Lindsley & Precision Teaching

Athabasca University Psychology Server
Psychology 387
http://psych.athabascau.ca/html/387/OpenModules/Lindsley/

Precision Teaching: A Brief History

Precision Teaching has its roots in free-operant conditioning laboratories.[1] Free operant means that "students are free to respond at their own pace without having restraints placed on them by the limits of the materials or the instructional procedures of the teachers" (Lindsley, 1990b, p. 10). During the 1950s, Ogden Lindsley was successfully applying these methods to the behaviors of psychotic children and adults at his Harvard Behavior Research Laboratory. His research was showing "frequency to be 10 to 100 times more sensitive than percentage correct in recording the effects of drugs and different reinforcers" (Lindsley, 1990b, p. 10). He was painfully aware that when researchers applied their methods, even behavioral methods, to academic behaviors of school children, they typically recorded only percentage correct, "the time-honored educational measure." He attempted to change this practice by urging visiting educators to his laboratory to standardize the frequency of response in their classrooms. He recalls

> I knew the real power of learning enhanced by free-operant conditioning lay in frequency of responding (by allowing the student to be both accurate and fluent) and standard self-recording. When education would not heed my caution and could not see my vision for dramatic learning opportunities, I decided the ethical thing to do was to close my hospital laboratory and devote myself to education. (Lindsley, 1990b, pp. 10-11)

In 1965, Lindsley shifted his focus to special education teaching training. His initial aim was to introduce free operant technology into public school classrooms.

> Our first class-wide frequency recording was in a Montessori class for special education children...Elaine Fink showed we could effectively use rate of response with curricula as varied and as difficult to measure as Montessori materials. Clay and Ann Starlin showed an entire first grade class could correct and chart their own academic work on standard celeration charts...Ron Holzschuh with Dorothy Dobbs and Tom Caldwell showed that academic frequencies (rates) recorded 40 times more effects of curricular changes than did percent correct...These and many other studies proved behavior frequencies significantly more sensitive to

---

[1] [Owen's comments] An "operant" is any behavior or class of behaviors whose rate or probability of occurrence is governed (at least in part) by its history of consequences (i.e., events *following* its emission). Operants are distinguished from "respondents," whose emission is governed primarily by antecedent events (e.g., reflexes). "Conditioning" is any operation that alters the rate or probability of a behavior through manipulation of the environment (e.g., reinforcement, punishment).

learning variables in the classrooms than percent correct and percent of time on task." (Lindsley, 1990a, p. 7).

Lindsley goes on to say that he and his colleagues "were successful beyond our dreams." The aim [of introducing operant conditioning into the classroom] was met within three years. One key development during that time was a standard chart for teacher and student recording. Since then, Lindsley and colleagues have collected data from thousands of these charts, resulting in a number of inductive, counter-intuitive discoveries, some of which will be described later in this module (for a complete summary, see Lindsley, 1990a; 1995; also Binder, 1996).

Precision Teaching: Concept Definition and Guiding Principles

Precision Teaching boils down to "basing educational decisions on changes in continuous self-monitored performance frequencies displayed on 'standard celeration charts'" (Lindsley, 1992a, p. 51). As such, it does not prescribe what should be taught or even how to teach it: "Precision teaching is not so much a method of instruction as it is a precise and systematic method of evaluating instructional tactics and curricula" (West & Young, 1992, p. 114).

Precision Teaching as a discipline can be summarized by several guiding principles (Lindsley, 1990b; West & Young, 1992; White, 1986):

1. Focus on Directly Observable Behavior
2. Frequency as a Measure of Performance
3. The Standard Celeration Chart
4. The Learner Knows Best

1. Focus on Directly Observable Behavior

To avoid ambiguity, Precision Teachers attempt to translate learning tasks into concrete, directly observable behaviors that can be counted and recorded. McGreevy (1983) recommends that the task be a physical movement, something the person is doing. For example, the physical acts involved in "putting on a sweater" could be observed and counted. Another alternative is to count a tangible product of something that has been done, such as "sweater on body."

At least three issues are important to consider here. First, some tasks are by their very nature private, such as reading silently. A Precision Teacher confronted with a child who is a poor silent reader needs to make silent reading public in some way, so he or she can count, record, and ultimately improve it (White, 1986). For example, in order to gauge the Mary's decoding skills, the teacher might require Mary to read out loud and count the number of words read properly. Or, in order to gauge Mary's comprehension skills, the teacher might provide a list of questions to Mary after she silently read a passage and then count the number of correct answers written by Mary.

Second, sometimes it is tempting to describe tasks as not doing something (e.g., not swearing) or as the absence of movement altogether (e.g., sitting quietly). The teacher attempting to count and work with these tasks, as defined, will certainly encounter difficulties. One solution is to invoke the Dead Man's Rule: "If a dead man can do it, then it ain't behavior." A dead man can "not swear" and a dead man can "sit quietly;" thus, neither of these task definitions is appropriate. However, this need not be a dead end, so to speak. "Not doing something" (e.g., not swearing) can easily be redefined in terms of the act of doing it (e.g., swearing). And, it is almost always the case that "non-movement" tasks (e.g., sitting quietly) can be re-conceptualized in terms of movement (e.g., speaking out loud).

