

Journal of Precision Teaching and Celeration

Volume 25, 2009

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EDITORS' COMMENTS

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Precision Teaching has application to any human behavior. The journal articles shared within each volume showcase what some of the practitioners and researchers presently investigate. Volume 25 of the *Journal of Precision Teaching & Celeration* has two discussion articles and two chart shares touching upon what Precision Teachers do in their practice. The articles by no means represent the full extent of PT; nevertheless, they serve as a written marker for what occurs in practice and where the field may go next.

The first discussion article comes from Spence and discusses behavioral fluency. Spence presents data from keyboarding and reading projects that illustrate fluency. The discussion article makes a cogent case for the importance of fluency with many clear examples of charted data. The article also offers a clear insight into the methods and procedures used at one of Precision Teaching's most venerable learning centers, Ben Bronz Academy.

A second discussion article comes from Kubina, Kostewicz, and Lin. In the second article, Tiemann and Markle's exquisite taxonomy of learning receives attention. The three-dimensional taxonomy has four basic types of learning; Psychomotor, Simple Cognitive, Complex Cognitive, and Emotional learning. The taxonomy can help Precision Teachers interested in behavioral fluency and beyond. The discussion article also provides an analysis of how the taxonomy helps in various stages of learning.

Volume 25 has two chart shares rounding out the issue. First, Ferris and Fabrizio describe how Talk Aloud Problem Solving helped shape the analytical thinking skills of an 11-year-old girl with autism spectrum disorder. The other chart share, by Ascah, describes how a 5-year-old kindergarten student identified as at-risk for reading problems learned to read.

Richard M. Kubina, Jr., PhD, BCBA-D

Editor, *Journal of Precision Teaching & Celeration*

In Search of Charts of Fluent Behavior

Ian Spence¹
Ben Bronz Academy

Precision Teachers have attempted to define fluent behavior in several ways. We are a charting community, so where are the exemplar charts? In this article, the author presents sets of possible exemplar charts in Keyboarding and Reading. He also presents some Arithmetic charts that do not yield clear indicators of fluency.

This article was originally delivered at a symposium at the Twenty-First Annual International Precision Teaching and Celeration Conference held at Penn State University in October 2009, and it benefits from the discussion among the participants there. It is hoped that this presentation can become part of a community-wide compendium of charts that assist us in making data-based decisions on what constitutes fluent behavior.

In this article, I am defining fluent behaviors as a set of actions that an organism can carry out smoothly and effortlessly while thinking about something else. Examples are walking, running, talking, and swimming. For accomplished musicians, it is sight-reading music—the fingers automatically arrange themselves to play the notes and the bow arm or mouth/breathing just “happens” while the mind is actively engaged in reading the notations. Of course, there are many examples in sports.

In the academic area, a competent reader is absorbed in the story that the collection of words is expressing and wastes no effort figuring out each word. A competent math student follows the teacher’s explanation and performs the arithmetic operations mentally, jumping to the next step without hesitation. The competent writer writes or types his or her thoughts without worrying about hand or finger movements. In all of these examples, the student is fluent in a set of underlying skills.

Fluent behavior, or “true mastery” (Binder, 1988), has been the topic of many discussions among Precision Teachers. Haughton (1980)

postulated that fluency is demonstrated not only by accuracy, but also by retention (exhibiting the skill after a period of nonpractice), endurance, (maintaining high rates for several minutes), and application performance standards (the ease with which component fluent behaviors are combined or become integrated into a composite behavior).

While an underlying tenet of Precision Teaching is that each individual is unique and may acquire proficiency at a different rate than other individuals, practitioners have dared suggest some ballpark rates of behavior in some skills. Kubina (2002) summarized these aims in a list and distributed it on the Internet.

As Precision Teachers, we say that we prefer a visual medium (the Chart) to assist us in making decisions. Flat lines and high errors indicate that some kind of intervention is necessary. Change lines and Celeration lines tell us that an intervention is succeeding or failing. Charts of fluent behavior often do not have such clear indicators. We sometimes have a student continue to practice a skill when he or she has already mastered it sufficiently

Figure 1. Students have access to their Fluency exercises at school and home through the Internet.



1. Ian Spence, Ph.D., is Headmaster Emeritus of Ben Bronz Academy and the developer of CyberSlate. His Chart Parent is Ann Dell Duncan-Hively.

Figure 2. Each student has an individualized menu of one-minute fluency exercises.

Fluency	Rank	Activity	Points
Keyboard Finger Trainer	Novice	To do: 2	
Typing Words	Novice	To do: 2	
Home Stretch	Novice	To do: 2	
Typing Sentences	Novice	To do: 2	
Digit Pad	Novice	To do: 2	
Arith. Speed Addition	Novice	To do: 2	25
Arith. Speed Subtract	Novice	To do: 2	25
Arith. Speed Multiply	Novice	To do: 2	
Arith. Speed Divide	Novice	To do: 2	
Dot and Break	Novice	To do: 2	
Reading Words	Fourth	To do: 2	
Reading Passages	Fourth	To do: 2	
Say/Break/Type Spell	Novice	To do: 2	

to move on to a more complex task. Is this a waste of student time? Can we collect charts that show us optimal times to change?

This article is a first attempt on my part to put together some charts that I believe show the acquisition of fluency, and some that show a need for more research.

The Setting

Ben Bronz Academy (BBA) is a state-approved private school for learning-disabled students, Grades 2 through 12. Our students come to us with severe deficits. In reading, most are dyslexic and at the time of admission they are not reading at or near grade level, or they read slowly or haltingly. The majority do not know their arithmetic facts. Most have labored handwriting. Only 2 (of 190) students had previously learned a systematic approach to keyboarding.

The charts presented here have been generated by students who have been introduced to fluency through a computer-based program that we named CyberSlate. In 1989 we began to automate several component fluency tasks into computer programs to make both the exercises and the data tracking as efficient as possible. This program provides all of our students with a fluency regimen in which they practice selected 1-minute timings daily. CyberSlate manages all the fluency activities, provides domains and slices of skills, keeps track of scores, and automatically produces and updates charts of progress.

We designed CyberSlate to work through the Internet, so that students can have access to the same exercises at home and at school, or wherever

they may be visiting (Figure 1). Each student has an individualized menu of twelve or more 1-minute fluencies (Figure 2). The individualized menu is changed as students master skill sets.

Figure 3. On Keyboard Finger Trainer, students learn and practice the correct finger positions.

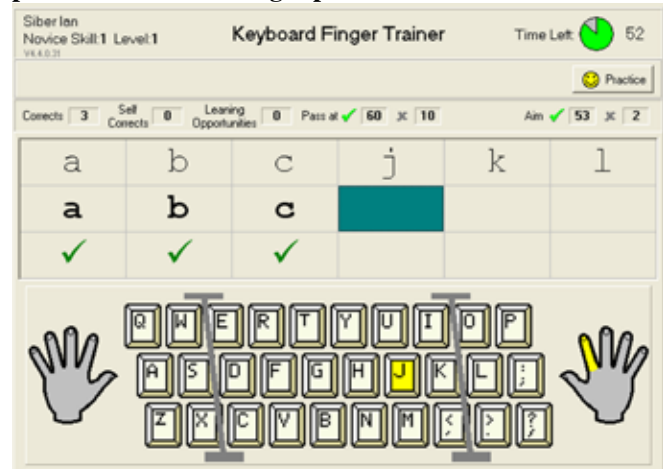


Figure 4. In Typing Words, Finger stretches are practiced in selected “words.”

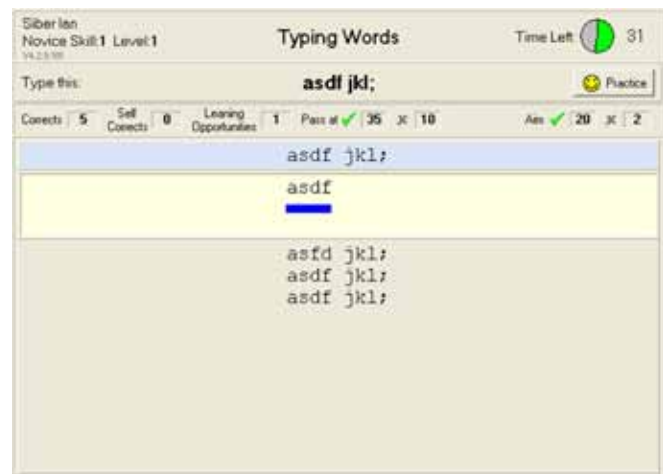


Figure 5. Specific finger stretches are practiced in 3 letter combinations in Home Stretch.

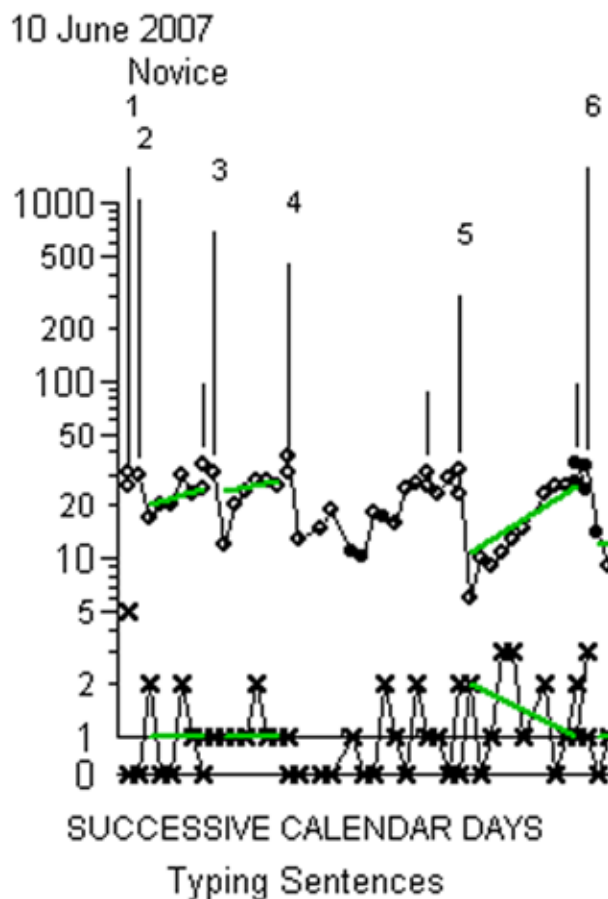


Figure 6. Finger Guides are placed on the keypad to help students keep the correct hand position.



The three-cycle standard celeration charts² produced by CyberSlate provide profiles of progress. In this article, I will present a selection of these charts that show what a chart of fluent

Figure 7. As a novice, the student attempts to reach the criterion speed of 35 wpm. before passing each subskill.



2. The Chart produced by CyberSlate meets the following standards: The left scale (y Axis) is Multiply-Divide. The horizontal scale is divided evenly into 140 days, with a stronger mark for the Sunday line. The aspect of the chart will produce a 33 degree x2 Acceleration line. The chart is Calendar Synchronized so that the first chart begins on the Sunday before Labor Day. A dot is used to indicate a pinpoint that you wish to accelerate. "x" is used to indicate Learning Opportunities or behaviors that you wish to decelerate. Vertical lines indicate phase changes. Celeration lines are calculated using a quarter intersect. An optional grid can be applied to the chart. No-chance and ignored days are plotted. The chart can be printed to size so that it will overlay correctly on a chart mylar.

Figure 8. Students earn an AlphaSmart when they become fluent typists.



behavior looks like. Three areas are examined: keyboarding, reading, and arithmetic.

Keyboarding

We insist that all of our students learn to touch-type. Most of our students come to us as non-writers. Some cannot formulate complete sentences. Most block when asked to write a coherent narrative. All have atrocious spelling and punctuation. None have smooth, flowing handwriting. Our first step with all of the students is to teach keyboarding skills. Students begin learning the touch-typing fingering on a practice exercise called Keyboard Finger Trainer (Figure 3). They work on building up the ability to type words (Figure 4), practice finger stretches from the home position (Figure 5), and, finally, practice putting together these discrete skills in a Typing Sentences Fluency. They keep Finger Guides (Figure 6) on their keypads to remind their fingers to stretch up and down rather than move laterally.

In each Typing program, we have sliced one aspect of the skill of typing into several sub-skills. In Finger Trainer, beginners ("novices") learn the stretches of the first six letters (three for each hand in alphabetical order). When they reach a criterion speed, two or three more letters are added. In Typing Words, Home Stretch, and Typing Sentences, novices usually begin with home-row keys and then add one or two stretches per level. The passing criterion is set at 35 wpm in Typing Words and Sentences, (Figure 7) and 120 keystrokes per minute in Keyboard Finger Trainer and Home Stretch. When the students master all of

Figure 9. Upon passing into the User Rank, Ryan maintains 45 wpm with two learning opportunities, and passes skill levels rapidly. This is an indicator of fluency in keyboarding.

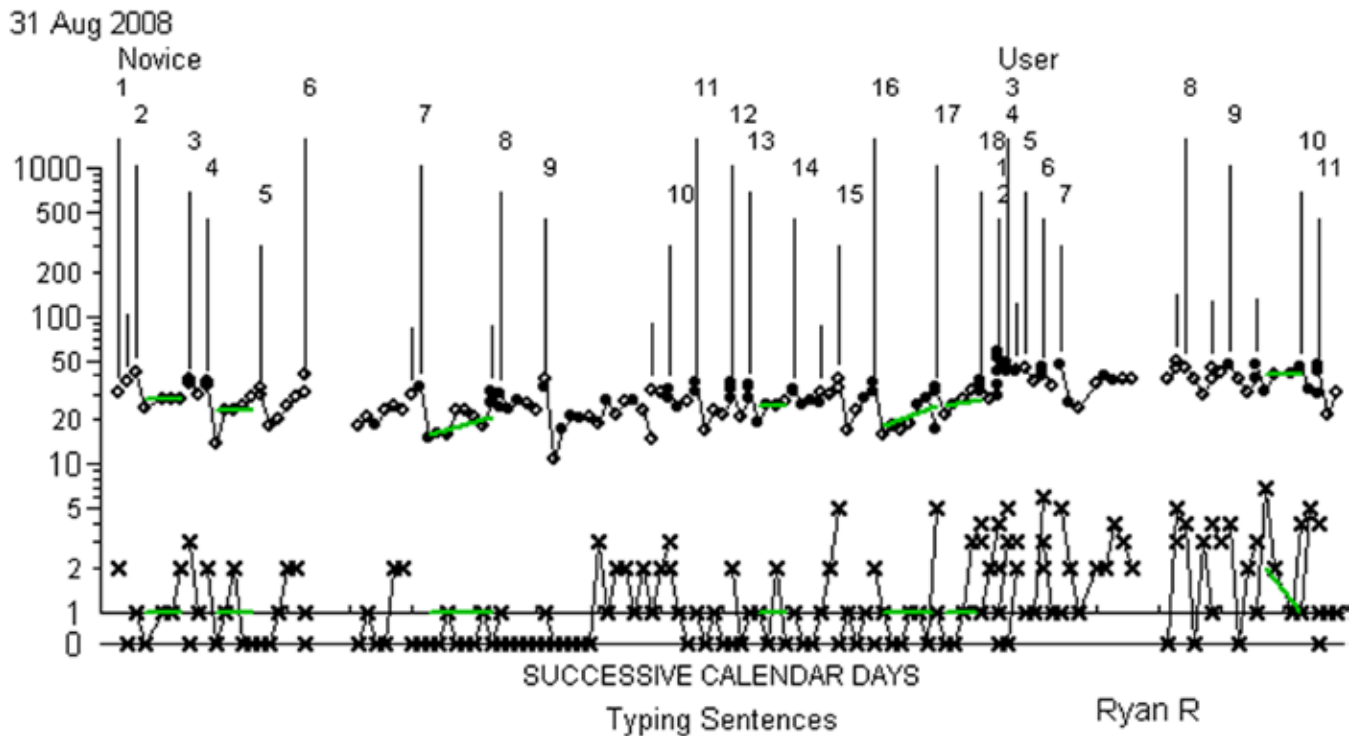
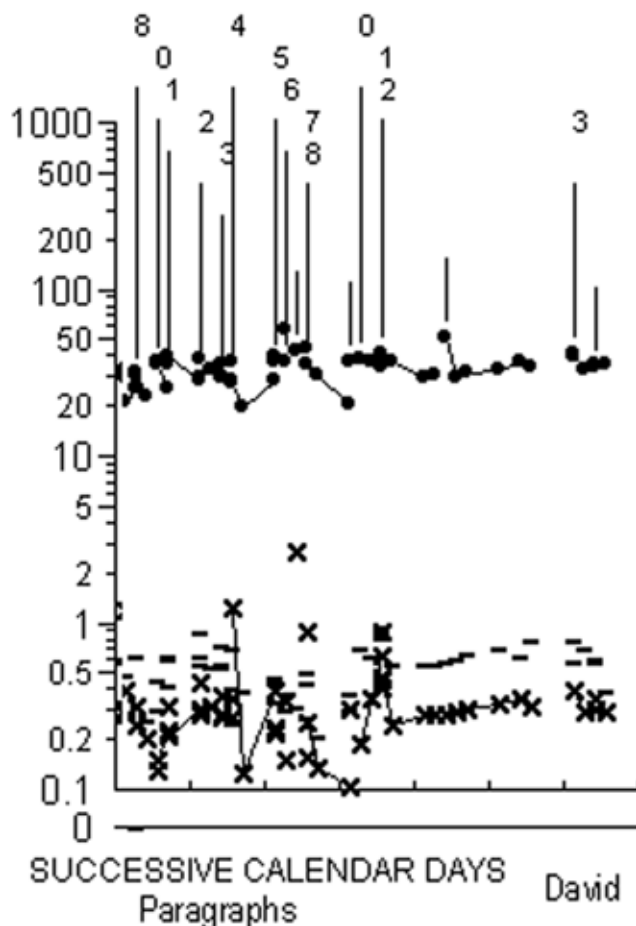


Figure 10. David completes a paragraph of over 60 words in just over 1 minute, with an average of less than 1 learning opportunity.



the slices as Novices, they graduate to the “rank” of User and go through all of the slices once more at a higher passing criterion. They can continue to pass through six ranks, but most apply to take a competency test when they reach the rank of Pro, which demands 55 wpm with fewer than five learning opportunities (errors).

The competency test is taken on a keyboard from which the letter symbols have been removed, and if the student uses the correct fingering and is twice able to type 100 letters in a minute with four or fewer errors without looking at his fingers, he is awarded a laptop keypad called an AlphaSmart (Figure 8), which is his to keep when he leaves the Academy to go to his next school. Students learn to take notes in class on their AlphaSmart, and they also use it for rough drafts, homework, etc. And they are no longer required to use the Finger Guides.

Finger Trainer, Typing Words, and Home Stretch were designed to teach specific component skills that lead to fluent typing. Typing Sentences represents the end product: smooth typing of sentences using the acquired component skills. The Typing Sentences Chart in Figure 9 indicates fluency in keyboarding. Words Correct is in a bandwidth of 12 to 35, and most students pass a skill level within a week. Learning opportunities

IN SEARCH OF CHARTS OF FLUENT BEHAVIOR

Figure 11. The words from a selected passage are presented in random order for one minute. The student reads them aloud to a coach who marks each word. If the student has said the word incorrectly, an “X” appears and the student tries again. After the second try, the word is presented phonetically, and the timer stops while the student decodes the word.

