INTRODUCTION

The twenty-first century has introduced an era of accountability, with a demand for advocates of important social and cultural activities to "prove" the "facts" they promote, so that decisions affecting the public will lead to consistent, socially valuable goals. "Evidence-based medicine" has emerged, for example, to answer these questions: "Are these medical procedures proven to promote health?" and "Is it a fact that this is the most effective and efficient treatment for this patient?" One current trend in clinical psychology is the promotion of "empirically supported treatments" to answer a similar question: "Is this therapy proven to be effective and efficient?" The turn of the century has become an era in which practitioners are being held increasingly more accountable for the time and money being spent to address important issues.

Education, perhaps a culture's most important issue, is witnessing a similar surge of interest in evidence-based practice. Educators, parents, taxpayers, and students all ask the same question: "Are the educational practices used in schools actually effective and efficient?" This desire for proof that the student is being well educated goes beyond the pre-K to 12th-grade classrooms. University settings, vocational schools, and training sites of all kinds search for economical and successful methods for imparting skills to their students. This demand for responsible educational practices led to the establishment of
the No Child Left Behind Act (NCLB) of 2001, which legislates that pedagogical practices must demonstrate measurable effects on the learning of America's children.

**NO CHILD LEFT BEHIND**

On January 8, 2002, President George W. Bush signed the No Child Left Behind Act (Public Law 107—110) in an effort to encourage the use of proven pedagogical techniques that can meet the growing demand for increased accountability with regard to the outcomes of education. The legislation puts "special emphasis on determining which educational programs and practices have been proven effective through rigorous scientific research" (U.S. Department of Education, n.d.), and it suggests that federal funding will be available for educators to learn new and successful pedagogical techniques. In the crucible of this cultural change, the need for evidence is made clear, and the term evidence-based education steels and shines.

*Black's Law Dictionary* defines evidence as "that which tends to produce conviction . . . as to the existence of a fact" (p. 489), and it supports the outcome of making reliable, valid, and valued decisions. Grover J. Whitehurst, Assistant Secretary for Educational Research and Improvement in the U.S. Department of Education, defines evidence-based education as "the integration of professional wisdom with the best available empirical evidence in making decisions about how to deliver instruction" (Whitehurst, 2003). So, prudent educational pursuits are guided by both "empirical evidence" and "professional wisdom." Empirical evidence leads to an objective report about which teaching methods reliably lead to scholastic gains and which of these work in a shorter amount of time or with fewer resources expended. Professional wisdom is required so that each empirically supported method is appropriately adapted to the current scholastic environment. This wisdom can also guide the decision process when research data are absent. In effect, Whitehurst suggests that evidence-based education occurs when educators select teaching methods supported by reliable and valid data from scientific experiments and then judiciously synthesize these methods into a functional curriculum for a given setting.

When accumulating research evidence, investigators must consider both methodological and philosophical issues. An extensive literature about these critical scientific concerns focuses on what constitutes reliable and valid observations, how to collect and synthesize data, and how to interpret and report the findings. A thorough review of basic science is beyond the scope of this chapter, but the definition that the legislation provides is a practical guide to the critical questions of educational research. An excerpt from the No Child Left Behind Act reads as follows:
The need for evidence-based educational methods

The term 'scientifically based research'—
(A) means research that involves the application of rigorous, systematic, and objective procedures to obtain reliable and valid knowledge relevant to education activities and programs; and
(B) includes research that—
(i) employs systematic, empirical methods that draw on observation or experiment;
(ii) involves rigorous data analyses that are adequate to test the stated hypotheses and justify the general conclusions drawn;
(iii) relies on measurements or observational methods that provide reliable and valid data across evaluators and observers, across multiple measurements and observations, and across studies by the same or different investigators;
(iv) is evaluated using experimental or quasi-experimental designs in which individuals, entities, programs, or activities are assigned to different conditions and with appropriate controls to evaluate the effects of the condition of interest, with a preference for random-assignment experiments, or other designs to the extent that those designs contain within-condition or across-condition controls;
(v) ensures that experimental studies are presented in sufficient detail and clarity to allow for replication or, at a minimum, offer the opportunity to build systematically on their findings; and
(vi) has been accepted by a peer-reviewed journal or approved by a panel of independent experts through a comparably rigorous, objective, and scientific review. (pp. 126–127)

So, the NCLB legislation has established an important challenge for social and behavioral scientists, but decades before this legislation and the era of evidence-based practices, scientists in the field of behavior analysis had been working within the rigors of the aforementioned guidelines.

**BEHAVIOR ANALYSIS AND EDUCATION**

Behavior analysis is a science that investigates the functional interrelations between stimuli in the environment and relevant behavioral responses. Its vast literature contains meticulously controlled experiments demonstrating effective, valuable techniques for behavior change in a range of areas, including industry, health, safety, social welfare, and education. Behavior analysis was founded by B.F. Skinner and has developed a large, dedicated community of researchers and practitioners. Applied behavior analysis addresses systematic, pragmatic methods of behavior change in the everyday world. And, despite all the definitions and theories of learning, when a college student takes a course called "Learning" a significant majority of the topics will be from the literature of behavior analysis.

The basic characteristics of this science of behavior include empiricism, parsimony, scientific verification, and the assumption that behavior is lawful (Cooper, Heron, & Heward, 1987). In other words, the pursuits of applied behavior analysis require the practice of objective data collection (empiricism),
the assumption that explanations are more useful when they are simple and logical (parsimony), the practice of controlled experimentation as a method of investigation, and the consideration (and accumulating evidence) that the relations between the environment and behavior are orderly. The educational methods described in this book answer the current call for evidence, and they draw on years of literature to support their claims.

This journey toward establishing "proven" effective interventions is arduous, and each of the pedagogical methods that follow is supported by various levels of research. Most of the techniques are based on behavioral principles from well-replicated laboratory and field research. For example, one instructional method, Direct Instruction, was investigated in Project Follow Through, the largest and most expensive educational research project in history (Adams & Engelmann, 1996). In 1967, Congress initiated Project Follow Through to determine which methods of instruction delivery were most effective in promoting various areas of learning and achievement. At a cost of approximately $1 billion, this research indicated that, when contrasted with the other comparison methods, Direct Instruction produces the most significant outcomes for basic scholastic skills (i.e., math computation or spelling), cognitive skills (i.e., math, problem solving, or reading comprehension), and affective outcomes (i.e., adjustment or self-concept). Yet, to the detriment of the children, Project Follow Through research is largely ignored, as the mainstream schools rarely use Direct Instruction (see Chapter 6 for more information). Fortunately, charter schools and private programs retained the methodology and continue to collect field research data, and Direct Instruction is being promoted in the literature of the No Child Left Behind Act (U.S. Department of Education, 2000).

Most of the educational methods described in this book have not had the benefit of the type of research and funding associated with Project Follow Through, but most of these instructional techniques have been developed using the basic scientific principles of behavior derived from the extensive literature on the experimental analysis of behavior and applied behavior analysis. Much can be gleaned from this literature to inform educators about how people learn and how behavior changes after an instructional experience.

Herbert Spencer, philosopher and sociologist from the Victorian era, wove this often-cited quote: "The great aim of education is not knowledge but action." Action is the behavior of individuals. Educational environments are designed to change an individual’s behavior, and the measure of the educator’s impact is in the measurable change in the individual’s behavior, whether that behavior be reciting the ABCs or writing a thoughtful, coherent, critical analysis of a poem. Instructional methods derived from the science of behavior have focused on such measurement issues—not only measuring the frequency of correct responses but also measuring the concurrent reduction of incorrect responses, as well as the rate or "speed" of those responses. In certain domains of behavior analysis, measurement of fluent responding is a gold
standard. This focus on fluency in education by Precision Teachers has yielded impressive scholastic gains (see Section 2 for more information), but Direct Instruction and Precision Teaching represent only a fraction of the pedagogical techniques associated with behavior analysis. Computer-aided learning, instructional design, and generative instruction are all parts of the interrelated core of pedagogical techniques that are accumulating evidence of effectiveness.

Education aims to facilitate the development of a student–culture relationship. Society provides the support of an educational environment to first assess each individual’s current abilities, then this environment must bolster those abilities while remediating skill limitations, recruit the individual’s abilities toward a constructive contribution, and deploy those abilities in a functional manner that promotes social growth and well-being. Education is for the good of the student and the good of society, and it deserves to be executed with wisdom and scientifically supported methods. This book provides many of the evidence-based educational methods we need to ensure that no child is left behind; now we must all apply those educational methods wisely.

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References

INTRODUCTION

Education is an entitlement in our society. Every child is entitled to an excellent education, yet not every child receives such an education (Barrett et al., 1991). We provide schools, transportation to the schools, teachers for the classrooms, and administrators to run the schools, making it possible for every child to attend, but we do not make it possible for every child to receive an excellent education. The difference between attending school and receiving an excellent education lies in the instruction students receive while in school. That instruction is a combination of the instructional methods and programs used and the skills of the teachers. In this chapter, we examine the outcomes of effective instruction and why those outcomes are important. We also delineate principles of effective instruction and their importance in producing the outcomes all children deserve. Finally, we introduce four pedagogical approaches that incorporate principles of effective instruction and we examine how these approaches produce the outcomes that are the entitlement of all children.

Definitions of effective instruction are as numerous as the scholars who study instruction. Most definitions include some aspect of students being able
to do something new after instruction that they could not do before the instruction, as well as some aspect of efficiency in learning. Our definition of effective instruction guides our discussion and uses concepts from Cartledge (2001) and Kozloff (2002): Effective instruction is instruction that enables students to demonstrate, maintain, and generalize competency on prespecified learning outcomes faster than students would be able to accomplish this either on their own or with less effective instruction.

The ultimate outcome of effective instruction is that students become lifelong learners. To become lifelong learners, students must learn both content and how to learn independently. It is not possible, nor is it the responsibility of education, to teach everything students will ever need to know. However, if critical content such as reading, math, and writing is taught, and it is taught in a way that teaches students how to learn, students are prepared to be lifelong learners. It is not our intent in this chapter to consider what the particular content is that students need to learn; rather, our concern is with the outcomes and the principles of effective instruction. The outcomes of effective instruction (Kozloff, 2002) are that students are fluent in the content they learn; that they can combine and apply various simple skills to solve complex problems; that they can maintain these skills over time; that they can generalize their learning to new, similar situations and problems; and that they can work independently.

Fluency, one of the outcomes of effective instruction, is a measure of accuracy and time. A student who reads 100 words correctly in one minute is more fluent than a student who reads 50 words correctly in the same time. Similarly, the student who correctly writes the answers to 50 math facts in the same time it takes another student to correctly write the answers to 20 math facts is more fluent. It is especially important that students are fluent in tool skills, the skills necessary for higher-order learning and complex problem solving. Every content area has tool skills; they are the basics, the critical components for that content. In reading, tool skills include decoding and blending sounds into words; in math, they are the math facts and order of operations; in writing, they are the parts of speech and agreement between subjects and predicates. To be fluent in tool skills is to be able to use the tool skills automatically without thinking about them so that students can focus on the big picture, allowing them to comprehend what they are reading, solve math problems, or write a coherent essay. Students who correctly read 100 words per minute are more likely to understand what they read than students who correctly read 50 words per minute. Similarly, students trying to solve a complex math problem are more likely to be successful if they are thinking about the problem rather than trying to remember that 6 times 9 equals 54. If instruction is effective, students become fluent.

A second important outcome of effective instruction is that students can apply what they learn. Students who are fluent are more likely to be able to combine skills and apply them. Consider addition problems with renaming.
If, when adding the 1's column, the total is more than 9, then the student has to make a set of 10 to be included in the 10's column and put the remaining number of 1's in the 1's column. This can continue across the problem, if, for example, the 10's column totals more than 9, etc. Similarly, if a student is demonstrating mastery of the content of an American history course by taking an essay exam, consider the importance of combining and applying writing skills and being able to organize and present course content to demonstrate mastery.

The remaining three outcomes of effective instruction—maintaining skills, generalizing skills, and being able to work independently—are all important and related. Because there is so little time to teach all that students need to know, students cannot afford the luxury of forgetting and then relearning. Effective instruction provides enough review and high-level application of information that students maintain what they learn. Similarly, it would be impossible to teach students every situation in which a particular response or behavior would be appropriate; therefore, it is essential that students learn to generalize their learning to new situations when appropriate. For instance, the math facts used to solve math problems are the same math facts used to solve chemistry problems, and when instruction is effective students readily see the appropriate applications. The final outcome, being able to work independently, is critical if students are to succeed and to continue to learn beyond the classroom. Ultimately, to be lifelong learners, students need to be able to work independently with what they have already learned and they need to be able to continue to learn new information on their own. These outcomes of effective instruction are the essence of mastery.

The key to achieving these outcomes lies in the principles of effective instruction. Effective instruction begins with clearly stated behavioral objectives; provides accurate, competent models; provides many opportunities for active responding; delivers immediate feedback about the accuracy of responses; allows self pacing; teaches to mastery; reinforces accurate responding; and frequently and directly measures responding that is explicitly tied to the behavioral objectives, using the outcomes of those measurements to make instructional decisions. A brief examination of these principles of effective instruction highlights their importance. Effective instruction is not possible unless we know exactly what we want students to learn. As behavior analysts, we insist that students demonstrate what they learn, so we write behavioral objectives that let students know what they will be able and required to do when they are at mastery. These objectives provide goals for students, as well as a guide for the day-to-day instructional decisions teachers must make.

Once we know what we want students to be able to do, it is efficient to provide a model of that behavior. When we are teaching letter sounds and we point to the letter m, we tell students the sound that is appropriate for that letter. We do not provide a list of words that begin with the letter m and then have students guess how those words are the same; some students will be
successful with this indirect approach, but it lacks efficiency, an important component of effective instruction. Having students imitate the models is very efficient and reduces the number of errors students make while learning. Although it is possible to learn from errors, it is not always the most efficient method because errors waste valuable instructional time, and once students make an error they are likely to make the same error again. It is far more effective to eliminate as much as possible the errors students make, and providing models accomplishes this.

