INTRODUCTION

We briefly summarize the findings of the major reviews of tutoring research and describe the critical topics that remain to be researched as identified by the last review. Next, we present several new research studies that address the identified needs. The results of this program of research are then discussed in terms of classroom practice and future research.

Tutoring is one of the most researched and effective pedagogical tactics in both the educational and psychological literature. Stephens' (1967) comprehensive review of the educational research prior to the mid-1960s, identified peer tutoring as one of only two reliably effective tactics out of all of the interventions tested in hundreds of research studies in the education literature for that period of time (see also Cloward, 1967, for a review of tutoring per se). A subsequent review of the tutoring literature (Devin-Sheehan, Feldman, & Allen, 1976) reviewed additional studies in psychology and education to the mid-1970s. This paper divided the findings into effects on tutees (those who
were tutored) according to same-age peer tutoring, cross-age peer tutoring, and trained versus untrained peer tutoring. The majority of the studies showed that tutoring was effective across all of the categories identified by the reviewers, in cases in which the tutors were trained in tutoring procedures. The effect of tutoring on tutors' academic or social behaviors was not a topic of investigation. During the 1980s and 1990s, much of the educational research (research not using behavior-analytic procedures or constructs) was associated with students teaching other students and took the form of "cooperative learning." The research on the cooperative learning tactic had mixed findings. Axelrod and Greer (1994) reviewed the cooperative learning literature and argued that, in cases where cooperative learning was effective, the effects appeared to be traceable to peer tutoring components.

During the late 1970s and early 1980s, the brunt of research in tutoring came from the applied behavior analysis literature. This research may be divided into research (1) on the effects of tutoring on the learning of tutees with regard to comparisons of peer tutoring with teacher instruction, (2) the effects of peer tutoring on the tutor's learning that which was tutored, and on the collateral behaviors of tutors. Two studies investigated the effects of peer tutoring on teacher performance as well (Davis, 1972; Polirstok & Greer, 1977). A review of that research and excellent descriptions of the types of tutoring and management of tutoring in applied behavior analysis were provided by Miller et al. (1994). Their review represents a statement of the state of the research literature to the mid-1990s. A review by the authors of this chapter of the major journals in behavior analysis revealed that no real change has occurred in the state of our understanding of tutoring as a tactic since the Miller et al. review. Moreover, the authors' recommendations for further research have not been addressed in the research to date. Miller et al. noted that the strong effects of peer tutoring could not be fully understood without an identification of the key instructional components of peer tutoring. The research that we report herein directly addresses the identification of the critical ingredients of effective peer tutoring on both tutee and tutor responding.

Research on the key instructional components, however, must be viewed in the context of the robust mainstream findings in behavior-analytic and educational research on the generic factors present in most effective instruction. These findings are associated with engaged academic time, also referred to as active student responding (Heward, 1994; Miller, Barbetta, & Heron, 1994); opportunity to respond (Greenwood Hart, Walker, Risley, 1994); and learn units (Greer, 1994, 2002; Greer & Hogin-McDonough, 1999). The findings associated with these terms actually represent a progression in the identification of key processes in effective instruction incorporating findings from educational research on the distribution of behavior between and within groups and findings in the behavior-analytic research on the components of effective instruction. In the former research, the identification of what works is based on outcomes after a period of time for a group, while in the latter research the identification of
what works is based on comparisons of instructional components that led to mastery for each individual. Regardless of the difference in focus, the two literatures came to an unusual consensual dénouement, and such consensus increases the validity of the outcome of this work (Greer, 1983).

**RESPONDING, ENGAGEMENT, AND AN EFFECTIVE TEACHER MEASURE**

Group research studies over several decades came to identify engaged academic time as the single most robust finding in their investigations of gross generic pedagogical practices in classrooms and schools that were found to be more effective when socioeconomic variables were statistically controlled (Berliner, 1980; Stallings, 1980). Classrooms that provided their pupils with more engaged academic time or “active academic responding” produced better outcome. Engaged time simply meant that the teachers spent more actual time having the students respond to academic material. These classrooms had less down time, and the responding was to valid curricula. Students spent more time responding to academic material in written or vocal forms. Indeed, in the educational research literature, it was, and remains, the single, strong finding concerned directly with pedagogy. However, engaged academic time is a measure of topography rather than behavior products, thus educators and researchers needed a better identification of just what was going on.

While the specifics of the components of engaged academic time were not clearly specified in the educational literature, findings from applied behavior analysis by Greenwood (1984) showed that one component was the provision of opportunities for students to respond to academic material. Greenwood et al. found that simply providing more academic antecedents and response opportunities doubled learning for students. Later on, Greenwood and his colleagues developed the class-wide, peer-tutoring tactic that multiplied students’ response opportunities and consequences to students’ responses (Greenwood, Delquadri, & Hall, 1989). In a related finding concerning parents teaching children language, Hart and Risley (1989, 1991, 1996) found that the provision of response opportunities and more positive and elaboration prompts were the key components of mother–child interactions that built effective language in toddlers and preschoolers in homes regardless of a family’s socioeconomic status. This body of research coincided with the identification of a measure of teacher effectiveness that incorporated opportunities to respond with instructional antecedents and consequences in teacher–student or computer–student interactions—the learn unit (Emurian, Delquadri, & Hall, 2000; Greer & Hogin-McDonough, 1999).

Teacher–student or computer–student interactions that consisted of learn units represented convergence in the literature on the importance of students’ responding and on the antecedents and consequences to responding. The
learn unit led to more learning than did interactions that were not learn units; the greater the numbers of learn units received by students, the greater the number of criterion referenced instructional standards achieved by students (Albers & Greer, 1991; Babbit, 1986; Bahadorian, 2000; Emurian, Hu, Wang, Durham 2000; Greer, McCorkler, Williams, 1989; Ingham & Greer, 1992; Lamm & Greer, 1991; Selinske, Greer, & Lodhi, 1991). Learn units are measures of teacher–child or parent–child interactions that meet certain criteria and include the key generic components to effective pedagogy.

First, the teacher must ensure that the student attends to the relevant antecedent instructional component, also known as the target or potential $S^d$ (which stands for discriminative stimulus), before presenting instructions in written or spoken forms (or combinations thereof, such as “read the word” and the printed word) as the student’s antecedent to responding (e.g., saying the word or textually responding). Second, the student must respond or have the opportunity to respond (written, vocal, selection, production, or construction responses). Third, the consequence for the student’s response or lack of response must be appropriate. The third component has two parts: (1) correct responses must be followed by positive reinforcers (consequences that act to increase antecedent-behavior relationship for the student); and (2) incorrect responses must be followed by a teacher correction that requires the student to emit the correct response in the presence of the relevant target antecedent (i.e., word, number problem, or question) before the next presentation of an instructional antecedent or target stimulus. Delayed consequences are equally effective for written responding provided that the student attends to their previously written response and the antecedent or target $S^d$ (Hogin, 1996). That is, the student observes the teacher’s mark for an error and hears or sees the teacher’s correction. Next, the student writes a corrected response. Thus, work from the previous day can function as learn units.

In addition, the rates of the presentations of learn units are a key variable, with faster rates being more effective generally than slower rates. Moreover, the more learn units the students receive, the better are their instructional outcomes.

What is learned by the student in the learn unit is the target student’s antecedent, response, and consequence within the setting of the instruction or the operant and context. As students learn component skills, the initial learn unit, the teacher’s learn unit progressively incorporates more and more responses for the student such that learn units are needed only at points in which unlearned components or composite skills are the target of instruction. For example, for solving addition problems, the early learn units involve individual numbers of single-digit combinations; later they involve multiple digit operations in which the single operations are the target until mastered. Next, the entire composite operation of a single problem is the target, followed by completing an entire page or grouping of problems with 100% accuracy. Next, the students need to meet a rate or time constraint in which they must
respond to all of the problems on a page quickly and accurately. In the last stage, the accurate completion of an entire page or collection of problems constitutes a single learn unit. This newly fluent component becomes a single component in a larger more complex operation (see Greer, 2002, Chapter 2, for an in-depth treatment). In the behavior-analytic literature, this constitutes something like chaining; however, the learn unit identifies not only how the student’s progression through components of a task is conseuated but also what the teacher or experimenter must do to make the process likely to work.