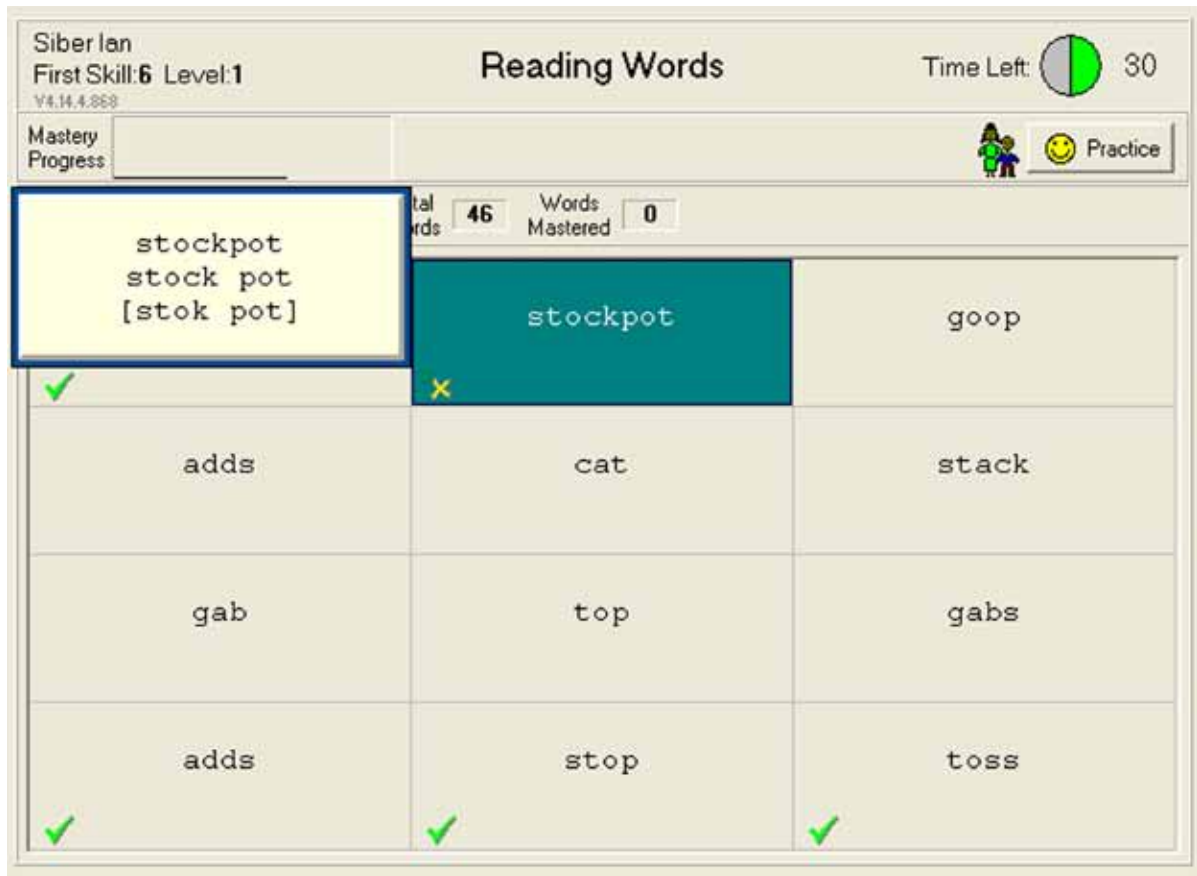


Figure 12. The computer provides information about the passage to be read, and a one-minute timer.

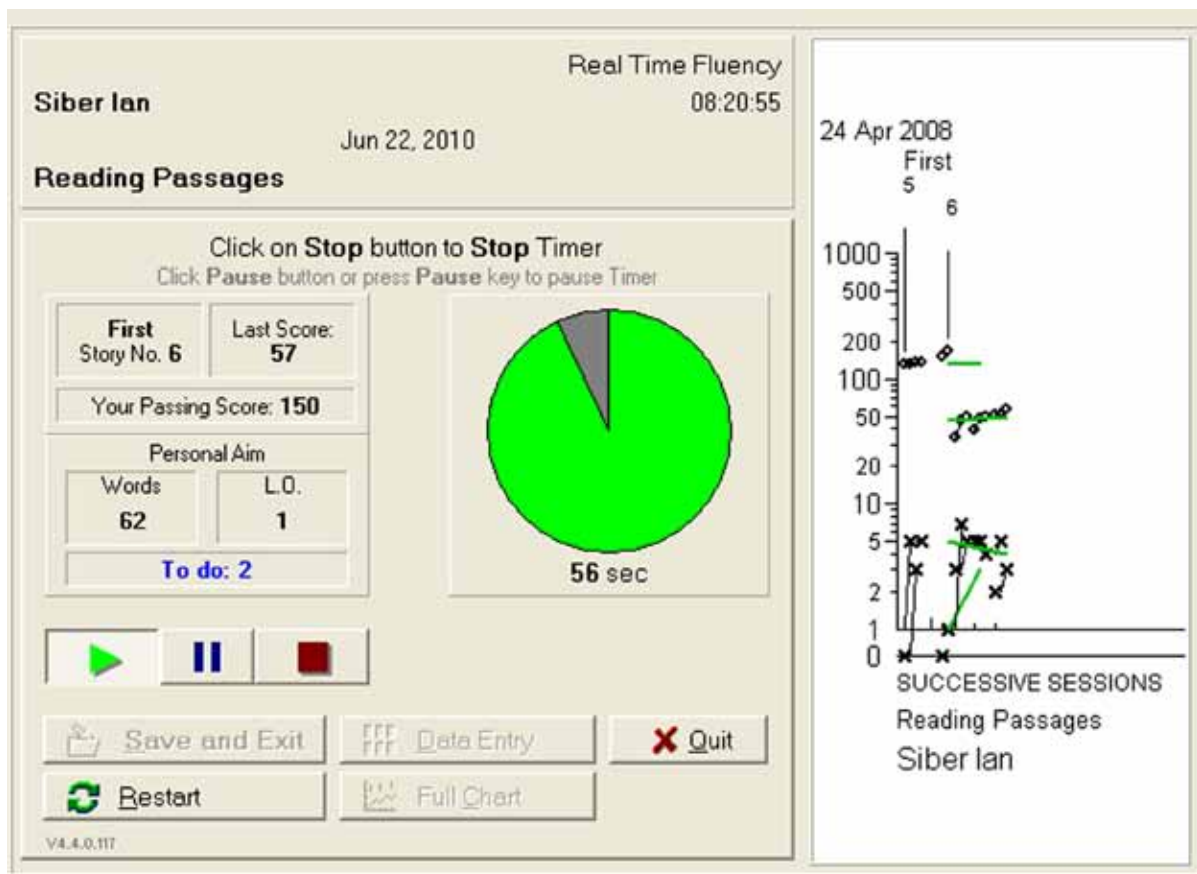


Figure 13. The Score Box appears at the end of the one-minute timing, and the score is entered by the student or coach.

average around one.

Of 129 students who completed the Competency test over the past 5 years, the median time taken to complete Typing Sentences was 328 days, 672 sessions in Typing Sentences, or 1.86 sessions per day. More than 70% of the students passed their test in their first two tries. Those who didn't had developed wandering finger habits that took a few weeks to correct. We informally checked these students in intervals after they earned the AlphaSmart. There was no regression to using other fingering, or looking at their fingers. Endurance was

Figure 14. The student starts the timer and reads the passage on paper. The coach or student counts the words read, and the score is entered into the computer by hand.

TIM ASKED QUESTIONS

Tim asked a lot of questions. His dad told him to go to the store for milk. Tim asked, "Which store?"

When his mom told him to set the cups on the shelf, he asked, "Which shelf?"

His sister said, "Give me a hand."

Tim said, "Which hand?"

Last week, Tim was at a ranch. The rancher told him, "Get on a horse and go down that path."

Tim asked 2 questions. What questions do you think he asked?

checked through their next fluency program, Typing Paragraphs, in which a paragraph of about 65 words appears on the screen, and the student must type it exactly, correcting errors while typing. Once the complete paragraph is typed, the student presses the enter key, and the computer issues a score of number of correct words per minute. Figure 10

Figure 15. The chart of a fluent reader. Ryan was a Grade 8 student. His standard scores on Reading Fluency, Decoding, and Comprehension were above 100. He is reading for fluency in books above his Grade level. His First Reads are above 100 wpm, and his learning opportunities average less than 1.

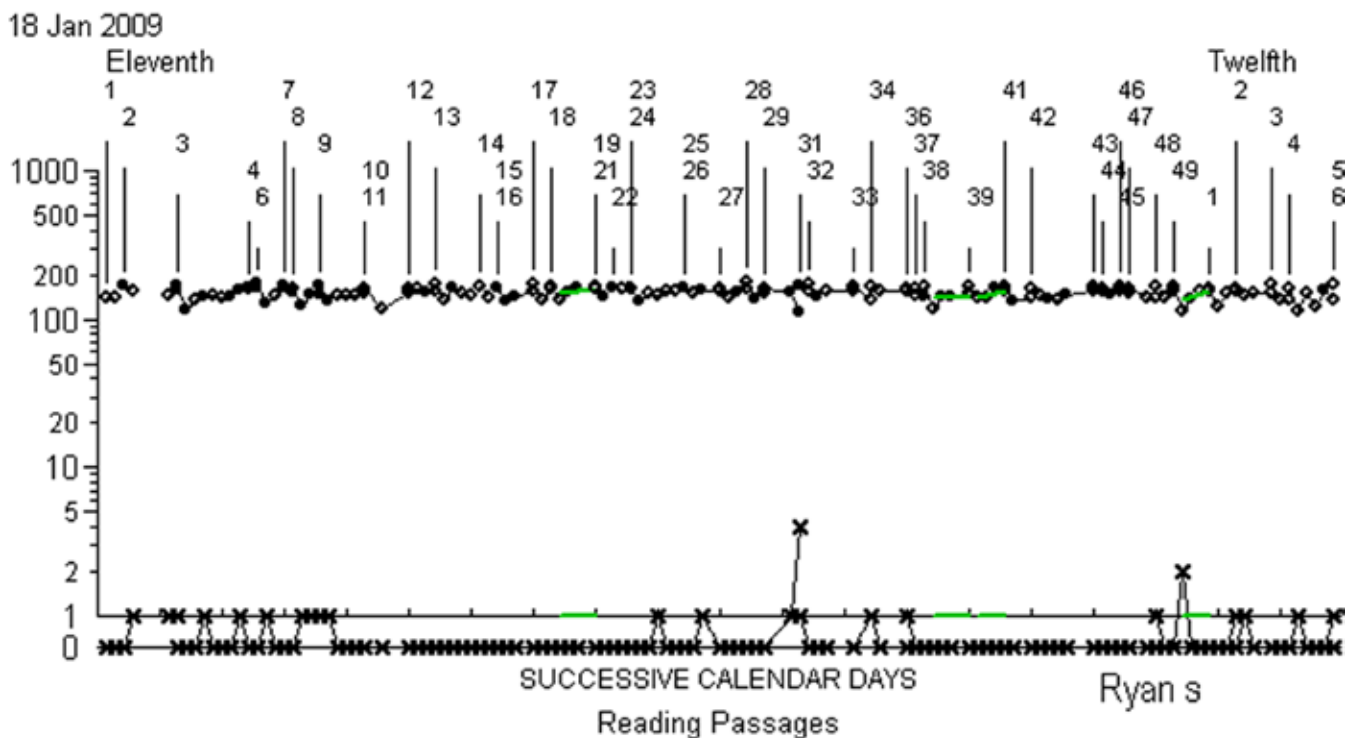
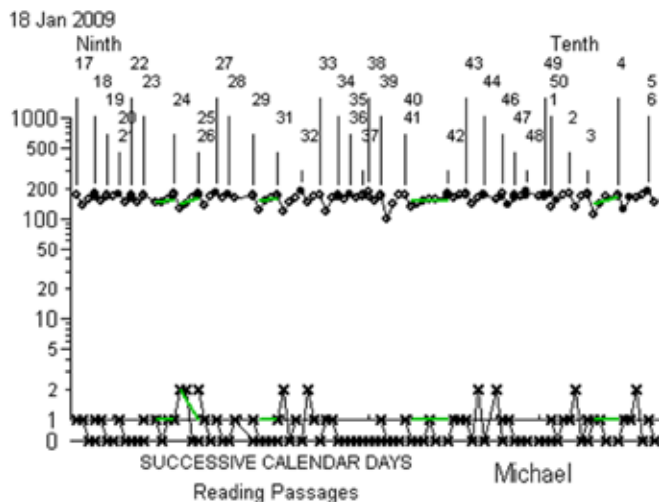
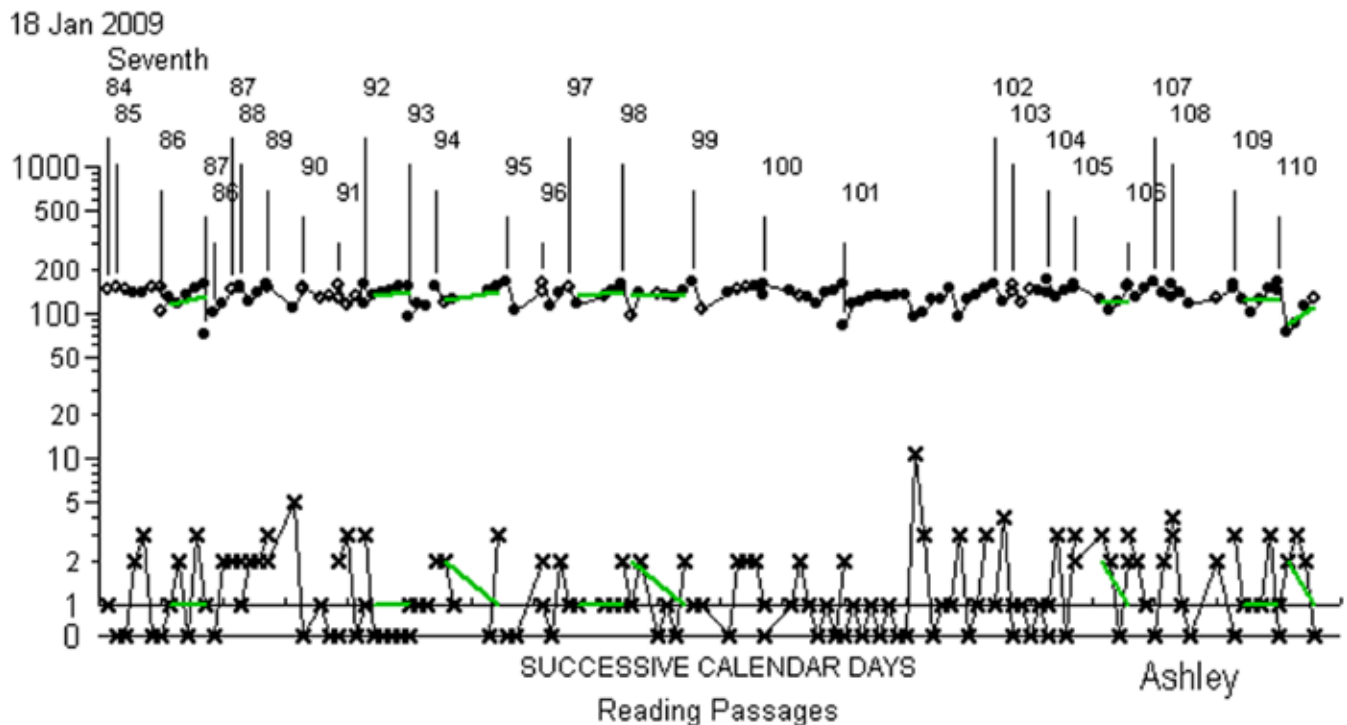


Figure 16. Some students with “fluent” charts do not test well on the yearly probe. Mike is a Grade 8 student who tested above 100 in Decoding and Comprehension, and scored 93 in Fluency. He is reading for fluency in books above his Grade level. His First Reads are also above 100 wpm, and his learning opportunities average less than 1.



who are chronologically in Grades 4 to 11 test at a Grade 1 level. Our comprehensive reading program is individualized for each student and can include phonemic awareness, phonics, linguistics (Let's Read at Ben Bronz), SRA Decoding and Comprehension, Visualize/Verbalize, and a fluency component that again uses the CyberSlate fluency engine. All students have at least two reading fluencies called “Words” and “Passages.” In Reading Words, the student reads words to a listener/coach. The words are taken from the passage and presented in random order for 1 minute (Figure 11). Then the student reads the passage aloud to the coach, beginning at the start of the passage each time, and repeats reading that passage until he or she attains a criterion of 150 words per minute. Differing from some reading fluency practitioners, we have the coach point to a learning opportunity when it occurs, and the reader decodes/corrects

Figure 17. A not yet fluent reader. Ashley scored in the low 80's on Standardized tests. She is reading Grade Level materials, scoring below 100 on several First Reads, and takes longer to pass a passage.



shows David's performance on the paragraphs. All of the students use their keyboarding skills both in taking notes on their AlphaSmarts in classes and in composing all of their assignments directly on the word processor.

Reading

Most BBA and CyberSlate students enter the Academy several years behind in reading. Some

it immediately. This of course slows the reader's performance so his or her score is lower. We count the words read and the learning opportunities and enter the scores into the computer by hand (Figures 12 and 13).

Students enter the Reading Fluencies at their present level of competence as tested by the San Diego Quick Test (LaPray, 1969) and read from a

Figure 18. The Digit Pad fluency has students practice the correct fingering. In this figure, the numbers are all home row keys.

Siber Ian
Novice Skill:1 Level:1
V4.3.0.107

Digit Pad

Time Left:  47

Home Row: **456 455 454 554 556 546**

 Practice


Corrects **9** Self Corrects **0** Learning Opportunities **0** Pass at  **100** ✕ **10** Aim  **60** ✕ **2**

456 456 	556 556 	554 554 	456 456 	554	455	554	456
455	546	456	454	556	455	556	546
455	454	455	454	456	554	546	554
556	454	456	455	546	456	554	454


Figure 19. Three arithmetic facts are presented in the first level, and one new fact in each successive level. There are 54 levels in the Addition and Subtraction series.