Effective instruction provides many opportunities for students to respond so they can make the response a part of their repertoire. Watching a competent model is informative and helpful, but students become competent when they actually practice the responses themselves. Imagine learning cursive writing by watching someone else write and never writing yourself. It would be much like trying to learn to sink a three-point basketball shot by only watching others do it. The responding that students practice needs to be active and it needs to be the same type of responding that will be necessary to apply the learning. Solving math problems typically requires students to write numerals; therefore, they need to practice and become fluent in writing math facts in addition to just verbally stating them.

It is critical for students to receive immediate feedback about the accuracy of the responses they are practicing. When students respond correctly and receive feedback that they are correct, it can serve to motivate students to continue; when they receive feedback that their response is incorrect, they can make immediate changes rather than continuing to practice the incorrect response. An important aspect of this immediate feedback is the information teachers provide for incorrect responses. To only tell students their response is incorrect gives students very little information; they know not to make that response in the future, but they do not know what response to make. To provide a long explanation of why their response is incorrect is to provide more information than students can typically process in a short time and can function as punishment to the extent that some students will stop responding. The most efficient feedback for incorrect responses is to tell students the response is incorrect and then to provide the correct response and ask the students to repeat it. Providing the correct response allows the students another opportunity to imitate the model correctly and to receive feedback that confirms their response. Effective instruction continually presents the correct response as a model at the outset of instruction, as a confirmation of the students' correct response, or as a correction for the students' incorrect response.

Providing frequent immediate feedback that lets students know if they are correct is of little value if students are required to continue in the instructional sequence when they learn they are incorrect. To be effective, instruction must allow self pacing. Not all students learn at the same rate and even some who learn at similar rates will not necessarily all learn the same content at the same
rate. Students need to be allowed to continue to practice and to work with information until they demonstrate mastery and only then continue in the instructional sequence. Without this opportunity, students who do not master requisite skills before moving on will be unlikely to master the course objectives. Effective instruction teaches to and requires mastery, a prerequisite for students to become independent learners.

When students are at mastery, their behavior comes in contact with the natural reinforcement that will maintain the behavior. As students are learning new skills, however, their correct responses need to be extrinsically reinforced until they are at mastery and contact the natural reinforcement. Extrinsic reinforcement is most often a simple confirmation of a correct response; it may be accompanied by a nod, a smile, a thumbs-up, or some other gesture that lets students know they have the correct response and that the teacher is pleased with their performance. These are very powerful reinforcers for most students. The ultimate reinforcement, however, is being able to accomplish something new with what students are learning and to experience the natural reinforcement that comes from engaging in that behavior. The natural reinforcement for reading is the information and/or pleasure one receives from reading. However, students with poor or underdeveloped reading skills do not get information or pleasure from their reading; at this level, reading is not naturally reinforcing and will not be maintained. One of the best ways to become a better reader is to read more. Reading more, though, is the last thing a poor reader wants to do, so we must provide effective instruction and extrinsically reinforce all the small steps in learning to read until eventually students are reading connected text fluently and comprehending what they are reading so that reading is naturally reinforcing because of the information and/or pleasure it is providing.

The final principle of effective instruction is to provide frequent direct measures of student learning tied to the behavioral objectives and to use the outcomes of these measures to make instructional decisions. Students know from the behavioral objectives what is required of them, what they need to be able to do to demonstrate mastery. Every time students respond, teachers have an opportunity to measure learning and to make instructional decisions. Possibly unique to behavioral instruction is that there is no penalty for incorrect responses when teachers are measuring achievement. Students are not blamed if they respond incorrectly; rather, it is assumed that the instruction or the delivery of the instruction is inappropriate and the instruction is changed.

In this chapter we introduce four behaviorally based instructional approaches: Precision Teaching, Direct Instruction, Programmed Instruction, and Personalized System of Instruction. With these approaches, teachers can help all students achieve their educational entitlement. After the introduction of each approach, we examine how that approach incorporates the principles of effective instruction delineated above.
**PRECISION TEACHING**

Precision Teaching (PT), founded by Ogden Lindsley, is designed to evaluate instruction (West, Young, & Spooner 1990) and can be used in conjunction with any instructional approach. The basic aim or goal of PT is to achieve fluency in the tool skills associated with academic content (Kame'enui et al., 2002). PT requires students to frequently (usually daily) practice, measure, and report an appropriate overt response associated with each academic subject. The measurement unit utilized in PT is *rate of responding*: the count or frequency of the target behavior divided by the time taken to emit the target behavior. The rate is charted by students on a semilogarithmic chart (Fredrick, Deitz, Bryceland, Hummel, 2000); this chart is referred to as a *Standard Celeration Chart* in PT circles. Student performance depicted on the chart is used to modify instruction, which reflects the most important tenet of PT: "The student knows best, or in other words, the student's behavior can tell us better than anything else whether or not instruction has been effective" (West et al., 1990, p. 8).

In PT classrooms, teachers may present content using a variety of methods. Teachers select the appropriate performance measures, and students count and record the data on their semilogarithmic chart. The individual data for each student are typically analyzed one or more times each week. If the data slope shows that the student's fluency is increasing, instruction continues. If the slope is flat or negative, the teacher alters the instruction.

Precision Teaching often employs tutoring. Students typically spend a few minutes each day in each subject working with another student and focusing on areas of performance where the students are not yet fluent. Part of these tutoring sessions has one student counting the frequency of a particular response within a specified time, often one minute. The response may be reading words aloud, spelling words on paper, solving math problems, or any other responses that require fluency. The students chart their data and then they reverse roles. The data for each student are then used as the basis for altering teaching (pedagogy, pacing, remediation, etc.) and tutoring and for determining what the students should focus on during the coming week.

Precision Teaching is an educational tool that can be used in any subject at any grade level with any instructional method. Teachers need to have clearly stated learning outcomes and identify overt performance measures associated with each. In daily tutoring sessions, which can precede or follow the class's regular instruction, students work on specific skills that the teacher has identified based on each student's performance as shown on the semilogarithmic charts.

Although PT is primarily an assessment procedure rather than an instructional procedure, it incorporates the principles of effective instruction, because assessment is a critical component of instruction. Teachers rely on clearly stated behavioral objectives to determine which responses students will
practice during PT, and tutors provide accurate, competent models for each other. Students have many opportunities to actively respond when they take on the role of the tutee, and when they are the tutor they must be especially focused on the accuracy of the tutee's responses. The tutor provides immediate feedback about the tutee's responses, and those responses determine the pace at which the student will continue through the program. Mastery is evidenced by the acceleration of the data, and if mastery is not forthcoming then instruction is changed until students ultimately master the objectives. Recording data points to show an acceleration in learning is a powerful reinforcer for correct, improved performance. Finally, PT is an evaluation tool to help educators objectively judge student progress and the effectiveness of instruction.

**DIRECT INSTRUCTION**

The Direct Instruction (DI) we present is the commercially available Direct Instruction sold by SRA and originally developed by Sigfried Engelmann. The late 1960s saw the first widespread dissemination and research on DI when Public Law 90–92 authorized Project Follow Through (PFT). DI was one of nine curricular programs evaluated on three dimensions (basic skills, cognition, and affective), and the DI model produced the highest average performance in all dimensions (Watkins, 1988). All nine of the PFT curricula were originally developed as approaches to address the needs of students who were at risk for school failure. Interestingly, instruction that works well for students who are at risk also works well for other students, including students in gifted programs (Ginn, Keel, & Fredrick, 2002).

Direct Instruction programs are available for reading, writing, spelling, and math. All programs provide scripted lessons based on faultless communication, with placements in instructional groups determined by each student's current achievement. Extensive logical analysis makes clear the skills students need to learn to become competent in different content areas. Placement tests for the DI programs are designed to determine the skills students have already mastered so that instruction begins with the necessary prerequisite skills and progresses in a logical sequence. Students are easily moved from one group to another as they master particular skills.

Direct Instruction lessons rely on choral responding so that during each lesson all students have many opportunities to respond rather than the one or two opportunities each student has or the multiple opportunities a few students have in more traditional classes. The teacher presents the lesson from a script that often begins with the teacher modeling the answer. This is followed with a request for students to make the same response, a couple seconds to think about the response they are going to make, and a signal to respond. The students respond in unison. If their response is correct and everyone responds together, the teacher confirms the response by repeating it. If even one student
does not respond correctly, the teacher immediately provides a correction by saying the correct response and asking the students to try again. If students do not respond in unison, the teacher requires the students to try again until they all respond together on signal. All students need to respond in unison so the teacher knows that all the students know the response and that some students are not just echoing the response after hearing the group.

Direct Instruction programs reflect a "bottom-up" philosophy in that outcome behaviors are thoroughly analyzed to identify their critical components and then the instruction is designed to explicitly teach each of these components in carefully sequenced lessons. For example, sounds are introduced before the symbols for those sounds are introduced so that students are fluent in producing a sound correctly before the symbol for that sound is presented. At that point, the student only needs to learn the symbol that goes with the sound the student already knows. Mastery of one lesson provides the students with the requisite skills to master the next. The lessons are designed to provide sufficient practice so that students become firm on all skills, applying them often in subsequent lessons until those skills become automatic and are subsumed within more complex skills (Engelmann, 1999).

Conceptually, one can view the content of a DI program as a stairway (Engelmann, 1999). Each student "steps" onto the stairway at the student's entry skill level and, through teacher-directed activities while on that step, masters its content. Each step is approximately equal in terms of the amount of time and effort required, and each higher step is associated with increasingly more complex behaviors, although they are not necessarily "more difficult" because the previous steps provide the students with the background skills and knowledge needed for success.

The inclusion of principles of effective instruction is evident in all DI programs. The programs begin with empirically established objectives that measure outcomes aligned with state and national standards for public schools. Accurate, competent models are provided by the teacher throughout the programs. Typically, the teacher models the response and then asks the students to give the same response. Because of the choral responding, all students have extensive practice responding throughout the lessons, and all responses are followed by immediate feedback. The feedback is either a confirmation of a correct response, which the teacher typically repeats, or a very direct correction that provides a model of the correct response. In an effort to teach as much as possible in the allocated instructional time and to keep students focused and engaged, teachers keep DI lessons moving at a quick pace; however, it is always student performance that determines when the teacher moves on to new activities in the lesson. After the choral responding, students receive individual turns to be sure all are firm before moving on to the next instructional activity. DI programs require mastery throughout, for all activities and all content. If students are not at mastery, the teacher provides correct models, remediation, and additional practice until mastery is achieved.
Teachers reinforce correct responding by confirming and repeating the response. Ultimately, because the programs have been so carefully analyzed, the instruction so explicit and systematic, and mastery a requirement for progressing, students quickly come in contact with the natural reinforcers associated with being competent. Finally, the principle of effective instruction that calls for frequent measures of responses tied to objectives and then used to make instructional decisions is evident throughout DI programs. After each activity the teacher provides individual turns to assess the responses tied to specified objectives, and student performance on these individual assessments determines subsequent instruction.

**PROGRAMMED INSTRUCTION**

The initial development of Programmed Instruction (PI) is credited to B. F. Skinner. Skinner (1954, 1968) cautioned that educators had overlooked several critical components required for learning and that these components can be addressed by implementing what he called teaching machines.* Teaching machines and today’s computers, with all their attendant software and variations, are especially useful in providing two of Skinner’s critical components of effective instruction. Students need to make thousands of responses and receive feedback for these responses if they are to acquire complex academic learning. Teaching machines can provide for both and as a result can shape complex verbal responses as well as teach subtle discriminations.

While Skinner’s teaching machine was one of the first applications of programmed instruction, most often the technology is thought of as textual materials in book form. Programmed instruction consists of sequenced frames, typically organized into sets of three. Each set of three frames follows an ABC approach. In this approach, the A frame is the antecedent, usually a small piece of information. The B (behavior) frame requires the student to make an overt response to a question based on the information in the previous A frame. The last frame in the set, C, allows the student to check the accuracy of the response made in the B frame (i.e., confirmatory consequence). With carefully constructed frames, students are not likely to make many mistakes. Students who make an incorrect response are instructed either to start the three-frame set over or to go back several sets and repeat the instruction. This illustrates linear programmed instruction.

The majority of current programmed instructional materials reflect what is known as branching programs. Students continue working through the frames in sequence until they make an error. When students make an error, the program breaks out of the original sequence into a branch designed to remediate and

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* Sidney Pressey of Ohio State University developed “automated learning machines” in the 1920s.
reteach the information on which students made the mistake. Once the error is corrected, the branch returns to the original sequence of frames. The main distinction between linear and branching PI materials involves how errors are corrected. In the linear programs, students simply repeat sets of frames they have already completed. In branching programs, students are introduced to new frames.

With the advent of personal computers becoming widely available in the late 1980s, PI became the basis for virtually all forms of computer-aided instruction. Computer-based examples of PI can be accessed through the Internet by opening a search engine such as Internet Explorer and searching for programmed instruction. Thousands of examples can be sampled. For example, the Center for Programmed Instruction's website (http://www.centerforpi.com/) offers a PI tutorial, tutorials on creating computer-based PI courses, one on preparing for the Behavior Analysis Certification Exam, and another on the field of behavior analysis. There are also hundreds of PI sites devoted to engineering and science. In addition, the Internet Encyclopedia (http://www.freesoft.org/CIE/Course) has a tutorial designed to teach people how the Internet works.

Used as either a supplement to other instruction or as the original source of content and skills, PI clearly incorporates the principles of effective instruction. Frames are written based on behavioral objectives that specify measurable outcomes. Models are provided in the first frame, students make an overt response in the second frame, and they receive immediate feedback in the third frame. If students are correct, they receive confirmation of their correct response; if they are incorrect, they are provided additional frames to learn the content. In this way, PI is self paced and teaches to mastery. Students advance only when their responses are correct. To keep students working toward mastery, reinforcement (the opportunity to continue with the next frame) is provided for correct responding. Enough correct responding brings students to the end of the program and they find they have new skills. Some programs also deliver points for correct responding. Students may accumulate these points and exchange them for a preferred reinforcer. All responding is a direct measure of the objectives, and the accuracy of each response is used to make instructional decisions to continue in the program, to repeat some of the frames in a linear program, or to branch to supplemental frames in a branching program.