Interestingly, the second of two important findings reported by Stephens (1967) in his review of educational research was the strong effects of programmed instruction, which we will show are related to the learn unit. Programmed instruction was developed by B. F. Skinner (1968) as a means of incorporating what was known at the time about learning from basic research in laboratories with nonhuman species such that instruction could occur without the teacher being present. Programmed instruction led to longer maintenance of learning than did teacher-directed study and provided greater short-term mastery across a range of subjects and ages. Programmed instruction was delivered by teaching machines or in a programmed text format but can now be delivered by computers if the instruction is designed as programmed instruction (Emurian et al., 2000; see also Section 4 of this book). The instruction involved frames, each of which included instruction (what we call antecedents to the students’ responses) and a requirement that the student construct a response (e.g., written) or, in some cases, to choose the correct response from those provided (Vargas & Vargas, 1991). If the response was correct, the student proceeded to the next frame; if not, the student had to perform a correction response. In some cases, the machine delivered edibles or tokens as reinforcement for correct responses, while in other cases simply being permitted to move to the next frame acted as the reinforcement. In short, Skinner’s frame was what we have come to identify, albeit belatedly, as the learn unit.

Some have confused the learn unit with the student three-term contingency formation or operant, or what the student learns. Actually, the learn unit is a teaching operation of an automated device (e.g., a computer instructional program) or teacher that occasions or sets the stage for the formation of the operant or the student’s learning and includes the student’s responses as well as all of the necessary teacher or teaching device responses to the student’s responses. Learn units are simply the pedagogical components that are necessary if not sufficient to teach students concepts, skills, and, operations. By necessary if not sufficient, we mean that in most cases where the student has the necessary prerequisites, the learn unit alone is sufficient; however, in other cases, additional tactics need to be employed with the learn unit (see Chapter 4 in Greer, 2002). The learn unit is a measure of the teacher, the teaching device, or, indeed, an experimenter’s effectiveness in creating conditions that are necessary if the students or subjects in experiments are to learn (Greer, 1994).
The learn unit is one of the most, if not the most, robust predictors of teaching effectiveness and thus must be taken into account in any analysis of other tactics and strategies. It is a measure of the effectiveness of the teacher or teaching device and can be systematically observed in any instructional setting (see Chapter 9 in Greer, 2002). We believe that the learn unit is a key factor in the relative success of peer tutoring as well as teacher instruction. The studies reported herein test this assertion.

Most tutoring studies have compared teacher instruction versus peer tutoring, and that research has shown that students learn more under tutoring conditions. Few, if any, of those research studies have controlled for learn units or components of instruction such that both teacher and tutor interactions were constant. Are the benefits of peer tutoring over teacher presentations findings due to a special peer or social effect, or are the results due to differences in types or numbers of teaching interactions? In addition, we address the following related questions associated with tutoring: What are the benefits for tutees and tutors involved in the tutoring process and peers who observed the tutoring process under conditions with and without learn units? Will tutors and tutees learn responses not directly taught as a function of tutoring a subset of material that they could then use to emit untaught novel responses without direct instruction (e.g., pronouncing words they have never seen before)? Can scripts of problem-solving or rule-governed tasks be used to teach both tutors and tutees new conceptual operations?

To answer these questions, we present the following series of studies. All of the experiments involved teaching repertoires that are part of the state and national academic standards that are key to curricular goals associated with academic literacy and problem solving (Greer, 2002). The instructional standards that were taught included those concerned with spelling, social studies, identifying national monuments, selection and production responses for contractions, morpheme textual responses, algebra, rounding numbers, learning conceptual operations, and reading bar graphs. The experiments are presented in a series of brief reports using a standard format followed by a discussion of the findings (the complete papers are available from the senior author). Taken together, the investigations are a programmatic research effort to identify the key instructional components of effective tutoring for tutees and tutors. We have also added a new individual to the mix—the peer who observes tutoring, because other than learn units one of the other means by which students learn in classrooms is by observation.

All of the experiments were conducted in classrooms using the CABAS® (Comprehensive Application of Behavior Analysis to Schooling) instructional model (Greer, 1996, 2002). All of the schools are publicly funded schools for classrooms of children and adolescents with the demographic characteristics of students who are typically left behind in schools that use non-scientifically based approaches to education. The model is described in Chapter 3 in this book. Inter-observer agreement for all of the experiments
was measured using the formula of point-to-point agreements between independent observers that summed agreement plus disagreement divided into agreements, thus providing a percentage of agreement index of the accuracy of the data.

NEW EXPERIMENTAL ANALYSES OF COMPONENTS OF EFFECTIVE TUTORING: BRIEF REPORTS OF FIVE STUDIES

Study 1

Researchers and Topic

Abstract
This study compared instruction delivered by a peer versus instruction delivered by a teacher on mastery of instructional material by tutees, when learn units were present under both teacher and peer tutor conditions. We also investigated the effects on correct responding by the tutors on the material they did not know prior to the functioning as a tutor. All tutees received instruction to a preset mastery criterion for state standards. All participants attended a classroom within a public middle school, located on the outskirts of a major metropolitan area.

Definition of Behaviors
The responses that were taught included taking dictation of spelling words, tacting or vocally identifying pictures of various national monuments, and intraverbal responding to social studies facts (i.e., answering questions about social studies). All instruction was tied to state and national standards (New York State Standards, 1998; English Excellence in Education Standards, 1998). The first standard taught was writing spelling words. A response was considered correct if the participant independently wrote the spelling word correctly within 5 seconds of the vocal antecedent, which was the word to be spelled. A response was considered incorrect if the participant did not independently write the spelling word correctly within 5 seconds of the vocal antecedent or did not respond within 5 seconds of the vocal antecedent. During each phase, a set of five spelling words was taught.
The second standard taught was tacting and identifying pictures of various national monuments. The participants were required to respond vocally to the presentation of a picture. In some cases, the antecedent was simply the presentation of the picture; in other cases, the antecedent was the presentation of the picture and one of the following vocal antecedents: “What is this?” or “This is the ____.” The participants could also respond by pointing to the correct picture when presented with an array of pictures and one of the following the vocal antecedents: “Which one of these is the ____?” or “Point to the ____.” During each phase, a set of five national monuments was taught.

The third standard taught was intraverbal responding to social studies facts. The participants were required to vocally respond to a vocal antecedent such as “Who was the first President of the United States?” A response was considered correct if the participant responded with the correct intraverbal to the vocal antecedent independently within 5 seconds. A response was considered incorrect if the student did not respond within 5 seconds of the vocal antecedent or responded with the incorrect intraverbal. During each phase, a set of five social studies facts was taught.

Data Collection

*Peer and teacher instruction phases:* Data were collected using the same method for both the teacher instruction and peer instruction sessions across behaviors. Data were collected using a paper and pencil format for correct and incorrect responses to learn-unit presentations. A plus (+) was recorded for a correct response, and an incorrect response was recorded as a minus (−). During both peer and teacher instruction phases, a correction was given immediately when the student responded incorrectly. A correction was a model of the correct response. Corrections were considered and recorded as incorrect responses. During the teacher instruction phase, the teacher collected data for each student response. During the peer instruction phase, the tutor as well as the teacher independently collected data. This served as inter-observer agreement. At the end of each session, the total number of correct responses out of 20 presented learn units was calculated and a data point was placed on the graph. The criterion for mastery was preset at two consecutive sessions at 90% or above for all phases. *Pre- and post-treatment probes:* Pre-treatment probes were administered to all participants and were conducted as trials; no reinforcement was delivered for correct responses, and no correction was delivered for incorrect responses. Data were collected and graphed as the number of correct responses to the trial presentations. A total of 20 trials were conducted for each probe. In order to assess tutors’ gains during treatment, a post-treatment, the same as the pre-treatment probe, was administered to each tutor at the conclusion of the study.
Design
A multiple-treatment counterbalanced design was used.

Inter-Observer Agreement
The teacher collected data with the tutor in all sessions. Inter-observer agreement for all pre- and post-treatment sessions was 100%. For the spelling instruction, inter-observer agreement for the teacher instruction phase was 100% during the two sessions it was calculated. For the peer instruction phase, inter-observer agreement ranged from 80% to 100%, with a mean of 90%. For the tacting of pictures of national monuments, inter-observer agreement observations were conducted in 57% of the teacher-directed sessions. Inter-observer agreement ranged from 95% to 100%, with a mean of 98.8%. Inter-observer agreement observations during the peer instruction phase were conducted in 100% of the sessions and ranged from 95 to 100%, with a mean of 98.3%. For the social studies facts, inter-observer agreement observations during the teacher instruction phase were conducted in 50% of the sessions. Inter-observer agreement was 100% across all sessions. Inter-observer agreement observations during the peer instruction phase were again conducted in 100% of the sessions and were 100% across all sessions.