Siber Ian
Novice Skill:1 Level:3
V4.2.9.121

Arith. Speed Addition

Time Left:  103

Focus Problem: **2 + 1**

 Practice

Corrects **9** Self Corrects **0** Learning Opportunities **0** Pass at  **30** ✕ **10** Aim  **20** ✕ **2**










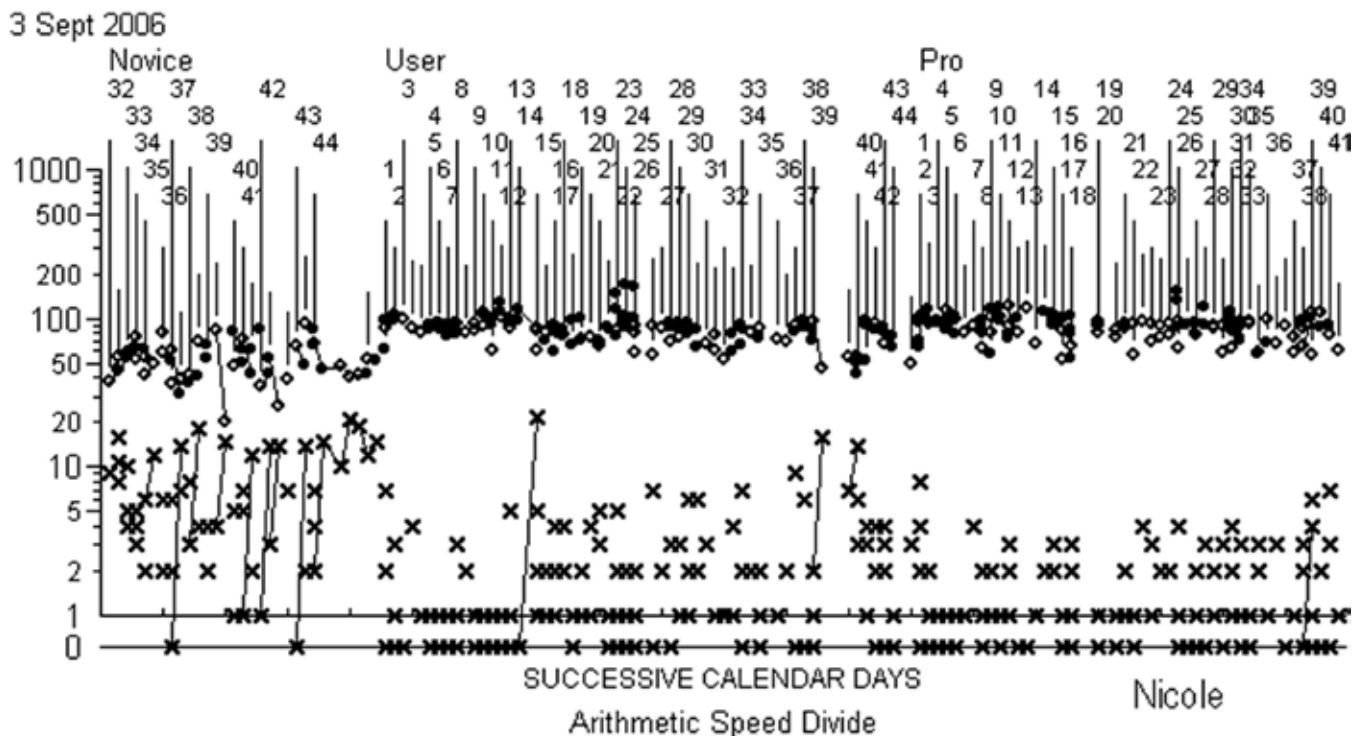
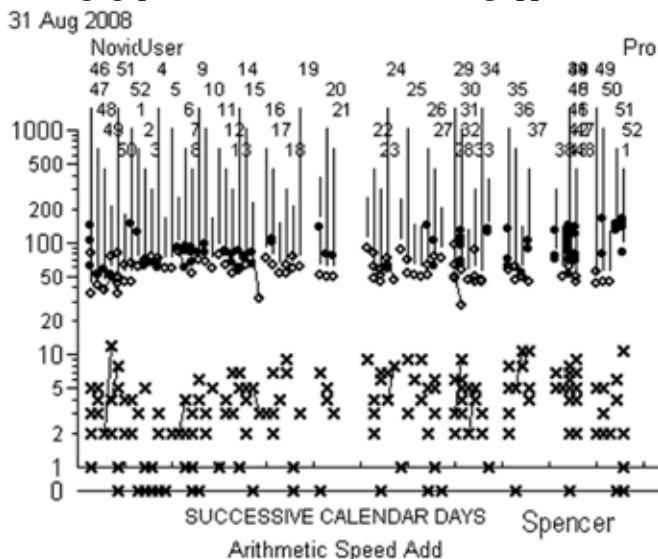
$\begin{array}{r} 2 \\ + 1 \\ \hline 3 \end{array}$ 	$\begin{array}{r} 1 \\ + 1 \\ \hline 2 \end{array}$ 	$\begin{array}{r} 1 \\ + 2 \\ \hline 3 \end{array}$ 	$\begin{array}{r} 1 \\ + 1 \\ \hline 2 \end{array}$ 	$\begin{array}{r} 1 \\ + 2 \\ \hline 3 \end{array}$ 	$\begin{array}{r} 1 \\ + 2 \\ \hline 3 \end{array}$ 	$\begin{array}{r} 1 \\ + 2 \\ \hline 3 \end{array}$ 	$\begin{array}{r} 2 \\ + 2 \\ \hline 4 \end{array}$ 
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Figure 20. As a Novice, (passing rate 30 correct facts per minute) Nicole's scores varied widely, with high error rates. When she repeated the facts as a User (passing criterion 40 facts per minute) and Pro (50 facts per minute) , she became much faster with fewer learning opportunities. At what point can she be considered fluent?



passage that is at the level indicated by the Quick Test. If the chart indicates that the student is not accelerating in repeated readings, he or she is assigned less difficult materials from an earlier grade. Similarly, if the student passes each passage on a first or second attempt, he or she is moved up to read more difficult materials. The brief assessment is made possible because a level adjustment can be

Figure 21. Spencer is a Grade 8 student, and an example of the “fluent” group. He passes all 55 levels at the rank of User in ten weeks, passing one level every day that he does the fluency. His learning opportunities average 3. There is a large gap between corrects and learning opportunities.

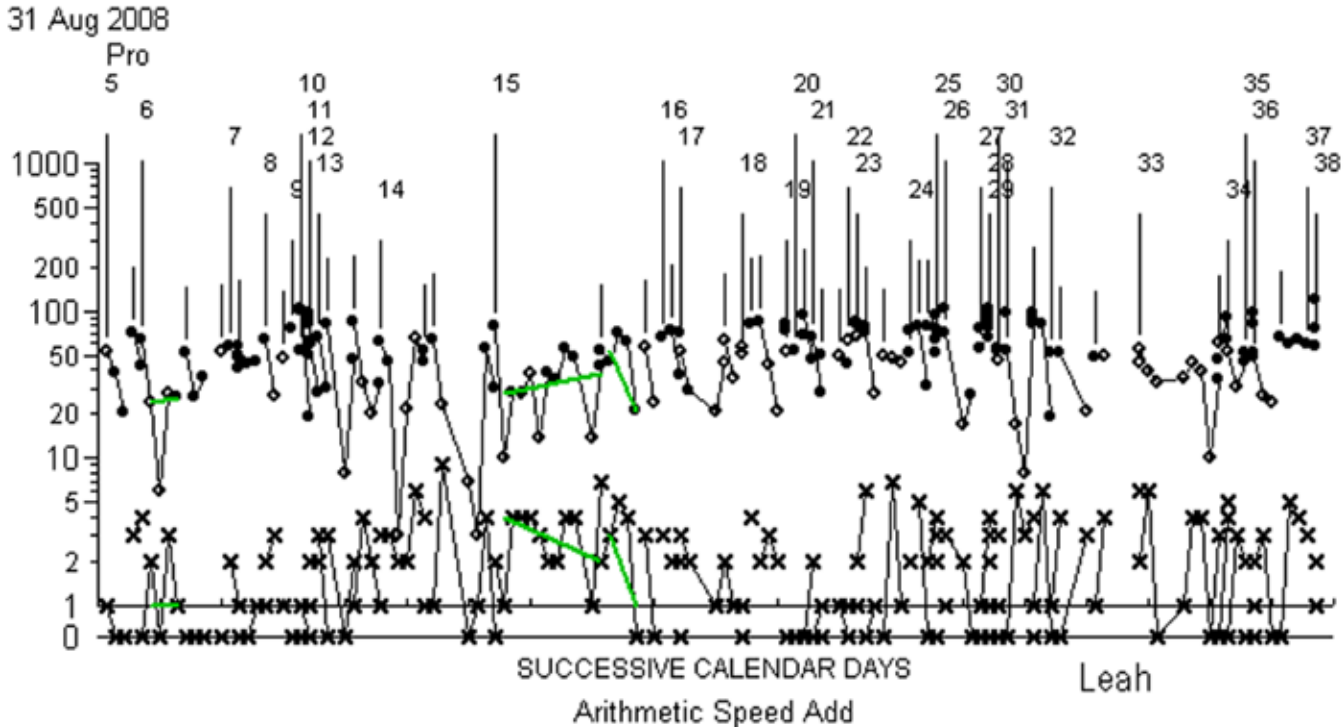


made immediately based on the chart's immediate feedback. We use phoneme-controlled materials from Grades 1 through 7. I composed a phoneme-controlled book for Grades 1 through 3. The Grade 1 section has four sets of sentences and six stories. Grades 2 and 3 each have ten stories. For Grades 4 through 7, we use the SRA Corrective Reading Decoding Series (Engelmann et al., 1978) (Figure 14). For Grades 8 through 12, we use the Jamestown Science series (1989).

We compared charts for two groups of students. For “fluent” charts, we chose students who tested at grade level (Standard Scores 96 or above) on three standardized tests, the Woodcock Johnson III Reading Fluencies (Woodcock, McGrew, & Mather, 2001), WRAT-4 Decoding (Jastak & Wilkinson, 1984), and Gates-MacGinitie Comprehension (MacGinitie, 1978). Those students had all completed Reading Fluencies to above grade level, passed each passage within 3 days, had a “first read” (cold read) consistently above 100 wpm, and averaged no errors (Figure 16).

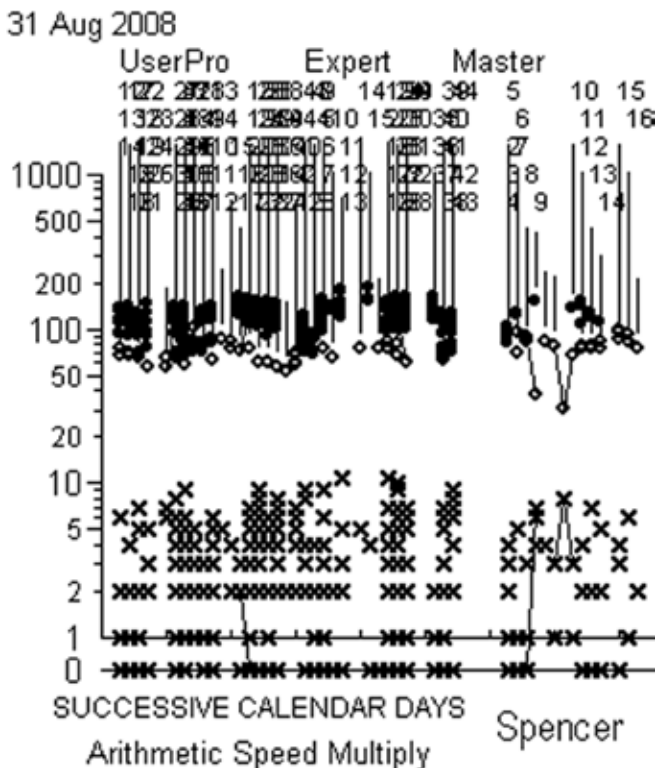
For the group that was not “fluent” (scoring between 80 and 90 on the three standardized tests), there were three chart indicators of nonfluency. The most consistent indicator was first reads below

Figure 22. Leah is a Grade 5 student, also in the “competent” group. Her struggle with some levels indicates that she has not mastered some specific facts. Her corrects vary widely, and at one point the corrects and learning opportunities cross over.



100 wpm. Two less consistent indicators were that the students were not yet in grade level fluency materials, and some took a few more days to pass from one passage to the next.

Figure 23. Spencer, Grade 8, sails through Multiplication at the rate of several levels per day.



There were some outliers in both groups. Figure 17 is an example of the scores of a student with a “Fluent” chart who did not score well on one or more of the standardized tests.

Figure 24. Gavin, who is in Grade 4 and considered “competent”, is still learning his Multiplication facts, reflected in the variance on his chart.

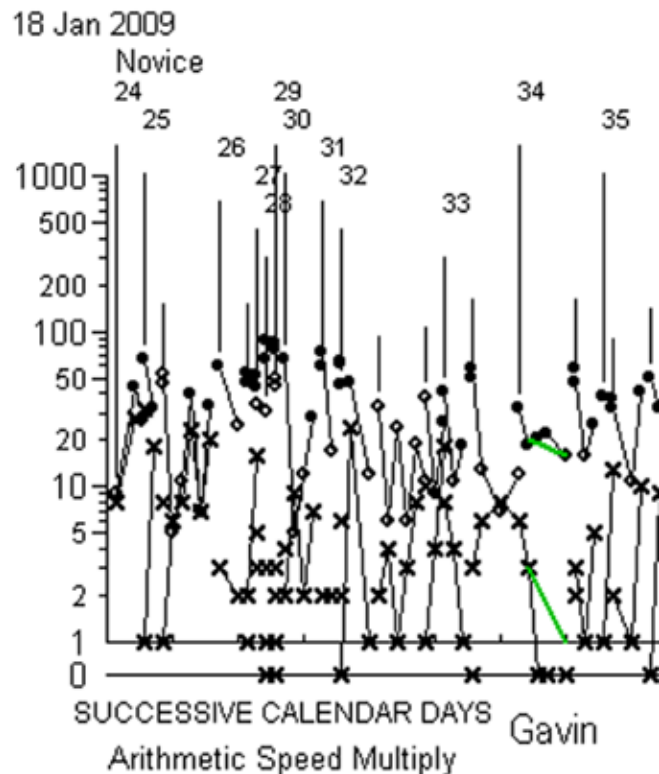
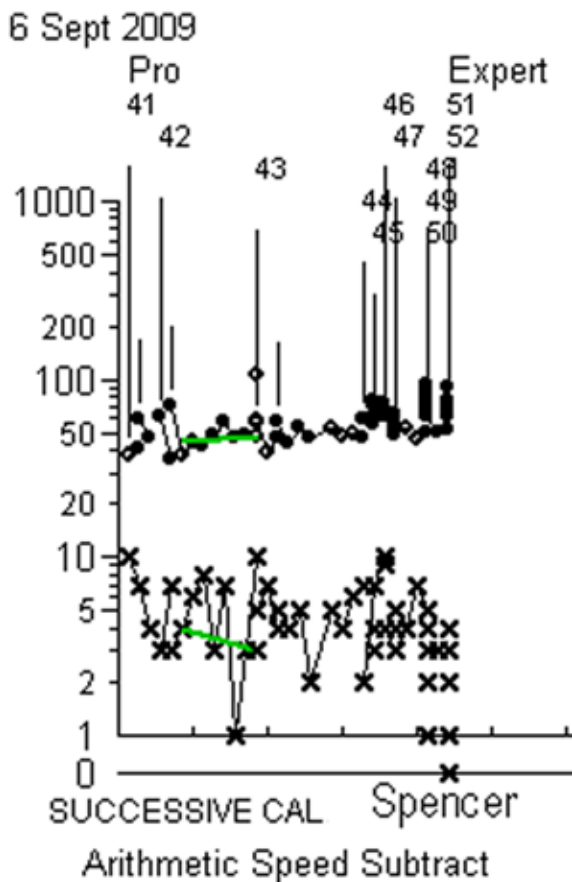


Figure 25. In Subtraction, all students take longer to pass the levels. *Arithmetic*



We first have the students learn the correct fingering on the Digit Pad, using the 4, 5, and 6 keys as home keys for the index, middle, and ring fingers of the right hand, and the pinky on the Enter key. The index finger moves up to the 7 and down to 1. Similarly, the other two fingers move up and down, and never sideways. Some students use their index finger for the 0 key, and others use their thumb. The digit pad fluency (Figure 18) begins with the home row numbers in combination, and then introduces one or two stretches per level. Students have no difficulty reaching 120 digits per minute within a few weeks.

The students then proceed to work on becoming fluent in all of the facts. CyberSlate presents two simple fact combinations in random presentation, and the student types the answer and presses the Enter key. If the answer is incorrect, an "x" appears and the student makes a second and/or third attempt. If the answer is still incorrect, the student is shown the correct answer, and the cursor moves on to the next fact. The student tries to complete as many correct facts as possible in a minute.

As is the case in the Keyboarding program, the student passes to the next level when he or she has reached a criterion of 30 correct facts per minute with fewer than 10 learning opportunities. Each skill level presents one new fact. The first level has only

Figure 26. Leah is in Grade 6. In Subtraction, younger students also show a greater variance in both corrects and learning opportunities than in Addition.

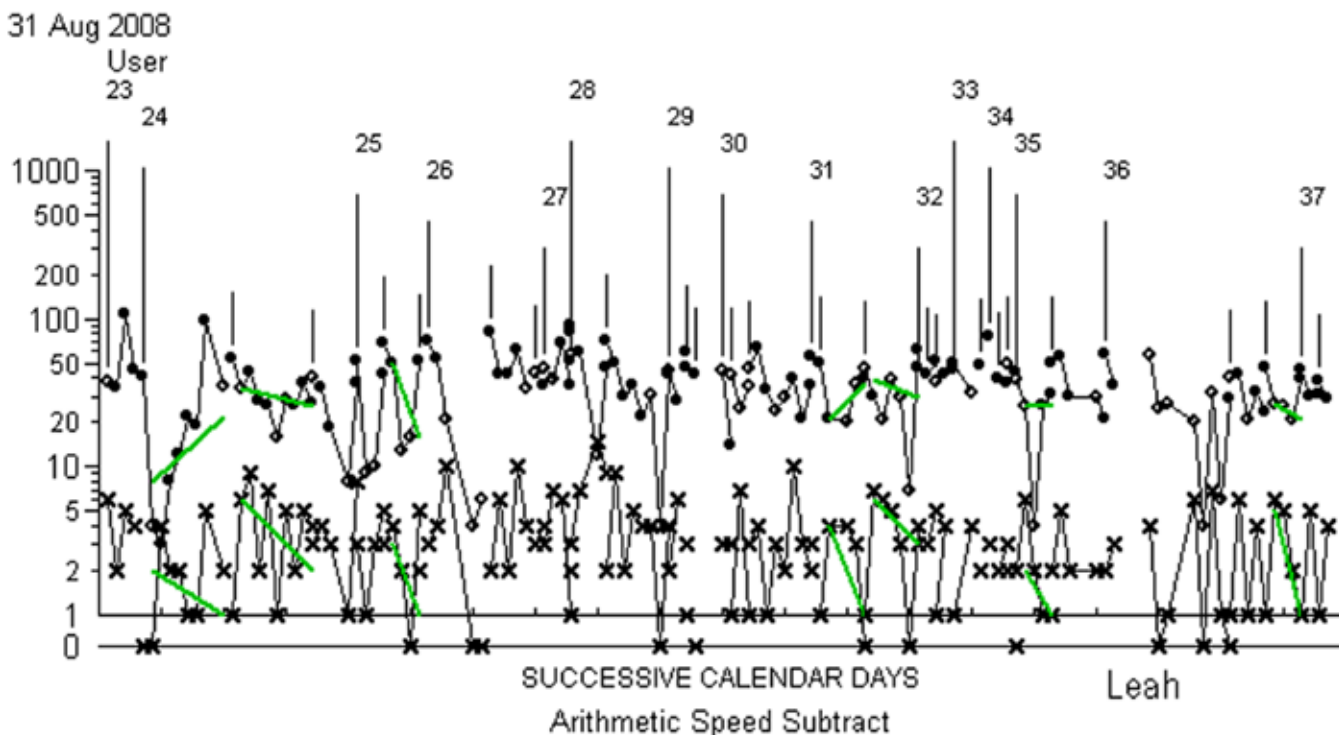
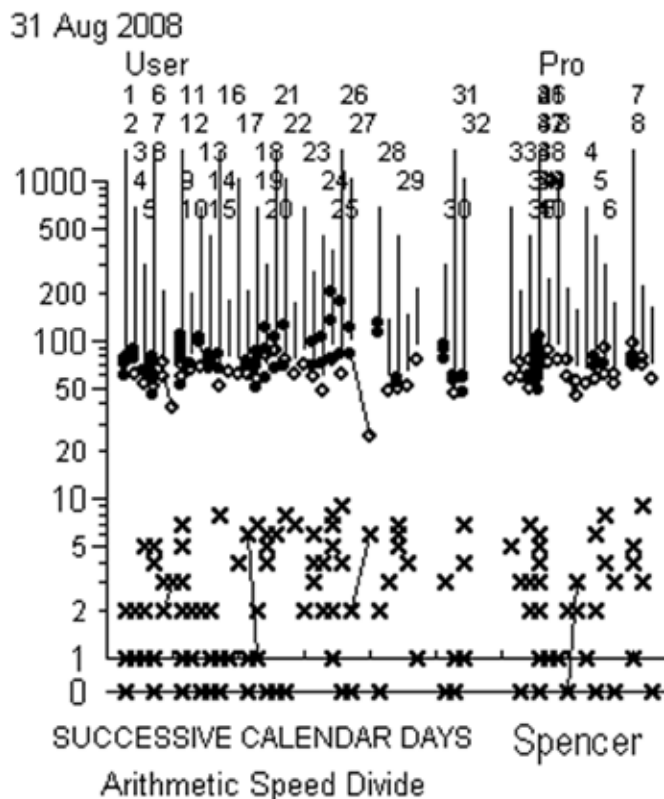


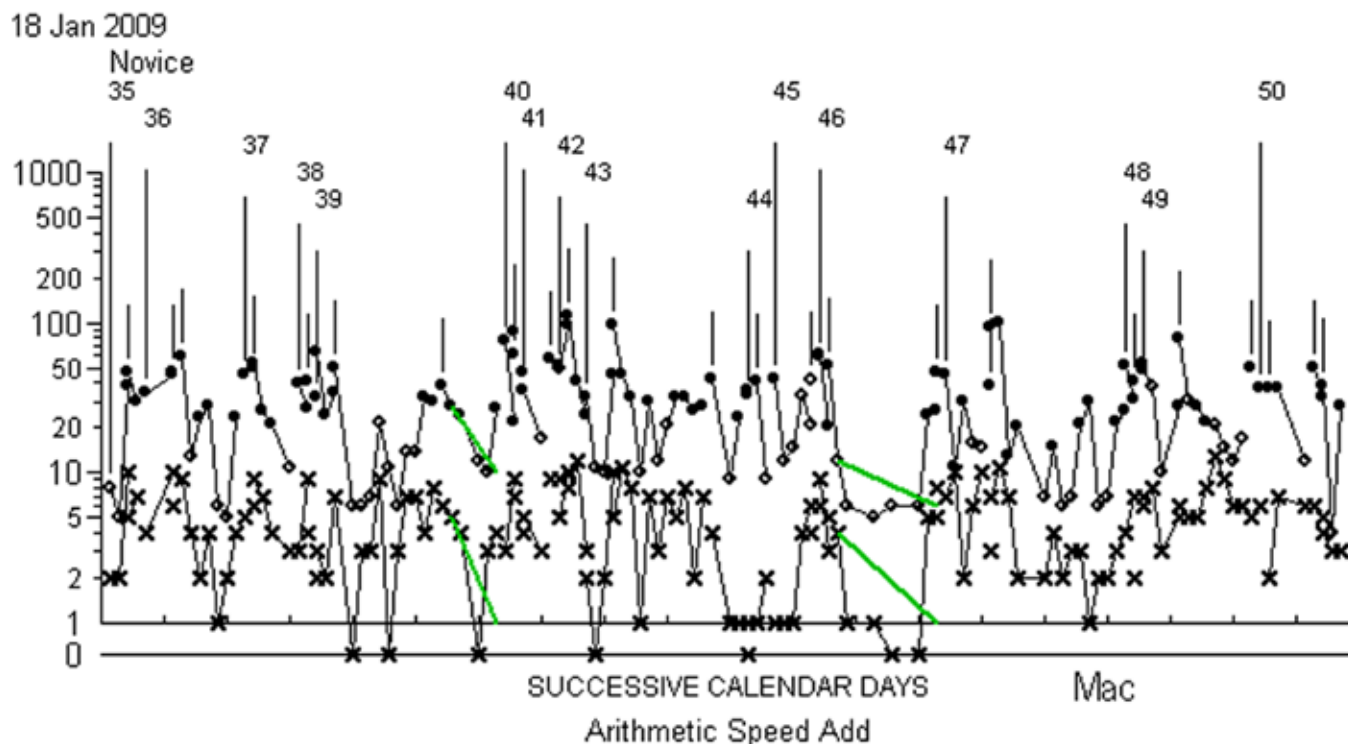
Figure 27. Spencer, Grade 8, is passing Division rapidly, but at about half the speed he passed his Multiplication fluencies.



three facts. In addition, this includes 2+1, 1+1, and 2+2 (Figure 19). Unlike flashcards, the computer can and will repeat the same fact combination several times in a row during the learning phase. Once a fact is mastered, it randomly appears again for review. In each successive level, one more fact is added. In Addition and Subtraction there are 55 skill levels, while in Multiplication and Division there are 44. Once the student has mastered all of the combinations at 30 correct in a minute, he or she graduates from being a Novice to the rank of User in which he or she repeats all of the levels again at 40 facts per minute. This repetition through ranks continues through Expert, Pro, Master, and Champion.

This Arithmetic regimen does not yield a clean set of charts, especially in the lower ranks. There is a high bounce in both corrects and learning opportunities. Figure 20 shows how Nicole's corrects and learning opportunities varied widely while she was a novice. Upon repeating the skills as a User and a Pro, she became much more accurate, generally passing at 80 facts per minute with around two learning opportunities.

Figure 28. Mac, Grade 6, does not demonstrate competency on this chart or in independent testing. His range of Corrects and Learning Opportunities continuously overlap. This overlap does not occur on the charts of the "competent" group.



To examine whether there is a distinctive chart of fluent behavior in Arithmetic, we selected two groups of 10 students, matched for grade level, but differing based on their scores in standardized

yearly testing. The “competent” group consisted of students whose scores on the Woodcock Johnson Math Fluency (standard score) measure, Calculation, and Applied Problems were all greater than 99. This group was contrasted with a group that was “not yet” competent, having an average standard score in the 80s. Like Spencer in Figure 21, most of the students in the competent group passed from level to level in half the time it took students in the noncompetent group. Younger students in each group stalled at some levels because they had not yet mastered particular facts (Figure 22). Both groups varied in the tightness of the bandwidth of corrects and errors, and a few of the lower group had crossovers in which errors were sometimes more numerous than corrects.

The different operations account for some variance. Students pass levels quicker in Addition and Multiplication, with tighter bounce in both corrects and learning opportunities. Some older students “catch on” to Multiplication and pass those levels rapidly (Figure 23). As is the case in Addition, younger students have much more variance because they are still learning the facts (Figure 24). In Subtraction, all students take three times longer to pass levels, with greater variance in both corrects and learning opportunities (Figure 25). In Division, students take about twice as long to pass as they do in Multiplication, but far less time than in Subtraction (Figures 26 and 27).

In arithmetic, there is only one distinction between the “competent” and the “non-competent” group charts. Charts with frequently overlapping Corrects and Learning Opportunities, like Mac’s Addition (Figure 28), do not occur in the “competent” group. But not all “non-competent” group students have the overlapping Corrects and Learning Opportunities. While Sarra scored in the “non-competent” range, her Addition Chart (Figure 29) has many features in common with those of the “competent” group.

Summary

The CyberSlate Keyboarding Charts have clear indicators of fluency. When a student attains Pro status using the correct fingering, the student is able to pass a keyboard fingering test, in two tries, and does not lose this skill after the test. The student is able to maintain a speed of 35 words correct per

minute when typing a paragraph that takes two or more minutes to complete.

CyberSlate Reading Charts also have clear indicators of fluency. The student has passed through books of passages until he or she is one or more years ahead of grade, and the First Read is almost always above 100 wpm.

The CyberSlate Arithmetic Charts do not yield as clear indicators. Some competent students pass rapidly through the skill levels with few errors. Others have a greater mix in their results, including a higher rate of learning opportunities, but they still score high on yearly testing.

Discussion

In Keyboarding and Reading, the CyberSlate Charts are more useful because they show clearly when a student has achieved a fluent rate. The charts have greater utility than the yearly probes because they yield a daily report and decisions can be made when fluent rates are achieved, rather than after the yearly test has taken place. Because he reads the charts, the behavior can predict for himself when he will become fluent. He can change the outcome by increasing his practice schedule and adding specific component skill exercises.

The CyberSlate Arithmetic charts do not yield distinctive differences between groups of students who test well in yearly probes and those who do not. Our discussion at the symposium yielded many paths to explore:

- There may be some underlying components that students must master before tackling the arithmetic fluencies, such as saying, writing, and typing numbers in order or randomly. Once those components are mastered, we might try raising the passing criterion on each of the operations fluencies and see if it results in a tighter bounce of corrects and learning opportunities.
- The CyberSlate Arithmetic fluencies present skill practice in each operation separately. The Woodcock-Johnson III Arithmetic fluency presents three operations (+, −, ×) on the same page in random order. A number of the student errors are because of the use of the wrong operation. We will design a fluency skillset with mixed operations to address that weakness.
- The CyberSlate Daily Chart selects the best score each day, or the best score of a skill level. An artifact of this selection is that students who pass a level daily appear to flatline because their scores do not increase from day to day. Merbitz (2009) suggests that this is an occasion on which to replot the available data, either on a Sessions

Chart that would reveal the steep acceleration within each level, or a One Year Chart, in which the count is levels passed per week, or sessions required per level.

Starling (2009) observed that “Science is messy” and some skill sets may not yield a collection of distinctive charts. This does not diminish the usefulness of the exercises. It just requires us to continue to look at many indicators to determine fluent behavior.

One of the first obstacles to overcome in Precision Teaching is to help the behavior establish daily practice routines. But once these routines are established, our greatest failure is to have students practice skills for days or weeks after they have become fluent. One reason to identify charts of Fluent Behavior is to make us more aware of when it is time for a student to move on to more useful exercises. Merbitz (2009) suggests that a “Fluent Chart” should trigger a situation in which the behavior is invited to drop the exercise in which he has demonstrated proficiency, and pick a new challenge from the available fluency exercises, or invent his own

This article is a beginning. Kent Johnson and Elizabeth Haughton have several charts of fluent behavior that they hope to share in a future Symposium. It is hoped that others will bring charts and observations to these Chart Shares, and that we might build a compendium of charts that either support or change the fluency benchmarks compiled by Kubina. Perhaps then we can publish the charts with links so our whole charting community can participate and share their wisdom toward our collective greater insight into the science of building fluency.

REFERENCES

- Binder, C. (1988, July). Precision Teaching: Measuring and attaining exemplary academic achievement. *Youth Policy*, 10, 12–15.
- Engelmann, S., et al. (1978). *Corrective reading*. Chicago: Science Research Associates.
- Haughton, E. C. (1980). Practicing practices: Learning by activity. *Journal of Precision Teaching* (1, 3), 3–20.
- Jamestown. (1989). *Timed readings* (Science). Providence, RI: Jamestown Publishers.
- Jastak & Wilkinson. (1984). *Wide range achievement test*. Wilmington, DE: Jastak Associates.
- Kubina, R. (2002). *Performance standards (or fluency aims)*. <http://www.precisionteachingresource.net/psfluencyaims.pdf>
- LaPray, M. (1969). *Teacher ratings and pupil reading readiness scores* (San Diego Quick Assessment). San Diego, CA: San Diego State College.
- MacGinitie, W. H. (1978). *Gates-MacGinitie reading tests*. Chicago: Riverside Press.
- Merbitz, C. (2009, October). Comments at the Symposium. Twenty-First Annual International Precision Teaching and Celeration Conference, College Park, PA.
- Starlin, C. (2009, October). Comments at the Symposium. Twenty-First Annual International Precision Teaching and Celeration Conference, College Park, PA.
- Woodcock, R. W., McGrew, K. S., & Mather, N. (2001). *Woodcock-Johnson III Tests of Cognitive Abilities*. Itasca, IL: Riverside Publishing.

The Taxonomy of Learning and Behavioral Fluency

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Instructional design refers to “the systematic and reflective process of translating principles of learning and instruction into plans for instructional materials, activities, information resources, and evaluation” (Smith & Ragan, 2005, p. 4). Said differently, instructional design represents how one will structure learning for success. While this may seem like a straightforward proposition, many factors influence instructional design and how an instructional designer engineers effective learning programs.

Morrison, Ross, and Kemp (2007) shared a comprehensive list of factors under their taxonomy of instructional design functions that include identifying instructional problems using needs assessment, goal analysis, and performance assessment; analyzing the learner and the context in which learning will occur; conducting a comprehensive task analysis that includes doing a topic analysis, procedural analysis, and using the critical incident method; creating objectives and using an expanded performance content matrix; sequencing learning; addressing strategies that facilitate recall, integration, organization, and elaboration; designating preinstructional strategies such as pretest, objectives, overviews, and advance organizers as well as the message design through signals and pictures; developing instructional materials; using formative, summative, and confirmative evaluation and assessing various standards of achievement and use of student self-evaluation; testing for knowledge items, skills and behavior, and attitudes; planning the proposal, project, and then management; and implementing the plan or program and making decisions.

While all consumers of learning materials should understand the many factors of instructional design in order to make thoughtful selections of instructional programs and curricula, instructional design reminds Precision Teachers of an important relationship: “What teachers teach is just as

important as how it is taught . . . having a clear understanding of what is taught ultimately helps the teacher decide how it should be taught” (Kameenui & Simmons, 1990, p. 58).

Precision Teaching and Behavioral Fluency

White (2005) defined Precision Teaching similarly as “a system for defining instructional targets, monitoring daily performance, and organizing and presenting performance data in a uniform manner to facilitate timely and effective instructional decisions” (p. 1433). Lindsley (1992) also described Precision Teaching as a comprehensive system of measurement: “Precision teaching is basing educational decision on changes in continuous self-monitored performance frequencies displayed on ‘standard celeration charts.’ Twenty-five years of practice . . . have produced a set of tools, methods, rules, and procedures for making these decisions. High performance aims and custom-tailored prescriptions maximize learning” (p. 51).

While Precision Teaching, as a comprehensive system, offers more than a method for understanding and achieving behavioral fluency, behavioral fluency nonetheless has taken a prominent role in education, psychology, and behavior analysis. Lindsley (1997) not only deemed behavioral fluency the “core of Precision Teaching practice” but also recognized it as one of Precision Teaching’s major discoveries

(1990, 1992).

Behavioral fluency posits that the attainment of performance standards, or frequency ranges of behavior, has associated critical learning outcomes. “The effects define fluency in the same way that the effects define reinforcement” (Lindsley, 1996, p. 212). Behavioral fluency has three effects or associated outcomes: retention, endurance, and application (Binder, 1996, 2005; Haughton, 1980, 1982). Retention refers to “the ability to perform a skill or recall knowledge long after formal learning programs have ended, without re-teaching in school year after year”

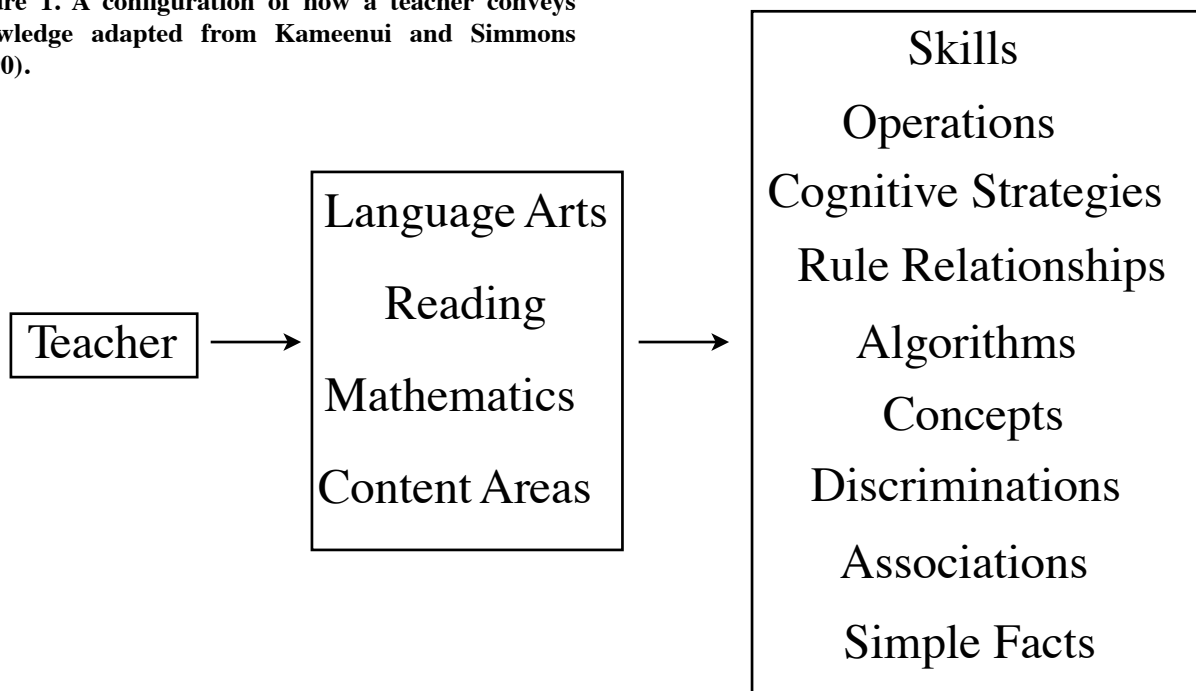
(Binder, Haughton, & Bateman, 2002, p. 4). For example, a study by Kubina, Amato, Schwilk, and Therrien (2008) demonstrated that students who read a passage to a high frequency aim (i.e., performance standard) when compared to reading to a lower frequency aim had comparable decrements in retention. During a 3-month retention measure, however, the students who read the passage to the performance standard had higher reading frequencies than students who read passages to the lower frequency aim.