PERSONALIZED SYSTEM OF INSTRUCTION

Personalized System of Instruction (PSI) was originally designed for use in the college classroom; however, since its introduction into the college classroom over 30 years ago, it has been used to deliver effective instruction in elementary, middle, and high school, as well as in business. PSI is also commonly
known as the Keller Plan, after Fred S. Keller, one of its designers. The five defining feature of PSI are that it emphasizes the written word, allows self-pacing, requires mastery, relies on proctors, and provides lectures for motivation or reinforcement.

**Emphasis on the Written Word**

The content for a PSI course is presented in units. Each unit includes objectives, often in the form of study questions, and a set of readings. These readings must provide all the information necessary for students to master the unit objectives. Teachers typically include readings they develop as well as journal articles and book chapters. Students work through each unit by reading the materials provided and checking their learning against the objectives or study questions. Students may work with these materials in the classroom during regularly scheduled class time or at any time outside the classroom. They may work independently or they may form study groups. Once students have studied the readings and are confident that they have mastered the objectives, they ask to complete an assessment for that unit. The assessment is typically a short test administered by the proctor. As soon as the student completes the assessment, the proctor grades it and provides feedback to the student. This feedback includes clarification for any items missed, an opportunity for the student to ask additional questions, and notification of whether the student demonstrated mastery. Students who do not demonstrate mastery on any unit assessment restudy the reading materials and take an alternate form of the assessment. This continues until students demonstrate mastery of the unit. At this point, students are permitted to begin the next unit.

**Self Pacing**

Given that not all students will demonstrate mastery on all units at the same time and mastery is necessary for students to be able to continue, self pacing is critical in a PSI course. Students' prior knowledge, their other commitments for the semester, and their intrinsic motivation to finish all affect the speed with which they master units. Ideally, there is no deadline by which all units must be completed; however, many institutions require that coursework be completed within a specific time period. When this is the case, instructors often limit the number of required units so that if students complete at least one unit each week they will complete the course within the academic term. Compared to traditional courses taught by the same instructor, PSI courses often have higher withdrawal rates because students procrastinate. While this is a negative aspect of self pacing, self pacing is essential for mastery. Creative methods to reduce student procrastination have been implemented to help reduce withdrawals from PSI courses.
Mastery

The mastery feature requires that students continue to study the content of a particular unit until their assessment score equals or exceeds a predetermined standard, often between 80% and 90%. If students do not demonstrate mastery, they are required to continue to work on the unit and then to take another form of the assessment for the unit. They may continue to do this as many times as they need to until they demonstrate mastery. There is no penalty for taking multiple forms of the assessment before demonstrating mastery. When students demonstrate mastery, they may begin work on the next unit.

Proctors

Self pacing makes the mastery requirement possible and proctors make self pacing possible. Keller (1968) originally viewed proctors as being students who had already finished a particular PSI course and assisted in the class for additional course credit. Their assistance included administering and immediately scoring unit assessments, providing corrective feedback to students about their scores on the assessments, tutoring students having difficulty with particular objectives, and helping to make the learning experience more personal for the students. According to Johnson and Ruskin (1977), proctors fall into two categories—external and internal—both of which work equally well. External proctors generally fit the description of proctors given above, while internal proctors are often students who are currently enrolled in the class. Internal proctors typically work only with students who are involved with units that the proctor has successfully completed.

Lectures for Motivation or Reinforcement

In PSI courses, lectures are used as a motivational tool rather than as a source of course content. Students are not permitted to attend lectures unless they have mastered particular units. The lectures are an opportunity to learn exciting things that are not included in the course units. Students are not accountable for the information so the lecture can be heard and processed without the burden of taking notes and thinking about how one might have to know this information for a test. Further, these lectures are an opportunity to pique students' interest in issues and research beyond the course requirements. The lecture may be offered by a noted researcher or expert who is not the professor for the course (i.e., it could be someone students typically would not have an opportunity to hear).

The defining principles of effective instruction are evident in PSI. All PSI courses begin with behavioral objectives that the instructor uses to design the course and the students use to guide themselves through the content of each unit and to prepare themselves to demonstrate unit mastery. Proctors serve as
models as they have already mastered the content and they can model correct responses to help students who are struggling. While students are encouraged to study actively, take notes, and discuss the readings with others who are studying the same unit, there is no requirement for this behavior built into PSI. However, to demonstrate mastery, students must actively respond to a unit assessment. Their feedback is immediate. The proctor grades the assessment immediately and shares the results with the student. Accurate responses are reinforced and remediation is provided as needed. Self pacing and mastery, two principles of effective instruction, are two defining features of PSI. Students may spend as much or as little time as they need on each unit and they are permitted to continue only after they demonstrate mastery. Frequent measurement of objectives occurs throughout the course as objectives are assessed for each unit. Instructional decisions are made based on these assessments; that is, the student is allowed to advance to the next unit or the student must restudy and complete another assessment.

SUMMARY AND CONCLUSION

In this chapter we introduced four instructional approaches based on behavioral principles and we demonstrated how each incorporates the principles of effective instruction. That is, they all begin with clearly stated behavioral objectives; provide accurate, competent models; provide many opportunities for active responding; deliver immediate feedback about the accuracy of responses; allow self pacing; teach to mastery; reinforce accurate responding; and frequently and directly measure responding that is explicitly tied to the behavioral objectives, using the outcomes of those measurements to make instructional decisions. Using instructional approaches that incorporate these principles of effective instruction gives all students access to the education that is their entitlement.

References


Precision Teaching: Foundations and Classroom Applications

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"The learner is always right."

WHY PRECISION TEACHING?

A public school implements a limited Precision Teaching (PT) program, and dramatically raises the standardized test scores of its elementary and middle school students, such that the majority of them eventually qualify for advanced placement courses. Private PT schools and learning centers reliably raise student performance by an entire grade level in 20 hours or less of instruction (Barrett, 2002). A fourth grader with school phobia and poor attendance comes to a PT learning center twice a week, quickly improves reading and math performance, and begins attending school with enthusiasm. A middle-aged
man of Mexican-American heritage who cannot get a driver’s license because he cannot read receives 1 hour per week of instruction with PT, and within 2 months has finished grade-I-level materials; he begins planning the jobs he can apply for once he reads well enough to take the driver’s exam. Two dedicated and enterprising PT teachers begin working with students with autism and their parents, and within a year they are so swamped with requests that they initiate a nationwide consulting and training service. Parents report that children who were written off are learning to speak, converse, and read. A private school accepts students with diagnoses of learning disability who are behind academically and failing, and within 2 years most improve enough to return to general education classes in public schools, get good grades, and keep up with their peers.

Proponents of every teaching approach provide stories and testimonials, and it is the individual success stories that move our hearts and pique our interest as educators. What each of us hopes to find as we learn about yet another approach is that its benefits can be repeatedly demonstrated across a variety of learners and settings, that the benefits are large and lasting, and that it can be implemented in our setting. It is hoped that, in this chapter, those who are interested in Precision Teaching will find enough supporting information to spur them to read further, ask questions of PT teachers, try the methods, and see results for themselves. Please note that our goal here is not to teach PT, but to introduce PT and provide sufficient information for readers to decide if they wish to invest the time it takes to learn PT skills. The next PT chapter provides additional information, references, and examples.

The motto of Precision Teachers—“The learner is always right”—succinctly expresses both its mode of operation and its behavioral heritage. More implications of this aphorism are spelled out below, but underlying all of them is the concept that it is what the learner does that guides and informs the teacher. The founder of PT, Ogden Lindsley, discusses PT as “a system of strategies and their tactics for the self-monitoring of learning” (G. Hrga, personal communication, 1997). Rather than a curriculum, method of, or approach to classroom instruction, PT is a measurement and decision-support system, a way for teachers to analyze and understand their effects on students. Use of this system of self-knowledge also has generated a growing set of techniques with known outcomes, some of which we outline in the two chapters in this section.

Precision Teaching is an astonishingly powerful technology. In one of its early implementations in the late 1970s at Sacajawea School in Great Falls, MT, students in lower grades used PT in addition to their standard curricula for 15 to 30 minutes each day. Their scores rose from average to the top of the Iowa Test of Basic Skills, while the rest of the district remained average. This was in spite of the fact that special education students at Sacajawea were tested along with general education students, while special education students in the rest of the district were excused. By the end of the 4-year project, the Sacajawea students
were so skilled that they overwhelmed the middle and high school advanced placement classes, as the schools were not organized for classes in which the average student performed at the advanced placement level (McManus, 2003; see also Beck & Clement, 1991). These gains were made using curriculum materials developed by the teachers. Now, with the benefit of several decades of curriculum and procedure testing and development, even greater gains are routinely made. PT centers can confidently promise to increase a student's performance by an entire grade level in 20 hours of instruction, and many adult learners can achieve such gains in fewer than 10 hours (Barrett, 2002).

**THE CHART**

The hallmark of PT is the blue, 140-calendar-day Chart, which was invented by Ogden R. Lindsley in the 1960s and subsequently refined by him and his students. This Chart provides a uniquely unbiased and helpful way to visualize the history and the future of a person's behavior over time. The Precision Teacher reads the Chart to see how the learner has responded to past events, so that the instructional conditions that were associated with more progress can be provided again, and conditions associated with less progress can be avoided. Thus, the motto reminds us that, whatever the learner's performance in the past, it is our responsibility to provide the instruction under which that learner will make progress in the future. The daily Chart worked so well that a new set of Charts was developed, ranging from minutes (session Charts) to days, weeks, months, and years, and many types of events have been plotted in addition to those of interest in classrooms.

The process of PT begins with determining where each learner is, and the learning outcomes are measured primarily in terms of progress from this baseline to true mastery. The motto reminds us to look for things we can influence to facilitate progress and not to blame the learner or focus too long on diagnoses and factors that cannot be changed (such as socioeconomic status or parent's educational level). It also reminds us when to stop teaching; PT offers a truly effective way to know when the learner has mastered something (has it right), and we can move on. It reminds us that learning is personal: While we cannot forget the whole class, if we teach each individual, we will teach the class (and the reverse is not true). PT allows each child to practice what is needed and only what is needed, thus providing functional individualization. The motto reminds us that our goal is empowerment of the learner through honest evaluation and feedback about performance, and that the learner becomes truly engaged through this process. Finally, it reminds us that whenever a learner does something that is contrary to our theories of education or learning, it is the theory that should be ignored, not the learner. Thus, PT is the quintessential form of data-driven decision making (Cromley & Merbitz, 1999; van der Ploeg & Merbitz, 1998).
EXAMPLE OF PRECISION TEACHING IMPLEMENTATION

As we noted earlier, one constant element of PT is the display of learner performance frequencies on a standard Chart to monitor improvement. In most cases, it is best and most empowering to have learners count, time, and chart their own performances. Here are few examples of things measured in schools: reading words or sentences correctly and incorrectly, generating positive adjectives that describe themselves, making factual or inferential statements about concepts from a passage, saying the steps they use in solving complex problems, or answering math problems orally or in writing. Selection of what is measured depends on the goals of the learner, but it must be countable and repeatable. In academic activities, analyzing learn units (see Chapter 3; Greer, 1999) that occur in current instruction is a good place to start.

Our first figure (Fig. 1) shows data from Lynn, a graduate student in an introductory course on special education. Lynn charted her SAFMEDS performance, a PT strategy for learning concepts and facts that Lindsley developed (Graf, 1994). SAFMEDS is an acronym for Say All Fast a Minute Every Day Shuffled. SAFMEDS cards resemble flash cards. Each card has a visual prompt on one side, such as a definition or problem, and the desired response on the other side, such as a term or answer.

In this course, the students were given a deck of 180 cards with special education definitions on the front side and terms on the back. They were instructed to study the definitions and terms each day (i.e., look at the definitions on the front of the cards and say the terms on the backs of the cards before turning them over). Next, they conducted one-minute timings, going through as many cards as they could and saying the answers out loud, then separating correct and incorrect responses in different piles and counting their correct and incorrect responses. Finally, they charted their timed responses (including corrects and errors) and shuffled the cards for the next timing. In timings conducted in class, the goal was to answer correctly at least 30 SAFMEDS per minute from a shuffled deck. Note that different classes use different SAFMEDS criteria, and the frequency also depends on the length of the stimulus to be read (i.e., briefer stimuli and answers are generally quicker when going through a SAFMEDS deck).

READ A CHART

Let us now review Lynn’s Chart in detail (see Fig. 1). What you see is a computer-generated version (http://people.ku.edu/~boms/) of Lynn’s Chart. While some elements of the original paper Chart were removed to maintain clarity during
Lynn’s chart. Her data appear to the left, and other sample frequencies are plotted to the right.
Charles Merbitz, et al.

printing, like any Chart this one tells us the scientific story of who was doing what when and what happened. Lynn’s data are on the left half of this Chart. Even before we orient you to the features of the Chart, it is easy to see the compelling story told by Lynn’s data. The line of dots going up and to the right show her number of correct answers getting higher over 9 weeks. The X’s show her errors decreasing and finally dropping to virtually none. The uppercase A indicates the level and target date of her goal frequency, which she exceeded early.

Now, let us discuss the standard features of this Chart. The units of time on the horizontal (x) axis are successive calendar days. The bold vertical lines are Sunday lines, so the chart begins on a Sunday and ends on a Sunday, for a total of 140 days. Each fourth Sunday is dated. Day lines are represented as vertical lines on paper Charts and can be seen as tic marks in our figures. This student began her timings on 15 April 2001. Note that this is a typical PT convention; this style of using day, month, and year provides clear date communication to all readers. Note also the date of the first Sunday; most North American schools use the same Sundays in Fall and January to synchronize their Charts, but Lynn’s quarter started later, so all of the Charts in her class started on 1 April 2001. These conventions facilitate fast and accurate interpretation by making it easy to see right away when the work took place relative to the current date, what absences or other events occurred, and so forth.

**CHART FEATURES**

The unique features of the Chart are important because they allow much faster, more accurate, and easier communication among chart readers (skilled teachers read 6 to 12 Charts per minute). Imagine a group of third-grade teachers gathered to talk about how their students are doing with multiplication tables, and all of the teachers in the room have transparencies of Charts from their students. Each teacher can show Charts, and all can see the rate of progress for the groups and the individuals. So, rather than spending time interpreting individually constructed graphs that have various scales for both time units and behavior, the teachers’ time can be better spent analyzing data to make appropriate instructional decisions and more time is available to plan what to do next. Thus, the student’s behavior can continuously guide educational decisions.

