Diagram](image)

Acceleration Target  
Deceleration Target |

© 2002 The Standard Celeration Society
A clear description of the performer's counted behavior.

The name of the person who charts the performer's counted behavior.

The name of the person who observes the performer's behavior.

The name of the performer's counted behavior.

The name of the person who observes the performer's behavior.

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The name of the person who observes the performer's behavior.

The name of the person who observes the performer's behavior.
Frequency Change (FC)

- Acceleration calculation
- Celeration calculation
- Bounce calculation
- Projection lines

Celeration Change (CC)

- Acceleration Target
- Celeration calculation
- Bounce calculation
- Projection lines

Bounce Change (BC)

- Acceleration Target
- Celeration calculation
- Bounce calculation
- Projection lines

SUCCESSIVE CALENDAR DAYS

- Frequency Change: x 5.0
- Celeration Change: [data points]
- Bounce Change: [data points]

COUNT PER MINUTE

- 1000
- 100
- 10
- 1
- 0.1
- 0.01
- 0.001

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ERRATUM

In volume 18, issue 2, Dana Stevens’ chart share “Single vs. Multiple Movement Frequencies: How Many Times Should We Measure” had only one of the two charts she submitted printed. Rather than include the additional chart by itself I have republished her entire chart share with the two charts. When referencing Stevens’ chart share please use the most current information:
