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PRECISION TEACHING: DISCOVERIES AND EFFECTS

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The only adult in the classroom seems to be loitering. She is not standing in the front lecturing, or sitting at the teacher's desk reading to the class, or grading papers. She is moving about the classroom from student to student, answering a question with a whisper here, offering a quiet suggestion there, helping with a chart decision here, and giving a pat and a smile of appreciation there. Now and then, she calls for a class one-minute practice session.

The students are busy at their desks, in teams of two, timing each other's practice, jumping up to take a chart down from the wall, or to post new data. The students are noisy, shouting correct answers as fast as they can at 200 words per minute, several shouting at once at neighboring desks. It sounds more like an adult cocktail party, or a school recess, than a school classroom. It is not the orderly class that student teachers were taught to manage, with one student out of 30 responding at a time and only when called upon.

The "precision teacher" performs like a coach, an advisor, and an on-line instructional designer. She arranges materials and methods for the students to teach themselves, including self-counting, timing, charting, and one-on-one direction and support.

Many teachers are threatened by this change in their jobs. They entered teaching because they loved to lecture or entertain children. They looked forward to doing that at least 6 hours a day. In this precision teaching (PT) classroom there is almost no lecturing. The entertainment is the thrill from students' visible performance gains. All the students are performing at once. It is noisy. It is mayhem.

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How can you tell how the students are doing? From their charts!

WHAT IS PRECISION TEACHING?

Precision teaching is basing educational decisions on changes in continuous self-monitored performance frequencies displayed on "standard celeration charts." Twenty-five years of practice across the United States and Canada have produced a set of tools, methods, rules, and procedures for making these decisions. High performance aims and custom-tailored prescriptions maximize learning. Least costly and most effective learning occurs with classroom performance timed, counted, and charted daily by the learners themselves. Least costly and most effective learning improvement changes occur with chart-based decisions made weekly by the learners and their teachers.

Tools, Tactics, and Principles for Making On-Line Learning Decisions

Self-counting (Haughton, 1974b; Lindsley, 1968), timing, and charting tools have been developed for the full range of academic and social classroom performance and include even the feelings and urges of learners and teachers. Graphically simplified statistical methods for describing and comparing performance and learning, for projecting future performance, and for summarizing learning within and across learners have been developed for both learners and teachers (Pennypacker, Koenig, & Lindsley, 1972). These simplified tools and methods permit even primary-grade students to project, improve, and summarize their own learning (Bates & Bates, 1971). Taken together, these monitoring methods, learning tactics, and performance principles comprise the current body of PT. Dynamic and continually evolving, PT promises even more powerful tools and methods in the future.

PT Can Improve Any Curriculum

Precision teaching combines well with any curricular approach, except those so antistructure that they cannot permit a counter, timer, or chart in the classroom. The very first classroom application was in a Canadian-style Montessori classroom for exceptional children (Fink, 1968). If an open classroom is open enough to permit counting and charting, its instruction can be improved by PT. Some of the most powerful applications have combined PT fluency monitoring with direct instruction (DI) materials and teaching tactics (K. Johnson, 1989). Direct instruction has even been used to teach children to chart (Maloney, 1982). Precision teaching fluency monitoring combined with personalized system of instruction (PSI) has been markedly successful teaching the full range of college courses (McDade, Austin, & Olander, 1985; Pennypacker, 1982; Pennypacker, Heckler, & Pennypacker, 1977).

A Standard Celeration Chart with Charting Conventions

Figure 1, taken from White (1986), displays Lisa's chart of Dolch words said correctly and incorrectly. Lisa's chart contains descriptions of the standard chart conventions. The charts in general school use do not include the descriptions, and are printed in light turquoise blue ink on special imported rag paper that will last a school semester in the hands of self-charting students (Lovitt, 1973). An early handbook of charting methods and standards is still available (Pennypacker et al., 1972). (Chart paper is available from Behavior Research Company, Box 3351, Kansas City, Kansas 66103.)