What features of the Chart allow for this quick and reliable interpretation of learners’ progress? Looking at Fig. 1, we see that the vertical (y) axis has horizontal lines for frequency, or count per minute. This axis is one of the key features of the Chart. It is a multiply (or logarithmic) scale including six cycles; for example, one of the cycles encompasses frequencies from 1 to 10, another from 100 to 1000, and so forth. (The horizontal (x) axis is not logarithmic, thus the Chart is **semi-logarithmic**). Note that within each cycle on the
vertical axis the lines become more closely spaced from the beginning to the end of that cycle. This seemingly esoteric convention of the Chart is in reality a critical feature that enhances its everyday utility. It confers at least three major advantages over the conventional “square” (non-log) graph paper commonly used: (1) prediction, (2) relative emphasis, and (3) wide-range display.

**PREDICTION**

Because most behavior changes, including academic learning, are proportional, a traditional square graph of behavioral change produces a curved line as behavior increases or decreases (the learning curve). When one looks at such a curve taking shape while the behavior changes, it is nearly impossible to predict future rates of behavior; however, the Chart displays behavioral changes in straight lines (or rather, as data through which a straight line can be drawn to summarize the overall trend). Such a line can be extended visually (or with a straight-edge) into future days and weeks for a quick and accurate estimate of rates in the future if current trends persist. It allows more accurate tracking and predicting of a learner’s change in performance, thus supporting more rapid and accurate judgments about learning and hence better decisions.

**RELATIVE EMPHASIS**

On a common square graph, the distance between counts of 80 per minute and 85 per minute is the same as the distance between 10 per minute and 15 per minute. In a teaching situation, when a child progresses from 10 words read aloud per minute to 15 words, it is a more significant event than going from 80 to 85 words per minute. A graph with frequency on a multiply scale reflects the relatively greater importance of small gains when the initial baseline frequency is low. This feature also means that the teacher can see instantly the bounce (variability) in data points from day to day and know when the day’s performance is a peach (unusually good) or a lemon (bad). Seeing when a performance is a peach or a lemon allows the teacher to follow up and find potentially critical information about how to repeat it (peach) or prevent it (lemon). Because of the Chart’s arrangement, peaches and lemons can be seen regardless of the frequency of the behavior and regardless of the goal (such as accelerating pro-social skills or decelerating harmful or dangerous behavior). Virtually anything of educational interest (such as arithmetic problems, out-of seats, reading, and absences) can be plotted with the same frame of reference or even on the same Chart, so the reader can make rapid and easy comparisons. Also, it makes for easy and fast communication between PT people reading the Chart. This helps in consultation and problem solving. Finally, children readily learn to read it, so they become empowered to manage their own learning, with the teacher as guide and coach.
WIDE-RANGE DISPLAY

With a logarithmic y-axis, a huge range of frequencies can be recorded within the confines of one display, from low-frequency events such as daily attendance at school to high-frequency events such as words read silently before answering comprehension questions. Thus, these can be compared and the teacher can assess the effectiveness of procedures across a huge range of behaviors. Fortunately, it is not necessary to know the properties of logarithmic scales in detail use to the Chart effectively. The important skill is to learn to count up the vertical axis. Maloney’s (1982) little rhyme can help students remember: “Big number in the margin that starts with one/tells you what to count by and what to count from.”

A dot at the exact middle line of the Chart (on the line marked 1) would indicate 1 per minute. The next heavy line going up is for 5 per minute, and then 10 per minute. Thus, beginning with the frequency line for 1, we count by ones until, going up the axis, the next “big number that starts with one” we see is at the 10 frequency line. From that point, we know to count by 10s to the 100 line. An example of a frequency in that range is resting pulse; your resting pulse might be a dot around 60 if you are in good shape or maybe 70 to 80 per minute if not. We have added some examples of these to the space on the right side of Lynn’s Chart, after Day 100. At the frequency line for 100, we count by 100s to the 1000 line. A nice reading speed of 250 words per minute would fall between the 200 and 300 lines (see the diamond on Lynn’s Chart).

Similarly, if we start at the bottom of the Chart, .001 per minute indicates something happening at a rate of 1 per 1000 minutes, or about 1 per waking day, such as going to school or making the bed. If you brush your teeth four times a day, your dot would be at the .004 line, like the diamond on the Chart. Then, further up at .01, we are in the range of 1 per 100 minutes, or 10 to 100 a day. An example might be weights lifted at the gym or (among examples of behaviors to be reduced) it might be acting out with self-injurious behaviors (another diamond on the Chart). Above .1, we are in the range of 1 per 10 minutes, or 100 to 1000 a day. As we reach the “1” line we are back in the range of events that may occur at a very high rate per day or may be performed many times within a brief practice period.

The Chart allows every kind of countable event to be expressed in the same language (by its count per minute), whether the target event is counted over the course of a day or within the span of 20 seconds. Note that Precision Teachers adjust the practice period to the material and learner, but they often use brief practice periods of 1 minute or less to great effect.

An important convention is that frequencies we want to accelerate (e.g., correct answers) are always denoted with dots (blue or green, if color is used) and incorrect and other deceleration frequencies are denoted with X’s (red or orange). Lynn’s Chart shows that on her first timing (Sunday, 14 April 2001), she correctly said the term for three definitions and either did not know or said the
incorrect term for 12 definitions. She performed her last timing on Thursday, 14 June 2001, a week prior to the end of the class. Lynn performed at a rate of 37 correct per minute with no errors during her final timing. An “AimStar” (uppercase A) on the Chart points to the goal rate of 30 per minute and the goal date of Thursday, 21 June 2001, the final day of the course. Her highest rate was 40 correct per minute, which she hit several times. We can also tell how long Lynn performed each day. The time bar is a dash mark placed at 1 per minute observed. For Lynn, these are at the “1” frequency line, as 1/1 minute is 1. Hence, the longer the observation interval, the lower the time bar. Note that some of Lynn’s Xs are placed below the time bar, because on those days she made no errors during the timing.

An interesting pattern on Lynn’s Chart is the crossover that occurred on the sixth day of recording when the correct responses became more numerous than the errors. From that point, errors remained below correct responses, and correct responses steadily increased, forming what some students have called a “Jaws” learning picture. A dozen types of “learning pictures” have been defined (for further information see www.members.aol.com/johneshleman/index.htmlr). Also, as with learning pictures, PT includes other standard conventions that, within the small space of one Chart, provide much information that skilled Chart readers can size up quickly. For those readers interested in learning more, sources are listed in this and the following chapter.

Other interpretations can be made rapidly from Lynn’s Chart. She performed last on 14 June 2001 (Day 74). She stopped making errors about Day 47, but her correct responses still accelerated, so she was still improving even though she was at 100% correct. After Day 60, when she achieved 40 per minute, she was high above the aim of 30 but her corrects did not accelerate further. Looking at the course overall, classes started on Thursday in the first week and ended on Day 81 in the twelfth week, but all of Lynn’s progress accrued between Day 14 and Day 60. So, with respect to the SAFMEDS part of the course, she achieved 12 weeks of learning in only 7 weeks!

**ANOTHER CHART EXAMPLE: MIDDLE SCHOOL**

Now let us compare Lynn’s Chart with Becki’s Chart (Fig. 2). Becki was in middle school when her Chart was made. She was also studying SAFMEDS, but these were made up by her teacher to address the U.S. and Illinois Constitutions and government. She took the cards home and studied them. In class, the teacher did timings. He paired each student in the class, and one student in each pair shuffled the deck. Each student had 1 minute to respond rapidly to the prompt on the front of the cards while the other student sat opposite and counted any errors in spoken response compared to the answer printed on the back of each card. “Corrects” went in one pile (minus any errors) and “skips” in another; students doing SAFMEDS always are encouraged to skip any card
Name of Behaver: Becki
Movement Cycle: 7th Grade Civics SAFMEDS

FIGURE 2
Becki’s SAFMEDS Chart. Note her outstanding final performance—over 100 per minute correct.
for which they cannot summon a quick response. At the end of 1 minute, each student counted the cards in the piles, plotted "corrects" and "errors plus skips" on their personal Charts, and then switched roles as listener and performer.

If you look at Becki’s Chart, you can see a trail of dots going up and to the right. Again, each dot shows her correct performance on 1 day, and the Xs show errors and skips. You can see when she was working and when she was not. Also, let your eyes draw a line through the dots. PT calls such a line a celeration line (adapted from accelerate when successively doing more or decelerate when doing fewer per minute). A strong, universal, and quantitative definition of learning is celeration (mathematically, count per time per time—one on these Charts, count per minute per week). However, to see and compare celerations (and hence learning), we do not need to do the math. Just look at the Chart. On Becki’s Chart, we did not have to actually draw the celeration line; however, we can take any straight-edge and draw a line that best goes through the dots to see the celeration line. A steeper celeration always means more learning; a flatter one always means less learning. Celeration is thus a universal definition of learning that can be applied to any situation in which frequencies can be obtained, and it allows precise comparison across all learners and all situations. Even very young elementary students can look at the celeration line and know that they are learning when it goes up and that they should talk to the teacher if it is flat or goes down. Also, it is not difficult to teach elementary students to chart; for example, Maloney (1982) describes teaching Charts about 20 minutes per day for 1 week, after which elementary-aged students usually are successfully charting their own data.

For our purposes, we can now compare the celerations that Lynn and Becki achieved, as well as the initial and ending frequencies. Obviously, Becki was performing faster, at over 100 per minute compared to Lynn’s 35 to 40 per minute, but the celeration lines let us see who was learning faster, because steeper lines mean faster learning. Lynn tripled her performance in the first week, but after that accelerated more slowly than Becki. Also, with Charts from some more students, we can compare the SAFMEDS with other curricula just as easily as we compared the students—either in terms of performance or learning. Next, we will discuss other things that make Becki’s case interesting.

First, recall that she was doing her SAFMEDS very quickly and by the end she reached over 100 per minute. Observing her being timed, one saw a relaxed, happy girl who was the picture of confidence, and she could discuss the concepts as well as do the SAFMEDS. Second, her teacher reported that the entire class was ready for the Constitution tests much more quickly than usual, and all students passed the first time. The State unit, which usually takes a class 5 to 6 weeks to complete, took about 4 weeks, and the U.S. unit, which usually requires 9 weeks, was completed in 7 to 8 weeks. (B. Bennett, e-mail communication, May 5, 2000). So, the State unit showed a 20% to 33% saving
of classroom time, and the U.S. unit showed a 10% to 20% savings. These gains were achieved by a teacher who had about a year of part-time experience with the Chart, who managed about 120 Charts in 6 classes, and who made up his own SAFMEDS.

Imagine if we could save even 10% of the education budget by helping all teachers apply this sort of effective, efficient teaching. One secret is that a focus on celeration (the rising line) lets both student and teacher arrange things to help learning. Another is that in this particular case the room had periodic "Chartshares" in which the students would briefly present their data to the class on transparencies and problem-solve about doing better. Because they learned faster, over time their cumulative learning was truly impressive, and they took fewer days to reach mastery than a non-PT class. The effects of celeration are like compounding interest; the higher the interest rate, the greater the amount that accrues, and it builds faster and faster as it compounds.

**LEARNING/Celeration**

Recall that the Chart actually shows learning. At its root, we infer learning from a change in performance between two (or more) measurement points. Technically, because frequency is count per time, learning (e.g., change in frequency) can be expressed as count per time per time, or celeration. But, while the Chart was constructed using exact math, to read it we do not need the same level of mathematical sophistication. We simply look at the dots (or Xs) and try to draw a line that best describes the trend. If there is too much bounce (variability) in the dots, we will not see a good line. If the dots are too far apart, data should be taken more often. It sounds basic, but having too few data or too much bounce compromises our ability to make an accurate inference. The Chart lets us know right away how solid our information is, so we can better judge what is really likely to be best for that learner.

Comparison of celerations is easy. All Charts are carefully constructed such that the same angle means the same celeration, regardless of frequency. For example, any celeration parallel to a line that goes from the lower left corner of the chart to the top right corner indicates a $X_2$ (i.e., times 2) celeration, or a doubling in frequency of behavior each week. A $X_2$ (times 2) celeration in performance is generally accepted as a significant change, and an appropriate goal for classroom performance. The celeration line on Lynn’s Chart shows a $X_{1.4}$ (times 1.4) change in behavior per week, while Becki’s almost doubles each week. For more details on how to use the Chart and additional Charting conventions, see Graf and Lindsey (2002), Pennypacker, Koenig, & Lindsley (1972), Pennypacker, Gutierrez, & Lindsley (2003); or White and Haring (1980) or visit the Standard Celeration Society webpage (www.celeration.org) to sign up for the SCS listserv, which can lead to finding someone who can help you learn PT.
PRECISION TEACHING'S PLACE IN TEACHING
AND EDUCATION

Precision Teaching is unique among approaches and methods of teaching and education. It has no fixed curriculum, subject-matter areas, types of students, or grade levels. It has been successfully applied with an incredible diversity of students, settings, and learning situations. PT does demand measuring the definition frequency (count per unit time) of each learner’s performance, displaying those data on a Chart, and making instructional decisions based on the data. Precision Teachers select and change curricula to optimize performance of individual students, and they discard ineffective curricula and practices. Thus, many PT classrooms use Direct Instruction methods and curricula (see Section 3) simply because they work and then supplement them with PT-designed practice materials because the students learn better. Similarly, many customary procedures and practices in standard classrooms do not really help students learn, and as Precision Teachers examine what they do the data help them reduce wasted time and gravitate toward more effective, learning-enhancing, and time-conserving methods. Also, because anyone who can read a Chart can understand the rationale for decisions, Precision Teachers can rapidly share effective curricula, techniques, suggestions, and consultation and can easily and completely test and personalize their application in a new classroom.

Another difference between PT and other educational theory may be its new vocabulary (e.g., celeration, bounce). Lindsley, the founder of PT, and other developers of PT have made a strong effort to use plain English words instead of jargon in developing a vocabulary for PT (Graf & Lindsley, 2002); however, the real differences of PT from other educational theories (and the secrets of its success in fostering learning) lie in its motto ("The learner is always right") and the use of learner's Charts to guide teacher efforts.