Third, it is important to keep in mind the distinction between a movement and a label. While a label is convenient for summarizing a performance, it usually has little to say about the movement involved in that performance. From a behavioral perspective there are a number of problems with labels (Grant & Evans, 1994), but for the Precision Teacher one stands out above all others: labels are not countable. What is the teacher to count when Ben is labeled a "sloppy eater" or Ann is labeled "shy in the classroom." Countable movements for each of these two problems could be: "Ben moves a utensil with food from his plate to his mouth without spilling the food" and "Ann raises her hand to volunteer an answer when the teacher poses a question."

2. Frequency as a Measure of Performance

In Precision Teaching, a behavior frequency is "the average number of responses during each minute of the assessment period" (White, 1986, p. 523). It is specified as counts per minute. Precision Teachers have written extensively about the advantages of frequency data over traditional measures in education such as percent correct (e.g., Binder, 1996; Lindsley, 1991; West & Young, 1992). Two of them will be noted here. First, frequency data are ultimately more useful. Fluent (i.e., accurate and high frequent) performance is retained longer, endures better during long time-on-task periods, is less likely to be affected by distracting conditions, and is more likely to be applied, adapted or combined in new learning situations, even in the absence of instruction (Binder, 1996; see also West & Young, 1992).

White (1986) recounts the story of Patsy, a third grade learning disabled student who had difficulties pronouncing short vowels. Patsy's teacher eventually taught her to correctly say the sounds, so well in fact that she went nine days in a row at school without making any errors. Unfortunately, Patsy was still unable correctly pronounce words during her daily activities. However, once she learned to say the sounds at a frequency of 80 per minute, twice the rate of her normal peers, her pronunciation in her daily life did improve. In other words, Patsy's ability to apply her newly learned skill had nothing to do with her ability to say the sounds correctly and everything to do with her ability to say the sounds fluently.

A second advantage of frequency data is that they provide a more complete account of how well an instructional program is working for any given student. For example, the accuracy of both David and Paul's in-class solutions to math problems may be 100% correct. However, David may have solved 10 problems in the allotted time, while Paul may have solved only three problems. Paul's slow or dysfluent (but perfectly accurate) performance may be the result of him relying too heavily on additional assistance. Maybe Paul's correct answers are dependent upon him first reviewing the model solutions in his textbook. Paul obviously does not know the subject matter as well as David, although his accuracy scores do not reflect this fact.

3. The Standard Celeration Chart

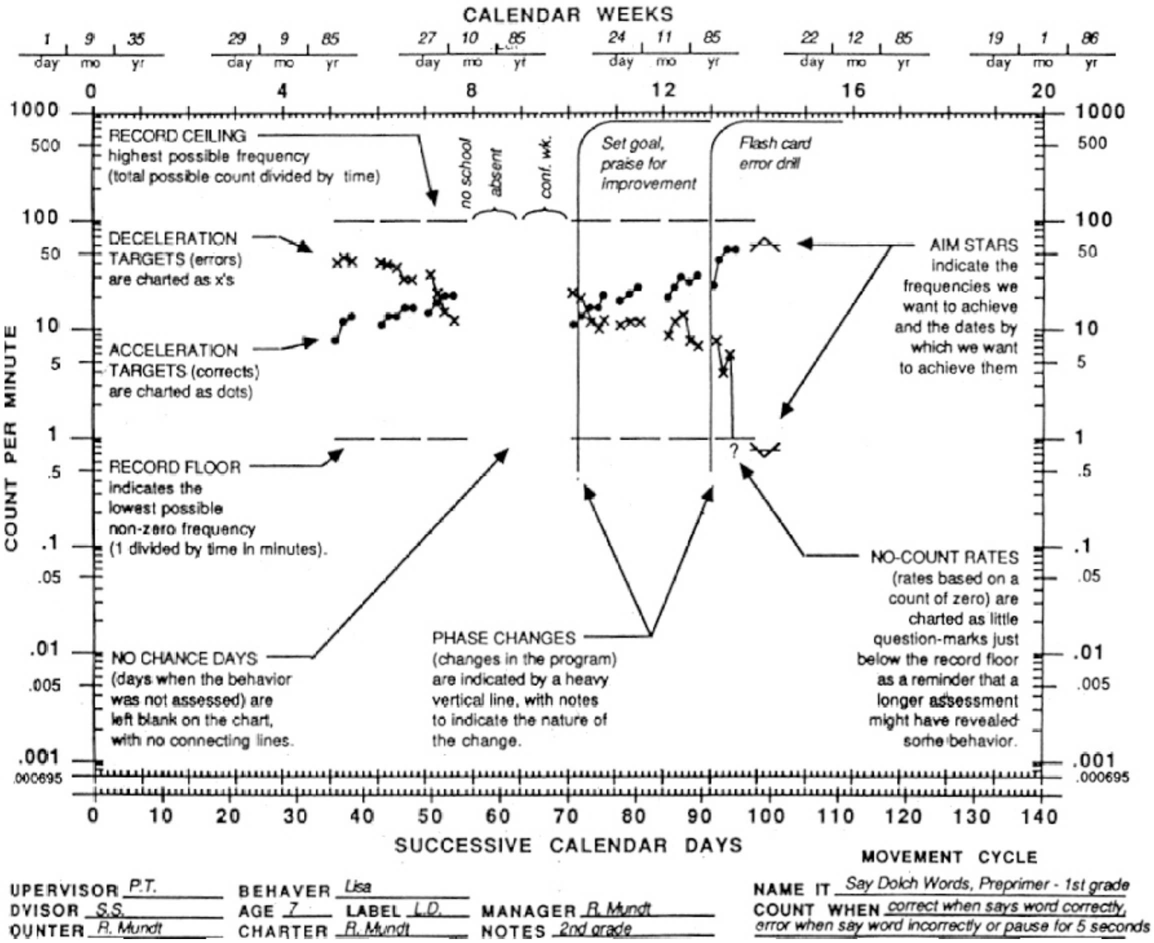

Figure 1: Standard Celeration Chart & Charting Conventions
(adapted from White & Haring, 1980).