From reading Lisa's chart, the following performance facts are clear. Lisa was 7 years old, in second grade, and was labeled learning disabled. On the 17th of September, Lisa started saying Dolch vocabulary words for a minute each school day, but not on Saturday and Sunday. R. Mundt, Lisa's teacher, counted and charted the words Lisa said correctly and incorrectly each day. Lisa's beginning frequencies were about eight correct words per minute with 50 errors per minute, an accuracy of six incorrect for every one correct (14% correct). This shows that Lisa has high curricular courage for Dolch words. Over the next 2 1/2 weeks of daily practice, her correct frequency multiplied by 1.5 per week and her errors divided by 1.8 per week, showing that her errors decelerated more rapidly than her correct responses accelerated. Her accuracy was 20 correct for every 12 errors (63% correct). Her learning picture at this time was what children have called "broken jaws cross-over," showing high correct and error learning.

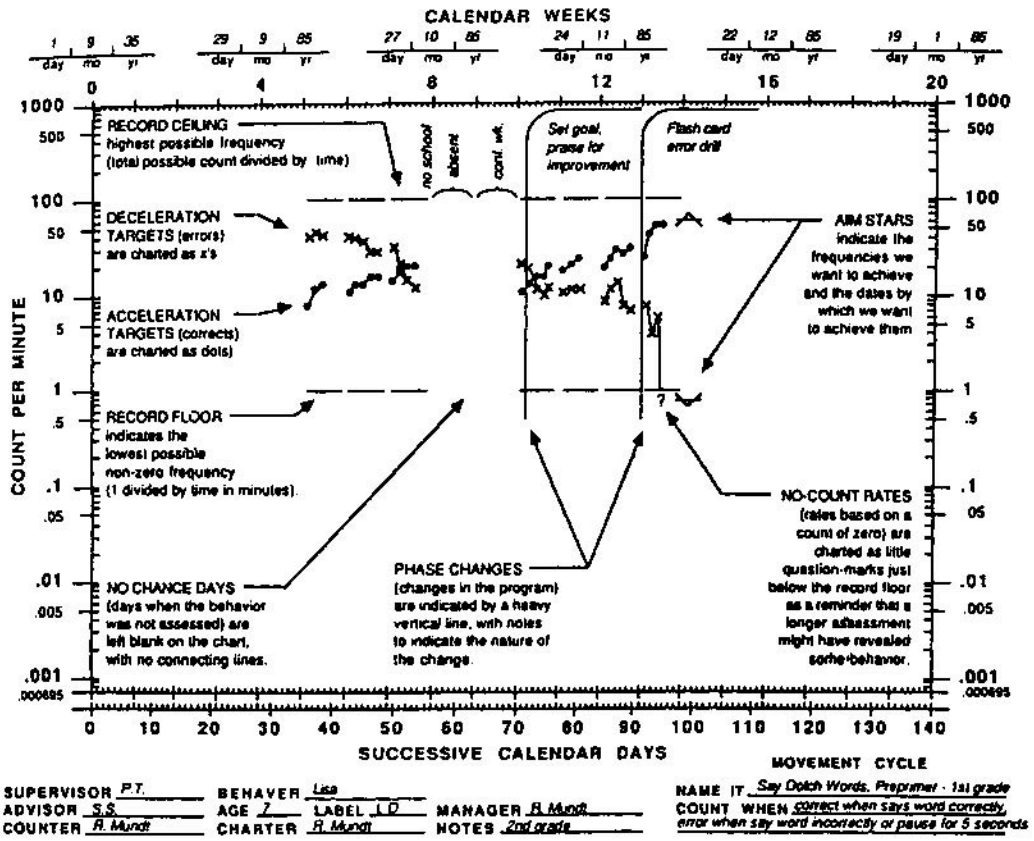
Next came a Friday with no school; she was absent the next week; and the week after that was teacher conference week with no school. Thus, there were over 2 weeks with no practice. On the 11th of November, Lisa's correct frequency had jumped down (divided in half), and her incorrect frequency had jumped up (doubled). This was the price she paid for the 2-week vacation. Precision teaching charts always show sizable setbacks from vacations. Lisa's errors were once again above her correct responses.