Peer and Teacher Instruction Tactics
Tutor training: The tutor had previously been taught to use learn units for tutoring operations; therefore, only one 15-minute session was conducted to review learn-unit presentation such as presenting unambiguous antecedents, reinforcing correct responses with verbal praise and tangible reinforcers (points for back-up reinforcers), providing timely corrections for incorrect responses to ensure that the student emitted the correction, and collecting data accurately. Peer instruction: During the peer instruction phase, the tutors delivered learn units in a one-to-one setting; 20 learn units were presented during each session. Teacher instruction: During the teacher instruction phase, the teacher delivered learn units in a one-to-one setting; 20 learn units were presented during each session.

Participants
The participants were four male tutees, one female tutor, and one male tutor, and they ranged in age from 12 to 15 years old. All participants were diagnosed with a behavior disorder and had reader/writer levels of verbal behavior, including inappropriate speaker repertoires, and listener repertoires that were not fluent. Their academic repertoires placed them between the second- and fourth-grade levels.
Results
For the instructional objective (Fig. 1) of tacting (identification of pictures of national monuments), participant 1 required 80 learn units during the first teacher instruction phase, 60 learn units during peer instruction, and 80 learn units during the second teacher instruction phase. Participant 2 required 60 learn units during the first peer instruction phase, 60 learn units during teacher instruction, and 60 learn units during the second peer instruction phase to meet criterion for the same behavior. Participant 3 required 60 learn units during the first teacher instruction phase, 60 learn units during peer instruction, and 60 learn units during the second peer instruction phase to meet criterion for the same behavior. Participant 4 required 60 learn units during the first peer instruction phase, 60 learn units during teacher instruction, and 60 learn units during the second peer instruction phase to meet criterion for the same behavior.

FIGURE 1
Numbers of learn units required to achieve criterion for identifying national monuments during teacher instruction and peer instruction phases for tutees 1, 2, 3, and 4.
units during the first peer instruction phase, 60 learn units during teacher instruction, and 60 learn units during the second peer instruction phase to meet criterion for the same behavior. Participant 4 required 100 learn units during the first teacher instruction phase, 60 learn units during peer instruction, and 120 learn units during the second teacher instruction phase. Two participants required more learn units in the teacher phases, and two participants showed no differences.

For the second instructional objective (Fig. 2) of intraverbal responding to social studies facts, participant 1 required 60 learn units during peer instruction and 100 learn units during teacher instruction. Due to circumstances beyond the teacher’s control, participant 1 was not available to participate after reaching criterion for the second phase. Participant 2 required 60 learn units during the first teacher instruction phase, 60 learn units during peer instruction, and 60 learn units during the second teacher instruction phase. Participant 3 required 60 learn units during the first teacher instruction phase, 60 learn units during peer instruction, and 80 learn units during the second teacher instruction phase. Participant 4 required 60 learn units during peer instruction and 120 learn units during teacher instruction. Due to circumstances beyond the teacher’s control, Participant 4 was not available to participate after reaching criterion for the second phase. For one of the students for whom we had incomplete data, more learn units were required in the teacher phases. There were no real differences in the two tutees for which we had complete data.

For the spelling words (Fig. 3), participant 1 required 100 learn units during the first teacher instruction phase, 60 learn units during peer instruction, and 80 learn units during the second teacher instruction phase. Participant 2 required 40 learn units during the first peer instruction phase, 80 learn units during teacher instruction, and 40 learn units during the second peer instruction phase. Participant 3 required 120 learn units during the first peer instruction phase, 60 learn units during teacher instruction, and 80 learn units during the second peer instruction phase to meet criterion. Participant 4 required 100 learn units during the first teacher instruction phase, 80 learn units during peer instruction, and 60 learn units during the second teacher instruction phase to meet criterion for the same behavior. Only one participant required fewer learn units with the peer tutor across all instructional objectives; for all of the others, there were no clear differences.

During the pre-treatment probe conducted for spelling instruction (no figures are presented), tutor 1 responded correctly to 0 of the 20 probe trials prior to tutoring but responded correctly to all trials following serving as a tutor. During the pre-treatment probe conducted for tacting of national monuments, tutor 2 responded correctly to 2 of the 20 presented items and responded correctly to all presented items following serving as a tutor. During the pre-treatment probe conducted for intraverbal responding of social studies facts, tutor 1 responded correctly to 0 of the 20 probe trials and responded correctly
FIGURE 2
Numbers of learn units required to achieve criterion for social studies facts during peer instruction and teacher instruction phases for tutees 1, 2, 3, and 4.
FIGURE 3
Numbers of learn units required to achieve criterion for writing spelling words during teacher instruction and peer instruction phases for tutees 1, 2, 3, and 4.
to 19 of the 20 presented items. After serving as tutors, the two tutors acquired correct responses to probe trials on responses they did not have in their repertoires prior to tutoring.

These results differ from most teacher-tutor comparisons because this study controlled for learn units. Specifically, all instruction was delivered using learn units by both the teacher and the tutors during each session. Only one student benefited from having the peer do the instruction, suggesting that tutoring benefits for tutees, when learn units are used in both teacher and tutor instruction, is a tactic that may be differentially beneficial for certain students only.

**Study 2 (Experiments 1 and 2)**

In this study, we investigated the effects of peers observing the tutoring process for tutors and tutees under conditions in which the tutors presented tutoring without learn units and conditions in which the tutor used learn units. We also investigated the effects of tutoring and observing tutees responding with and without corrections.

**Researchers and Topic**

K. Meincke and J. Hong (2002). Effects of peer tutoring with corrections compared to observing tutoring in which the tutees receive all correct responses on foreign language for the tutee, tutor, and an observer (Columbia University Teachers College).

**Abstract**

We investigated the academic benefits of peer tutoring of foreign language terms for the tutor, tutee, and an observer across two experiments. Pre- and post-tutoring probes were administered to all three participants on the terms that were peer tutored. The results of experiment 1 showed that peer tutoring increased correct responses during the post tutoring probes for all three participants even though it was only the tutee who received direct instruction. The results were consistent with research on peer tutoring, supporting the suggestion that it is an effective and profitable tactic to use in individualizing education. The results of experiment 2 showed a higher number of correct responses during the correction condition compared to the reinforcement condition.

**Participants**

The participants were three males (ages 12 to 15) diagnosed with emotional and behavioral disorders. The tutor had speaker, reader, and writer levels of
verbal behavior with emergent listening and self-editing repertoires. The tutee and the observer had speaker, reader, and writer levels of verbal behavior with emergent listening repertoires. At the time of the study, a formal peer-tutoring program had not been implemented in the classroom. During experiment 2, a teaching assistant participated as a confederate. The teacher assistant had no prior experience in peer tutoring.

**Definition of the Behaviors**

The behavior taught was translating five printed phonetic Korean terms into English. According to the ninth-grade New York State Standards (1998), students should be able to communicate with the use of another language other than English. The dependent variables were (1) the number of correct responses to probe trials that were not learn units (no consequences) during baseline and (2) correct responses to learn units during tutoring sessions. A trial was defined as a teacher presenting an antecedent and the student responding. No reinforcements or corrections were provided to the student during or after the trial. The independent variable was peer tutoring, which consisted of the learn units presented during the tutoring sessions between the tutor and tutee.

**Procedures and Data Collection for Experiment 1**

Before any tutoring occurred, a probe was conducted on all three participants for 20 trials on 5 Korean terms. The 5 terms were basic and common terms. Each word was written phonetically on one side of a 3 × 5 index card, and the phonetic equivalent was written on the opposite side. The experimenter prompted the tutor initially to correctly present the vocal antecedent. During tutoring, the tutor phonetically read the terms and the tutee gave a vocal response. The tutor reinforced the tutee by saying “Good job, great!” when the tutee gave a correct response. If the response was incorrect, then the tutor gave a correction, which involved the tutor stating the correct responses and the tutee repeating it. Then, the tutor presented the next vocal antecedent. Both the teaching assistant and the observer recorded the accuracy of the tutor’s learn-unit presentations using a modified version of the Teacher Performance Rate and Accuracy Observation (TPRA) during both experiments (Ingham and Greer, 1992; see Chapter 3). During the learn-unit presentations by the peer tutor, data were collected using a paper and pen format. When a correct response was observed, a plus (+) was recorded, and a minus (−) was recorded when an incorrect response was observed. A correction by the tutor immediately followed the incorrect response and the tutee was required to give the correct response; correct responses were praised. Criterion was set at 90% or above for 2 consecutive sessions for the tutees’ mastery of the instruction.
Inter-Observer Agreement for Experiment 1
Inter-observer agreement was conducted throughout this and the second study during pre- and post-intervention probes and during learn-unit presentations. Inter-observer agreement was 100%.