Persons who do not practice data-driven decisions and instruction may have a difficult time understanding how Precision Teachers can verify that a given curriculum is or is not effective in their classrooms. School curricula typically are selected according to theoretical fads or political expediency, and data-driven evaluation of curricula is superior to those arbitrary processes. Data-driven decision-making also affects the decision of when to present the next new topic within a curriculum. Look at Becki’s Chart again. Where the celeration line flattens, Becki’s progress slowed, and because she was already performing with great speed and accuracy we could have given her the final test right then, instead of continuing to work on the SAFMEDS. When time is saved in the classroom, teachers can decided what to add to the current semester and how to change plans for the future semesters (which can affect the plans of other teachers).

When first hearing about PT, many educators cannot imagine how they could operate such a truly individualized system with a whole class of students,
even if the students did their own charting. Many think their students could not possibly chart themselves. Yet, many classrooms have successfully used PT, and many students have charted their own performances. Calkin (2000) estimates that over 1 million Charts have been completed, many by students. It is certainly true that adding PT to what is currently happening in a classroom involves adding timings, Charting, and prep time. It is also true that the strong, well-organized teacher gets better results than a weaker, less well-organized one. Typically, though, added time is soon dwarfed by the increased learning, and even more time is saved when less efficient and less informative methods of assessment are discontinued.

The first step to making these improvements is to read more about PT, perhaps by consulting some of the Internet resources listed herein. Then, think through the curriculum and arrange for practice materials that are appropriate for the subject and students. For example, Becki’s teacher used the available subject texts and made sets of SAFMEDS. Some of the resources listed in the next chapter provide worksheets and curricula, particularly for math and reading; Precision Teachers use a variety of materials other than SAFMEDS. As you develop or obtain PT materials, you will want to set the performance criteria for mastery. In PT, such decisions about goal setting are often discussed in terms of fluency, a topic described in detail in the next chapter. Roughly speaking, fluent describes a performance that is smooth, accurate, and sufficiently rapid and does not decay in the presence of distractors or in novel applications. You may be able to find fluency standards for your material within the available PT literature; if not, a few timings with adults who have already developed competence with that skill can provide a rough guide. Next, learn to chart and teach the learners to chart, and look at the Charts each day. Systematically search for and remove the fluency blockers that impede the learners, and put in place fluency builders instead (Binder, 1996). Finally, celebrate learning. Tell each student, “Beat your own score,” and make that the standard for measuring achievement.

ETHICS AND PRECISION TEACHING MEASURES IN SCHOOLS

Precision Teaching and the measurement of learning bring us to some ethical issues in education. Some may assert that measuring student performance is emotionally damaging and argue against any timed measurement or direct feedback. Of course, any procedure can be misused, but in the typical PT situation, when students are timed each day, they and their teachers use that data together to improve teaching and learning. In a PT environment, the learner is not pressured by comparisons to others who may be ahead, nor embarrassed by unwelcome use as an example to others who may be behind; instead, students have direct access to their own data over time and beat your
own scores becomes the incentive. Data feedback in this type of situation is empowering and may be compared directly to athletics and music where data on personal performance are key to self-improvement when the feedback is handled in constructive ways.

Any consideration of ethics in education must include the problem of limited resources. Resources (including the students' time and the public's money) can be wasted through failure to teach. In typical educational settings, such failure is not immediately apparent, but with PT anyone who can read a Chart can tell if learning is occurring or not. Thus, administrators and parents may be encouraged to regularly view students' Charts, and the data will show if students are learning or not. Contemplating this level of true accountability may provoke anxiety, but remember that the student and teacher see the data each day, so there are many opportunities to change procedures and move forward before much time is wasted or to call for consultation and get help with the problem. The repeated assessment and rapid formative feedback of PT compares very well to the increasingly common situation of teachers and schools facing censure based on once-per-year tests and students facing the possibility of not receiving a diploma.

The teacher who honestly hones his or her practice of teaching as a craft will find PT to be an immensely invaluable tool, while a teacher who just goes through the motions or one who is intimidated by change may find many arguments against PT. Students themselves see the effects of PT procedures and how they are intended to facilitate learning. The result is a system that is student centered, facilitative, empowering, liberating, and refreshingly honest to the student.

Because the learner is always right, PT is resistant to the fads and fashions that often plague education (Grote, 1999; Lindsley, 1992). Educational innovations and theories must be tested in the crucible of the classroom, and show benefit through data from individual students over time. Those that benefit only their originators, bureaucrats, and consultants must be modified or discarded. To help people learn, there is no substitute for good data.

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INTRODUCTION

In the previous chapter, we introduced some foundations of Precision Teaching (PT) and provided individual examples. In this chapter, we present some of its innovations in more detail and describe applications for special education, college classrooms, prevocational training, accommodation to disability, personal growth, and other topics. Finally, we present an annotated bibliography of PT websites and some PT resources.

In addition to many other activities, teachers problem-solve, invent, and try new things. In this arena, Precision Teachers have been especially productive, and standard Charts facilitate sharing their innovations. Because the learner is always right (see previous chapter), PT teachers test their teaching practices with every student, and with the Chart everyone can see rapidly what works and
what does not. While space does not permit a full discussion of all the topics raised here, we will briefly introduce a few critical concepts and innovations used in PT. Note that the order of exposition here is not the order of discovery, and we apologize that most references to the people who discovered these are omitted to save space.

An interesting concept in PT is that of fluency, or a fast, comfortable, effortless performance (Binder, 1996; Graf & Lindsley, 2002; Kubina & Morrison, 2000). In PT, fluency has a specific meaning; it refers to performing at true mastery, or a level at which the skill becomes reliable and useful. The characteristics of fluency have been analyzed and widely discussed among Precision Teachers and are often presented as an acronym to facilitate understanding and retention. Various Precision Teachers have used different acronyms, but we will use SARGE—fluency is stable (resistant to distractions), is easily applied (incorporated in more complex skills or new combinations), is retained over long periods with little or no practice, is generalized to new situations, and shows endurance (can be performed for long durations without undue fatigue or loss of quality). Fluency means more than performing at 100% correct (see Barrett, 1977, 2002); it indicates when we should stop teaching a skill and move to another. Johnson and Layng (1992, 1994) use a different fluency acronym; they discuss "generative instruction," in which selected components of complex skills are taught to fluency such that learners generate other components without specific instruction. Acronyms aside, our goal of fluency means learner independence.

Celerations and frequency ranges at which fluency is observed when we test the learners with more complex skills have been discussed in the PT literature for over 20 years (Haughton, 1980). Along with fluency is the related notion of components of more complex composite behaviors (or skills). Because all visible behavior is made up of smaller behaviors, when key smaller component behaviors are performed fluently, we can easily teach the more complex composite behavior. Thus, if a learner’s celeration is low when performing complex tasks, one tactic is to measure to see if components of that composite behavior are at fluency. If not, we may switch efforts to teach the components. For example, if a child reads slowly and makes inaccurate guesses at pronunciation, component reading skills of phonemic discrimination and decoding should be taught to fluency before much progress will be made in reading. In rare cases of disability, we may bypass a component (e.g., auditory discrimination for a person with severe hearing loss) and substitute another learning stream, as discussed below.

Note that a behavior can be successfully performed at 100% correct and not be fluent. To see the difference, look for labored, effortful, and slow performances; low endurance; difficulty in learning the next more complex skill; and even escape, evasion, and tantrums when the more complex skill is addressed. For example, several early Precision Teachers worked with learners having a variety of severe disabilities. They identified the ‘‘Big Six’’ components of skilled hand movements: reach, touch, point, place, grasp, and release (Binder &
Haughton, 2002; Binder, Mallabello, Desjardins, & McManus, 1999; Haughton, 1980) that are the basis for useful hand function. Deficient skills on these components frustrate learners and impede or prevent acquisition of more complex skills that use the hands. For example, dysfluent hand skills will make learning math difficult and unpleasant if one has to write answers. Again, it is not that the movements are absent; they are just slower. A motor dysfluency that blocks learning of academic tasks may escape detection if frequencies are not measured.

The “Big Six” and other hand movements can be independently sampled and should be in the range of hundreds per minute. When they are that fast, making slash marks and Os with a pencil can also be taught to the rate of hundreds per minute. These simple hand skills (and some gross motor movements) will then support teaching the student to write numbers in sequence and randomly at rates of over 150 correct per minute, which in turn will support learning elementary math (+, −, ÷, ×) in the range of 80 to 120 digits per minute correct, which in turn will support learning fractions, geometry, algebra, and calculus. Obviously, we may fill in the slices of many curricula here, from basic mobility skills to reading, writing, and other academic and life skills. Thus, fluency provides true mastery goals as well as new tactics; when learning is stalled, we can address its components. For the learner comes confident competence. The resources listed later can guide you to curriculum slices and fluency goals devised by PT people, sometimes utilizing existing curricula (e.g., Direct Instruction) and sometimes developing new material.

Precision Teaching also uses the notion of Learning Streams (earlier called Learning Channels; Lindsley, 2002) to label in plain English what learners are being exposed to and what they are supposed to do. For example, SeeSay words in context clearly use the active verbs “see” and “say” as unambiguous terms for the actions that are counted. Other Learning Streams include HearWrite, SeePointSay, ThinkSay, and so forth. The term “comfort pairs” denotes the PT practice of counting two academic behaviors simultaneously, one to accelerate and one to decelerate, as in math digits correct and errors (or “learning opportunities”). This focus on the situation and on active verbs to describe behavior helps us to change the situation to advance the learner and to ensure that the desired effects are being achieved (Barrett, 2002; Lindsley, 1964).

An interesting PT finding is that the frequency, celeration, and bounce of a behavior are independent; interventions may affect any of these and not the others. Because PT uses the standard Chart, any effects can be seen and classified: frequency may jump up or down, celeration may turn up or down, and bounce (variability in frequency from one performance to the next) may converge, diverge, narrow, or widen. Similarly, corrects may accelerate without changing error frequency (an outcome invisible to percent-based measures). The simultaneous display of all of these distinct features makes Chart analysis quick, easy, and accurate (see Lindsley, 1992, for a concise and readable summary of learning effects).
Space precludes a full list of PT innovations, but we will mention two more powerful techniques resulting from Chart standardization. First are the Chart-shares, where the learners can put up transparencies of their Charts, discuss their learning, ask peers for advice, and give the results of last week’s consultation. Typically, showing a Chart at a Chartshare requires only 1 to 2 minutes, and it is a heartwarming and inspiring experience to see young, previously shy and school-averse students confidently present their learning pictures. Chart-shares are a dramatic way to empower learners, engage them in a search for effective study methods, and create a true and productive learning environment. Another technique is that of stacking multiple transparencies of Charts on top of each other (or, in digital versions of the Chart, viewing overlaid data from multiple Charts). In this way, a teacher, student, parent, or administrator can review data from several skills for one learner or data from one skill for several learners. Chart stacks summarize without the loss of individual data (Cooper, Kubina, & Melanga, 1998). Examples of questions that could be addressed by stacking include: On which skill did this learner show a greater celeration? Of the students in this classroom, which are showing greater celerations and which are having problems? In which of these classrooms are students making the most rapid gains? Which curricula shows a wider range of gains?

**PRECISION TEACHING AND SPECIAL EDUCATION**

The motto "The learner is always right" succinctly expresses why PT is appropriately used in special education. The fast and convenient measurement, decision-making, and communication of Precision Teaching help teachers arrange the educational environment to benefit each learner and allow stakeholders to assess the celeration (learning) of each student. Students are by definition placed in special education classes when their performance is sufficiently below that of their age and grade mates. Logically, if these students are ever to match the performance of their peers, they must learn at a faster rate than the peers. While the reader might question whether that is possible for many of the students in special education, the usual delivery of slow, inefficient, and watered-down instruction guarantees its impossibility. Opening doors to other possibilities requires that instruction be more intense and effective in the special education classroom, and there should be less tolerance for inefficient and ineffective procedures and curricula. However, a great strength of special education is the recognition that additional resources (such as teacher time and training) can and should be provided to these students to facilitate their learning, and PT is ideal for determining how to focus resources to accelerate learning, to document outcomes, and to communicate with caring stakeholders.

The Individuals with Disabilities Education Act Amendments of 1997 (IDEA) mandates a free appropriate public education for all children with disabilities in
the United States between the ages of 3 and 21. It includes several major provisions that PT meets more effectively than other systems. Two provisions of IDEA are related to evaluation and individualized education programs (IEPs). In terms of evaluation, IDEA requires that schools: (1) use testing and evaluation materials and procedures that are not racially or culturally discriminatory or biased by a student’s language or disabilities; (2) use assessment tools and strategies that provide functional and developmental information for determining the content of the child’s IEP, that provide relevant information that directly assists in determining educational needs, and that provide information regarding involvement and progress in the general curriculum; and (3) not use any single procedure as the only criterion for determining whether the child has a disability or for determining an appropriate educational program for the child. The IEP is a written document provided for each child with a disability. The content of an IEP must include the child’s current level of performance, measurable annual goals and short-term objectives, special education services, related services, supplementary aids, program modifications necessary for the child to make progress toward the goals, a plan for how progress toward the goals will be measured, and timelines for services.

Precision Teaching is ideally suited for meeting these requirements of IDEA (and similarly the No Child Left Behind legislation). Because PT can be used to measure learning in any curriculum or method, it does not discriminate racially or culturally, nor is it biased by language or disability. In addition, PT provides a relevant measure of a student’s performance that is immediately applicable to selecting IEP content, determining educational needs, and measuring progress in the curriculum. By analyzing Charts of a student’s achievement in various areas of the curriculum, teachers can easily summarize a student’s current level of educational performance in each of those areas and select appropriate goals and objectives based on the student’s needs and known fluencies. With celeration, teachers can evaluate the effectiveness of current methods and set an appropriate AimStar (i.e., goal frequency and date) for each objective. Then, by drawing an expected line of progress from the current performance to the AimStar and comparing actual progress to the expected progress, advancement toward the objectives can be continually evaluated and programs modified as needed.