Aims were set at 60 words correct per minute with errors below one per minute to be reached before Monday the 9th of December, and praise was added for improvement. The aims and praise did little to increase Lisa's learning. Her correct responses continued to accelerate, multiplying by 1.6 per week, and her errors decelerated, dividing by 1.5 per week. Lisa had a good "jaws" learning picture. However, straight-line projections showed she would not reach her correct aim until the 22nd of December, and her error aim would not occur until the 19th of January. Lisa and Mundt knew they must make a curriculum change to reach their aims by the 9th of December.

In an attempt to increase Lisa's learning (steepen her chart), flash-card error drill on the Dolch words she said incorrectly was begun on the 2nd of December. Lisa's performance at first suffered. Her correct responses jumped down, dividing by 1.5 (—67%), and her errors jumped up, multiplying by 1.5 (+ 50%). However, the jaws of her learning picture widened enough to meet the aims a few days ahead of time. The acceleration of the correct responses had been multiplying by 1.6 per week during praise alone and now turned up to multiply

Figure 1

STANDARD CELERATION CHART AND CHARTING CONVENTIONS



From "Precision Teaching—Precision Learning" by O. R. White, 1986, *Exceptional Children, 52*, p. 529. Copyright 1986 by The Council for Exceptional Children. Reprinted by permission.

by 30 per week, a turn up of 19 (30 / 1.6). Lisa's errors had been dividing by 1.5 during praise alone and now turned down to dividing by 100 per week, a turn down of 67 (100 / 1.5).

The above four paragraphs contain 506 words describing how Lisa practiced and learned her Dolch preprimer, first grade vocabulary words. The learning details displayed on this standard celeration chart are more precise than can be seen in the commonly used percentage correct charts. That's one reason we call it precision teaching. We did not go further into detail and describe the daily bounce in both correct and error frequencies. Neither did we search and locate the causes of exceptional days or celeration shirts. Had we done so, our single picture of Lisa's learning would truly have been worth 1,000 words of text.

Of course, in practice Lisa and her teacher do not read and enumerate all these values, they simply see them in the changing learning pictures. They just set their aims, watch Lisa's learning pictures develop, and try to make changes that will project the learning picture lines to reach both frequency aims before the aims day. Several introductory texts

have been written for teaching PT to special education teachers (Backhoff, 1983; Howell & Morehead, 1987; Kunzelmann, Cohen, Hulten, Martin, & Mingo, 1970; White & Haring, 1976, 1980; Wolking, 1972).

WHERE DID PT COME FROM?

Precision teaching came from free-operant conditioning laboratories to classrooms in 1965. Essentially, it is applying free-operant conditioning's rate of response and standard slope cumulative recording tactics to classroom teaching and research. In 1965, I closed my Harvard Behavior Research Laboratory and went into special education teacher training with the goal of installing frequency monitoring in classrooms. Our laboratory comparisons of frequency monitoring (called rate of response then) with percentage correct monitoring had shown frequency to be always twice and often 50 times more sensitive to environmental and drug changes than was percentage correct. I considered then, and now, as did Skinner (Evans, 1968), that rate of response and the cumulative recorder were Skinner's major contributions. Because most early classroom applications of behavior analysis abandoned both in favor of percentage correct, or percentage of time observed on task, I felt something had to be done (Lindsley, 1971).

Roots in Laboratory Free-Operant Conditioning

I have detailed the roots of PT in several publications (Lindsley, 1971, 1991b, 1991c). The following recendy published acronym helps recall these laboratory contributions (Lindsley, 1991a):

B = Behavior (cycle and results) F = Frequency (count per time) S = Standard slope (charts) K = Kid knows best (learner decisions) I = Induction (teaching and research strategy) N = N of one (teaching and research tactic) N = No observer (self-recording) E = Environment (selects and controls behavior) R = Relationships (recorded directly)

There is not space here to detail these free-operant strategies and tactics and illustrate how they were applied in PT. See the above mentioned references for details. (If the *Journal of Precision Teaching* is not available, printouts of particular articles can be obtained at the Educational Resources Information Center (ERIC), or purchased from the Center for Individualized Instruction, Jacksonville State University, Jacksonville, Alabama 36265-9982.)