Lindsley (1990b) provides a brief history of the Standard Celeration Chart.

> ...it was not until I was training teachers at the University of Kansas Children's Rehabilitation Unit that I was compelled to have a custom chart printed. The teachers met once a week for a 3-hour class. I required that they improve a behavior of one of their pupils and also one of their own behaviors. The teachers shared their progress on these behavior change projects by showing charts in class each week. It took 20 to 30 minutes to share one behavior project because most of this time was spent describing each teacher's unique charting and recording system. (p. 11)

Lindsley recalls that "in desperation" he developed a standard chart. The y-axis was set up on a multiply scale to accommodate behavior frequencies ranging from 1 per day to 1,000 per minute; the x-axis was set up on an add scale to accommodate 140 successive calendar days, which is about the equivalent of one school semester. Thus, both frequent and infrequent behaviors could be plotted on the same graph and displayed for an entire semester. A goal of standardization was to save teachers time drawing and labeling the charts, and reading and interpreting the data. This latter point is especially important: "When teachers allow themselves the luxury of making a new chart for each behavior and learner, different pictures of progress are formed, the comparison of one program with another is difficult, and the evaluation of how well as program is working can be in error" (White, 1986, p. 524). Figure 2 illustrates how the same data plotted on two different scales can suggest different impressions of a student's progress.

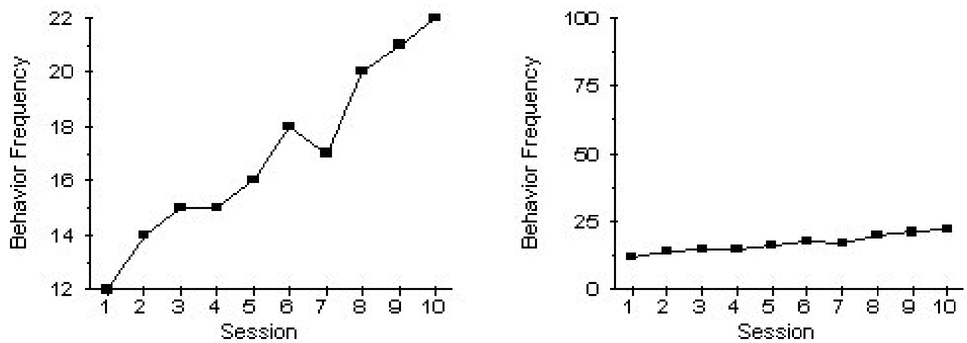

Figure 2. *The same data plotted on two different scales. Performance appears to be changing much more rapidly in the left panel.*

The multiply (logarithmic or ratio) scale of the y-axis on the Standard Celeration Chart offers other advantages. As West & Young (1982) note:

> When the scores from repeated measures of performance are plotted on the more typical 'equal interval' or 'arithmetic' scale, learning (represented by a line or function which 'best fits' the data) is found to accelerate. In other words, a curve with an ever steeper slope is created. When data are plotted on the standard celeration chart, learning is generally represented by a straight or nearly straight line. The value of the slope of the line which best fits the distribution of values on the logarithmic scale is thought of as an 'index of learning' The steeper the slope, the faster the learning is; the flatter the slope, the slower the learning is. (p. 132).

The word celeration is the root word of acceleration and deceleration, the two ways in which behavior can change on the chart. When frequency doubles from one point in time to the next, it is said to be accelerating at "times 2," abbreviated as x2. When frequency is cut in half from one point in time to the next, it is said to be decelerating at "divided by 2," abbreviated as /2. Celeration is standardized in the sense that equal ratios of performance change appear as equal slopes on the chart, independent of the starting frequency. For example, a change from 1 to 2 (x2) would look similar to a change from 50 to 100 (x2). On an add scale, a change from 1 to 2 (+1 but x2) would be dwarfed by a smaller proportional change from 80 to 100 (+20 but x1.25). This is illustrated in Figure 3. Lindsley (1990a) suggests we abandon the terms "increase" and "decrease" altogether when describing behavior change. He claims that a major discovery of Precision Teaching is that all behavior "multiplies" or "divides" and that we best think in these terms.

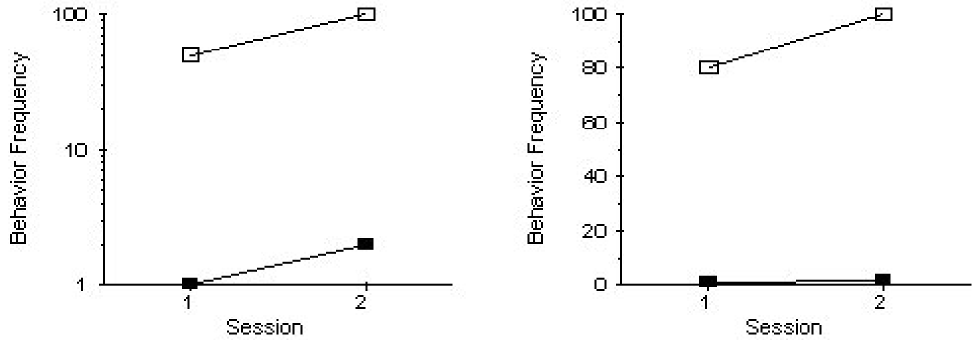

Figure 3. *In the left panel, a multiple scale is used for the y-axis. A change from 1 to 2 (filled squares) has the same slope as a change from 50 to 100 (open squares). In both cases, frequency multiples by 2. In the right panel, an add scale is used for the y-axis. Although a change from 1 to 2 (filled squares) is proportionally greater than a change from 80 to 100 (open squares), the slope of the line is actually much steeper in the latter case because frequency adds by one when changing from 1 to 2 and adds by 20 when changing from 80 to 100.*