Endurance refers to the ability to attend to a specified task for a given length of time and in the presence of environmental distractions (Binder,

1984, 1996, 2005). Binder, Haughton, and Van Eyk (1990) provided an example of endurance when they examined the effects of endurance on writing fluency. Seventy-five students ranging from kindergarten through eighth grade wrote digits from 0-9 as quickly as possible. Students wrote for intervals of 15 sec, 30 sec, 1 min, 2 min, 4 min, 8 min, or 16 min. The results showed that students who wrote at a frequency of 70 responses per minute performed similarly across all writing intervals. Students who could not write as quickly had increasing decrements in their performance when they had to write for longer intervals.

Another effect of fluency, application, means that one or more behavioral elements can combine with another element or elements to form a behavioral compound (Barrett, 1979; Binder, 1996, 2005; Haughton, 1972, 1980). A study by Bucklin, Dickinson, and Brethower (2000) demonstrated application by randomly assigning participants to one of two groups: an accuracy-only group or a fluency group. The participants practiced the two behavioral elements (i.e., Seeing Hebrew symbols and writing associated nonsense syllables, and seeing nonsense syllables and writing associated Arabic numbers). When given the compound behavior, reading arithmetic problems written in Hebrew symbols and writing answers in Arabic numerals,

Figure 1. A configuration of how a teacher conveys knowledge adapted from Kameenui and Simmons (1990).



participants in the fluency group completed more items than the accuracy-only group, reaching the threshold of statistical significance. Additionally, when the element behaviors were measured, the participants in fluency group demonstrated statistically significant retention compared to the accuracy only group.

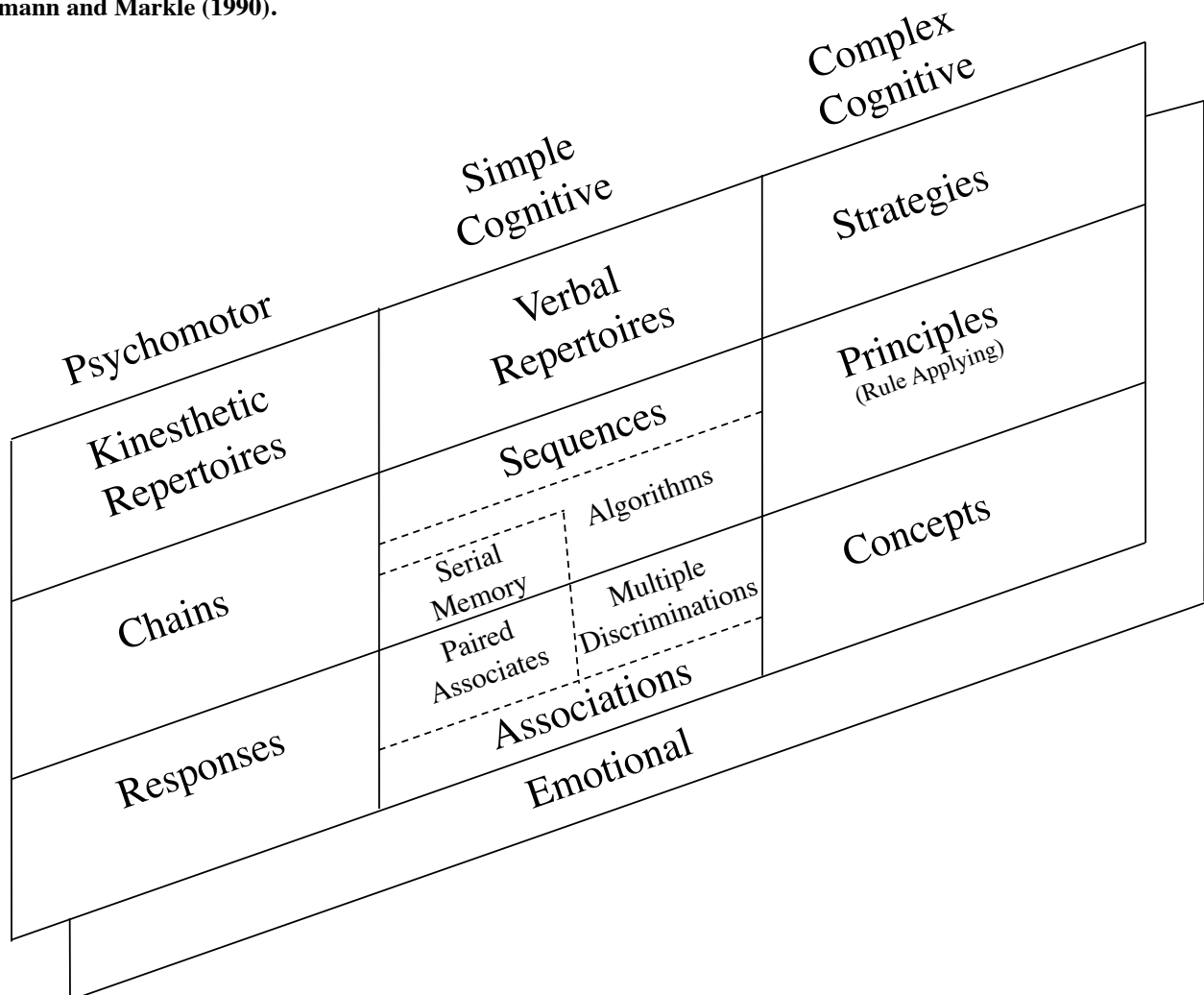
A database spanning more than 35 years and 33 research articles supports the behavioral fluency theory that attaining performance standards has associated effects, namely, retention, endurance, and application (Kubina, 2010). While a large number of studies exist to support the specific notion that behavioral fluency has associated effects, many other studies show the importance and usefulness of fostering fluent behavior. A study by Bell, Young, Salzberg, and West (1991), for example, helped high school students with and without disabilities pass the written maneuvers portion of their driver education class. Students received a combination

of direct instruction, peer tutoring, and practice to fluency monitored with Precision Teaching.

Behavioral fluency also has support at the organizational level of individual classrooms and schools, showing dramatic academic achievement outcomes (Beck & Clement, 1991; Johnson & Layng, 1994; Johnson & Street, 2004; Kubina, Commons, & Heckard, 2009; Maloney, 1998; Spence, 2002). Johnson and Street (2004) captured the goal of practice when they wrote: “The goal of fluency building is to build hardy academic behaviors—behaviors that weather periods of no practice, occur with short latencies, are impervious to distraction, and are easily accessible in new situations” (p. 30).

As with abundant studies either measuring the associated effects of fluency (i.e., retention, endurance, application) or showing how fluent performances help learners accomplish a goal,

Figure 2. A taxonomy of learning as described by Tiemann and Markle (1990).



behavioral fluency occurs as a result of practice (Kubina, 2005b). The theory of behavioral fluency indicates that a learner will engage in practice until meeting a predetermined performance standard, at which point effects of fluency appear (Kubina, 2010). While the Precision Teaching literature does not advocate a preferred method for practice, some models argue for adopting a systematic routine that encompasses timed practice, corrective feedback, positive reinforcement, and daily decision making informed by Standard Celeration Charted data (Kubina, 2005a; Kubina & Yurich, 2009).

Behavioral Fluency and Designing Instructional Content

While a much expanded article may ask how Precision Teaching can interface with instruction, the present article asks more narrowly what role behavioral fluency plays during the instructional process. A structural analysis of knowledge helps to answer such a question. The structural analysis helps explain teaching that could involve explaining, directing, defining, communicating, or describing, all of which involve imparting information (Kameenui & Simmons, 1990). The information could involve a rule, idea, fact, operation, concept, or other forms of knowledge (Kameenui & Simmons, 1990).

Figure 1 shows an adapted configuration of such a structural analysis of how a teacher conveys knowledge. The far left box represents a teacher who may teach from any of the following curricular areas, language arts, reading, mathematics, and from content areas (the middle box). The box to the far right shows that each of the curricular areas contains different forms of knowledge ranging from an association (e.g., in reading seeing an s and saying the sound ssss) to a cognitive strategy (e.g., in science using the scientific method in an experiment).

A mathematics teacher may wish to instruct a student to discriminate among three numbers. To best teach discriminations, the teacher would identify the form of knowledge and offer instruction conducive to the particular form of knowledge (i.e., multiple discriminations). For instance, a teacher might present three numbers such as 2, 5, and 8, which the student would discriminate. Instruction could involve a plan for introducing new numbers

through modeling (e.g., Stein, Kinder, Silbert, & Carnine, 2006, format 5.1). A teacher would write a numeral on the board and then directly model the identification of each. For instance, pointing to a 2, the teacher would say, "This is a 2. What is this?" The student would respond by saying "2." After modeling each individual numeral, the teacher would write all three numerals on the board and ask the student to respond each time the teacher touched a different numeral. Once the student can say each numeral correctly in the presence of the other two numerals, the student has learned to discriminate among 2, 5, and 8.

Conversely, if the teacher wanted to teach word problems, he or she might choose to use a different instructional tactic for the problem solving. Therefore, teachers should carefully select different instructional designs to properly convey various forms of knowledge. Gagné (1965) first classified the many forms of knowledge a teacher might use and called them the "varieties of learning." Gagné identified eight types of learning: signal learning, stimulus-response learning, chaining, verbal associations, multiple discriminations, concept learning, principle learning, and problem solving. While Gagné would later refine his concepts, others such as Tiemann and Markle (1990) further extended the different forms of learning.

Tiemann and Markle's Taxonomy of Learning

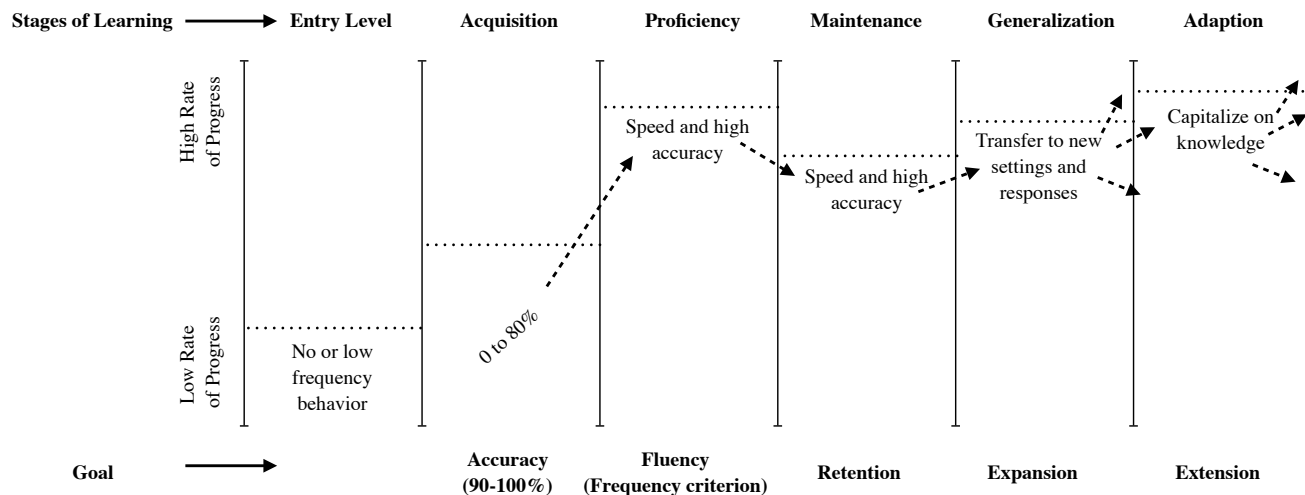
Figure 2 shows the classification system created by Tiemann and Markle (1990). The three-dimensional taxonomy has four basic types of learning; three columns, Psychomotor, Simple Cognitive, and Complex Cognitive, appear on top of the fourth type of basic learning, Emotional. Emotional learning underlies all of the other categories to remind teachers that whenever people learn something, whether simple or complex, a level of physiological arousal also co-occurs (Tiemann & Markle, 1990). Emotions experienced by the person can cover the full spectrum of feelings from mild amusement and excitement to abounding frustration or panic. A groan from a student each time the teacher announces math instruction offers insight into the emotional learning that has already transpired.

The other three types of learning range across an encompassing tract of human learning, each of

Table 1. Definitions of the basic types of learning and the subcategories in taxonomy of learning

Basic Type of Learning	Definition	Example(s)
Emotional Learning	Reacting to an antecedent stimulus with a private event or inner behavior (the involuntary reaction to the stimuli). Emotional learning can manifest itself through observable, visible actions or may remain private.	Inner feeling (unobservable): Anger, anxiety, fear, boredom, and happiness. Observable behavior (inner feeling): Face turning red (anger), excessive sweating (anxiety), looking away from instruction (boredom), and smiling (happiness).
Psychomotor Learning	Any single or multiple physical response(s). Expressed by the voluntary control and movement of muscles in a precise way.	Cleaning up blocks, setting a table, flossing one's teeth, shuffling cards, playing an oboe.
Psychomotor Learning Subcategories		
Responses	Performing a single motor behavior.	Twisting a door knob, turning on a light switch, picking up a small marble, erasing the board.
Chains	Connection of multiple motor responses in a sequence to form a complex or chained response.	Drawing a face by drawing eyes, ears, nose, mouth, and hair, tethering a boat using a clove hitch.
Kinesthetic Repertoires	A collection of responses and chains occurring in the presence of the appropriate stimuli.	Engaging in a racquetball volley with forehands, backhands, and ceiling shots. Driving a truck in traffic (shifting gears, looking at mirrors, speeding up and slowing down).
Simple Cognitive Learning	Basic stimulus-response relations, sequences, and expansive/detailed verbal repertoires.	Reciting addition facts, recalling a friend's phone number, telling a fable.
Simple Cognitive Learning Subcategories		
Associations	In the presence of a stimulus, the individual makes an appropriate response.	Recognizing a person's name when seeing his/her face, seeing color "red" and saying "red," hearing and then singing the "A" note.
Paired Associates	A set of responses made to a set of stimuli.	Naming all classmates, naming all of the primary colors, identifying and saying nonsense syllables.
Multiple Discriminations	Discriminating differences between two or more stimuli.	Identifying a smile in a picture with two other pictures showing a frown and no expression, picking out a hot dog with other sandwiches on a table.
Serial Memory	Responding to a particular stimulus by producing a series of associations in specific sequence.	Reciting the alphabet in order, rote counting from 1 to 100, singing the lyrics for "Twinkle, Twinkle, Little Star."
Algorithms	Following a sequence-dependent step-by-step procedure.	Solving multidigit multiplication problems, sorting values for data analysis.
Sequences	Producing a set of sequential responses for an activity.	Following the steps to bake a cake, assembling a model.
Verbal Repertoires	Acquiring many different types of associations and sequences producing a large verbal repertoire.	Discussing U.S. presidents and recounting notable events with specific years, sharing major contributions, and describing personal information not widely known.
Complex Cognitive Learning	The individual applies and integrates previous learning to new contexts.	Applying a note-taking strategy in a different class, predicting the stock market using finance rules.
Complex Cognitive Learning Subcategories		
Concepts	A set of stimuli in which all members share the same characteristics.	Learning that "fish" includes tuna, redfish, groupers, and trout.
Principles	A rule that sets a relationship between two or more concepts.	Fish, amphibians, reptiles, birds, and mammals are all vertebrate animals. If an animal has a backbone, it is a vertebrate animal.
Strategies	A series of multistep associations and procedures that can include any psychomotor, simple, or complex cognitive skills to deal with a new situation.	Placing animals into correct categories using the knowledge of fish and principles of invertebrate and vertebrate anatomy.

Figure 3. The stages of learning adapted from Smith (1981).



which further divides into multiple levels and also associates with one another. For example, simple to complex physical behaviors constitute the Psychomotor Learning column. Simple stimulus-response relations to complex and expansive verbal repertoires make up the Simple Cognitive column, whereas instances in which the learner now must produce functional responses to new stimuli represent the Complex Cognitive column. Table 1 provides full definitions and examples of each type of basic learning and the components.

Teaching and forms of knowledge. As suggested previously, understanding the classifications or types of learning allows the teacher to better design instruction. Consider an example of a response from the psychomotor column: writing a letter. Elementary education teachers start teaching students to write letters in kindergarten and first grade. The proper formation of a letter calls for proper posture, pencil gripping, and producing consistent and legible strokes. By understanding task analysis and the unique contribution of each single response, a teacher would use procedures

tailored for teaching letter writing. For example, a tripod grasp of a pencil along with circular and vertical marks leads to making a lowercase *d*.

Teachers also take into account the form of knowledge with simple cognitive behaviors such as paired associations. Science teachers may have a chapter learning objective of naming five influential physicists during the 20th century, their contributions, and dates of research. A paired association instructional approach would follow. Students first learn the association between Enrico Fermi and nuclear chain reactions in the 1910s, then Einstein and the theory of relativity in the 1920s, and so on, continuing with different combinations of physicists, contributions, and dates. Once mastered, later instruction may involve multiple discriminations among physicists, specific contributions, and years.

A teacher's understanding of strategies, the apex of the complex cognitive column, can lead to the attainment of sophisticated student behavior. A student's inability to resolve conflicts, for instance, presents serious problems for all involved: the student, peers, and the teacher. A strategy of

Figure 4. The three phases of instruction adapted from Kameenui and Simmons (1990).

Phases of Instruction

Before Instruction → During Instruction → After Instruction

conflict resolution includes a set of actions that adapt to the environmental resources to achieve social benefits. Therefore, teaching such a strategy involves multiple components. The teacher may focus first on the student's ability to identify body language or more overt responses indicating a problem situation. The teacher would also instruct behaviors such as speaking calmly and walking away. By bringing other children and adults into role playing or natural situations, the teacher can further evaluate functionality and generality of such conflict resolution strategy.