Design of Experiment 1
We used a multiple probe design for this and the second study.

Results of Experiment 1
Tutee, tutor, and observer scored 0 correct responses during the pre-intervention probe. During the post-intervention probe, the tutee scored 19 correct responses, the tutor scored 20 correct responses, and the observer scored 11 correct responses (Fig. 4).

Procedures for Experiment 2
This experiment used the same tutoring procedures with the addition of two conditions. A reinforcement condition and a correction condition were used in this study. In the reinforcement condition, with a new set of Korean terms another pre-intervention probe was given to the tutor and the observer for 20 trials. The tutor presented the vocal antecedent and the tutee gave the correct vocal response. The tutee had previously learned the Korean terms and acted as a confederate in the study such that only reinforcement operations would be given for all 20 learn units for 3 sessions. A post-intervention probe was given to both the tutor and observer. In the correction conditions, 5 more Korean terms were introduced and another pre-intervention probe was conducted. Three tutoring sessions were then conducted and the tutee acted as a confederate in the study; only correction operations were given for all 20 learn units for 3 sessions. A post-intervention probe was given to both the tutor and observer. The observer measured the accuracy of the learn units by using the modified TPRA observation for all sessions as discussed in Experiment 1.

Results for Experiment 2
Tutor and observer scored 0 correct responses during both pre-intervention probes for the reinforcement and correction conditions (Fig. 5). Following the reinforcement condition, the tutor scored 7 correct responses in the post-intervention probe. The observer scored 2 correct responses during the post-intervention probe. In the correction condition (Fig. 6), the tutor and observer scored 0 correct responses during the pre-intervention probe. Following the correction condition, the tutor scored 20 out of 20 correct
FIGURE 4
Pre- and post-tutoring responses to Korean language words for a tutor, a tutee, and an observer.
responses in the post-intervention probe. The observer scored 19 out of 20 correct responses in the post-intervention probe. Thus, in these studies we found that serving as a tutor or an observer resulted in the tutor and the observer learning from either acting as a tutor or collecting data on tutoring as an observer. In the second study, we found that observing corrections or providing tutoring corrections was the key factor in the tutor or observer learning. Thus, the operations and experiences involved in the correction process for the learn unit were the key to success.
Pre- and post-tutoring responses to Korean language terms when the tutee received learn units with corrections and reinforcement operations for correct responses.
Study 3

In this study, we investigated the effects of tutoring on students who were observers to the tutoring process under conditions when the tutors did not provide learn units and under conditions in which the tutors did provide learn units.

Researcher and Topic

G. Gautreaux (2002). The effects of a peer observing the peer tutoring process in the presence and absence of learn units for social studies (Columbia University Teachers College).

Abstract

In the study, five middle school students served as observational learners across six instructional phases in order to test the effect of the presence or absence of learn units on observational learning. The content of the material presented was social studies vocabulary. Pre-experimental and post-treatment probes were conducted in a multiple-probe, counterbalanced ABABAB or BABAB design. The results of the study showed that students who observed learn-unit tutoring sessions had significant gains over sessions that involved tutoring when learn units were not present. These findings showed that peers who were functioning as observers learned as a function of observing learn-unit presentations by tutors to tutees.

Participants

All participants (3 males, 2 females) had diagnoses of behavior disorders and ranged in age from 12 to 14. Three participants were near grade level academically with fluent reader/writer and speaker listener repertoires and emergent self-editing skills. The other remaining participants had significant deficits in their reader/writer repertoires and read at approximately the third-grade level.

Setting

This study was conducted across two classrooms that were located in a suburban middle school serving students with emotional or behavioral disorders. The students in the classroom had been trained in peer tutoring procedures, and peer tutoring was considered part of their daily routine.
Data Collection

Pre-experimental probes: One pre-experimental probe consisting of 30 questions was conducted across each experimental phase for each participant. Each phase contained a different content area (U.S. history, world history, geography). Students were required to textually respond to preprinted index cards on which the definitions of words appeared. They were asked to emit a vocal verbal response to each definition by supplying the word that reflected the definition. No feedback was given during these probe sessions. Peer tutoring phases: In each of the experimental phases, a tutor, tutee, and peer who was conducting a TPRA participated in the session. The peer served in the role of an observational learner, as he was simply required to record the behavior of both the tutor and tutee. Post-tutoring probes: Upon completion of the peer tutoring sessions of each phase, a post-treatment probe was administered. These probes were conducted in the same manner as the pre-experimental probes and, again, no feedback was given.

Design

This study used a counterbalanced multiple probe design (ABABAB). For each phase, the content area was changed. Also, phases alternated between sessions that included learn units and those that contained non-learn-unit presentations.

Results

The results of this study showed that across all five participants, a significant difference occurred between post-treatment probes that followed learn-unit presentations and those that did not (Figs. 7 to 9). The results showed that when students observed learn units they showed impressive gains compared to when they observed non-learn units.
FIGURE 7
Observation by peers of tutoring without learn units (pre-learn-unit probes) and observation by the peers of peer tutoring done with learn units (post-learn-unit probes) for students A and B.
FIGURE 8
Observation by peers of tutoring without learn units (pre-learn-unit probes) and observation by the peers of peer tutoring done with learn units (post-learn-unit probes) for students C and D.
Study 4

This study tested the effect of tutoring that used multiple exemplar instruction on the emergence of responses not directly taught. The tutees were taught a subset of responses such that untaught responses that belonged to the same class emerged without direct instruction (see Chapter 16.)

Researchers and Topic


Abstract

We examined the effect of peer tutoring of multiple exemplar instruction on the use of contractions and morphemes not directly taught for both tutors and tutees. Two participants were paired as a tutor and a tutee for the contraction words program, and two other participants were paired as a tutor and a tutee for the morpheme program. Prior to the experiment, probe sessions were conducted to determine the number of correct responses emitted by the tutor and the tutee on different response forms of contractions and on the morphemes. In the baseline condition, the tutees were taught to master one of the response functions for contractions (selection) and one morpheme set to a mastery criterion, with probe sessions on untaught morpheme responses being con-
ducted following mastery of the single set. The tutors then taught the tutees set 2 contraction words and set 2 morphemes using multiple exemplar training until the students achieved criteria. Multiple exemplar instruction involved alternating the two response functions (selection or production) in the case of contractions or alternating the morphemes across different untaught forms for the set 2 tasks. Probe sessions were conducted for the set 1 untaught responses following the multiple exemplar training on the set 2 tasks. The tutees were then taught to master one of the response forms and one of the morpheme sets with set 3, and the other untaught responses were probed. After multiple exemplar training was taught by the peer tutors, the data showed the emergence of untaught responses for both the tutors and tutees for both programs, indicating that the multiple exemplar training contributed to the transfer of function (from selection to production) and the development of derived relational responding (from a subset of morphemes to untaught morphemes) for the tutees who was receiving the instruction as well as for the tutors who were delivering instruction.

Definition of the Behavior

The dependent variable consisted of the number of correct responses on the students' emission of untaught responses that belonged to the same class as those that were tutored or to a different response function. The dependent variable for participant B, when he functioned as a tutor, was the correct responses on the production responses after tutoring the tutee for set 1, the correct responses on production responses in set 1, and the production responses for set 3 after tutoring the multiple exemplar instruction. The same behavior was measured for tutee T. The dependent variable for participant A, when he functioned as a tutor, was the number of correct responses on the morpheme probe set after set 1 was taught, the number of correct responses on the probe set in set 1, and the probe set in set 3 after tutoring the multiple exemplar instruction. Same behavior was measured for tutee B.

Data Collection

For the dependent measure of the contraction words program, the pre-experimental probes consisted of the tutors and tutees' untaught production responses for set 1 and set 3 contraction words taught as selection responses. For the independent measure of the contraction words program, we taught and collected data on both selection and production responses in alternating fashion (the multiple exemplar training condition) with set 2 contraction words and then taught selection responses only for set 3 contractions. For the morpheme program, the pre-experimental probes consisted of the tutors and tutees' untaught textual responses (or vocal reading responses) to set 1 and set 3 morphemes. For the independent measure of the morpheme program, data were collected on the taught responses in the multiple exemplar training condition with set 2 morphemes (alternating combinations of
morphemes) and then taught responses for set 3. Correct responses were recorded using a pen and paper format with a plus (+) and incorrect responses and no responses were recorded with a minus (−). All probe sessions consisted of no reinforcement or correction procedures.

**Inter-Observer Agreement**

Inter-observer agreement was assessed by having two observers simultaneously but independently collect data on 40% of the instructional sessions across all conditions as well as scoring the permanent product for the contraction words program. The inter-observer agreement for all probe sessions and instructional sessions was 100%.