Inductively Developed by Teachers

Over the years, I have stressed the need for developing PT in public school classrooms, both special and regular (Lindsley, 1971). Only in this way can one be sure the methods will be practical and work under school conditions. The lack of materials forces teachers to develop new PT tactics. The laboratory schools are usually too well staffed to foster the discovery of inexpensive monitoring techniques. Recently I described how following the founding policies of (a) monitor frequency daily, (b) use self-recording, (c) use standard charts to display major changes, and (d) the child knows best enabled classroom teachers to discover effective teaching techniques (Lindsley, 1990b).

WHAT WAS DISCOVERED BY PRECISION TEACHING?

The argument over basic and applied research seems to go on forever. In our field, *basic* seems to be equated with laboratories and the *Journal of the Experimental Analysis of Behavior,* whereas *applied* seems to go with wards, clinics, offices, classrooms, and homes and *the Journal of Applied Behavior Analysis*. The implication that new basic discoveries cannot be made in the field, and that is why we need the laboratories, is wrong. Isolating variables cannot be done easily in the field, but PT has demonstrated that field monitoring can produce basic discoveries without extensive laboratory isolation. However, continuous monitoring is probably the crucial aspect of successful field discoveries. Follow-up laboratory research could isolate and further refine these discoveries. It is well known that practitioners should watch the laboratory research closely for new discoveries to put

into field practice, but it is not well known that laboratory researchers should watch applied research closely for new variables to validate, isolate, and parametrically analyze. Here follow the 23 major basic discoveries that emerged from thousands of self-monitored standard celeration charts. They are merely mentioned with references included for follow-up details. They are organized under the mnemonic mediators developed for their easy recall.

PRACTICED MUSIC REAPS FUN

PRACTICED helps recall the eight important features of practice that were discovered by precision teachers. Practice must be Particular, Rapid, have Aims and be Added to the curriculum, be Counted by the learner, have 1-minute Timings, be Informed, be Charted, be Error-full, and done Daily.

MUSIC helps recall the four basic counter-intuitive rules of performance discovered by PT. Performance lives in a Multiply world—not add (Koenig, 1972; Lindsley, 1990a). Maximizing performance requires Unique conditions—not common (Lindsley, 1971). Performance is always Specific to the learning situation—not generalized (Galloway, 1972; N. Johnson, 1972). All performance features are Independent—not dependent (All, 1977; Koenig & Kunzelmann, 1980). Performance is pushed by Consequences, not pulled by cause. Although PT did not discover this latter rule, it certainly has supported this feature of the three-term contingency.

REAPS lists the seven performance results produced by fluency (i.e., high performance frequencies usually well above 60 per minute) (Haughton, 1974a, 1981), including longer Retention, greater Endurance, greater generalization to Application, Performance aims for teaching, and Standards for aims and evaluation. The application of these results of fluency to developing standards (Haughton, 1984) and to building attention span (Binder, Haughton, & Van Eyk, 1990) is well documented.

FUN covers three additional performance goals produced by fluency that had not been included in Haughton's original REAPS. Fluent performance is more Fun, generates interest in searching for Understanding, and there is No cheating—not enough time. Adding FUN also completes our mnemonic sentence: PRACTICED MUSIC REAPS FUN!

How effective is precision teaching?

Wherever precision teaching has been used it has almost always doubled student learning at median costs per teacher per year no higher than $90 (Albrecht, 1984). The following two recent cases only sample the large learning gains produced by PT.

Morningside Guarantees Children Two Grade Levels per Year

Morningside Academy in Seattle was established in 1980. It combined PT to fluency with direct instruction and Tiemann-Markle instructional design to teach children with learning and attention problems. Morningside students are given a money-back tuition guarantee if they do not gain two grade levels per year; and in the 7 years since offering the guarantee, Morningside has never had to refund tuition for failure to meet the money-back guarantee (K. Johnson, 1989). Morningside students gain an average of two to three grade levels per year.