By matching instruction to the form of knowledge, teachers can design more appropriate lessons in conveying skills/concepts of interest. In addition to such a direct benefit, the taxonomy of learning also helps teachers diagnose learning problems and make instructional decisions to meet students' needs. Take the example of an algorithm for multidigit multiplication. The standard algorithm for solving problems follows:

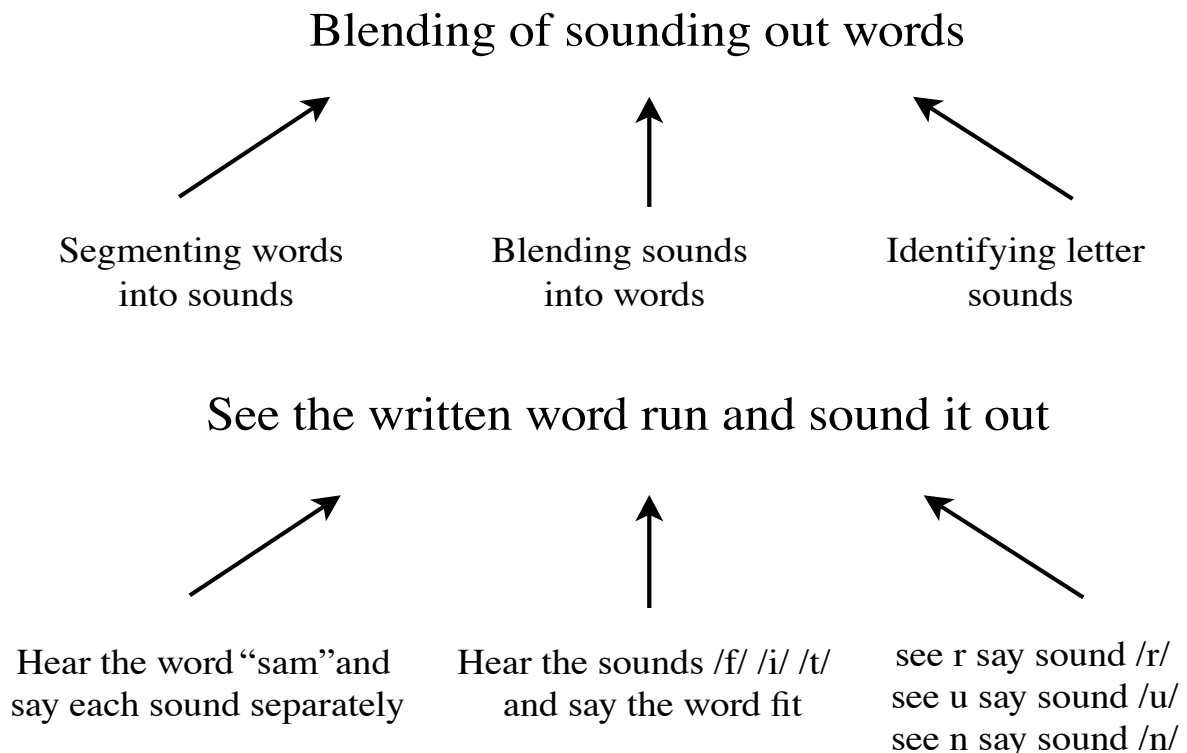
		2	3	4	
	X		5	9	
		2	1	0	6
1	1	7	0		
1	3	8	0	6	

For students having difficulty with the algorithm, performance of paired associates (e.g., numbers and quantity), multiple discriminations, (e.g., numerals), and algorithms (e.g., addition) will shed light on how to better help the student. Through error analysis, a teacher can identify what aspect of knowledge his or her student experiences difficulties with and therefore respond properly. In such an example, if a student struggles to apply an algorithm, the teacher can look at how well the student has learned addition and multiplication facts, and how well the student has the constituent forms of knowledge necessary for learning the new multi-digit multiplication.

Stages of Learning

Regardless of the targeted form of knowledge, each type of learning proceeds through stages as shown in Figure 3 (adapted from Mercer and Mercer, 2005, in line with design techniques suggested by Tufte, 2006). At the top of the figure each stage has its name. Parallel to the stages, at the bottom, each stage has a specific goal. At the far right, moving from the bottom of the figure to the top indicates the rates of progress. A behavior such as factoring trinomials at the entry level would mean the student exhibits a low rate of progress toward learning.

Figure 5. How identifying forms of knowledge helps with analysis of academic behaviors.



On the other hand, a student who quickly and accurately factors trinomials, a proficient behavior, demonstrates a high rate of learning progress.

The first stage shows the entry level where the behavior occurs at a very low frequency or not at all. A student with entry level behavior for letter sounds may know the sounds of /s/ and /m/ but not know the other 40 beginning sounds (cf. Carnine, Silbert, Kame'enui, & Tarver, 2010). Some form of instruction follows entry level behavior, and the student progresses to the acquisition stage of learning. The student who is learning letter sounds may receive instruction with a teacher modeling, leading, and testing for acquisition of the selected letter sounds. The acquisition stage culminates with the goal of highly accurate behavior.

After a student has met the criteria for the acquisition stage, learning shifts to the next stage, called proficiency. Proficiency, like acquisition, also has a terminal goal to indicate that the student has met the goals of the stage. Engaging in a behavior that has high degrees of accuracy but also occurs with speed or at the appropriate frequency represents fluency (Binder, 1996, 2005). After the student meets the criteria for the proficiency stage, he or she moves on to maintenance, generalization, and then adaptation.

The stages of learning depict learning as a multifarious, not a unitary, process. Learning does not manifest itself as traditionally held with a two-way exchange of information in which a teacher speaks and a student listens. Examining the rich tapestry of learning reveals an intricate fabric of different types of learning held together by the weaving of the different stages of learning. The recognition and discovery of the effects of behavioral fluency by Precision Teachers points to the importance of practicing a behavior to fluency. Within the context of the stages of learning, behavioral fluency fosters retention, which leads to maintenance. Additionally, a behavior maintained through time can also become available for generalization. And studies showing the increased likelihood of application (e.g., Bucklin, Dickinson, & Brethower, 2000; Chiesa & Robertson, 2000; Kubina, Young, & Kilwein, 2004) lend themselves to the adaption stage of learning.

Behavioral Fluency and the Taxonomy of Learning

A large amount of information from Precision Teaching has demonstrated the validity of behavioral fluency. Kubina (2010) found 33 peer-reviewed studies in which performance standards occurred with either retention, endurance, application, or a combination thereof. While Precision Teaching has much to offer the teaching profession, the specific discovery of behavioral fluency appears particularly well-suited for classroom application. The possibility of designing instruction via a taxonomy of learning and fostering behavioral fluency holds great promise for teachers.

The findings of behavioral fluency intersect the taxonomy of learning when considering the phases of instruction. The three distinct stages of instruction, as shown in Figure 4, direct a teacher to effectively respond before, during, and after instruction (Kameenui & Simmons, 1990). The before phase has 15 features that include defining, designing, managing, and modifying and adapting instruction. During instruction, the teacher still manages instruction but also delivers and modifies his or her teaching. After instruction, a teacher assesses instruction, decides if further modifications and adaptations need to occur, and manages, transfers, and reflects in the instruction. Kameenui and Simmons (1990) offer a full and detailed description of the three phases. The remainder of this article will focus on how behavioral fluency and the taxonomy of learning can come together in the three phases of instruction.

All three phases of instruction pertain mainly to the acquisition stage of learning. Using the three phases of learning, however, does also have relevance for maintenance, generalization, and adaptation to varying degrees. Behavioral fluency, and practice in general, cements the information learned in the acquisition stage. Therefore, scheduling practice to performance standards belongs in the before phase of instruction. The form of knowledge scheduled for the practice routine then influences the lesson planning. If practicing multiple discriminations of letter sounds, a teacher needs a practice sheet with the targeted sounds displayed on the page. If practicing chains, such as the square dance moves taught in gym class, the teacher may develop a mnemonic rhyme to help students memorize the proper steps. In the before phase of instruction, the

teacher not only painstakingly crafts instruction but also pays close attention to how students will practice the specific behavior to a performance standard.

The critical learning outcome of behavioral fluency also has relevance for the before, during, and after instruction phases. Application refers to the process element behaviors combining to form a compound behavior (Barrett, 1979; Binder, 1996, 2005; Haughton, 1972, 1980). An application study by Lin and Kubina (2004) demonstrated the relationship of skill elements and a compound behavior. For the study, 157 fifth-grade students wrote answers to basic multiplication problems for 1 min and then complex multiplication problems for 1 min. The resulting correlation of .75 between the skill element basic multiplication facts and the skill compound complex multiplication facts highlighted the importance of fluency; skill competence with an element behavior greatly predicted skill competence with the compound behavior.

For the before instruction phase, instructional planning, understanding what elements consist of or, more specifically, how skill elements fit into a taxonomy of learning, allows teachers to harness the full analysis of a compound skill. Figure 5 shows how different types of learning or skill elements can combine to form compound behavior. A student who can blend letters into a word, or sound out a word, engages in an algorithm. The step-by-step procedure calls for the student to see a word made up of letters and to say each letter sound in a left-to-right order. The algorithm will allow the student to decode the word “fit” by seeing the f and saying the sound for f, then i and saying the sound for i, and concluding with t and saying the sound for t. The student must say the f and i for one to one and a half seconds and the t for only a fraction of a second.

Teaching in the course of the During Instruction phase has teachers presenting instruction at a brisk pace, using clear signals for responses, providing thinking time before responses, and presenting in an enthusiastic manner (Kameenui & Simmons, 1990). The recommendations for presenting the information mostly concern helping students acquire the selected content. Therefore, a student learning paired associates such as letter sounds would benefit from all of the instructional delivery

recommendations. Behavioral fluency would most directly affect the practice phase taking place either after, or concurrent with, the teaching of letter sounds.

The recommendations for After Instruction affected by behavioral fluency fall within “transferring instruction.” One suggestion speaks to generalization and asks if the newly acquired skill occurs in different contexts. Teachers must plan for generalization and foster it during the initial teaching and subsequent practice of a form of knowledge. A great many tactics lead to attainment of such effect (Cooper, Heron, & Heward, 2007). Take the example of serial memory. A student reciting dialogue for a play may acquire the lines in the room of the drama club teacher. But also practicing the lines in different rooms and ultimately on the play with the props of the play fosters generalization. Furthermore, practicing the lines to fluency in a generalized setting increases the probability that the behavior will occur as desired.

The other goal for transferring instruction calls for scheduling practice via independent seatwork. Kameenui and Simmons (1990) have the teacher determine if the student has met the teacher-specified criterion of performance. But with behavioral fluency, a student will practice any form of knowledge until he or she meets the objective performance standard or fluency aim. The performance standard for letter sounds, paired associates, reported in practice and research falls within the 100–120 letter sounds per minute range (Freeman & Haughton, 1993; Kubina, Commons, & Heckard, 2009). Students will then practice until they meet the performance standard for letter sounds instead of relying on more subjective teacher-imposed criteria.

Conclusion

Precision Teaching can augment any curriculum. While Precision Teaching offers some insight into instructional design (e.g., Lindsley, 1997), understanding a taxonomy of learning will also lead the Precision Teacher to more carefully create, modify, or refine instructional and/or practice materials. In addition, when students practice and achieve behavioral fluency, the taxonomy of learning clearly defines what the students have achieved competence with and what they may need

to practice next.

REFERENCES

- Barrett, B. H. (1979). Communitization and the measured message of normal behavior. In R. York & E. Edgar (Eds.), *Teaching the severely handicapped* (Vol. 4. pp. 301-318). Columbus, OH: Special Press.
- Beck, R., & Clement, R. (1991). The Great Falls Precision Teaching Project: An historical examination. *Journal of Precision Teaching*, 8(2), 8-12.
- Bell, K. E., Young, K. R., Salzberg, C. L., & West, R. P. (1991). High school drivers education using peer tutors, direct instruction, and precision teaching. *Journal of Applied Behavior Analysis*, 24, 45-51.
- Binder, C. (1984). The effects of explicit timing and performance duration on academic performance in elementary school children. Unpublished doctoral dissertation, Columbia Pacific University.
- Binder, C. (1996). Behavioral fluency: Evolution of a new paradigm. *The Behavior Analyst*, 19, 163-197.
- Binder, C. (2005). Behavioral fluency. In M. Hersen, G. Sugai, & R. Horner (Eds.), *Encyclopedia of behavior modification and cognitive behavior therapy*. Volume III: Education applications (pp. 1185-1188). Thousand Oaks, CA: Sage.
- Binder, C., Haughton, E., & Van Eyk, D. (1990). Increasing endurance by building fluency: Precision teaching attention span. *Teaching Exceptional Children*, 22, 24-27.
- Bucklin, B. R., Dickinson, A. M., & Brethower, D. M. (2000). A comparison of the effects of fluency training and accuracy training on application and retention. *Performance Improvement Quarterly*, 13, 140-163.
- Carnine, C. W., Silbert, J., Kame'enui, E. J., & Tarver, S. G. (2010). *Direct Instruction reading* (5th ed.). Upper Saddle River, NJ: Prentice Hall/Merrill.
- Chiesa, M., & Robertson, A. (2000). Precision teaching and fluency training: Making maths easier for pupils and teachers. *Educational Psychology in Practice*, 16, 297-310.
- Freeman, G., & Haughton, E. (1993). Building reading fluency across the curriculum. *Journal of Precision Teaching*, 10(2), 29-30.
- Gagné, R. M. (1965). *The conditions of learning*. New York: Holt, Rinehart and Winston.
- Haughton, E. C. (1972). Aims: Growing and sharing. In J. B. Jordan & L. S. Robbins (Eds.), *Let's try doing something else kind of thing* (pp. 20-39). Arlington, VA: Council on Exceptional Children.
- Haughton, E. C. (1980). Practicing practices: Learning by activity. *Journal of Precision Teaching*, 1(3), 3-20.
- Haughton, E. C. (1982). Considering standards. *Journal of Precision Teaching*, 3(3), 75-77.
- Johnson, K. R., & Layng, T. V. J. (1994). The Morningside model of generative instruction. In R. Gardner, D. Sainato, J. Cooper, T. Heron, W. Heward, J. Eshleman, & T. Grossi (Eds.), *Behavior analysis in education: Focus on measurably superior instruction* (pp. 173-197). Belmont, CA: Brooks-Cole.
- Johnson, K., & Street, E. M. (2004) *The Morningside model of generative instruction: What it means to leave no child behind*. Concord, MA: Cambridge Center for Behavioral Studies.
- Kameenui, E. J., & Simmons, D. C. (1990). *Designing instructional strategies: The prevention of academic learning problems*. Englewood Cliffs, NJ: Macmillan.
- Kubina, R. M. (2005a). Developing reading fluency through a systematic practice procedure. *Reading & Writing Quarterly*, 21, 185-192.
- Kubina R. M. (2005b). The relationship between fluency, rate building and practice: A response to Doughty, Chase, and O'Shields. *The Behavior Analyst*, 28, 73-76.
- Kubina, R. M., (2009). Performance standards and behavioral fluency: A literature review. Manuscript submitted for publication.
- Kubina, R. M., Amato, J., Schwilk, C. L., & Therrien, W. J. (2008). Comparing performance standards on the retention of words read correctly

- per minute. *Journal of Behavioral Education*, 17, 328-338.
- Kubina, R. M., Commons, M., & Heckard, B. (2009). Using precision teaching with direct instruction in a summer school program. *Journal of Direct Instruction*, 9, 1-12.
- Kubina, R. M., Young, A. E., & Kilwein, M. (2004). Examining an effect of fluency: Application of oral word segmentation and letters sounds for spelling. *Learning Disabilities: A Multidisciplinary Journal*, 13, 17-23.
- Kubina R. M., & Yurich, K. L. (2009). Developing fluency for students with autism: A guide for parents and teachers. *Intervention in School and Clinic*, 44, 131-138.
- Lindsley, O. R. (1990). Our aims, discoveries, failures, and problem. *Journal of Precision Teaching*, 7(2), 7-17.
- Lindsley, O. R. (1992). Precision teaching: Discoveries and effects. *Journal of Applied Behavior Analysis*, 25, 51-57.
- Lindsley, O. R. (1997). Precise instructional design: Guidelines from Precision Teaching. In C. R. Dills & A. J. Romiszowski, (Eds.), *Instructional development paradigms* (pp. 537-554). Englewood Cliffs, NJ: Educational Technology Publications.
- Maloney, M. (1998). *Teach your children well: A solution to some of North America's educational problems*. Cambridge, MA: Cambridge Center for Behavioral Studies.
- Markle, S. M. (1990). *Designs for instructional designers*. Champaign, IL: Stipes Publishing Company.
- Mercer, C. D., & Mercer, A. R. (2005). *Teaching students with learning problems* (7th ed.). Upper Saddle River, NJ: Merrill.
- Morrison, G. R., Ross, S. M., & Kemp, J. E. (2007). *Designing effective instruction* (5th ed.). Hoboken, NJ: Wiley.
- Smith, P. L., & Ragan, T. J. (2005). *Instructional design* (3rd ed.). Hoboken, NJ: Wiley.
- Spence, I. (2002). Reducing the time required by dyslexic readers to become fluent: A comparison of two approaches. *Journal of Precision Teaching and Celeration*, 18, 2-9.
- Stein, M., Kinder, D., Silbert, J., & Carnine, D. W. (2006). *Designing effective mathematics instruction*. Upper Saddle, NJ: Pearson.
- Tiemann, P.W., & Markle, S. M. (1990). *Analyzing instructional content: A guide to instruction and evaluation* (4th ed.). Champaign, IL: Stipes Publishing Company.
- Tufte, E. R. (2006). *Beautiful evidence*. Cheshire, CT: Graphics Press.
- White, O.R. (2005). Precision teaching. In M. Hersen, G. Sugai, & R. Horner (Eds.), *Encyclopedia of behavior modification and cognitive behavior therapy*. Volume III: Education applications (pp. 1433-1437). Thousand Oaks, CA: Sage.

Teaching Analytical Thinking Skills to a Learner with Autism

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Learners with an autism spectrum disorder often require explicit instruction in many areas important for their success in school and life, including requiring such instruction in analytical thinking. Talk Aloud Problem Solving (TAPS) is an approach to analytical thinking that involves teaching students to make their thinking behavior explicit so that their behavior can be shaped and strengthened (Whimbey & Lochhead, 1999). TAPS allows what are typically private events to become public so that the student's teachers can influence those events in ways that support effective analytical thinking. This article illustrates how we applied analyses of verbal behavior (Michael, 1982; Skinner, 1957; Vargas 1986) to help identify measures that would allow us to shape the analytical thinking skills of Leila, an 11-year-old girl with high-functioning autism.

Although Leila was fully integrated into general education, it was essential to improve her analytical thinking skills as she prepared to transition from elementary school to middle school. Teaching Leila TAPS presented us with an important opportunity to analyze where her interpretation of text broke down, and where she became confused while studying texts from various academic subjects. Leila's language and thinking skills impairments hindered her synthesis and understanding of material she encountered in the classroom and negatively affected her academic performance.

The acceleration targets presented in this chart share included sequelic and tact responses that Leila emitted while solving problems. Sequelic behavior is a subtype of intraverbal responding where the form of the responses matches neither the form nor the order of its preceding verbal stimulus (Vargas, 1986). Examples of sequelic responses related to Leila's analytical thinking included: after reading a math word problem that asked Leila to determine the total distance a train traveled, and that also described the time at which the train left, Leila stated, "I know

that starting at 10 AM isn't important because the question asks how far she went, so what time she started won't help me." Another example included Leila emitting the statement, "It's asking me how many shoes were made all together. 'All together' means that I will have to add."

Tacts are a class of verbal responses occasioned by some feature of the physical environment and maintained by generalized conditioned reinforcement (Skinner, 1957). In terms of Leila's problem solving, tact responses often related to the completion of tables or diagrams and occurred frequently during her written work. For example, when referring to a table, Leila emitted a tact response that included, "This box shows what one factory did." When starting to complete a vocabulary exercise, Leila said, "I need to complete these blanks with a power word." When working on fractions, Leila commented, "This numerator tells how many parts."