**Design**

A multiple baseline probe design across students and programs was used in the study. Prior to the baseline condition, all response topographies in each program and the combination of morphemes were probed in 20 trial sessions for both tutors and tutees. In the baseline condition of the contraction words program, selection response was taught to mastery with 90% correct and two sessions consecutively; in the baseline condition of the morpheme program, one set of morpheme was taught to mastery. As the tutees met criterion, probe sessions were conducted on the correct responding of both tutors and tutees’ untaught responses (production for the contraction words program and another set of morphemes for the morpheme program). The multiple exemplar training condition was then introduced, and the selection and production response forms in the contraction words program as well as the combinations of morpheme sets were taught to the tutees in an alternating fashion by the tutors. After the tutees achieved criteria, probe sessions for set 1 morphemes not directly taught were conducted for the tutors and the tutees. Following the probe sessions, set 3 morphemes were presented and taught to the tutees by the tutors. After the criterion was met, another probe session was conducted on the untaught responses for both tutors and the tutees.

**Procedures for Tutoring Multiple Exemplars**

The independent variable of the study was the tutors' presentations of learn units of the multiple exemplar training to the tutees. As part of the independent variable, the tutor was instructed to record data on the tutee's correct and incorrect responses in addition to consequating the tutee's responses. The teacher also obtained reliability with the tutor's presentation of learn units to ensure that all instruction of the tutor was correctly done. The independent variable also consisted of correct and incorrect responses to learn-unit presentation of the two response topographies in the contraction words program.
on set 2 contraction words. For the morpheme program, the independent variable consisted of correct and incorrect responses to learn-unit presentations of five combinations of morphemes, each set starting with a vowel ($a, e, i, o, u$), using multiple exemplar training.

**Participants**

Three of the students were from the same special education, self-contained classes. Participant B (tutor B for the contraction words program and tutee B for the morphemes program) was classified with a language delay. This participant was a 6-year-old, first-grade male who functioned at a listener/speaker and an emerging reader/writer level of verbal behavior. Prior to the study, the student has mastered taking data on another student, and he also had mastered peer tutoring across various academic programs. Participant T (tutee T) was a 6-year-old female who was classified with mental retardation. Participant T functioned at a listener/speaker and emerging reader/writer level of verbal behavior. Participant A was a 6-year-old male who was classified with a language delay and other health impairments. Participant A (tutor A) functioned as a listener/speaker and an emerging reader/writer level of verbal behavior. For the contraction words program, participant B functioned as a tutor and was paired with participant T, who was a tutee; for the morphemes program, participant A functioned as a tutor and was paired with participant B, who functioned as a tutee.

**Results**

Prior to the experiment for the contraction words program, the participants did not emit any of the correct responses across response forms on the contraction words program. Figure 10 shows the untaught responses prior to and after the multiple exemplar training for both the tutor and the tutee. The results showed that prior to the multiple exemplar training in the contraction program, the tutee emitted 0 (0%) correct production responses, and the tutor also emitted 0 (0%) correct production responses on the set 1 contraction words program. After the multiple exemplars training, the number of correct production responses increased for both participants with Set 1 contraction words: tutee T emitted 12 (60%) correct production responses, and tutor B emitted 7 (35%) correct production responses. Both participants also showed transformation of stimulus function, from selection to production, in set 3 contraction words in the final training phase in which the tutee was taught one response form (selection) and probed on the untaught response form (production). Tutee T emitted 8 (40%) corrects on the untaught production response, and tutor B emitted 3 (15%) corrects on the untaught production response. In the same figure, the data show that in the morpheme program the tutee did not emit any correct responses to the
FIGURE 10
Tutor and tutee responses to untaught general case production responses to contractions (top panel) and untaught morpheme combinations (bottom panel) before and after tutoring in multiple exemplars.
probe set after the tutor instructional session; however, the tutor emitted 3 (15%) correct responses after tutoring the tutee with set 1 morphemes. Stronger results accrued for the first tutor-tutee pair for the third set of contractions.

**Study 5**

This study addressed the effects of tutors using a script for teaching problem-solving operations across a variety of national and state academic standards. The research represents a test of tutoring benefits for complex problem-solving tasks.

**Researchers and Topic**

J. Pereira, L. Yuan, and R. D. Greer. The effects of peer tutoring on the tutor and tutee's problem-solving repertoires utilizing a script for tutoring algebra, rounding numbers, and bar graphs (Columbia University Teachers College).

**Abstract**

We tested the effects of peer tutoring on teaching students to respond accurately to problem-solving tasks utilizing academic scripts (Marsico, 1998). The participants were four students, two males and two females. This study was conducted across school settings. In each setting, one student served as the tutor and the other student served as the tutee. Across both settings, the students completed three problem-solving activities. A multiple probe design was implemented in which a baseline probe demonstrated that the students did not independently respond accurately to the problem-solving tasks without and with the use of a script. In the subsequent phases, peer tutoring was implemented as a tactic in which one student in each setting tutored the tutee utilizing learn units to teach a script of the steps in solving the problems. The results showed that the tutee learned from the tutor across problem-solving tasks. The tutor also responded at a higher level than they had in their pre-tutoring baseline following having served as tutors to teach the tutees to criterion on the problem solving tasks. Furthermore, in some instances, the tutee and tutor met criterion within one session following peer tutoring. This study suggests that peer tutoring is an effective tactic for teaching students to use written rules.

**Definition of Behaviors**

The dependent variables were correct responses to learn-unit presentation across three problem-solving tasks for the tutee during peer tutoring. In addition, the dependent variables were probes that were conducted with and without a script for the tutee and tutor prior to and following tutee training by the tutor across problem-solving tasks.
Data Collection

The data were collected as responses to learn units by the tutor during training sessions. The pre-experimental and post-experimental probes for the tutor and tutee were administered by the teacher with and without a script. All responses were collected as permanent products. In addition during peer tutoring, the instructor on the tutor conducted TPRA observations across all sessions.

Inter-Observer Agreement

The teacher collected agreement data with the tutor in 100% of the sessions. The inter-observer agreement was 100% across all sessions. The data recorded for correct and incorrect responses across programs and across students were observed during both probe and instructional sessions. Inter-observer agreement was assessed by having two observers independently record the number of correct and incorrect responses on 30% of the students' permanent product across all conditions and classrooms. In addition, inter-scorer agreement was conducted for 100% of the sessions and was calculated at 100% across programs and settings.

Tactics

The independent variable of the study was having the peer tutor teaching the tutee to solve problems using a script (see Chapter 7 for more information). The classroom teacher for each problem-solving program wrote a script providing students with step-by-step instructions that led to the solution to each problem. Prior to the onset of this study, both tutors had been taught to tutor using learn units to a predetermined criterion. As part of the independent variable, the tutor was instructed to present learn units and record data on the tutee's correct and incorrect responses using a pen and paper format. The teacher also consequated the peer tutor for the correct learn-unit presentation and gradually faded her presence once the peer tutor achieved reliability with TPRA observations (Greer, 2002).

Participants

Four students enrolled in a public school located in a suburb of a major city participated in the study. Participants B and T were 5-year-old students diagnosed with developmental disorders. Participant B was a male who was classified with a language delay; he functioned as a listener/speaker and an emerging reader/writer according to the Preschool Inventory of Repertoires for Kindergarten (PIRK). Participant T was a female who was classified with mental retardation and was functioning at a listener, pre-speaker, and emerging reader/writer level of verbal behavior. Participants R and M were 14-year-old
students diagnosed with behavior disorders. Participant M was a female who
was diagnosed with emotional and a learning disability; she was functioning at
a reader, writer, and self-editor level of verbal behavior. Participant R was a
male who was classified with an emotional disability and was functioning as a
non-listener, reader, writer, and emerging self-editor.

Results for Tutor B and Tutee T
Prior to the experiment, both participants did not emit any correct responses
either with or without a script across bar graphs, word puzzles, and word
problems, as shown in Figs. 11 and 12. After the tutor presented learn units
using a script (data not shown for brevity's sake) across the instructional
programs, the tutee quickly learned to solve the problems. A probe session
was conducted, and the data showed that the tutor (Fig. 11) also learned
to solve the bar graphs with 100% accuracy without a script after teaching
tutee T (Fig. 12).