Rather than waiting for the required annual review of IEPs to determine student achievement and modify goals and objectives, PT provides an easy way to evaluate progress on a daily basis. With this daily evaluation, PT facilitates the crucial function of driving these educational decisions with data. Programs are promptly changed if progress is insufficient, and programs are kept in place when progress is being made. The nature of the Chart is to show proportional gains, which is particularly valuable when the learning is just beginning. Thus, PT avoids both wasting the child’s time with ineffective curricula and wasting opportunities and teaching resources by switching students out of effective curricula when continued progress is subtle. Also, communication with other
stakeholders is facilitated; parents may review charts for updates on their children's progress toward goals and objectives. Thus, PT is the perfect tool for making educational decisions that meet the requirements of IDEA and for providing a truly accountable, effective, and individualized educational program. Finally, because PT data are kept on a standardized Chart, paperwork and wasted time are kept to a minimum. Meetings can be brief and more focused on what can be tried to help the child accelerate. Also, if data are computerized and online, parents, administrators, and other authorized individuals can have ready access to student Charts.

PRECISION TEACHING FOR ADULT LEARNERS IN COLLEGE AND PRE-VOCATIONAL TRAINING

Teaching introductory courses at the college level and finding acceptable ways for students to master large numbers of new concepts is challenging, and PT techniques have been used in colleges for over 30 years (Johnston & Penny-packer, 1971). Lynn's Chart in the previous chapter (see Fig. 1 in Chapter 4) came from a contemporary course in introductory special education. In it, graduate elementary education majors used 180 SAFMEDS cards to learn special education terms and recorded their performance at www.AimChart.net (see Internet resources on pp. 74-76). They viewed their celerations on computer-generated charts. At one class session a week, students conducted 1 minute timings with a partner. After the final timing during the last class session, students completed a written quiz, which required them to write the corresponding term for all definitions listed in random order. Students received points toward their final course grade for daily charting, for their final timing, and for their score on the final written quiz. Celerations increased for all students, with all but a few reaching or exceeding the goal rate of 30 correct per minute. At the beginning of the term, students expressed some initial concern and resistance for the task. By the end of the term, however, only two students gave negative comments concerning the SAFMEDS task on the course evaluations.

A major positive aspect of the task was that, as students were learning the terms, they were able to understand and converse with professionals in the schools they visited for their clinical experiences. In addition, students continued to contact the instructor during the next school year regarding their use of SAFMEDS in their other course work and with the students they taught. The charting task also was beneficial, as indicated by student comments regarding their excitement when seeing correct rates accelerate and when crossover occurred. Figure 1 shows stacked data from this class for a few students.

Other PT projects and programs have used the power of PT to reach older students who had been unsuccessful in previous academic settings. One such program in Malcolm X College in Chicago (Johnson & Layng, 1992, 1994) has been operating successfully for over a decade, and a program with similar goals
FIGURE 1
Stacked data from four students in a special education class.
at Jacksonville State University (JSU) in Alabama has been operating continuously since 1978. McDade and Brown (2001) have published a concise sampler of their PT curricula at JSU for mathematics and English language instruction, as well as two editions of a manual focused on English composition skills (Brown, n.d.).

Adult learners also are successfully taught in other venues. For example, DuPage County officials in Illinois contracted with the AimStar Precision Learning Center to teach literacy and numeracy skills to adults who were having difficulty maintaining employment. Four adults classified with learning disabilities were immediate referrals. Results of an assessment showed that, although these adults performed decoding skills at an acceptable level, they had difficulty with comprehension (including following multitask directions), lacked fluent basic math skills, and lacked the basic knowledge necessary for functioning in various environments. Using PT, direct instruction, oral comprehension lessons, practice sheets, and SAFMEDS, two teacher/consultants taught reading comprehension and basic math skills to these four adults over a 6-week period. Embedded within the comprehension lessons were opportunities to strengthen oral listening skills and basic knowledge. All students mastered many comprehension lessons and a variety of addition, subtraction, multiplication, and division facts. These adult students particularly enjoyed viewing their charts for celerations in their learning. Johnson and Layng (1994) report dramatic gains from a similar project.

**PRECISION TEACHING APPLICATIONS FOR INDIVIDUALS WITH VARIOUS DISABILITIES**

As can be imagined, because the PT measurement technology can be applied to any countable behavior, it offers a powerful and effective method for working with persons who have disabling conditions. In Boston, the Judge Rotenberg Center (JRC) provides such services to clients with severe behavioral and academic challenges, maintaining Charts on numerous goals for the residents in a coordinated program. The JRC website (judgerc.org) offers current information about these programs and their effects. AimStar Precision Learning Center, located near Chicago, IL, provides services to clients with a wide range of ages, abilities, and needs. "Mindy" was an 18-year-old student with Down syndrome. Her parents had become frustrated with her public school after the school staff told them that she had reached a plateau and had learned everything that she was going to learn. Mindy's parents believed that school staff were severely underestimating her potential, so they requested services at AimStar. Mindy’s assessment revealed that she could read at about the first-grade level, although not fluently, and that she was able to perform some basic math skills, primarily addition and subtraction. Observation at school showed that Mindy spent most of the school day playing
5. Precision Teaching: Applications in Education and Beyond

computer games, listening to music, and watching movies. Given the opportunity, however, she preferred to practice reading and math skills. At AimStar, Mindy was an eager learner who was highly reinforced by mastering skills, teacher praise, and celebrations on her charts. She also practiced the skills every night at home. Although her Charts showed lower than average celebrations, she continues to master writing, reading, comprehension, and math skills. Hardly a plateau with no learning!

An example of PT in the rehabilitation of persons with severe brain injury is provided in an article by Merbitz, King, Bleiberg, & Grip (2000) that illustrates how PT data were used to assess medical and pharmacological issues as well as instructional ones. It also provides a specific example of how monitoring and charting the instructor’s behaviors as well as the learner’s can enable rather stunning insights to removing fluency blockers. The application of PT in rehabilitation after stroke (Cherney, Merbitz, Grip, 1986; Neely, 2002) has also been documented. Other data regarding rehabilitation (Merbitz, Miller, & Hansen, 1985) have shown that life can be stronger than our interventions; in one case, for example, PT data clearly revealed very strong effects associated with going home on a pass and partying at Christmas and New Year’s. But, ultimately, good data do reflect life.

In recent years, the population of persons diagnosed with autism and autism spectrum disorders has mushroomed. Concurrently, Precision Teachers have made significant progress in working with this population of people (especially children). Building on the pioneering work of Lovaas and others (Lovaas et al., 1981), Precision Teachers found that Lovaas’ discrete trial procedures often could be used to teach a new skill, but that the free operant procedures of PT were highly successful in taking it further to a point at which the skill could be considered fluent. Precision Teachers also identified fluency blockers for people with autistic behavior, such as deficiencies in components (e.g., “Big Six” and other hand skills as well as social and academic skills).

In Fabrizio and Moors’ highly successful programs, Charts are used to document the progress of each child as fluency is reached for each target behavior (Fabrizio, Pahl, & Moors, 2002; Moors & Fabrizio, 2002). Among all of the other instructional activities that they employ are several non-obvious tactics that spring directly from PT and bear closer examination here. One such tactic is the “Sprint”—a practice session of brief duration (such as 6 to 10 seconds) during which the child repeats the requested behavior a few times correctly, followed immediately by reinforcement. When the frequency rises, then the time bar can be lowered (increasing the timing interval) to 20, 30, or 45 seconds, while maintaining (or building up to) the desired frequency. In effect, when the child can do a short burst of correct responses, we can selectively reinforce that high frequency of performance and then gradually shape to lengthen the duration of correct responding. Finally, when the learner is at the target frequency, endurance can be built by extending the duration of the practice as appropriate for that skill (Binder, Haughton, & Van Eyck, 1990).
As a routine element of their practice, Fabrizio and Moors also systematically test achieved skills for stability and retention. Both of these checks generally occur when the learner has reached frequency and endurance goals. When a learner can perform a task correctly at the target frequency, even when a favorite video is playing, people are talking and moving about in the environment, and distracting things are happening, that task can reasonably be called stable. Similarly, a retention check also is deceptively simple: Do not present any further opportunities for practicing that particular skill for an extended period (up to a month, depending on the practical and ethical issues of not teaching in that curriculum area). Fabrizio and Moors’ Charts simply show the month with no data on that skill, and then another dot. If there is no drop in frequency, instruction can move on past that goal. Charts and discussions of these and other issues can be accessed at http://students.washington.edu/fabrizio/index.htm.

When accommodations to disability are necessary within a classroom, PT offers an efficient way to manage and evaluate the effects of those accommodations, as the following example illustrates. In a combined graduate-advanced undergraduate course, Medical Aspects of Disability, students used a set of 375 SAFMEDS cards while learning medical terminology, anatomy, the functions of various body systems, and evolving concepts of health and disability. One student (Sara) had moderate impairments in visual acuity as well as severe impairments in physical strength and dexterity. She worked with the instructors to find a method of presenting the SAFMEDS that would allow her to meet the mastery criteria for an A on that portion of the course (i.e., 35 cards correct per minute).

Bigger, large-print cards were tried and were not helpful. An Excel file was developed that presented the card information on her computer, and within 3 weeks she reported she was regularly reaching her aim in her home practice sessions. However, her in-class performances were still significantly slower by about 15 cards per minute. She and one of the instructors worked to identify possible fluency blockers; her first hypothesis was anxiety. Various strategies were attempted to reduce anxiety, but home practice performances continued to reach or exceed her aim, and in-class performance remained low. Next, they searched for features that might distinguish between home and in-class assessment. Because she used a portable respirator and had to coordinate her speech with the air supply, they tried having her speak her answers more softly for the instructor to conserve breath, but this did not increase her rate. As they searched for any other differences, it was determined that the screen display of the classroom laptop did not duplicate that of her home computer. The screen display was adjusted until Sara said it matched her home screen. This was immediately followed by a performance at 36 correct per minute. Figure 2 shows Sara’s Chart. Dots show her SAFMEDS performance at home and diamonds show it in class. Vertical tic marks have been placed along the 100 frequency line to indicate the days on which the class met. Notice how the
Name of Behaver: Sara

Movement Cycle: Home & Class Med Aspects SAFMEDS

FIGURE 2
Sara's Chart.
Thursday in-class SAFMEDS rose after Day 63 to blend in with the at-home performance frequency, after the computer screen was adjusted to match her home screen.

The instructor and Sara herself initially looked for features of the learner that might set limits on performance (note the insidious “blame the learner” habit), and both had begun to consider lowering the aim before fully exploring objective features of the environment. This “solution” would have deprived her of the opportunity to demonstrate (and celebrate) her competence with the material; true accommodations to her multiple disabilities did not mean lowering standards.

**PRECISION TEACHING WITH THOUGHTS, URGES, AND OTHER “INNER” PHENOMENA**

Precision Teaching procedures have been used to count and chart a wide variety of important life activities. For example, mothers have charted babies’ kicks before birth, and these Charts present orderly data (Calkin, 1983; Edwards & Edwards, 1971). More recently, several investigators (Neely, 2002) have charted end-of-life phenomena using PT measures with terminally ill persons. In another arena, as Calkin (1981, 1992) and others (Cooper, 1991) have convincingly demonstrated, people can use PT techniques to chart their thoughts, urges, and feelings, and the resulting data are orderly and useful; for example, they can be used as part of a plan for self-improvement, relationship enhancement, and so forth. Thus, PT has begun to grapple with some important arenas of personal life.

**PRECISION TEACHING, COMPUTERS, AND INTERNET RESOURCES**

Over the last three decades, a number of computerized versions of the Chart and PT data collections systems have been developed (Merbitz, 1996). The source for copies of the original, and still indispensible, blue paper Chart remains Behavior Research Company (Box 3351, Kansas City, KS 66103). While paper Charts and computer screen displays may differ in effects on the learner, the computer Charts offer some advantages for administration and long-distance sharing. With the growth of the Internet and development of more capable hardware and better software have come many more PT resources. Almost all of the sample sites listed on the following pages offer links and resources for many PT sites, such as learning centers. Because others are being developed, this list is simply a place to begin; Google listed about 2000 PT hits in 2003. Also, centralized databases of Charts are now becoming available (e.g., www.AimChart.net) building on Lindsley’s pioneering Behavior Bank database of the 1970s.
www.celeration.org: The official website of the Standard Celeration Society, a group that uses PT and supports its development; an active and friendly Listserv can be accessed through the website; it also has numerous links to professionals using PT and PT projects.

http://psych.athabascau.ca/html/387/OpenModules/Lindsley: The website for David Polson's and Lyle Grant's course at Athabasca University; it contains an excellent introduction to PT.

http://www.celeration.net: A great site by John Shewmaker, in which he collects many annotated resources for people coming to PT from the "real world."

http://www.fluencyfactory.com/PrecisionTeachingLinks.html: The Fluency Factory (Richard McManus) teaches anyone in the Boston area; site also has an annotated list of excellent PT links.

www.morningsideinfo.com: The Morningside Academy, started by Kent Johnson, is a complete school built upon PT and scientifically validated instruction; visitors can see data-driven instruction and decisions in Morningside classes.

www.tli.com: The Learning Incentive offers instructional technology as well as interesting links; it is the home base of Ben Bronz Academy, a school based on PT with a dramatic record of instructional achievements and developments in databased technologies as applied to instruction.

www.judgerc.org: The website for the Judge Rotenberg Center in Boston, an organization for severely impaired persons; IRC offers both day and residential programs within which decisions are guided by PT data, operating under a computerized system.

http://members.shaw.ca/celerationtechnologies/index.html: Celeration Technologies is the source for Joe Parsons' ThinkFast computerized SAFMEDS system, an alternative to printed cards.

http://www.simstat.com/PracticeMill.html: Normand Peladeau’s PracticeMill at the Simulation and Statistical Research and Consulting Centre (SimStat) supports practice sheets and SAFMEDS utilization.

www.chartshare.net: This site, developed by Jesus Rosales and a group at North Texas State University, promises support in the task of collecting large groups of Charts (metacharting) and preparing Charts for scientific publication.

www.fluency.org: Excellent site with a great collection of papers that may be downloaded; Carl Binder’s 1996 review article on fluency is easily accessed here.

www.binder-riha.com: Carl Binder’s site, which features applications of PT to business and industry.

www.members.aol.com/johneshleman/index.html: John Eshleman’s Instructional Systems Site offers a series of tutorials on PT and data-
driven instruction; see the Learning Pictures descriptions and PT References.

www.headsprout.com: An Internet-based reading system built in part on PT data and a careful analysis of steps involved in successfully teaching reading.

www.haughtonlearningcenter.com: A site presenting the highly respected Haughton Learning Center PT curricula.

www.teachyourchildrenwell.com: Michael Maloney’s PT curricula and Learning Centers.

www.sopriswest.com: Sopris West publishes PT materials and offers skilled PT consultation.

http://people.ku.edu/borns/: Developed by Scott Born, this site contains a number of Excel templates that faithfully reproduce various Charts for publication and posting.

http://students.washington.edu/fabrizio/index.htm: This site, developed by Michael Fabrizio, has downloadable versions of many of his publications and presentations; a particular "must visit" for anyone interested in autism or instructional advancement.

www.teenor.com/ptdocs/: Many useful PT articles available in downloadable form.


www.aimchart.net: At this site, under development by the first author, you can deposit data, immediately see it on a Chart, and update the Chart whenever needed. Teachers can set up classes with a password for each student, so students can enter data and see their Charts. The teacher, however, can see all Charts and various overlays, including frequency and celeration stacks (such as this chapter’s Charts). Parents can use students’ passwords to see their children’s data (if the child has an IEP, this feature allows parental access to the data). It also will draw a minimum celeration line to an AimStar. While many schools will opt to use traditional paper Charts, this site allows the data to be shared easily across the web. Early versions of the site were supported in part by the North Central Regional Educational Lab (NCREL).