A straight line drawn from the lower left corner to the upper right corner of the Standard Celeration Chart has an angle of 33 degrees, which represents a x2 change. (Similarly, a straight line drawn from the upper left corner to the lower right corner represents a x2 change.) Lindsley's hope was that "If the central slope of the chart was a doubling, it would prompt our teachers to produce doublings of their pupil's frequencies each week" (Lindsley, 1990b, p. 11). In this way, teachers might be more prone to discover major classroom variables that would affect student learning.

The major conventions for the Standard Celeration Charting are beyond the scope of this tutorial, although many of them are listed on Figure 1. For an excellent source of additional information regarding the Standard Celeration Chart, see Dr. John Eshleman's web site, Standard Chart Topics -- A Precision Teaching Resource Website

4. The Learner Knows Best

Lindsley (1990b) tells a story of how he came to adopt this statement as a policy and slogan for Precision Teachers.

> When I was a graduate student, I trained a rat whose behavior did not extinguish exactly as the charts in Skinner's (1938) book had shown. My rat at first had responded much more rapidly when his responding was no longer reinforced. The rapid responding went on for about 30 minutes, at which time the rat stopped abruptly. I took the cumulative record of the rat's unusual extinction to Dr. Skinner and asked him how this had happened. How could the rat do this when the book showed a very different gradual extinction curve? Skinner answered, "In this case, the book is wrong! The rat knows best! That's why we still have him in the experiment! (p. 12)

A general rule of thumb in Precision Teaching is that if a student is progressing according to plan, then the program is appropriate for that student; otherwise, there is a flaw in the program and it needs to be changed in some way. In other words, the student's performance determines the "right" teaching strategy.

Students are active participants in Precision Teaching. Typically, students keep count of their movements on a daily basis and record the counts on a Standard Celeration Chart. This enables students to "see" their learning. The visual display reveals ongoing performance in relation to the goal, and is the basis on which the teacher and student decide what to do next. Lindsley (1990a, p.11) notes five advantages of students taking this active role:

1. It costs less than teacher or observer recording.
2. It produced records as reliable and much more valid than other recording.
3. The effects produced were usually larger than teacher managed effects.
4. It developed a trust of the learner in contrast to the erosion of trust produced by double checking of counts by teacher and observer.

The learners developed higher order self-management skills to take with them in later life.

Precision Teaching: Applications

According to White (1986), Precision Teaching "has been used successfully to teach the progress of learners ranging from the severely handicapped to university graduate students, from the very young to the very old" (p. 530). Because Precision Teaching dictates neither the content nor the teaching strategy, it combines well with any curricular approach (Lindsley, 1992a). The first classroom application was in conjunction with a Canadian-style Montessori curriculum for exceptional children (Fink, cited in Lindsley, 1992a). Precision Teaching has also been combined with Direct Instruction and Tiemann-Markle instructional design to teach children with learning and attention problems (Johnson & Layng, 1992; 1994) and the Personalized System of Instruction to teach a variety of college courses (Pennypacker, Heckler, & Pennypacker, 1977; but see McDade & Olander, 1987). The Center for Personalized Instruction at Jacksonville State University developed a "Computer-Based Precision Teaching Learning System" (McDade, 1992). The Center encourages faculty members to employ this system to teach their courses. Instructors who participate write content-related questions and bring them to the Center, where the questions are then incorporated into a Precision Teaching format. Courses have been developed in anthropology, archeology, biology, geography, history, mathematics, political science, and psychology. In 1986, the Center offered 100 sections of 28 courses (McDade & Olander, 1987).

One of the most widely cited successful applications of Precision Teaching was conducted in Great Falls, Montana in the early 1970's (Beck, cited in Binder & Watkins, 1990). During a four year span, teachers at Sacajawea elementary school incorporated 20 to 30 minutes of daily Precision Teaching into a curriculum that was otherwise identical to other schools in the district. Their students advanced 19-40 percentile points higher on the Iowa Test of Basic Skills than students elsewhere in the district. Impressive results have also been reported at Morningside Academy[2], a school in which Precision Teaching plays a major role.

> Due to its successes, Morningside Academy now offers parents two money-back guarantees. The first is for children who are two or more years behind in school. Many children in this group have been officially classified as "learning disabled" by public school personnel. These learners, who have rarely gained more than a half a year in any one academic year, will gain at least two grade levels per school year or their parents will receive a tuition refund in proportion to the shortfall. The second guarantee is for any other learners who are not much behind in grade-level achievement but who stand apart from their peers because they do not coordinate visual and motor skills effectively, as is most apparent in their handwriting. These students are also highly distractible, hyperactive, disorganized, and have poor study and independent learning skills. Many children in this group have been officially classified by their pediatricians or other medical personnel as "attention deficit disordered" (ADD). Morningside Academy guarantees that these learners will increase their time-on-task endurance from their typical 1 to 3 minutes spans to 20 minutes or more-an attention span longer than that of the average college learner...Since the seven years since the assurances have been in place, Morningside has never had to refund tuition for failure to meet its money-back guarantees. (Johnson & Layng, 1994, pp. 174-175).