Results for Tutor M and Tutee R
The results for tutor M and tutee R were similar to the previous findings. The
baseline probe for the tutee and tutor across the three problem-solving
programs—algebra, rounding numbers, and bar graphs—demonstrated a low
level of responding with and without a script (Figs. 13 and 14). During tutee
training sessions where the tutor tutored the tutee utilizing a script, the tutee
met criterion within one session for each program, responding at 18, 20, and 20
correct responses to the problem-solving programs. A post-experimental
probe session following tutee training showed that the tutor (Fig. 13) and
tutee (Fig. 14) learned to solve each of the problems and responded at a high
level without a script.
Correct responses of tutor B before and after tutoring using scripts for tutoring bar graph problems, word puzzle problems, and word problems.
Correct responses of tutee T before and after tutoring using scripts for tutoring bar graph problems, word puzzle problems, and word problems.
FIGURE 13
Correct responses of tutee R before and after tutoring using scripts for tutoring algebra, rounding numbers, and bar graphs.
Correct responses of tutor M before and after tutoring using scripts tutoring algebra, rounding numbers, and bar graphs.
GENERAL DISCUSSION

These series of experiments provide evidence that the key ingredients for effective tutoring, as in the case of effective teacher presentations, are the presence of the components of learn units. Not only are learn units the key components for tutors and tutees, but they are also necessary for students who are observing tutoring if the observing students are to learn. One student in the teacher versus tutor comparison study, with learn units constant, did learn more across all three tasks when the tutor presented the learn units than when the teacher did so, suggesting that for some students there may be a peer advantage; however, for the most part, the presence of learn units ameliorated any differences between peer tutoring and teacher presentations. Other researchers have shown that the presence of learn units was necessary for criterion-level performance when instruction was delivered in programmed form by computers (Emurian et al., 2000). In summary, the evidence to date shows that learn units should be present when students engage in peer tutoring or when teachers or computers present instruction. These research studies addressed the need identified by Miller, Barabetta, & Heron, (1994) for the identification of key instructional components for successful tutoring. The students who achieved mastery of the standards taught were students who had been left behind in their prior schooling—the very category of students that our educational system does not serve. The evidence from our studies demonstrates that these students can be taught skills with adequate scientifically based instruction that they were not able to learn before.

Studies 1, 2, 3, and 5 involved students whose learning deficits were a result of lack of prior learning opportunities and the lack of scientifically derived schooling procedures similar to the students identified by Greenwood et al. (1994) and Hart and Risley (1996). The students in the fourth study were children who had native learning disabilities (e.g., diagnoses of autism or developmental disabilities). In fact, the students with developmental disabilities acquired repertoires associated with learning responses not directly taught, and both the tutor and the tutee learned.

The other tutoring research need that was identified by Miller et al. (1994) concerned possible social benefits or effects that might accrue from tutoring or being tutored. We did not address that issue; thus, future research should do so. However, prior research (Greer & Polirstok, 1982; Polirstok & Greer, 1986) did identify changes in collateral behaviors for tutors as a function of serving as tutors with nine different tutors over a 3-year period. That is, these students’ academic and social behaviors changed in educational settings and in subject matter areas not related to the areas that they had functioned as a tutor. Those studies identified that the collateral changes were linked to approvals received by tutors from their tutees. We suggest that this is an important line of research concerning possible social benefits for both tutors and tutees. Given the
effects of observing tutoring that we found in the studies reported here, a
fruitful line of inquiry for investigating the source of collateral behavior change
for tutors would seem to be related to the observational learning process.

Clearly tutoring that contains learn units benefits tutors, tutees, and stu-
dents observing the tutoring. Tutoring that does not include learn units is not
as effective. Interestingly, benefits did not result from observing students
receiving correct responses alone (i.e., tutees emitted only correct responses,
with no correction). That is, observing other students emit the correct answer
and receive reinforcement did not lead to observational learning. Thus, learn-
ing is occasioned for tutors and peer observers when they observe correction
operations done by tutors with tutees. How students benefit from observation
in classrooms appears to be critical to a student’s success in a mainstream
setting. Data from classrooms in which the teachers are not expert in behav-
ioral procedures suggests that relatively few learn units are occurring (Greer,
1994). If few learn units are presented in these classrooms, and if our findings
on the necessity for the presence of corrections hold widely, the possibility for
students learning by observation is reduced even more dramatically. It would
appear that if education is to leave no child behind the first critical step is to
train teachers to present instruction using learn units. The process of teaching
teachers to present learn units is not difficult and it is a cost-effective and
relatively simple procedure. It can be done in the classroom by trained obser-
vers who provide consequences and visual displays to teachers, as Ingham and
Greer (1992) found.

Tutoring provides one of the most powerful ways for teachers to increase
learn units in classrooms. Learn units are a necessary if not sufficient component of
any teaching effort devoted to leaving no child behind. Moreover, students
who teach other students or observe tutoring benefit as much, if not more,
than those who are tutored, and they do so across a wide range of curricular
goals concerned with academic literacy, problem-solving repertoires, and re-
sponses that lead to novel applications of tutored responses. While tutoring is
only one of the 200 or so tactics in the educational arsenal of applied behavior
analysis (Greer, 2002), it is one that needs to be present in every classroom.
Were all teachers to use frequent learn units and multiply the effect of learn
units by using peers to present learn units, we would make a significant step
toward saving more children.

It is important to note that in these studies the research was conducted by
teachers in classrooms where they were responsible for all instruction. More-
over, these teachers use tutoring and many other tactics from applied behavior
analysis (see Chapter 3). Thus, the procedures of applied behavior analysis
are doable in real-world settings, if teaching is approached as a science rather
than an art.
Acknowledgments

We acknowledge the assistance of Lisa Morsillo, now at the Dublin CABAS School, and Susan Mariano-Lapidus, of the Rockland CABAS School, in the collection of data for these experiments and in the pursuit of what was truly a programmatic effort by many CABAS professionals in the United States, Ireland, and England.

References


Only about 8% of all psychological research is based on any kind of observation. A fraction of that is programmatic research. And, a fraction of that is sequential in its thinking. This will not do. Those of us who are applying these new methods of observational research are having great success.
—R. Bakeman and J. Gottman (1997, p. 184)

HISTORY AND INTRODUCTION

Behaviorally based feedback strategies designed for undergraduate teacher education activities have been documented as effective in training teachers to use a variety of effective instructional behaviors in a variety of undergraduate practice teaching settings (Cooper, Thomson, & Baer, 1970; Cossairt, Hall, & Hopkins 1973; Hall, Panyon, Rabon, & Broden, 1968; Ingham & Greer, 1992; Kamps, Leonard, Dugan, Boland, & Greenwood, 1991; Page et al., 1982). A consistent finding in the education literature is that direct observation and feedback provision on select target behaviors (i.e., behaviorally based feedback) is effective in altering the classroom behaviors of teachers and, consequently, the behavior of their pupils. Many professional teacher-training programs that have implemented behavior analysis data as an ongoing instructional feedback and goal-setting treatment package are also procedurally available in the literature (Darst, Zakrajsek, & Mancini 1989; Landin, Hawkins, & Wiegand, 1986; Miller, Harris, & Watanabe, 1991; O'Reilly & Renzaglia, 1994; Warger & Aldinger, 1984).
Though documented as effective in the primary training setting, behaviorally based feedback approaches to teacher education are currently the subject of criticism in the mainstream teacher education profession. The main criticism suggests that the criterion-based approaches used in this method are inappropriate. **Criterion-based** is defined in this argument as a procedure in which teacher-trainees are held accountable for the demonstration of a predetermined number or percentage use of a particular behavior or set of behaviors (e.g., verbal instruction, feedback, questioning) that are hypothesized to be effective across a variety of instructional settings. A pupil behavior measure (e.g., activity engagement, on-task behavior, or ratio of correct to total skill trials) has traditionally been used to determine the relative effectiveness of a teacher’s instructional activities when using traditional behavior feedback strategies. (For examples of criterion-based behavior feedback techniques, refer to Carnine and Fink, 1978; Greer, 1985; Ingham and Greer, 1992; Kamps et al., 1991.) Doyle (1990) states that this criterion-based approach to teacher training provides a simplistic and inappropriately generic characterization of teaching. He concluded that it does so by stripping an analysis of complex interactive settings (such as those that teaching exemplifies) of all setting context and curriculum content through the fragmentation of the interactive process into discrete elements that are oftentimes wrongly assumed to affect client or pupil practices in particular instructional situations.