CONCLUSIONS

With our motto, "The learner is always right," and standard Charts, it is possible to deliver learning and hence effective education. PT includes a body of techniques that are empirical and based in natural science, which makes it possible to really know what is working for your students. We hope that the
resources and information provided here are useful in helping you access these techniques and improving life for you and your learners.

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References


Direct Instruction is a systematic attempt to build a technology of effective academic instruction that includes all of the school-based components necessary to produce academic growth. Direct Instruction includes three broad components, each of which addresses a distinct set of issues that are critical to academic instruction: First, Direct Instruction includes a specific approach to determining what should be taught and how the curriculum should be organized. The driving principle is that the curriculum should be organized to teach generalizable strategies (Engelmann & Carnine, 1982). Second, Direct Instruction includes a set of specific instructional programs that are designed to systematically build skills by carefully organizing lessons, sequencing skill introduction, gradually reducing supports for student performance, providing sufficient practice, and specifying teaching procedures in specific detail. The programs cover a wide range of elementary and secondary level curricula (Marchand-Martella, Slocum, Martella, 2004). Third, Direct Instruction includes a distinct set of procedures regarding how teachers and students interact. The guiding principle is that lessons should maximize students' active and productive engagement with tasks that are at an appropriate instructional level. This chapter describes each of the three basic components, explains how the components are translated into specific instructional practice, and reviews the scientific research related to the effectiveness of the Direct Instruction approach.
TEACHING GENERALIZABLE STRATEGIES

Educators are faced with the challenge of teaching a long list of standards and objectives to a diverse set of learners in a very limited amount of time and, as a result, they must be keenly aware of the efficiency of their practices. In the Direct Instruction model, efficient and powerful instruction begins with a careful consideration of the curriculum. The goal is to identify or invent ways to organize the curriculum for efficient teaching and learning. For example, if we want to teach a student to read 1000 phonetically regular words, we could teach each of the 1000 words as a separate entity. Alternatively, we could teach the most common sound for each letter and the skill of blending sounds to form words. It would be tremendously more efficient to take the latter approach. Teaching the sounds and the ability to blend would not only enable the student to read the 1000 words in much less time, but students would also have skills that could be applied to many additional words. Learning the generalizable skill of phonetic decoding also provides a platform for learning more complex word-reading skills and even facilitates the learning of irregular words (irregular words have many phonetically regular sounds).

The key is to teach "big ideas" that allow students to go beyond the specific examples that were used in instruction and to respond correctly to new examples and in new situations that they never encountered in previous instruction. Such big ideas include skills, concepts, generalizations, and other knowledge structures that enable the student to generalize appropriately (Carnine, 1994; Kame'enui, Carnine, Dixon, Simmons, & Coyne, 2002). One of the primary challenges for instructional designers is to identify or invent powerful big ideas that can provide the foundation for efficient instruction. Phonetic decoding is, of course, a crucial big idea in early reading instruction. In elementary mathematics programs, the concept of a number family is a big idea that reduces fact memorization and provides a structure for solving story problems. The general skill of speaking in complete sentences is a big idea in preschool language development programs. Direct Instruction history programs are organized around the big ideas of a problem–solution–effect sequence and five basic types of solutions to historical problems (accommodate, dominate, move, invent, tolerate). In spelling, the big idea of dividing words into morphographs and using specific rules to join morphographs allows for highly efficient instruction. These are just a few examples of the dozens of big ideas that provide the foundation of Direct Instruction programs. For a more complete description of the big ideas in specific Direct Instruction programs, see Marchand-Martella et al. (2004).

The strategic and efficient use of big ideas is not apparent in a superficial examination of Direct Instructional materials. Like physical foundations, it is not the most obvious aspect of a structure, but it largely determines the value of the more obvious features.
INSTRUCTIONAL PROGRAMS THAT POWERFULLY AND SYSTEMATICALLY BUILD SKILLS

The big ideas that result from a careful analysis of the subject matter provide the core of the content to be taught. The next component of Direct Instruction is the program that organizes the content and specifies the procedures to teach this content. An instructional program is similar to a staircase that climbs from its base in prerequisite skills to its top at the program's objectives. To be effective, powerful, and inclusive, a program should enable the widest possible range of students who arrive at the start of the staircase (i.e., who have the prerequisite skills) to reach the top (i.e., to master the objectives). The key to creating a powerful program is to ensure that each student completes each step. Direct Instruction programs use five main strategies to make the staircase as simple as possible.

Clear and Explicit Instruction

To teach effectively and efficiently, big ideas must be conveyed to the students clearly, simply, and directly. The details of Communication depend on the learner's skills and the nature of the subject matter, but all communication is ultimately based on the use of examples. Direct Instruction programs use an elaborate and detailed analysis of communication to produce instruction that is consistent with only one interpretation. This system is described in depth by Engelmann and Carnine (1982).

When verbally stated rules are used, the instruction must carefully prepare the students to learn and apply the rule. For example, *Spelling Mastery Level C* (Dixon & Engelmann, 1999) teaches the spelling rule, "When a short word ends with a CVC [consonant–vowel–consonant pattern] and the next morphograph begins with a vowel letter, you double the last consonant" (p. 187). This rule would be worthless without careful preparation and systematic application with feedback. First, any terms or concepts used in the rule must be taught to mastery before the rule is introduced. Thus, the program includes specific instruction and practice on: (1) identifying the morphographs in words, (2) identifying whether the next morphograph begins with a vowel letter, and (3) identifying short words (less than five letters) that end with a consonant–vowel–consonant pattern. All of this instruction occurs before the overall rule is introduced. Second, the verbal statement of the rule must be explicitly taught and overtly practiced until students can say it reliably. Third, students must be carefully guided through the application of the rule. (This procedure of systematic guidance through application of a rule is illustrated in the next section.) Fourth, the rule must be implemented with the full range of relevant examples and non-examples. Thus, *Spelling Mastery Level C* provides practice that requires students to apply this rule to numerous words, including examples (e.g., stopping) as well as non-examples that (1) are based on a
word that is not short (e.g., watering), (2) are based on a word that does not end with a CVC morphograph (e.g., hoping), and (3) have an added morphograph that does not begin with a vowel (e.g., runway).

Sequence of Instruction

The sequence of instruction is the order in which topics are taught, practiced, reviewed, and combined with other skills. The sequence must be carefully worked out if an instructional program are to reach a wide range of learners. Sequencing of Direct Instruction programs are based on three general guidelines. First, prerequisite skills should be taught and thoroughly practiced before students are taught the strategy that uses these skills; this guideline was illustrated with the example of teaching a morphographic spelling rule in the previous section. Second, instances consistent with a strategy should be taught and well established before exceptions to the strategy are introduced. If exceptions are introduced too early, students can make excessive errors, become confused about when to apply the rule, and guess rather than apply rules. After students have mastered a rule, exceptions can be introduced without undermining the general rule. Third, items that are likely to be confused should be separated in the sequence. Several classic learning problems are a matter of confusing similar items or processes. For example, many remedial readers confuse the similar letter-sound relations of b and d. When introducing similar items, one item should be taught and thoroughly practiced before the second item is introduced. In the Direct Instruction program, Reading Mastery I (Engelmann & Bruner, 2003), the letter d is introduced in lesson 27 and b is not introduced until lesson 121; this greatly reduces the confusion between d and b.

Provide Initial Support, Then Gradually Reduce Support

To create a sequence of small steps toward mastery of these complex skills, Direct Instruction programs often introduce skills with substantial support in the form of prompts from the teacher and from the written materials. Then, as students gain skills, the level of support is gradually reduced. This sequence of movement from highly supported to highly independent performance has been referred to as mediated scaffolding (Carnine, 1994; Kame‘enui et al., 2002). For example, Table 1 shows a sequence of formats that are used to teach the rule for reading words that end with the vowel–consonant–e pattern (e.g., hope, fire). When the rule is introduced, the teacher leads the students through its application with a series of questions (see Table 1, Format 1). As the students gain skill, the level of teacher support is reduced to that shown in Format 2, then 3, then 4. By the end of the sequence, students are able to encounter new words that end with a vowel–consonant–e pattern and read them correctly without any assistance from the teacher.
### TABLE 1
Sequence of Formats Showing Gradual Fade of Strong Support

<table>
<thead>
<tr>
<th>Format 1</th>
<th>1. Teacher: Remember, when there is an &quot;e&quot; on the end, this letter (point to it) says its name.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2. Teacher: Is there an &quot;e&quot; on the end? Students: Yes.</td>
</tr>
<tr>
<td></td>
<td>3. Teacher: Will this letter (point) say its name or its sound? Students: Name.</td>
</tr>
<tr>
<td></td>
<td>4. Teacher: What is its name (or sound)? Students: ____</td>
</tr>
<tr>
<td></td>
<td>5. Teacher: What is the word? Students: Lake.</td>
</tr>
<tr>
<td></td>
<td>Repeat steps 2 through 4 for each of the following words: fade, rot, note, bat, him, time.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Format 2</th>
<th>1. Teacher: Is there an &quot;e&quot; on the end? Students: Yes.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2. Teacher: What sound will this letter (point) make? Students: ____</td>
</tr>
<tr>
<td></td>
<td>3. Teacher: What is the word? Students: Lake.</td>
</tr>
<tr>
<td></td>
<td>Repeat steps 2 through 4 for each of the following words: fade, rot, note, bat, him, time.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Format 3</th>
<th>1. Teacher: What sound will this letter (point) make? Students: ____</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2. Teacher: What is the word? Students: Lake.</td>
</tr>
<tr>
<td></td>
<td>Repeat steps 2 through 4 for each of the following words: fade, rot, note, bat, him, time.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Format 4</th>
<th>1. Teacher: What is the word? Students: Lake.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Repeat steps 2 through 4 for each of the following words: bat, float, first, toy, plane.</td>
</tr>
</tbody>
</table>

| Format 5 | Students read VCe (vowel-consonant-e) words in passages without previous practice on those words. |

---

**Provide Sufficient Practice and Mastery Criteria**

Direct Instruction programs include the tools necessary for teachers to provide an appropriate amount of practice for a wide range of students and the provision that certain tasks should be repeated until students’ responses are firm. The teacher repeats the examples in that task until the students respond correctly and without hesitation to all the items. This procedure of repeating tasks until firm is a way of adjusting the amount of practice provided in each task to the needs of the specific group. It allows the program to accommodate the needs of lower performing groups without requiring higher performing groups to work through unnecessary practice. Thus, in almost all cases, students master the particular items in a task by the end of the lesson. In addition to the adjustable amount of practice in each daily lesson and the distribution of practice across many lessons, Direct Instruction programs also include periodic mastery tests. Many Direct Instruction programs include a mastery test every five or ten lessons (i.e., days). These tests provide a formal check on
student mastery of skills. The programs suggest specific remedial sequences for students who fail to meet mastery criteria. Again, this system adjusts the amount of practice on each skill to ensure that students are well prepared for each new challenge in the program.

**Provide Clear Instructions to Teachers**

In education, as in building, plans can only be successful if they are clearly conveyed to the person who will implement them. Vague sketches with broad suggestions for building may be sufficient for creating simple structures such as a single plank spanning a creek, but complex structures such as the Golden Gate Bridge can only be constructed from detailed and specific plans. So, too, in education simple skills can be taught with relatively loose planning. This is especially true if we are working with students who bring excellent learning skills and strong prior knowledge, or if we are willing to accept a wide range of outcomes. However, if we aspire to teach complex skills to high levels of mastery with a wide range of students, then detailed and specific plans are necessary. The careful planning described in the previous sections of this chapter must be clearly conveyed to the teacher. Thus, Direct Instruction programs include scripts that specify explanations, examples, wording of rules, correction procedures, and criteria for judging mastery.

The use of scripts focuses the teacher's role in Direct Instruction. The teacher is not expected to identify big ideas, develop series of steps that build complex skills, or design sequences of examples. Instead, these tasks are the role of the program designer. In the Direct Instruction system, teachers have three main roles. First, they must present the material accurately, clearly, and with an engaging style. The teacher's presentation must breathe life into the script in the way that an actor's performance brings a dramatic script to life. Second, teachers must make numerous instructional decisions based on their understanding of each student's changing needs and abilities. The teacher must adjust the pacing the lessons, make corrections that are appropriate to the particular response, repeat activities or lessons as needed, adjust students' placement and grouping, and so on. Third, teachers must motivate the students to be engaged with the academic tasks and to apply their skills beyond the confines of the instructional session.

Scripts are an important component of the Direct Instruction system. They are intended to convey the program designer's plan to the teacher in a clear and direct manner and focus the teacher's role on making the critical instructional and management decisions that require specific knowledge of individual students (see Chapter 7 for more information).