Sequelic and tact responses were counted separately. Leila's frequencies of sequelic responses are shown as dots on the first SCC. Her frequencies of emitting tacts are shown as open circles on the first SCC. Additionally, any "doing" response (not vocal) related to solving the task was counted and

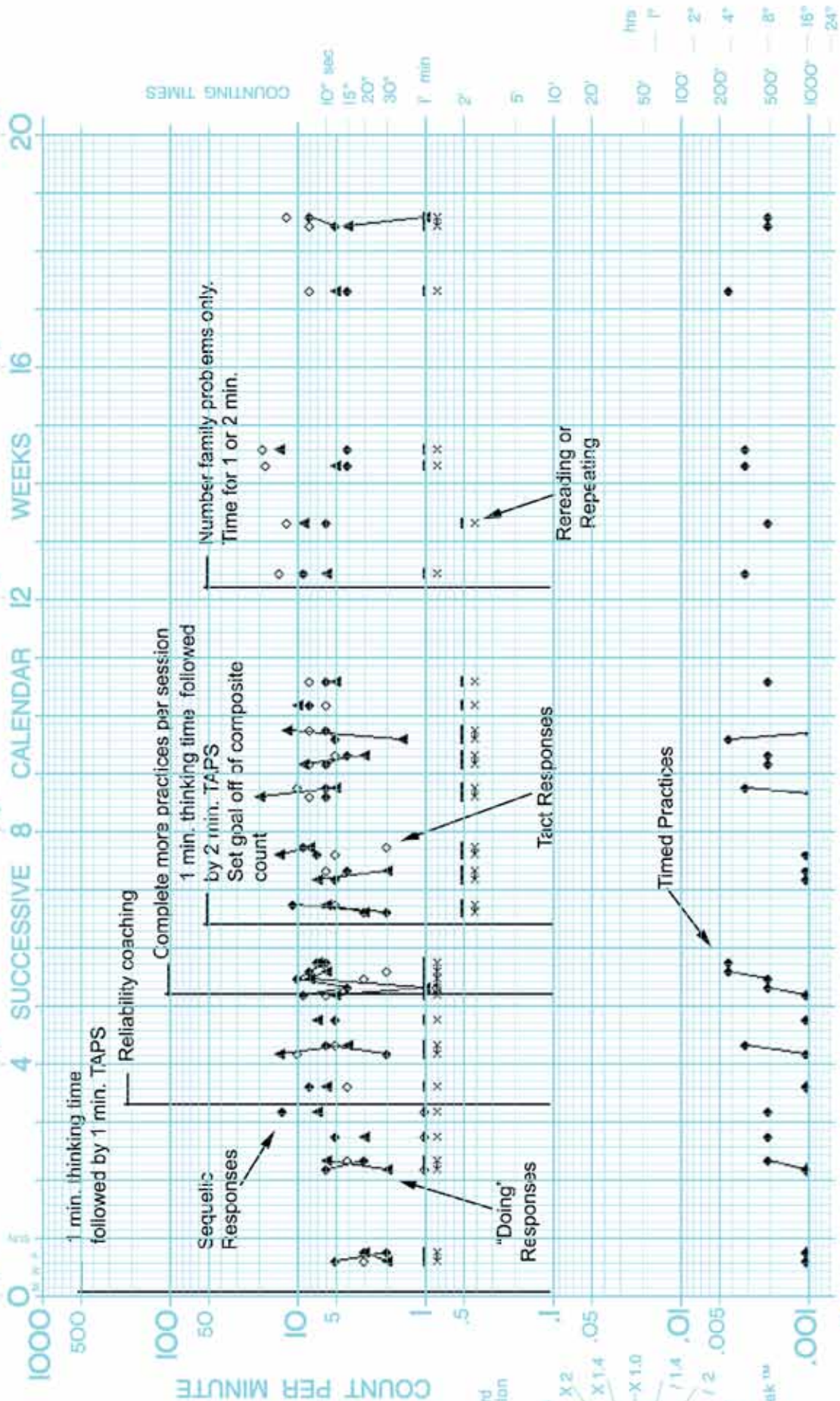
Keywords: Autism, Precision Teaching, Problem Solving, Analytical Thinking, Verbal Behavior



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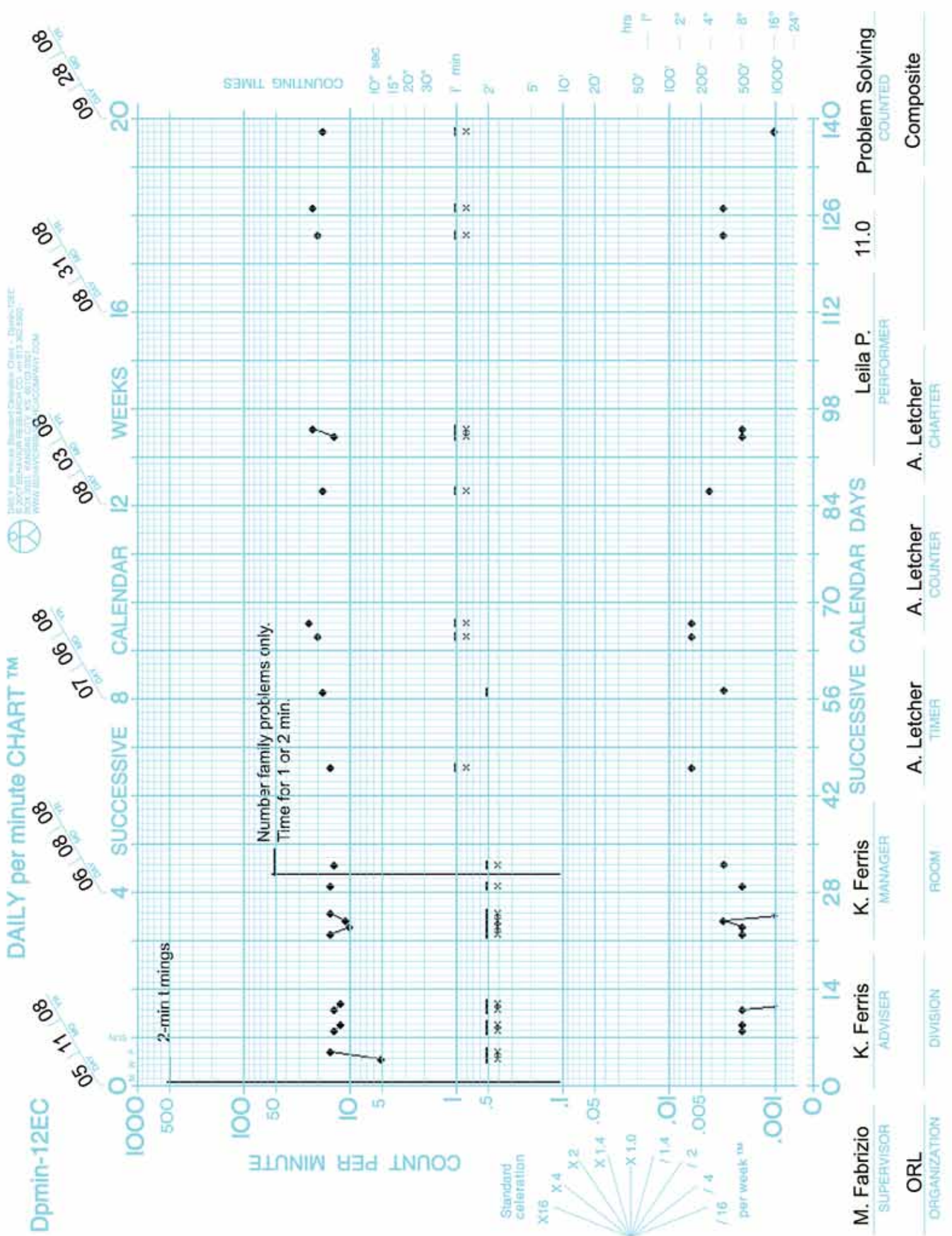


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shown as triangles on the first SCC. A “doing” response included pointing, circling, underlining, or writing.

The deceleration movement cycles were Leila’s rereading of the problem or restating verbatim what the problem told her. These responses were coded as deceleration movement cycles because repeatedly rereading instructions or restating the question after reading it were common patterns in Leila’s early responses, and such behaviors rarely helped her solve the problem at hand. Instead, repeated rereading and restating often led Leila to engage in cyclical reasoning and kept her from identifying the important and unimportant pieces of information contained in the problem.

The curricula that served as sources of practice problems included Mastering Reading Through Reasoning (Whimbey, 1995), Connecting Math Concepts—Level D (Engelmann, Engelmann, & Carnine, 2003), and Reasoning and Writing—Level D (Engelmann & Silbert, 2001). While we charted Leila’s problem-solving performance on a separate SCC for each of the curricula previously listed, we present here data only from Leila’s problem solving within the Connecting Math Concepts Level D curriculum because these data nicely illustrate her performance across the other curricula employed.

In the first phase of intervention, Leila’s tutors allowed her 1 minute to think about what she would do after she read a problem, and 1 minute of measured problem-solving time. Leila’s tutors set daily improvement goals for her based on her exceeding the frequency of sequelic responses she had previously emitted. Tacts served as an auxiliary measure, meaning that they were not considered in calculating Leila’s daily improvement goal. During this phase of intervention, Leila’s frequency of sequelic, tact, and “doing” responses all increased, with her sequelic responding showing the most bounce from one day to the next.

The second phase of intervention involved improvements in procedural and measurement reliability. Leila’s team consisted of two tutors, both new to Precision Teaching. Neither tutor had any formal education in either behavior analysis or the analysis of verbal behavior. It was important to compare measures regularly between each of the tutors and between the tutors and the supervising

behavior analyst to ensure that the appropriate responses were not only being counted but also (and more importantly) reinforced. Reliability sessions involved one tutor implementing TAPS with Leila while the second tutor and the first author counted Leila’s responses separately. These separate counts were then compared. If the counts differed from one another, the behavior analyst recalled aloud statements Leila had made and specified how they should be counted. Following this, Leila completed a second TAPS timing. Both counts matched each other after the second timing. Sometimes the behavior analyst had to tact the verbal operants Leila emitted while she was solving problems to more closely establish a connection between her responses and how the tutors should categorize her responses.

The third phase of intervention consisted of asking Leila and her teacher to complete more timed practices per day. Comparing Leila’s data on skills with her progress on this SCC, we noted that Leila rarely achieved her daily improvement goal in only one timing. Instead, Leila’s performance often improved significantly from the first timed practice to the final timed practice. We sought to replicate the facilitating effects of multiple timed practices by asking Leila to complete more timed practices per day on this SCC. This change increased the practices from an average of 1 per day to 3 per day.

The fourth phase of intervention increased the timing interval to 2 minutes of measured problem solving. While during the 1-minute timings, Leila often spoke about her plan for solving the problem and identified what was important within the problem, these 1-minute timings only allowed her to actually start to solve the problem for the final 15 seconds of the minute. Measuring her performance for 2 minutes allowed Leila’s tutors to provide her feedback both on her problem-solving planning and her execution of the plan. During the fourth phase, a second change was made to the daily improvement goal-setting procedure used; in this fourth phase of intervention, Leila’s tact and sequelic responses were combined to create a problem-solving composite measure, and this composite measure served as the basis for Leila’s daily improvement goal. This change happened because it became clear that different types of problems required different tact and sequelic response frequencies.

Complicated tables and diagrams seemed to demand higher frequencies of tact responses along with frequencies of “doing” responses. Other problems required lower frequencies of tacts to describe and execute skilled problem solving. The combined measure reduced the bounce in the data and allowed both the tact and the sequelic responses to contribute equally and flexibly to the daily improvement goal frequency. Once Leila’s tact and sequelic counts were combined into a problem-solving composite measure, a second Daily per Minute SCC was started to track this combined frequency of responding.

The fifth and final phase of intervention specifically targeted number family math problems and gave Leila’s tutors the flexibility to measure for either 1 or 2 minutes. Number families presented the greatest instructional challenge for Leila, and she lacked a consistent algorithm for solving these problems. Targeting number family problems through TAPS allowed us to mediate her plan effectively to avoid practicing the same errors.

The composite measure showed an initial acceleration in the frequency of problem-solving responses. Upon changing to number family problems, Leila gradually increased her frequency of problem-solving statements to a high of 26 per minute. As Leila’s frequency of responding increased, she was more efficient when she stated the details of her plans, and so timings were shortened to 1 minute. The summer months imposed many breaks in the implementation of the programs. However, with only 11 implementation days across 15 weeks, Leila’s frequency of problem solving remained steady while her effort, or number of practices required to achieve that frequency of responding, decreased from 6 practices to 1 practice.

The problem-solving composite measure proved an appropriate measure for shaping the critical aspects of problem solving for Leila. The composite measure allowed the unique requirements of different math problems to vary freely without producing undue bounce in the data. The composite measure allowed us to begin to identify a potential predicted frequency aim for analytical thinking skills. We plan to collect further data in the future and test various problem-solving frequencies for their ability to predict the outcomes of fluent performance.

Leila now approaches instructional tasks by first stating what she knows, what she thinks is being asked of her, and her plan for solving the problem. Her tutors and parents can more effectively intervene at critical times to correct or praise as appropriate. When recently tested on a standardized test of academic achievement, Leila commonly emitted problem-solving responses and reviewed her responses carefully before moving on. This performance differed greatly from previous testing sessions when she answered quickly, never reflected on what she was doing, and always appeared confident regardless of her accuracy. Leila, for the first time, notices when she gets confused, pauses, and asks for more information at appropriate times. She seems to have a much better sense of what she knows and what she does not know.

REFERENCES

- Engelmann, S., Engelmann, O., & Carnine, D. (2003). *Connecting math concepts—Level D*. Columbus, OH: McGraw-Hill Publishers.
- Engelmann, S., & Silbert, J. (2001). *Reasoning and writing—Level D*. Columbus, OH: McGraw-Hill Publishers.
- Michael, J. (1982). Skinner’s elementary verbal relations: Some new categories. *Analysis of Verbal Behavior*, 1, 1-3.
- Skinner, B. F. (1957). *Verbal behavior*. New York: Appleton-Century-Crofts.
- Vargas, E. A. (1986). Intraverbal behavior. In P. N. Chase & L. J. Parrott (Eds.), *Psychological aspects of language* (pp. 128-151). Springfield, IL: Charles Thomas.
- Whimbey, A. (1995). *Mastering reading through reasoning*. Cary: NC. Innovative Science.
- Whimbey, A., & Lochhead, J. (1999). *Problem solving and comprehension*. Lawrence Erlbaum.

Regina's Reading Program and Progress

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Regina was a 5-year-old kindergarten student identified as being at-risk in reading during her suburban, central Pennsylvania school district's kindergarten screening. According to her teacher, she was of average intelligence but behind most of her peers in beginning reading skills. She enjoyed pretend play and crafts; however, during gathering times for instruction she would often stretch out on her back on the carpet, saying that she was tired, and would slump down in her chair during language arts centers.

Regina had difficulty with many beginning reading skills. She struggled with telescoping words, could not segment words, and did not know most of the letter sounds and phonemes. Although already part of a small group that received daily instruction from her elementary school's Instructional Support Teacher from the Reading Mastery program, Regina was selected to receive additional reading instruction due to her significant deficits in foundational skills. The focus of intervention for Regina was providing instruction and practice in telescoping, segmenting, letter sounds, and eventually sounding out words, so that she could catch up to her peers and begin to read.

Methods

Prior to intervention, assessment data were collected in order to figure out with what skills to begin instruction. The instructor informally assessed hear-say segmenting, hear-say blending, see-say letter sounds, see-say blending, and see-say sight words. Fluency aims appear in Table 1. Regina was not fluent in any of the assessed skill areas, as she only correctly blended three words in a minute for hear-say blending, could not segment words, only knew the letter sounds for m and s, and could not perform any see-say tasks (Kubina, 2002). Given assessment results, her instruction began with phonemic awareness (telescoping and blending) and see-say letter sounds.

The instructor worked with Regina Monday-Thursday mornings for 8 weeks with occasional missed sessions due to in-service days or classroom events (fire drill and special morning activity).

These sessions included instruction and practice in blending and segmenting and letter sounds, with sounding out regular VC and CVC words added in the fifth week of instruction. Lessons took place in the hall behind a large folding divider so as to block out distractions. They began as soon as Regina had taken off her coat and put away her backpack. Instructional sessions lasted between 5 and 10 minutes, depending on the time that Regina arrived at school and her classroom schedule.

Lessons began with instruction and practice in letter sounds, then segmenting and blending, with sounding out words during weeks 5-8. Each skill area had a model, lead, and test phase following the formats of Direct Instruction Reading (Carnine, Silbert, Kame'enui, & Tarver, 2004). See Figure 1 for a sample lesson plan. Starting in the second week of instruction, Regina did practice trials, in keeping with the practices of Precision Teaching with an eight-letter sound sheet to build fluency after each lesson (Lindsley, 1990). Regina was read the following instructions before the first trial each day:

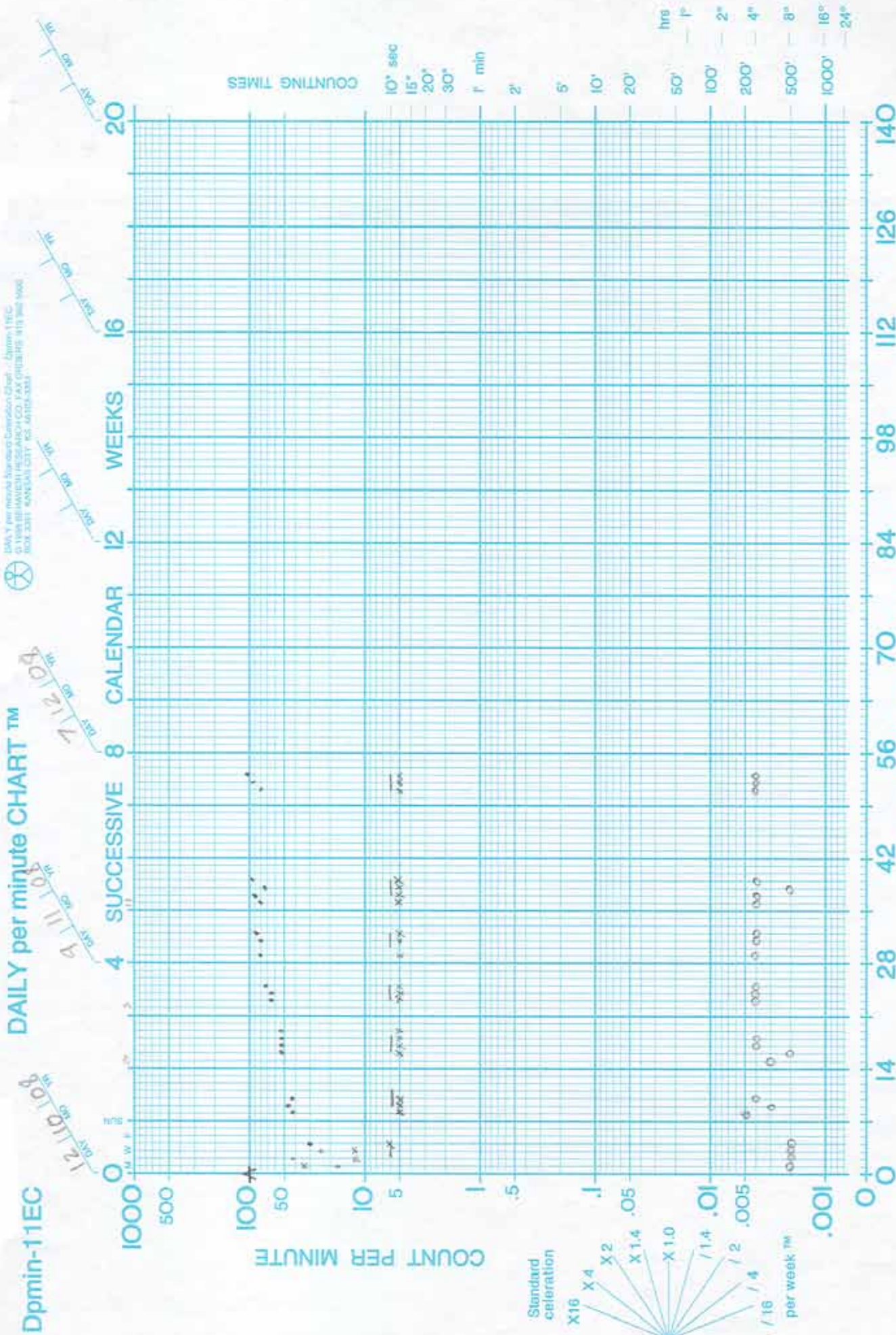
When I say "begin," point to each letter and say its sound. Try to do as many as you can. Move your finger across the paper as you point and say each sound. Try to say as many sounds as you can. Don't worry if you do not finish this sheet, just try your best. Are there any questions? Please begin.