Proponents of the behaviorally-based feedback approaches provide an important alternative argument in response to these criticisms (Morris, 1992; Sharpe, 1997; Sharpe, Hawkins, & Ray 1995, 1998; Sharpe & Koperwas, 2003). The response arguments of those cited also provide an important foundation for the sequential behavior instructional strategy that is summarized and evaluated in this chapter. Response argument goes something like this: If, for example, a criterion-based framework is used to provide feedback and goal setting for teachers in training, then this activity would fall within what Morris terms demonstration (1992, p. 9). Using a demonstration approach, teachers are trained in a rule-governed manner (i.e., told to exhibit certain behaviors or actions in a general way under the assumption that these behaviors and actions are generally effective) to demonstrate particular behaviors to criterion when practice teaching. If training stops with demonstration, it is argued that teacher-trainees may not come to an understanding of the functional relationships between what a teacher does and how it affects pupil behaviors in particular instructional situations. If a teacher-trainee does not leave the training program with adequate understanding of the setting specific nature of teacher–pupil interactions, then long-term use of effective teaching practices may not be realized.

An appealing alternative to a criterion-based approach, and one recommended by this chapter, is termed **discovery** (Morris, 1992, p. 9). In a discovery approach, teacher-trainees are first explicitly taught which behaviors and setting conditions may be strongly related to the use or nonuse of certain pupil
behaviors. In behavior analysis terms, this is much like a \textit{contingency-managed} approach to skill learning. If the specific time-based or sequential connections between what a professional (\textit{e.g.}, teacher) does in a particular setting and how those activities impact on a specific clientele (\textit{e.g.}, pupil) are explicitly taught, it is hypothesized that those professionals may then become more effective in determining which behaviors to use in certain situations to maximize their effectiveness in terms of desirable client behavior change. In a discovery approach to professional teacher preparation, instead of defining explicit criteria for certain behavior usage (\textit{e.g.}, provide a minimum of three feedback statements a minute), a descriptive mapping of the many teacher and pupil behaviors that are used in a particular educational setting is first provided and is then analyzed in terms of the relative effectiveness of those teacher behaviors in relationship to the time-based connections with certain student behaviors within a particular educational situation. From this kind of analysis, a better understanding of just what works in particular educational situations may be discovered, and, from that discovery, objectives for future teacher behavior use may be defined and recommended for future instructional episodes.

\section*{Technology}

One of the main difficulties of implementing a discovery approach to behaviorally based instructional feedback strategies lies in having access to capable and user-friendly direct observation descriptive mapping tools. Currently, many computer-based instruments have been developed and implemented to support the use of sequential behavior analysis and to facilitate the ability to collect and analyze multiple measurement types of multiple ongoing behaviors and events (Greenwood, Carta, Arreagamayer, & Rager, 1991; Sharpe, 1996; Sharpe & Koperwas, 2000). Many of these tools provide a primary focus on a sequential analysis, meaning that educational researchers have the capability to explicitly investigate how the behavior of the teacher affects the behavior of the student and in turn how actions of the student may change a teacher's behavior. Using sequential analysis allows supervisors to see the connections across time among these behaviors, and they may be made quantitatively explicit using amenable analysis techniques (Bakeman & Gottman, 1997; Sharpe, 1997; Sharpe & Koperwas, 2000). This capability is important to the analysis of a variety of interactive settings, in general, and instructional and therapeutic settings, in particular, given the importance of analyzing the relationship between what a teacher does and how a pupil responds. If successfully implemented, these tools provide an important next descriptive step for teacher education research and development. Researchers who take advantage of direct observation tools are beginning to find consistent results in areas previously not considered for quantitative analysis (Bakeman & Gottman, 1997; Sharpe & Koperwas, 2003). Examples include discovery of important time-based relationships among how babies learn to interact with their parents.
in productive ways, how young children engage in productive social interactions, how marriages succeed or fail as a function of how spouses interact, and how a variety of professionals succeed or fail in their interactions with a variety of clientele. In this last regard, we feel strongly that computer-based sequential observation techniques that include a thorough quantitative methodology provide an important set of scientific tools by which to discover much more of the setting-specific functional relationships that characterize the complex, interactive milieu that comprises most instructional settings.

A Sequential Analysis Illustration

When collecting data to illustrate the sequential connections (also known as time-based connections) among multiple behaviors, it is first important to define measures so that they explicitly capture the sequential character of behavior and event interactions (i.e., in the case of this chapter's teacher education illustration, teacher and pupil behaviors that describe how those teachers and pupils interact in a variety of instructional and organizational situations). To illustrate the difference, a demonstration-oriented investigation might look at the Off-Task behaviors of pupils, and then monitor the teacher's treatment of Pupil Proximity or Positive-Verbal Praise. A decision might then be based on the number of times each pupil or teacher behavior occurs, or the relative percentage of class time each behavior takes up. In a discovery-oriented sequential study, on the other hand, a more global student measure might be used such as student Organizational Opportunities, with a variety of teacher behaviors monitored as a function of occurring in time around those Organizational Opportunities. The most often used measure in a sequential study is a conditional probability of occurrence of a particular behavior. In other words, sequential investigations attempt to find out the likelihood of a particular teacher behavior occurring given the recent occurrences of a targeted pupil behavior of interest (Bakeman & Gottman, 1997; Sharpe, 1997; Sharpe & Koperwas, 2003). In this latter approach, the time-based relationships among teacher and pupil behaviors are made explicit. When this information is used as an instructional feedback strategy with teacher-trainees after a particular practice teaching episode has concluded in an instructional setting, it has been successful in (1) eliminating inappropriate teacher behaviors that occur or tend to trigger undesirable pupil behaviors, and (2) increasing appropriate teacher behavior around pupils who are experiencing instructional or organizational challenges (Sharpe et al., 1995; Sharpe, Lounsbery, Bahls, 1997; Sharpe & Lounsbery, 1998).

Providing a Database

In order to advocate using a sequential behavior approach in the field-based or deliberate practice education of undergraduate teacher-trainees, it is important to show empirical support for the educational method. In this
manner, a genuine science and technology of effective professional practice may be made available. In many respects, the creation of a database supporting sequential behavior techniques as applied to educational concerns may be perceived as a scientific return to the flurry of behavior analysis in education activity of the 1970s and early 1980s. While the principles we summarize here have been used before, we are showing an alternative way of looking at educational behavior in terms of the sequential patterns that tend to recur over time. From the data presented in this chapter we hope to convince readers that there is a lot to be gained from thinking about direct observational data in a time-based fashion. We also propose that when collecting behavioral data, omitting information related to sequential interactions is to potentially miss an important opportunity for discovery and evaluation. It is in this regard that we feel that the application described provides opportunity for significant impact on the future of training professionals, in general, and on educating future teachers specifically.

The study presented in this chapter is based on a line of research pursued in response to the criticisms of using behaviorally based instruction and feedback strategies in mainstream teacher education (Sharpe et al., 1995, 1997, Sharpe, Hawkins, Lounsbery, 1998; Sharpe & Lounsbery, 1998). Termed sequential behavior analysis (SBA) and sequential behavior feedback (SBF) when used as a feedback strategy with teacher-trainees, it provides an alternative behavioral approach to the direct observation and feedback provision process. To date, the immediate training and short-term maintenance effects of SBF on teacher and pupil behavior in the primary undergraduate practice teaching setting has been well documented (refer to Sharpe et al., 1997, for a complete description of these settings). In addition, studies have shown SBF to be beneficial to the improvement of the self-monitoring accuracy of experienced teachers working in public school settings (Sharpe, Spies, Newman, Spickelmier, Villan, 1996).

The next important questions to this line of research include:

- The amount that increased teacher-trainee proficiency as a function of SBF exposure generalizes to the first 2 years of on-the-job practice after exiting the teacher training program.
- The relative effectiveness of an SBF strategy when used as an on-the-job continuing education tool with professional teachers who have not been exposed to SBF strategies during their undergraduate training experiences.

These questions are particularly important to answer given that the long-term generalization of effective teacher practices that have been successfully trained during an undergraduate experience are not typically well maintained once an individual is teaching in a school setting (Graham, 1991; Lawson, 1991; Lawson & Stroot, 1993; Stroot & Williamson, 1993).

The purpose of providing the example data contained in this chapter is to observe and compare a matched group of teacher professionals currently
working in public school settings to those who had been exposed to SBF strategies during their undergraduate experience and those who had not. An additional purpose of gathering the data provided in this chapter was to provide SBF to those teachers not previously exposed within their undergraduate training experiences to determine if a sequential behavior instructional feedback strategy was effective as a continuing-education activity.

**SCIENTIFIC METHODS**

**Participants and Setting**

Participants in this study included 6 male and 2 female teachers, all characteristically matched with the exception of exposure versus non-exposure to SBF strategies during their undergraduate teacher-training experiences. Each study participant began their first full-time teaching job with the onset of this study (Table 1). All participants were purposefully selected based on successful completion of a K–12 physical education teacher certification undergraduate degree within 4 years and with similar GPAs. Past teaching and coaching activities were also characteristically matched. Participants all matriculated through the same undergraduate program setting and were grouped and matched according to exposure versus non-exposure to SBF strategies (i.e., experimental participants received SBF, and control participants received qualitative narrative feedback only). All undergraduate experiences were similar outside of SBF strategy exposure and included a core set of courses that combined educational theory with guided clinical practice activities in local public school settings.