**Tracks**

In most instructional programs, the teaching about a given topic is concentrated into a set of consecutive lessons—a *unit*. Because unit organization
masses all the instruction on a given skill into a relatively small number of lessons, this method of organizing instruction tends to: (1) limit the time available for mastery of component skills, (2) limit the time available for introducing complex skills with strong scaffolding then gradually reducing the scaffolding as students gain competence, (3) limit the extent of application of the skills to diverse situations, (4) limit the extent of periodic review, and (5) produce lessons that are exclusively devoted to a single topic.

To solve these problems, Direct Instruction programs are organized by tracks. A track is the sequence of instruction on a given topic; however, no lesson is devoted exclusively to a single track. Instead, each lesson includes activities that are parts of several tracks. Track organization allows a program to prepare students for the introduction of a complex skill, to practice the skill, and to expand its application across many lessons. This form of organization supports the use of small instructional steps that build a skill across many lessons. For example, *Spelling Mastery Level C* (Dixon & Engelmann, 1999) develops the rule about doubling consonants across 69 lessons (i.e., 69 days of instruction). Prerequisites for the rule are introduced in Lesson 51, and they are gradually elaborated across 40 lessons until the rule itself is taught. The rule is introduced in Lesson 91 with an elaborate format that makes the application of the rule overt. The rule is applied to numerous words, and the format is gradually simplified across the remaining 29 lessons of *Spelling Mastery Level C*.

**ORGANIZE INSTRUCTION TO MAXIMIZE HIGH-QUALITY INSTRUCTIONAL INTERACTIONS**

The third component of Direct Instruction is the organization of instruction in the classroom to produce high-quality interactions between teachers and students. Specifically, this component includes placing students into appropriate programs lessons, grouping students for efficient instruction, orchestrating active student engagement with the material, providing effective corrections, and ensuring that students spend sufficient time engaged with the content.

**Placement**

Direct Instruction programs are designed to provide a smooth sequence of steps that climb from the prerequisite skills to the program's objectives, but no instructional sequence, no matter how well constructed, can be effective if the students are not placed at a level in that sequence that is appropriate for their current skills. Students who have not mastered the prerequisite skills for the program and lesson on which they are working are unlikely to be successful in that lesson. Careful and flexible placement of students into programs and lessons is essential.

Each Direct Instruction program includes a placement test or specific placement guidelines. These assess whether the student has mastered:
(1) the program's prerequisites, (2) skills taught in various key points in the program, and (3) the program's objectives. Results from the placement test are used to determine whether the program is appropriate for the student and, if so, where in the program the student should begin. However, placement tests are not the last word on placement. Direct Instruction teachers often comment that the real placement test is performance on the first few lessons. When the student responds to the exercises in the lesson, the teacher can see whether that student has the skills necessary to succeed or has already mastered the material that is being taught. The teacher can then adjust the student's placement accordingly.

Even finding the ideal initial placement is not enough. Direct Instruction programs are designed to provide for smooth progress from beginning to end for a wide range of students; however, some students can leap ahead faster than the lessons allow and other students may progress more slowly. In both these cases, teachers must monitor daily and weekly progress throughout the programs and be alert for indications that a student's lesson placement is no longer appropriate. Thus, the concern with proper placement does not end when teaching begins; rather, it must be constantly monitored.

Flexible, Skill-Based Grouping for Efficient Instruction

Ideally, we would like to provide instruction tailored to each student's immediate needs each day, and we would like to provide the instructional step that is perfectly suited to the individual student's current skills; however, individual tutoring is rarely practical in schools. A viable alternative to individual tutoring is formation of small groups of students who have similar instructional needs. If we teach to the needs of these instructionally homogenous groups, we can come close to the effectiveness of tutoring. The success of this strategy is dependent on homogeneity of the group. If all the members of the group have very similar instructional needs, then this approach can be very successful; however, if the members of the group have diverse needs, then no single lesson can meet all their needs.

There are many instructional advantages to teaching small groups of students who have similar needs, but this method also has a potential danger. If we are not sensitive to the students' changing needs or we do not teach efficiently to every group, then the groups could impose limits on how much students can achieve. Thus, Direct Instruction programs include the means to frequently monitor student progress, and teachers must use these means to ensure that they are aware of each student's needs. A student who is capable of progressing more quickly than the rest of the group should be shifted to a more advanced group; a student who is not able to progress at the rate of the rest of the group should be shifted to a less advanced group. Thus, flexibility is a critical element of grouping in Direct Instruction.
Direct Instruction groups are formed on the basis of students' current instructional needs. Thus, the key question is what specific skills the student has and what specific skills the student needs to learn. Groups are not formed on the basis of labels such as "dyslexia," "attention deficit hyperactivity disorder," and "gifted and talented," nor are they formed on the basis of so called "general ability measures" (i.e., IQ tests). It is more valid and effective to form groups on the basis of direct measures of students' initial skills (i.e., placement tests) and adjust groupings on the basis of students' performance on lessons. Thus, Direct Instruction groups are based on students' current skills rather than being based on any vague, general, or long-lasting characteristic.

**High Rates of Overt and Active Engagement**

Students learn most when they are actively engaged with the instructional content. Active engagement means that the students behave with respect to the things that are being taught. In general, more engagement results in more learning. When they are engaged, students have opportunities to perform a skill, receive feedback (either from their own judgment of their responses or from an external source), and perform the skill again. Overt responses (e.g., speaking, writing, gesturing) have the important advantage that teachers can observe the responses and (1) know whether students are, in fact, engaged; (2) provide confirmation or correction; (3) judge whether the group needs more practice or is ready to move on; and (4) judge whether individual students have needs that are different from the rest of the group. Thus, overt engagement is extremely important for effective and efficient instruction.

There are many ways of organizing overt engagement. Probably the most basic way is for teachers to ask questions or make requests directed to individual students. The main limitation of this approach is that while one student is engaged, all the other students may not be engaged with instruction at all. For example, if the teacher asks one direct question of each member of a 10-student group, each student makes only one overt response and may experience as much as 90% downtime. Written responses solve this problem because all students can respond simultaneously; however, written responses have the limitations of being difficult for some students and not providing the teacher with instant feedback on each student's performance.

Many Direct Instruction programs use group unison oral responses to promote overt engagement while avoiding the problems mentioned above. If the teacher asks oral questions and all students respond in unison, then all students can respond to each question and the teacher is made instantly aware of each student's response. If the teacher asks 10 questions with group unison responses, then each student makes 10 overt responses and experiences little, if any, downtime. The tremendous efficiency that is obtained by the use of group unison responses justifies the effort required to orchestrate them.
If all students initiate their responses at exactly the same time and makes a crisp (not sing-song or droned) response, then students do not receive hints from listening to other students and the teacher can hear a single error in a group. However, if some students answer slightly after the others or if students drone their answers, then students may receive subtle hints from hearing the others respond and the teacher cannot clearly hear any errors.

To receive the efficiency of group unison responses, the program must provide a means of coordinating the timing of student responses and teachers must use these means skillfully. Direct Instruction programs include specific signals that are used to enable all students in a group to answer together. A visual signal such as pointing is used when students are looking at the teacher or materials that the teacher is holding. An auditory signal such as a clap or finger-snap is used when the students are not looking at the teacher. With either type of signal, the teacher asks a question, pauses, and signals, and then the students answer together. An important skill for a Direct Instruction teacher is the ability to make clear signals and teach the students to respond correctly. This requires some learning on the part of teachers and students, but the return on this investment is a tremendous amount of efficiency.

Group unison responses can be tremendously efficient for providing guided practice on skills; however, they are supplemented by individual oral responses in all Direct Instruction programs and by written responses in all Direct Instruction programs in which students have the requisite skills. The mix of group unison, individual oral, and written responses varies according to the program’s content and the skills assumed of students in the program.

**Provide Effective Corrections**

Students make mistakes during learning. The effectiveness and efficiency of error correction procedures is an important contributor to the overall success of the program. Direct Instruction teachers can make very effective error corrections because of the explicit and systematic initial presentation of instruction. In Direct Instruction programs, error corrections can refer to previously taught rules or procedures that would produce a correct response. This is a substantial advantage over less-explicit and less-systematic programs in which students may face a task without having been taught specific rules or procedures. In such a situation, the teacher must do substantial instruction in the form of error corrections, and this error correction/instruction has usually not been carefully planned in advance. This is akin to building a structure by starting with poorly planned construction, then renovating when faults become clear.

Direct Instruction programs specify the use of a variety of corrections depending on the content and the nature of the error. All corrections are variations on the basic plan in which the instructor (1) *models* the correct
response, (2) tests the student by re-presenting the item that was missed, and then (3) performs a delayed test by working on some other items then returning to the item that was missed. Direct Instruction programs refer to this procedure as "model, test, delayed test." One common variation is to add a lead step in which the teacher makes the response along with the student, and the correction then becomes "model, lead, test, and delayed test." When students err because they did not apply a verbally stated rule, one or more prompts to support application of the rule are used instead of a model of the correct response, and the correction becomes "rule, test, and delayed test." When a student demonstrates a need for more practice on the corrected item, additional delayed tests are added. The correction then becomes "model, test, delayed test, delayed test, delayed test." Many other variations are used to correct specific kinds of errors.

RESEARCH RELATED TO DIRECT INSTRUCTION

Direct Instruction is one of the most thoroughly research-based and research-validated systems in education. The biggest challenge in describing the research related to Direct Instruction is organizing and summarizing the multiple streams of relevant research. We can divide the research base into two categories: (1) the indirect research base provides evidence about the effectiveness of various components, strategies, techniques, and approaches that are used in Direct Instruction programs; and (2) the direct research base provides evidence about the effectiveness of one or more specific Direct Instruction programs.

The indirect research base includes the huge body of research on teacher effectiveness (Brophy & Good, 1986; Rosenshine and Stevens, 1986) that supports many aspects of lesson organization and student-teacher interaction that are built into Direct Instruction programs. A second source of research that provides important but indirect support for Direct Instruction is research on specific subject areas that are addressed by Direct Instruction programs. For example, two recent reports summarizing research related to beginning reading instruction (National Reading Panel, 2000; Snow, Burns, Griffin, 1998) confirm the importance of phonological skills, phonic decoding, whole-word instruction on frequently occurring irregular words, and oral reading of passages. These are all core components of Direct Instruction reading programs.

An indirect research base is not sufficient, however. In order for a program to be to be empirically validated, that program must be directly subjected to research. There is also a large body of literature that directly examines the effects of specific Direct Instruction programs. This literature includes Project Follow Through and dozens of smaller studies. Project Follow Through was a massive study of the effectiveness of nine major approaches to compensatory education for students disadvantaged by poverty. The research aspect of the
project lasted 8 years (1968 to 1976), involved over 10,000 students, and cost $500 million (Adams & Engelmann, 1996). Outcomes studied included basic skills (e.g., word recognition, spelling, math computation), cognitive skills (e.g., reading comprehension, math problem solving), and affective outcomes (e.g., self-concept, attributions of success). Each of the nine approaches (or "sponsors") worked with multiple sites (local schools) across the country. Each site was paired with a nearby control site that had similar demographics and was not working with a sponsor (Stebbins, St. Pierre, Proper, Anderson, Cerva, 1977).

Figure 1 shows the results of an overall comparison of each of the nine approaches to control sites on the three kinds of outcomes. Each site was compared to its control site on multiple measures. A comparison was considered significant if the difference was statistically significant and the effect size was greater than .25. From Figure 1, it is clear that Direct Instruction was the only one of the nine models that had consistently positive effects. The Direct Instruction outcomes were vastly superior to all of the other models. Project Follow Through produced a huge amount of data and numerous analyses. Several good summaries of this research are available (Adams & Engelmann, 1996; Engelmann, Becker, Carnine, Gerstein, 1988; Watkins, 1997).

In addition to Project Follow Through, dozens of reports of specific research studies have been published. Adams and Engelmann (1996) conducted a meta-
analysis of 37 research studies on Direct Instruction. These studies included 374 individual comparisons of groups that received Direct Instruction with groups that received some other treatment. Fully 64% of these individual comparisons found statistically significant differences that favored the Direct Instruction group, 35% found differences that were too small to achieve statistical significance, and only 1% found statistically significant differences favoring the non-Direct Instruction group. When the results of all of the studies are combined, the average effect size is .97 favoring the Direct Instruction groups. By any standard, this is a very large effect (see Chapter 9 for further information about effect sizes).

Adams and Engelmann also found that studies of general education students had an average effect size of 1.27 and studies of students in special education had an average effect size of .76. Both effects are very large. They found that studies conducted with students at the elementary level had an effect size of .84, and those at the secondary or adult level showed an effect size of 1.50. Again, both results indicate very strong positive results. They found a moderate average effect size in language (.49), a large effect size in reading (.69), and an extremely large effect size for social studies (.97), math (1.11), spelling (1.33), and science (2.44). This meta-analysis indicates that Direct Instruction has been extremely successful in research studies across general and special education, grade levels, and subject areas.

In 1998 and 1999, the American Federation of Teachers (AFT) commissioned a series of analyses of educational research literature to discover what works in various areas of education. The reports described Direct Instruction as (1) one of seven promising reading and language arts programs (AFT, 1998a), (2) one of six promising schoolwide reform programs (AFT, 1998b), and (3) one of five promising remedial reading intervention programs (AFT, 1999). One of the reports commented, "When this program [DI] is faithfully implemented, the results are stunning" (AFT, 1998a, p. 9).

The American Institutes for Research (AIR) was commissioned by the American Association of School Administrators, American Federation of Teachers, National Association of Elementary School Principals, and National Education Association to examine the literature on schoolwide reform approaches. The AIR examined 130 studies on 24 prominent models. They found that Direct Instruction is one of only three models that has "strong evidence of positive outcomes on student achievement" (Herman et al., 1999). More recently, Borman et al. (2002) published a meta-analysis of results from 29 comprehensive school reform models. They considered 232 studies and 1111 separate comparisons. From this large database, the authors identified Direct Instruction as one of just three models that achieved the criteria of "strongest evidence of effectiveness."

This very brief summary of research reviews related to Direct Instruction indicates that Direct Instruction (1) is consistent with effective instructional practices; (2) has been found by an independent evaluation to have strongly positive effects in Project Follow Through; (3) has been found to be effective
across variations in student population, grade level, and content areas; and (4) has been judged to be well supported by research in several recent independent reviews.

**References**