Precision Teaching also appears to be cost effective. A survey by Albrecht (cited in Lindsley, 1991) found that the median cost for teacher training was about $300 per year per teacher in the first year and $60 per teacher per year in subsequent years. This latter figure translated to only $3.50 per pupil per year.

Applications have not been limited to the classroom. For example, Binder & Bloom (1989) employed Precision Teaching strategies to help employees at two banks attain fluency with facts about products and service. A written post-test revealed that they "were able to respond to questions and statements of need with near total accuracy in about three to four seconds." Furthermore,

> This is a level of performance that supports fluent face-to-face sales interactions. With results like these, it's no wonder that line managers call this program a business advantage. The Fluency-building approach makes a tangible difference in the performance of sales staff, and anecdotal reports confirm that sales were made after the training which would have been missed before. (p. 20)

Another interesting application is under way by David Feeney, Distance Education Project Director at Temple University. Precision Teaching is being delivered online to promote self-management of behaviors such as exercise, smoking, and studying. To see a summary of this recent research, click here.

---

[2] [Owen's Comment] Morningside Academy is a private school located in Seattle. Students might find a tour of that school instructive. If you're interested, contact Kent Johnson kent@morningsideacademy.org

Precision Teaching: A Five-Step Process

McGreevy (1983) outlined Precision Teaching as a five-step process in his wonderful book, Teaching and Learning in Plain English. What follows is a summary of McGreevy's presentation. A complete account of Precision Teaching is beyond the scope of this module. The remainder of this section (and the ensuing exercise) attempts only to highlight some important features of each of these steps in order that readers get their feet wet, so to speak. Anyone interested in learning more about Precision Teaching is encouraged to seek out this informative source (see also White & Haring, 1980).

1. Select a Task (Pinpoint)
2. Set an Aim
3. Count and Teach
4. Develop a Learning Picture
5. Decide What to Do

Step 1: Select a Task (Pinpoint)

A task should be: (A) countable, (B) have a counting period, (C) include a correct /incorrect pair, (D) specify the learning channel set, and (E) be a movement that is "hard-to-do."

A. Countable

Earlier we described how Precision Teachers attempt to translate learning tasks into concrete, directly observable behaviors that can be counted and recorded. For issues related to this topic, review the Focus on Directly Observable Behavior section.

B. Counting Period

The counting period is the amount of time each day one spends counting the movement (McGreevy, 1983, p. 11-12). The counting period might be as short as 1 minute or as long as 24 hours. For example, one might count "Susan makes free-throw shots for 1 minute" or "Dan eats a candy bar throughout the day."

It is important that the counting period be the same each the day. Suppose "Susan makes free-throw shots" is assessed for 2 minutes on some days and for 4 minutes on other days. Even if all the scores are converted to "counts per minute," there is a problem. Susan may become fatigued during 4-minute timings, with her performance deteriorating about half way through. Thus, the two timings of the same movement seem to represent two separate tasks, distinguished by differing levels of required endurance.

The counting period needs to be long enough so that the movement can occur frequently, at least 8-10 times. For example, if the counting period is 1 minute and Susan is unable to shoot, let alone make, 8-10 free-throw shots in that time, then the teacher should consider lengthening the counting period.

Another scenario concerns movements that occur infrequently throughout the day. For example, Dan might normally attempt to set his alarm clock once daily. Even if the counting period was extended to as long as 24 hours, at best the frequency would be one. In cases like these, Dan and his teacher may have to set up a special time (maybe 5 minutes each night) when Dan can practice the behavior over and over again.

Yet another scenario concerns complex movements. For example, "Mark feeds the dog" consists of four smaller movements: (1) Mark gets the dog bowl from cupboard, (2) Mark opens the bag of dog food, (3) Mark pours the right amount of dog food into the bowl, and (4) Mark places the food bowl in dog eating area. In such a case, McGreevy (1983) recommends that the counting period be the length of time that it takes a skilled person to perform the task. Mark's parents may be able to feed the dog in 2 minutes; thus, the counting period for "Mark performs the four steps of feeding the dog" would be 2 minutes (with each step constituting a count). When the counting period is less than 5 minutes, one should consider including more than a single counting period each day. For instance, Mark might practice feeding the dog three times daily, for a total counting period of 6 minutes.

C. Correct/Incorrect Pair

A task description should include both what to do (correct) as well as what not to do (incorrect). Ideally, one should count and work with both correct and incorrect movements. Sometimes it is easy to forget this, especially when the student's problem is severe. For example, the greater the frequency of Bobby whining throughout the day, the greater the resolve of the teacher to eliminate it. But the teacher should always consider what movement should occur in place of the undesirable one. Otherwise, he or she may get rid of one problem (whining) only to see it replaced with another one (tantruming). Behavior reduction procedures are improved when the teacher maximizes the conditions for a desirable alternative behavior (Martin & Pear, 1998).

To illustrate, consider the improved modifications to some of our previous examples. In each case, the teacher would be counting and working with a correct and an incorrect movement.

- Ben moves a utensil with food from his plate to his mouth without (correct) or with (incorrect) spilling the food
- Mark performs each of the 4 steps of feeding the dog correctly or incorrectly for 2 minutes
- Susan makes (correct) or misses (incorrect) free-throw shots for 1 minute
- Dan eats a piece of fruit (correct) or eats a candy bar (incorrect) throughout the day

McGreevy (1983) recommends that if one cannot work with both correct and incorrect movements, then always count and work with the correct movement.