Adult Illiterates Gain Two Grade Levels per Month at Morningside

In the fall of 1987, Morningside began a comprehensive adult literacy program in reading, mathematics, and writing for the Job Training and Partnership Act. Morningside agreed to be paid only for those participants who progressed at least two grade levels in two skills in 21 months. Twenty-nine of the 32 African-American males exited with skills at or above the national eighth-grade literacy standard. Their average attendance was 3.8 days per week; they received about 1 hour of instruction in each of two skills per day; and they gained an average of 1.7 grade levels per month (20 hours of instruction) per skill. The U.S. government standard requires only one grade level gain per 100 hours of instruction. Thus, Morningside Academy typically produces over 10 times the gain required by the government standard. Morningside's director attributed part of this success to the economic

contingencies: The faster the students advance, the sooner Morningside Academy is paid (K. Johnson & Layng, 1991).

The Next Source of Learning Discoveries

New learning discoveries from PT have leveled off since 1980. Is this because we have learned all there is about learning? I think not. Our data indicate the contrary. Is this because we have learned more than we need to know about learning? I think yes. As it is now, our methods are overproductive. They produce more learning than the enrollment, tuition, and credit-hour based schools require. Because our methods are now overproductive, our credit-hour based compensation is reduced by further learning production. When the contingency is the more you discover, the less money you make, you will end up discovering nothing at all. The occasional extremely high accelerations seen in our data (celerations as high as multiplying by 10 or even by 40 per week) indicate that students are capable of learning much higher than the doubling per week that we now expect from a top-managed PT classroom.

With center, teacher, and student compensation based on accomplishment (performance gain per week), the motivation to produce more effective learning will be so high that inductive discoveries will start rolling in again. The centers with significantly large learning commissions will be the next source of inductively discovered new learning facts, tools, methods, and rules.

A HOPEFUL FUTURE

I hope, in the future, that if someone observes an adult in a regular classroom, sitting at his or her desk reading to the students, or standing in the front lecturing, or calling upon students to answer questions one by one, he or she will shout, "Where's the teacher?"

REFERENCES

Albrecht, P. L. (1984). *Summary of ten major school precision teaching programs.* Unpublished doctoral dissertation, University of Kansas, Lawrence.

All, P. (1977). *From get truckin' to jaws, students improve their learning picture.* Unpublished master's thesis, University of Kansas, Lawrence.

Backhoff, E. E. (1983). *La ensenanza de precision: guia practica para la evaluacion educativa.* Mexico, D.F Mexico: Editorial Trillas, S.A. de C.V.

Bates, S., & Bates, D. F. (1971). ". . . and a child shall lead them." Stephanie's chart story. *Teaching Exceptional Children,* 3, 111-113.

Binder, C. V., Haughton, E., & Van Eyk, D. (1990, Spring). Increasing endurance by building fluency: Precision teaching attention span. *Teaching Exceptional Children.* 24-27.

Evans, R. I. (1968). *B. F. Skinner: The man and his ideas.* New York: E. P. Dutton & Co., Inc.

Fink, E. R. (1968). *Performance and selection rates of emotionally disturbed and mentally retarded preschoolers on montessori materials.* Unpublished master's thesis, University of Kansas, Lawrence.

Galloway, C. (1972). Precision parents and the development of retarded behavior. In J. B. Jordan & L. S Robbins (Eds.), *Let's try doing something else kind of thing* (pp. 92-109). Arlington, VA: Council for Exceptional Children.

Haughton, E. C. (1974a). Define your act and set your fluency goals in personal, social, and academic areas. *Special Education in Canada,* **48,** 10-11.

Haughton, E. C. (1974b). Myriad counter (or, beads that aren't for worrying). *Teaching Exceptional Children,* 6, 203-209.