Trials lasted 10 seconds, starting when the instructor said "begin" and ending with the beeping of a digital kitchen timer that had been set for the aforementioned time. The letter sound sheet used

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COUNTED

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TIMER

COUNTER

CHARTER

PERFORMER

COUNTED

8 sound sheet

CHART SHARE: REGINA'S READING PROGRAM

Figure 1. A sample lesson plan.

Instructional Strand	Monday	Tuesday	Wednesday	Thursday
Letter Sounds	In-service Day-No School	Reading format 7.3	Reading format 7.3	Reading format 7.3
		<i>Model:</i> t	<i>Model:</i> n	<i>Model:</i> n
		Reading format 7.4	Reading format 7.4	Reading format 7.4
		<i>Prompt:</i> t, th, f, d, r	<i>Prompt:</i> n, t, th, f	<i>Prompt:</i> n, th, t, f
		<i>Check:</i> (Point to the letter and have student identify the letter sound): t	<i>Check:</i> n	<i>Check:</i> n
Phonemic Awareness		Reading format 6.3	Reading format 6.3	Reading format 6.3
		<i>Model:</i> sit	<i>Model:</i> man	<i>Model:</i> near
		<i>Prompt:</i> mit seem that	<i>Prompt:</i> rim feet than	<i>Prompt:</i> sit neat fat
		<i>Check:</i> fit	<i>Check:</i> fin	<i>Check:</i> fear
Sounding out regular words		Reading format 8.1	Reading format 8.1	Reading format 8.1
		<i>Model:</i> this	<i>Model:</i> sit	<i>Model:</i> ran
		<i>Prompt:</i> this feed fat	<i>Prompt:</i> sit sad this	<i>Prompt:</i> ran sit me
		<i>Check:</i> this	<i>Check:</i> sit	<i>Check:</i> ran

had rows of the letters a, m, s, ē, r, d, f, and i in random order, with more rows on a page than Regina could read in the 10-second time period. During the first week, Regina completed two trials each day, then four trials each day for the remaining weeks with deviations every so often due to time constraints (Figure 2). As Regina read, the instructor marked her errors, recorded the last sound read, and totaled her correct and incorrect responses. If she made an error or hesitated with a sound, the instructor would point to the letter, ask for the sound, then say the correct sound if Regina did not know before beginning the next trial. Her best trial was charted each day on a Daily Standard Celeration Chart.

Regina was motivated to work through the use of a reward system. At the beginning of each session, the instructor (and eventually Regina in

the later weeks) reviewed the expectations for the lesson. They were as follows:

1. Sit up in your seat.
2. Be quiet unless called on.
3. Pay attention.
4. Try your hardest.

At the conclusion of the lesson, Regina was given a sticker to put on her reading sheet if she had met the expectations. When she had earned all the stickers of one type, she was able to move on to a new type of her choosing (seals, seahorses, monsters, etc.).

Results

The see-say letter sound chart (Figure 2) shows

Regina's increased fluency with letter sounds. read words.

During the first week of the practice trials, Regina's correct letter sounds per minute (CLSPM) increased at a celeration of $\times 4$, going from 18 CLSPM the first day to a high of 42 CLSPM on the second day, then down to 24 on day 3 and ending at 30 on the fourth day. In this week, her errors decreased by a celeration of $\div 16$. After the first week, Regina's errors dropped to zero and held there for all of the days thereafter. Between the first and second week there was a frequency change of $\times 1.6$, as Regina's CLSPM jumped to 42 on the first day of the second week. Her progress was limited during the rest of the week; however, between the second and third weeks she made gains again with a frequency change of 1.3. The next two weeks showed gradual improvement with celerations of $\times 1.2$, starting with 60 CLSPM and ending with 90 CLSPM. Regina's performance was variable in the seventh week, with 84, 90, 78, and 96 CLSPM across the week. Following a week break for Thanksgiving, Regina started at 84 CLSPM, then increased by 6 each day to end with making the criterion of 100 (Kubina, 2002) on the final day of instruction. Viewed as a whole, over the course of 7 weeks of practice with the eight-letter sound sheet, Regina's corrects increased at a celeration of $\times 1.8$.

Discussion

Regina was a 5-year-old kindergarten student who had difficulty with critical early reading skills. As she struggled to telescope, segment, and identify letter sounds, many of her fellow classmates were writing the sounds they heard in words during journal writing time, and reading simple words and sentences. She would often get frustrated during reading-related times, slouching in her chair, putting her head down, or hiding under the table. Due to her reading skill deficits, Regina was selected for one-on-one instruction in addition to what she already received in a small-group setting from her school's Instructional Support Teacher.

Over the course of the 8 weeks of instruction and 7 weeks of practice trials with letter sounds, Regina made rapid and substantial progress. In addition to being able to telescope and segment without errors, she was fluent with the first eight letter sounds targeted for instruction. With these critical skills in place, Regina was able to meet the goal of intervention by starting to sound out and

The combination of Direct Instruction and Precision Teaching was highly effective for Regina. As Figure 2 indicates, she continued to increase her fluency with letter sounds during the weeks of instruction and intervention. Regina looked forward to the practice trials, asking during lessons, "Are we going to do the 10-second thing?" She also took great pride in her hard work toward becoming a reader, pointing and saying excitedly, "Look! I got all the way to here!" when she made it further on the letter sound practice sheet than she had before. This pride and enthusiasm carried over to other aspects of reading. After sounding out words was introduced, Regina would want to do words first during the lesson and ask to read more words because she liked it so much. Her classroom teacher noticed that she was hearing more sounds in words and that she knew more letter sounds. In addition, her teacher and the instructor noticed an increase in Regina's willingness to participate in reading activities and language arts centers, as she no longer hid under tables for reading-related projects and sat up and paid attention during lessons and centers.

Regina's letter sound performance accelerated during intervention. The student who only knew the sounds for m and s at the beginning of October knew a dozen by the beginning of December and was fluent with eight. As her fluency increased, so did her confidence in her abilities as a reader. Although she was excited on the last trial of the last day of instruction when she met the fluency aim for the first time, her smile was one of self-assurance, as if to say, "I knew I could do that." With the foundational reading skills she has in place, she will be able to do much more.

FLUENCY AIMS

Task	Fluency Aim
Hear-say Segmenting	40-60 sounds per minute
Hear-say Blending	10-15 words per minute
See-say Letter Sounds	100-120 sounds per minute
See-say Blending	80-120 blends per minute
See-say Sight Words	80-120 words per minute

REFERENCES

- Carnine, D. W., Silbert, J., Kame'enui, E. J., & Tarver, S. (2004) *Direct instruction reading* (4th ed.). Upper Saddle River, NJ: Pearson Prentice Hall.
- Kubina, R. M. (2002). *Performance standards* (or fluency aims). Retrieved May 5, 2009, from <http://www.precisionteachingresource.net/psfluencyaims.pdf>
- Lindsley, O. R. (1990). Precision teaching: By teachers for children. *Teaching Exceptional Children*, 22(3), 10-15.

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. [Note: We encourage performers (e.g. students, clients, patients) to submit their own charts to the chart share section.]

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) If submitting by postal mail*, submit three typewritten, doubled spaced copies of the manuscript without author’s names or affiliations. If submitting by e-mail, send to rmk11@psu.edu.
- (2) If submitting electronic manuscripts, we recommend OpenOffice Writer (v3 or higher), Word Perfect (v4), Apple iWork, or Microsoft Office 2003. We discourage Microsoft Office 2007 and will not accept pdfs.
- (3) Follow the format outlined in the Publication Manual of the American Psychological Association (5th edition, 2001);
- (4) Do not exceed 20 words in the article title;
- (5) Include an abstract and do not exceed 250 words in the abstract (Technical Notes do not require an abstract);
- (6) Select 3 to 5 key words that describe the manuscript;
- (7) Secure permission for use of copyrighted materials;
- (8) Send all charts and graphics in vector format or as 600 dpi bitmapped images, uncompressed;

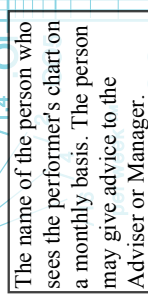
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Editors reserve the right to edit all material accepted for publication.

BASIC CHARTING CONVENTIONS for the DAILY STANDARD CELERATION CHART

TERM	DEFINITION	CONVENTION
1. CALENDAR SYNCHRONIZATION	A standard date for starting all charts.	The synchronization date begins on the first Sunday before Labor Day. The second chart begins 20 weeks after the synchronization date. The third chart begins 40 weeks after synchronization date. Three charts cover a full year.
2. CHARTED DAY	A day the charter records and charts a behavior.	<ol style="list-style-type: none"> 1. Chart the behavior frequency on the chart on the appropriate day line. 2. Connect charted days. 3. <i>Do not</i> connect charted days across <i>phase change lines</i> or <i>no chance days</i>.
a) ACCELERATION TARGET FREQUENCY	Responses of the performer intended to accelerate.	Chart a dot (•) on the appropriate day line.
b) DECELERATION TARGET FREQUENCY	Responses of the performer intended to decelerate.	Chart an (x) on the appropriate day line.
3. NO CHANCE DAY	A day on which the behavior had <i>no chance</i> to occur.	Skip day on daily chart. (Do not connect data across no chance days).
4. IGNORED DAY	A day on which the behavior could have occurred but no one recorded it.	Skip day on daily chart. (Connect data across ignored days).
5. COUNTING-TIME BAR (aka Record Floor)	Designates on the chart the performer's lowest possible performance (other than zero) in a counting time. Always designated as "once per counting time."	Draw solid horizontal line from the Tuesday to Thursday day lines on the chart at the "counting-time bar."

TERM	DEFINITION	CONVENTION
6. ZERO PERFORMANCE	No performance occurred during the recording period.	Chart on the line directly below the "counting-time bar."
7. PHASE CHANGE LINE	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.	Draw a vertical line between the intervention phases. Draw the line from the top of the data to the "counting-time bar."
8. CHANGE INDICATOR	Words, symbols or phrases written on the chart in the appropriate phase to indicate changes during that phase.	Write word, symbol and/or phrase. An arrow (➡) may be used to indicate the continuance of a change into a new phase.
9. AIM STAR	A symbol used to represent: (a) the desired frequency, and (b) the desired date to achieve the frequency.	Place the point of the caret... A for acceleration data C for deceleration data ...on the desired aim date. Place the horizontal bar - on the desired frequency. The caret and horizontal line will create a "star."
10. CELERATION LINE	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.)	 



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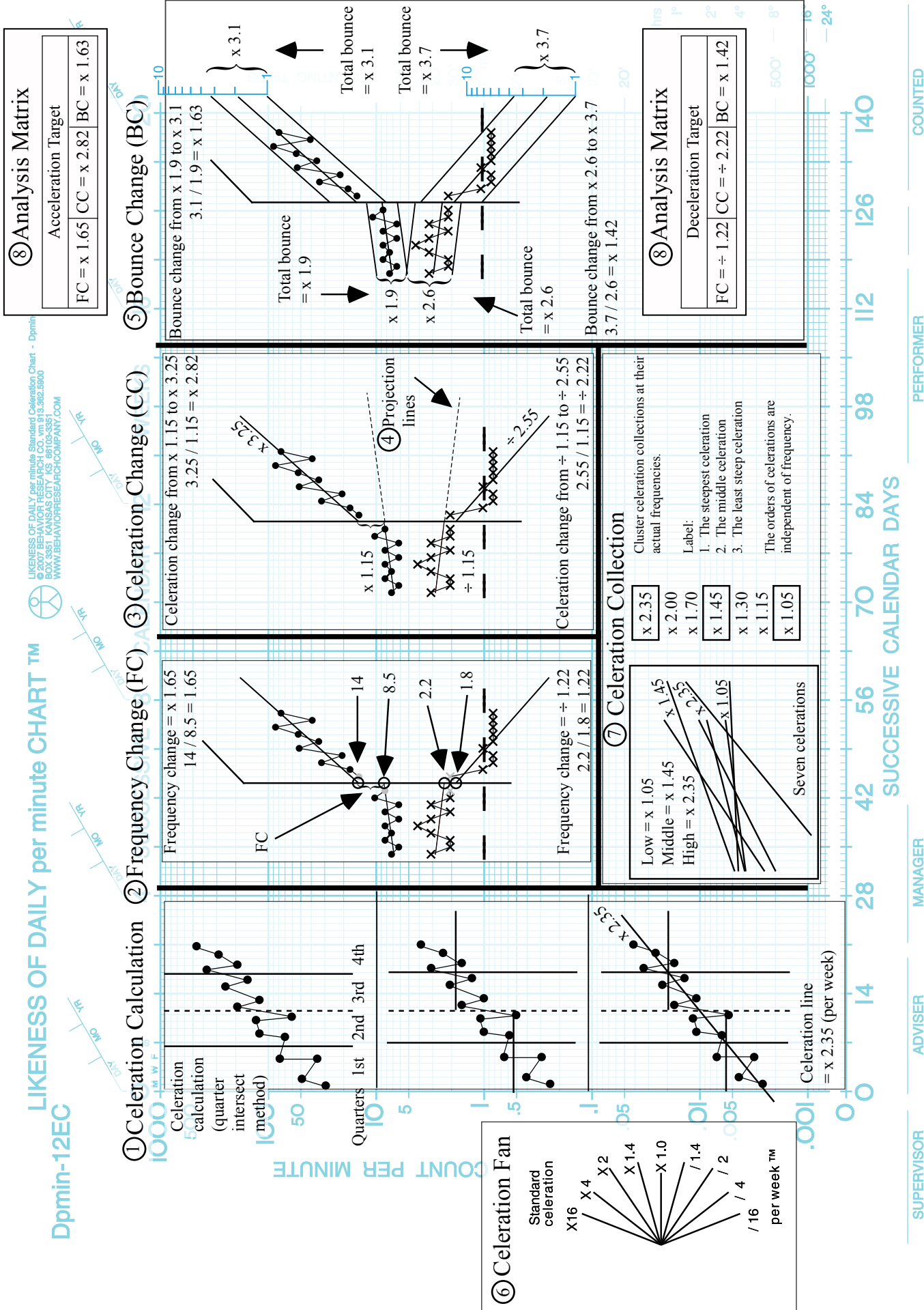
The name of the organization where the counted behavior takes place.

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ADVANCED CHARTING CONVENTIONS for the DAILY STANDARD CELERATION CHART

TERM	DEFINITION	CONVENTION
Tools:		
CELERATION FINDER	A translucent tool (often Mylar) with celeration lines or calibration lines used for computing celeration line values. One edge of the celeration finder has the vertical axis of a Standard Celeration Chart, called a frequency finder, to assist in plotting frequencies and other common charting practices, including alternate techniques to compute celeration line values.	Bought commercially. For a frequency finder, one can copy and cut out part of the vertical axis on the Standard Celeration Chart.
Calculations:		
1. CELERATION CALCULATION (Quarter-Intersect Method)	The process for <i>graphically</i> determining a celeration line (aka "the line of best fit"). Divide the frequencies for each phase into four equal quarters (include ignored and no chance days), locate the median frequency for each half, and then draw a celeration line connecting the quarter intersect points.	See advanced charting conventions sample chart.
Frequency:		
2. FREQUENCY CHANGE (FC) (aka frequency jump up or jump down)	The multiply "x" or divide "÷" value that compares the final frequency of one phase to the beginning frequency in the next phase. Compute this by comparing the frequency where the celeration line crosses the <i>last</i> day of one phase to the frequency where the celeration line crosses the <i>first</i> day of the next phase. E.g., a frequency jump from 6/minute to 18/minute. $FC = x \ 3.0$.	Place an "FC =" in the upper left cell of the analysis matrix. Indicate the value with an "x" or "÷" sign (e.g., $FC = x \ 3.0$).
Celeration:		
3. CELERATION CHANGE (CC) (aka celeration turn up or turn down)	The multiply "x" or divide "÷" value that compares the celeration of one phase to the celeration in the next phase (e.g., a celeration turn down from $x1.3$ to $\div 1.3$. $CC = \div 1.7$).	Place a "CC =" in the upper middle cell of the analysis matrix with the value indicated with an "x" or "÷" sign. (e.g., $CC = \div 1.7$).

TERM	DEFINITION	CONVENTION
4. PROJECTION LINE	A dashed line extending to the future from the celeration line. The projection offers a forecast that enables the calculation of the celeration change value.	See advanced charting conventions sample chart.
5. BOUNCE CHANGE (BC) (aka bounce diverge or converge)	The multiply "x" or divide "÷" value that compares the bounce of one phase to the bounce in the next phase. Computed by comparing the total bounce of one phase to the total bounce of the next phase. (e.g., a bounce change from x 5.0 to x 1.4, BC = $\div 3.6$).	Place a "BC=" in the upper right cell of the analysis matrix with the value indicated with a multiply "x" or divide "÷" symbol (e.g., BC = $\div 3.6$).
6. CELERATION COLLECTION	A group of three or more celerations for different performers relating to the same behavior over approximately the same time period.	Numerically identify the high, middle and low celeration in the celeration collection and indicate the total number of celerations in the collection.
7. CELERATION FAN	The nine-blade celeration fan shows nine reference celerations used to quickly provide a visual estimate of any celeration value by using modifiers of "equal to," "greater than," or "less than."	Celeration fans are printed on all commercial standard celeration charts.
8. ANALYSIS MATRIX	The analysis matrix provides the numeric change information regarding the effects of the intervention(s) on frequency, celeration and bounce between two phases.	Place the analysis matrix between the two phases being compared. For acceleration targets place the matrix above the data. For deceleration targets place the matrix below the data.



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