D. Learning Channel Set

Each task description should be make clear both the input (or receive) channel and an output (send) channel. Ways in which we input information include seeing, hearing, smelling, touching, tasting, and feeling (tactile). Precision Teachers also consider internal events such as thinking and feeling (emotion) to be input channels. The output channel could involve any movement on the part of the learner. Common output channels include saying, writing, pointing, drawing, and performing. A learning channel set specifies both the input channel and the output channel. For example, suppose a student uses flashcards to learn common terms in her course. If she does so by looking at a definition on one side of the card and then saying the term that comes to mind, the learning channel set would be summarized as see and say.

McGreevy (1983) notes that two advantages of learning channel sets are that they "tell other people how we are teaching a task" and they alert to the teacher to the fact that "there are many ways to learn the same movement" (p. II-18). For example, in the beginning, the learning channel set for Susan may be guide and shoot: "Susan feels the coach guide her arms as shoots a free throw correctly or incorrectly in one minute." Later, the learning channel set may be hear and shoot: "Susan hears the coach tell her what to do as she shoots a free throw correctly or incorrectly in one minute." Ultimately, the learning channel set would become think and shoot: Susan thinks about making a free throw as shoots a free throw correctly or incorrectly in one minute." Specifying the learning channel set at each stage in teaching makes it clear that the coach is providing less and less assistance.

There is another reason why teachers should consider learning channel sets. Lindsley (1990; 1995) claims that behavior is independent. This implies that we should not assume that because a student has mastered a task in one learning channel set that the student can then perform a second task in another learning channel set, no matter how apparently similar the two tasks. For example, a student who has mastered a hear and select task (e.g., hear "Dog" / select picture of dog) will not necessarily be able to perform a related see and say task (e.g., see picture of dog / say "dog") (cf., Sidman, 1994, pp. 227-228).

E. "Hard-To-Do"

A task should be selected on the basis that it is "hard-to-do." An assessment should reveal that there is room for improvement for both correct and incorrect movements. The goal is to teach the student a new task, not something he or she already knows how to do.

Sometimes an assessment may reveal that the correct movement occurs well below the goal level but incorrect movements are at or close to zero. Thus, there is room for improvement for correct movements only. This sort of learning picture suggests that the student may be avoiding any sort of movement that could be scored as incorrect, perhaps because errors had been punished in the past. The teacher should encourage to go faster and not worry about mistakes (e.g., see Bower & Orgel, 1981). In Precision Teaching, errors are considered to be learning opportunities: the more movements, correct or incorrect, the more chances to learn.

Step 2: Set an Aim

The aim refers to the final desired level of performance, generally one in which there is a high frequency of correct movements and a zero frequency of incorrect movements. This is referred to as reaching aim and "0". The pacing of correct movements specified in the aim should be "rapid, smooth, and natural," that is, performance should be fluent (Binder, 1996). To determine an aim, the teacher might ask a skillful person to perform the task during the counting period; the frequency obtained by that person would then be used to determine the aim for the student. If the star of the basketball team typically sinks at least 10 free-throw shots in 1 minute, then the aim for Susan could be: sinks at least 8 free-throw shots in 1 minute. Enhanced self-esteem and motivation are likely outcomes for the student who reaches fluency aims (McGreevey, 1983).

Early on, Precision Teachers set aims as described above, that is, based on norm-based reference criteria such as the average performance of "typical" students or "truly competent" students (Johnson & Layng, 1994). In recent years, however, many Precision Teachers have abandoned this practice and started using minimum component behavior frequencies to establish aims (Binder, 1996). Earlier we noted that fluent (i.e., accurate and high frequent) performance is retained longer, endures better during long time-on-task periods, is less likely to be affected by distracting conditions, and is more likely to be applied, adapted or combined in new learning situations, even in the absence of instruction. Minimum component frequencies predict these outcomes. As Binder (1996) explains:

"The determination of performance standards based on the criterion that they optimally support retention, endurance, and application suggests a virtually endless program of investigation that could keep researchers busy for decades. To meet the challenge...we need to determine for each behavior class, the frequency ranges required for optimally supporting each of these outcomes. Moreover, the frequencies are likely to vary for any given class of behavior. For example, an individual might permanently retain or remember math facts practiced to 60 to 70 per minute, with negligible improvements in retention beyond that range, yet continue to improve in the ability to apply the skill in mental math as it accelerates beyond 100 per minute. That is, the optimal frequency for retention may be different from that for endurance or application. Multiplied by the total number of response classes in a human repertoire, this challenge may be practically impossible to address for every important one. Nonetheless, practitioners and researchers will continue to investigate and experiment with levels of performance and their effects in several important domains, most notably academic and intellectual skills." (p. 174)

Step 3: Count and Teach

Exactly what one counts obviously depends upon the task. There are two general possibilities. If the output channel involves saying or performing, then the teacher may simply watch the student and count instances of correct and incorrect movements as they occur. If the output channel involves a task with physical properties that are difficult to quantify, such as the act of writing a correctly spelled word, then the teacher might count some critical outcome of that movement at the end of the assessment period (e.g., the frequency of correct and incorrect word spellings written on paper by the student).