Haughton, E. C. (1981, March). REAPS. *Data Sharing Newsletter.*

Haughton, E. C. (1984). Standards: Refining measurement. *Journal of Precision Teaching,* 4, 96-99.

Howell, K. W., & Morehead, M. K. (1987). *Curriculum-based evaluation for special and remedial ed.* Columbus, OH: Merrill.

Johnson, K. R. (1989). *Executive summary.* Seattle Morningside Corporation.

Johnson, K. R., & Layng, T. V. J. (1991). *Breaking the structuralist barrier: Literacy and numeracy with fluency.* Seattle: Morningside Corporation.

Johnson, N. (1972). Precision teaching cuts across cultural lines. In J. B. Jordan & L. S. Robbins (Eds.), *Let's try doing something else kind of thing* (pp. 84-91). Arlington, VA: Council for Exceptional Children.

Koenig, C. H. (1972). *Charting the future course of behavior.* Unpublished doctoral dissertation, University or Kansas, Lawrence.

Koenig, C., & Kunzelmann, H. P. (1980). *Classroom learning screening.* Columbus, OH: Merrill.

Kunzelmann, H. P., Cohen, M. A., Hulten, W. J., Martin G. L., & Mingo, A. R. (1970). *Precision teaching: An initial training sequence.* Seattle, WA: Special Child Publications.

Lindsley, O. R. (1968). A reliable wrist counter for recording behavior rates. *Journal of Applied Behavior Analysis,* 1, 77-78.

Lindsley, O.R. (1971). From Skinner to precision teaching The child knows best. In J. B. Jordan & L. S. Robbins

(Eds.), *Let's try doing something else kind of thing* (pp. 1-11). Arlington, VA: Council for Exceptional Children.
Lindsley, O. R. (1990a). Our aims, discoveries, failures, and problem. *Journal of Precision Teaching,* 7, 7-17.
Lindsley, O. R. (1990b). Precision teaching: By teachers for children. *Teaching Exceptional Children,* **22,** 10-

Lindsley, O. R. (1991a). B. F. Skinner—Mnemonic for his contributions to precision teaching. *Journal of Precision Teaching,* 8, 2-7.
Lindsley, O. R. (1991b). B. F. Skinner (1904-1990): Thank you, grandpa Fred! *Journal of Precision Teaching,* 8, 5-11.
Lindsley, O. R. (199lc). Precision teaching's unique legacy from B. F. Skinner. *Journal of Behavioral Education,* 1, 253-266.
Lovitt, T. C. (1973). Self-management projects with children with behavioral disabilities. *Journal of Learning Disabilities,* 6, 15-18; 20-28.
Maloney, M. (1982). Teaching the daily standard behavior chart: A direct instruction approximation. *Journal of Precision Teaching,* 2, 11-30.
McDade, C. E., Austin, D. M., & Olander, C. P. (1985). Technological advances in precision teaching: A comparison between computer-testing and SAFMEDS. *Journal of Precision Teaching,* 4, 49-53.
Pennypacker, H. S. (1982). Higher education [about PT]. *Journal of Precision Teaching,* 3, 25-26.
Pennypacker, H. S., Heckler, J. B., & Pennypacker, S. F. (1977). The personalized learning center: A university-wide system of personalized instruction. In T. A. Brigham & A. C. Catania (Eds.), *Handbook of applied behavioral research* (pp. 591-617). New York: Irvington Press.
Pennypacker, H. S., Koenig, C. H., & Lindsley, O. R. (1972). *Handbook of the standard behavior chart.* Kansas City, KS: Precision Media.
White, O. R. (1986). Precision teaching—Precision learning. *Exceptional Children,* **52,** 522-534.
White, O. R., & Haring, N. G. (1976). *Exceptional teaching: A multimedia training package.* Columbus, OH: Memll.
White, O. R., & Haring, N. G. (1980). *Exceptional teaching, 2nd ed.* Columbus, OH: Merrill.
Wolking,W. (1972). *Precision educational measurement: The direct and continuous measurement of pupil behavior: A self-instruction module.* Tallahassee, FL: Florida State Department of Education.

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