The instructional component of Precision Teaching considers four factors: (1) what to do before a movement occurs (materials and teacher's assistance), (2) what to do after a correct movement occurs (pleasant consequence), (3) what to do after incorrect movement occurs (ignore or unpleasant consequence), and (4) how the teacher practices the task with the child (McGreevy, 1983; White & Haring, 1980). Expanding on these teaching strategies is beyond the scope of this module. Technically, these procedures involve (1) stimulus control, prompting, and fading, (2) reinforcement, and (3) extinction and punishment. An excellent introduction to these procedures and factors influencing their effectiveness is provided by Martin & Pear (1998).

Step 4: Develop a Learning Picture

We have already discussed the Standard Celeration Chart and you have seen an illustration of the chart along with charting conventions in Figure 1. The chart is inspected for changes in counts per minute over daily assessment periods for both correct and incorrect movements. The two trends form a learning picture. The picture tells the teacher and student how rapidly the movements are increasing or decreasing and helps them project if or when the student will reach aim and "0." Some examples of typical learning pictures are illustrated in McGreevey (1983) and White & Haring (1980). For online examples of learning pictures, see the Learning Pictures Menu of Dr. John Eshleman's Standard Chart Topics -- A Precision Teaching Resource Website

Step 5: Decide What to Do [3]

Teaching decisions are based on the shape of the learning picture that emerges on the Standard Celeration Chart. White & Haring (1980) recommend that "If the correct rate of a skill is higher than the error rate and is accelerating (regardless of how the error rate might be changing), the skill is probably appropriate for one or more of the instructional procedures" (p. 243). Given this learning picture, the decision would be to continue with the current program.

A program change is indicated when the learning picture shows that "hard-to-do" has "easy-to-do." This occurs when the chart reveals that student has reached aim and "0" for two consecutive counting periods (McGreevey, 1983). It is time to select a new task.

A program change is also indicated when the learning picture shows that "hard-to-do" has become "hard-to-learn." In other words, the student is advancing too slowly, or not at all. For example, at Morningside Academy students must maintain a doubling of performance frequency per week; if the Standard Celeration Chart suggests otherwise, then the teaching procedure or the material to be learned is altered (Johnson & Layng,

---

[3] [Owen's Comments] The material in this section differs considerably in at least a few respects from my own current recommendations. Note that my own work is cited (1980), but that subsequent data have shaped different opinions in me since then. The rules I discuss now in my class, based on research concerning the phase of learning and factors that influence generalization, seem more useful and advanced. However, it is important to realize that Precision Teaching *per se* does not encompass any specific decision rules. It is, rather, limited to guidelines for identifying and measuring behavior, and for organizing those measures on a standard chart for evaluation. Those procedures have remained useful over the course of many decades with remarkably little need for modification. The "knowledge" gained from those procedures (e.g., "data decision rules"), on the other hand, continues to be refined as our use of basic Precision Teaching tools expands.

1992). Some general options to consider when "hard-to-do" has become "hard-to-learn" are: change the movement, change the counting period, and change the aim. The other possibility, of course, is to change the teaching method. (For more detailed discussions of these strategies, see McGreevy, 1983, and especially White & Haring, 1980).

A. Change To A Slice Back Movement

Sometimes the task may involve complex movement beyond the current capability of the student. In such cases, one possibility is to break the complex movement down into simpler movements. Previously we described such an example. The complex movement "Mark feeds the dog" was divided into four parts: (1) Mark gets the dog bowl from cupboard, (2) Mark opens the bag of dog food, (3) Mark pours the right amount of dog food into the bowl, and (4) Mark places the food bowl in dog eating area. Another hard-to-learn task could be "June answers the phone." The teacher could reduce this complex movement to three simpler movements: (1) June lifts the ringing receiver, (2) June appropriately positions the receiver to ear and mouth, and (3) June says "hello."

A slice back is defined as "a smaller movement or 'slice' of the original movement" (McGreevy, 1983, p. II-7). Suppose that June is unable to learn the complex movement "June answers the phone correctly or incorrectly for 1 minute." The teacher might opt to build fluency with the slice back movement "June positions the receiver to her ear and mouth correctly or incorrectly for 1 minute." A slice back from the complex movement "Mark feeds the dog correctly or incorrectly for 2 minutes" could be "Mark performs the first three (of four) steps of feeding the dog correctly or incorrectly for 2 minutes." White & Haring (1980) recommend that a slice back be considered when "the error rate is higher than the correct rate and they are both accelerating, or the correct rate is a little higher than the error rate but is flat or decelerating while the error rate is accelerating" (p. 243).

B. Change To A Step Back Movement

If a slice back does not solve the problem, then the teacher may consider a step back, defined as "a movement that is supposed to be 'easier to do' than the original movement" (McGreevy, 1983, p. II-8). A step back is more elementary than the original movement; it is a prerequisite skill. In our earlier example, the movement "June places the telephone receiver to her ear and mouth correctly or incorrectly for 1 minute" may be too difficult to learn. The teacher may choose to build fluency with the step back movement "June places the telephone receiver to her ear and mouth with verbal instructions from her teacher correctly or incorrectly for 1 minute." (Note how this changes the learning channel set from "June hears and places the ringing phone to her ear" to "June feels you guide her hand as she places the ringing phone to her ear", that is, from "hear and place" to "guide and place"). Another step back movement could be "June lifts the receiver correctly or incorrectly for 1 minute (whether or not it is ringing)." A step back from "Mark gets the dog bowl from the cupboard correctly or incorrectly for 2 minutes" could be "Mark discriminates bowls from plates correctly or incorrectly for 2 minutes." White & Haring (1980) recommend that a step back be considered when "the error rate is higher than the correct rate and is accelerating or remaining flat, while the correct rate is remaining flat or decelerating" (p. 243).

The most rudimentary step back is called a tool movement, defined as "a basic body movement necessary to perform the original movement" (McGreevy, 1983, p. II-9). Tool movements for school children often involve saying, writing, and doing. For example, in order to detect instances of faulty logic in reading passages fluently, a student must first be able to read words fluently (Johnson & Layng, 1992). Tool movements are practiced over and over. Returning to our earlier example, if June is unable to learn the movement "June lifts the ringing receiver correctly or incorrectly for 1 minute," then a possible course of action is to build fluency with the tool movement "June lifts her hand to her ear over and over correctly or incorrectly for 1 minute."

C. Change the Counting Period

This option should be considered when endurance is an issue. Endurance involves the maintenance of fluent performance over an extended period of time. Consider the following case recounted by Binder, Haughton, & Van Eyk (1990):

"Roy, a 9-yearold boy in a day-school program who was diagnosed as having behavior disorders and severe mental retardation, was charted as he practiced putting pieces into a puzzle with prompts from the teacher...When he worked for 1 minute at a time, there were many instances in which he either placed the puzzle piece incorrectly or threw the piece away from the table. The rate of correct responding was variable between 1 and 30 per minute, with no consistent pattern of progress. When the teacher shifted to working for only 15 seconds at a time, correct responding began to show less day-to-day variability, with errors and noncompliant responses virtually disappearing." (p. 26)

The authors recommend that "performance should always be evaluated at the duration that will be required in real life," and that "if long durations [counting periods] cause problems, teachers can help students become fluent for shorter durations and gradually work up to the required performance" (Binder et al., 1990, p. 12).

D. Change the Aim

McGreevy (1983) suggests that in some cases it may be helpful to set temporary aims. Suppose Susan's teacher tells her that when she "sinks 8 free-throw shots in 1 minute," she will be awarded a special badge. It may take a while for Susan to achieve this aim. Consistently not making that aim over several days may be discouraging, and Susan may stop trying altogether. Here, the teacher should consider setting a temporary, more readily obtainable aim, such as: "Susan sinks 4 free-throw shots in 1 minute." Now, Susan will be more likely to experience early success and be rewarded for her efforts. The aim could then be set a bit higher, and hopefully Susan will be better motivated to keep trying.

References

Binder, C. (1996). Behavioral fluency: Evolution of a new paradigm. *The Behavior Analyst*, 19, 163-197.

Binder, C., Haughton, E., & Van Eyk, D. (1990). Increasing endurance by building fluency: Precision teaching attention span. *Teaching Exceptional Children*, 22(3), 24-27.

Binder, C., & Watkins, C. L. (1990). Precision teaching and direct instruction: Measurably superior instructional technology in schools. *Performance Improvement Quarterly*, 3(4), 74-96..

Bower, B., & Orgel, R. (1981). To err is divine. *Journal of Precision Teaching*, 2(1), 3-12.

Grant, L. & Evans, A. (1994). *Principles of behavior analysis*. New York: HarperCollins College Publishers.

Johnson, K. R., & Layng, T. V. J. (1992). Breaking the structuralist barrier: Literacy and numeracy with fluency. *American Psychologist*, 47, 1475-1490.

Johnson, K. R., & Layng, T. V. J. (1994). The Morningside Model of generative instruction. In R. Gardner III, D. M. Sainato, J. O. Cooper, T. E. Heron, W. L. Heward, J. Eshleman, & T. A. Grossi (Eds.), *Behavior analysis in education: Focus on measurably superior instruction* (pp. 173-197). Monterey, CA: Brooks/Cole.

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(3), 10-15.

Lindsley, O. R. (1991). Precision teaching's unique legacy from B. F. Skinner. *Journal of Behavioral Education*, 1, 253-266.

Lindsley, O. R. (1992a). Precision teaching: Discoveries and effects. *Journal of Applied Behavior Analysis*, 25, 51-57.

Lindsley, O. R. (1992b). Why aren't effective teaching tools widely adopted? *Journal of Applied Behavior Analysis*, 25, 21-26.

Lindsley, O. R. (1995). Ten products of fluency. *Journal of Precision Teaching*, 13(1), 2-11.

Martin, G. & Pear, J. (1998). *Behavior modification: What it is and how to do it* (6th ed.). Upper Saddle River, NJ: Prentice Hall.

McDade, C. E. (1992). Computer-based precision learning: A course builder application. *Behavior Research Methods, Instruments, & Computers*, 24, 269-272.

McDade, C. E., & Olander, C. P. (1987). Precision Management of instructional technology: A program update. *Educational Technology*, 27, 44-46.

McGreevy, P. (1983). *Teaching and learning in plain English*. Kansas City, MO: Plain English Publications (University of Missouri).

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.

Skinner, B. F. (1938). *The behavior of organisms*. Englewood Cliffs, NJ: Prentice-Hall.

Sidman, M. (1994). *Equivalence relations and behavior: A research story*. Boston: Authors Cooperative.

West, R. P., & Young, K. R. (1992). Precision teaching. In R. P. West & L. A. Hamerlynck (Eds.), D*esigns for excellence in education: The legacy of B. F. Skinner* (pp. 113-146). Longmont, CO: Sopris West, Inc.

White, O. R. (1986). Precision teaching—Precision learning. *Exceptional Children*, 52, 522-534.

White, O. R., & Haring, N. G. (1980). *Exceptional teaching* (2nd Ed.). Columbus, OH: Merrill.