All participants were purposefully chosen as a function of similarly positive letters of recommendation, of having accepted a full-time middle school

<table>
<thead>
<tr>
<th>Participant</th>
<th>Age</th>
<th>Gender</th>
<th>GPA</th>
<th>Experience</th>
<th>Certification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exposed 1</td>
<td>22</td>
<td>M</td>
<td>3.3</td>
<td>YMCA youth sport coach</td>
<td>K–12, PE</td>
</tr>
<tr>
<td>Control 1</td>
<td>22</td>
<td>M</td>
<td>3.2</td>
<td>Middle school sport coach</td>
<td>K–12, PE</td>
</tr>
<tr>
<td>Exposed 2</td>
<td>23</td>
<td>F</td>
<td>3.6</td>
<td>Age-group swimming coach</td>
<td>K–12, PE</td>
</tr>
<tr>
<td>Control 2</td>
<td>23</td>
<td>F</td>
<td>3.5</td>
<td>Middle school basketball coach</td>
<td>K–12, PE</td>
</tr>
<tr>
<td>Exposed 3</td>
<td>22</td>
<td>M</td>
<td>3.1</td>
<td>Summer camp counselor</td>
<td>K–12, PE</td>
</tr>
<tr>
<td>Control 3</td>
<td>22</td>
<td>M</td>
<td>3.2</td>
<td>Summer camp counselor</td>
<td>K–12, PE</td>
</tr>
<tr>
<td>Exposed 4</td>
<td>24</td>
<td>M</td>
<td>3.7</td>
<td>High school football coach</td>
<td>K–12, PE</td>
</tr>
<tr>
<td>Control 4</td>
<td>23</td>
<td>M</td>
<td>3.6</td>
<td>High school football coach</td>
<td>K–12, PE</td>
</tr>
</tbody>
</table>
physical education teaching position the fall semester immediately following their undergraduate graduation, and all were within the same large metropolitan school district. Each physical education classroom used for observational purposes consisted of a well-equipped gymnasium and swimming pool setting in which team and individual sport skills (basketball, indoor soccer, volleyball, golf, flag football, and swimming) and fitness activities (flexibility, cardiovascular, and strength-training exercises) were taught in an individually prescribed, workstation format with end-of-class organized game activities.

**Dependent Measures**

In order to measure the differences between the two groups observed in this study, a set of dependent measures was implemented. Primary to this study was a sequential numerical measure of how a teacher behaved when an opportunity for instructional or organizational interaction presented itself during class time. Based upon an SBA framework (Bakeman & Gottman, 1997; Sharpe & Koperwas, 2003), the measures included:

- **Instructional opportunity (IO)**, which represented an opportunity for a teacher to provide instructional action and was defined as a pupil or group of pupils who were having difficulty with the skills to be learned (e.g., incorrect performance attempts) or were having difficulty discerning how to attempt a successful performance (e.g., reading a task card for an extended period of time or passive observation of others practicing a skill).

- **Appropriate instructional action (AIA)**, which provided an indication of whether a teacher took some form of appropriate behavioral action in the context of an IO incident; it was recorded if a teacher used a behavior in the context of an IO incident which clearly remedied that IO incident. To have an instance of AIA recorded, the teacher must have (1) implemented a behavioral interaction with a pupil or small group designed to specifically remedy the IO incident (e.g., modeling a skill, explaining how to perform a task, providing skill information designed to encourage successful participation in an activity), and (2) the pupil or group involved in the IO incident must have returned to active and successful skill practice or activity engagement. If a teacher did not interact with a pupil or group in the context of an IO incident or a behavioral strategy was employed but the pupil did not return to successful skill or activity engagement within a 1 to 2-minute prescribed time period, then an AIA was not recorded.

- **Organizational opportunity (OO)**, which represented an opportunity for a teacher to provide organizational or managerial action. It was defined as a pupil or group of pupils who were involved in an activity other than that prescribed for the day or were engaged in some form of disruptive behavior that required bringing that pupil or group back into appropriate activity practice.
• **Appropriate organizational action** (AOA), which provided an indication of whether a teacher took some form of appropriate behavioral action in the context of an O0 incident; an AOA was recorded if a teacher used a behavior in the context of an O0 incident that clearly remedied that O0 incident. To record an instance of AOA, the teacher must have (1) implemented a behavioral interaction with a pupil or small group designed to specifically remedy the O0 incident (*e.g.*, establishing close proximity to a pupil to encourage a return to the activity, verbally directing a pupil to return to the activity at hand), and (2) the pupil or group involved in the O0 incident must have returned to active and successful skill practice or activity engagement. Similar to the recording of AIA, if a teacher did not interact with a pupil or group in the context of an O0 incident or a behavioral strategy was employed but the pupil did not return to successful skill or activity engagement within a 1- to 2-minute prescribed time period, then an AOA was not recorded.

Two non-sequential measures of pupil activity were also used in this study:

• **Activity engagement**: A percentage of class time measure that was recorded when a pupil was engaged in practicing a skill or was participating in a fitness or game activity, according to the criteria set by the teacher for that lesson.

• **Off-task**: A percentage of class time measure that was recorded when any pupil was engaged in passive behaviors clearly not related to prescribed class activities or was engaged in any disruptive behavior that detracted from or interrupted the class activities prescribed by the teacher.

**Observation Protocol**

Participants given sequential behavior feedback during their undergraduate teacher training experience are referred to as the *exposed* group, and those without prior training in SBF are referred to as the *control* group. Each participant was observed for one complete 45-minute class period every other week over the course of four consecutive academic semesters. Each observed class period represented skill-based lessons in which teaching new skills necessary for successful team and individual sport participation was the primary focus. Data were collected by trained observers in real time using appropriate behavior analytic observational software run on laptop computers. *The data collection...*
method included the pressing and holding of alphanumeric keys that corresponded to the measures used in this study. Multiple keys could be pressed simultaneously, allowing the collection of overlapping event occurrences. A real-time recording format was used, generating the start and stop times of all recorded events as they actually occurred in each observational setting. From this time-based data record, an analysis program was used to extract a variety of measurement data, including the number and percentage data on all behaviors represented in the results section and related sequential data that reflected the time-based relationships among behavioral measures.

As noted previously, all IO, AIA, OO, and AOA data were recorded by pressing and holding alphanumeric keys on a keyboard as these behaviors actually occurred. Off-task data were recorded in the same manner for every off-task episode that occurred regardless of which pupil exhibited the particular episode. Recording off-task data in this manner provided a general percentage of time in relation to total class time in which off-task activity was occurring. To record activity engagement, pupils within each class being observed were rotated through a 2-minute recording schedule. Observers recorded the activity engagement for a particular pupil for a 2-minute period and then moved on to the next pupil to capture a general representation of the percentage of total class time pupils tended to devote to activity engagement.

**Inter-Observer Agreement**

Prior to collecting data for this study, observers were trained using a 50-minute criterion videotape of structured physical education settings not used for this study but which demonstrated repeated occurrences of the behavioral measures collected. Observers were trained to a minimum standard of .85 or greater agreement with the primary investigator on three consecutive 4-minute segments of the criterion videotape. Inter-rater checks were made once per experimental phase for each participant observed in this study. Checks at periodic intervals occurred between two independent data recorders during the data collection phase of the study. The formula \( \frac{\text{agreements} - \left(\text{agreements} + \text{disagreements}\right) \times 100}{\text{observations}} \) was used to compare data records for observer training and inter-observer agreement steps, with occurrence data across all IO, AIA, OO, AOA, off-task, and activity engagement behaviors being aggregated and used for formula purposes. Mean observer training agreement was .96, with a range of .88 to 1.00. Mean inter-rater agreement was .92 with a range of .87 to .98.

**Experimental Design**

A multiple baseline design was used to compare relative changes in AIA and AOA in respective IO and OO contexts and relative changes in pupil activity engagement and off-task behaviors. In other words, change was analyzed as a
function of exposure versus non-exposure to the sequential behavior feedback strategy treatment when used as a continuing-education or in-service teacher education strategy across all experimental and control participants. In addition, a social validation questionnaire was administered to all participants at the end of this study to determine the relative receptivity for the SBF strategy (see Table 2 for complete questionnaire instrument).

**General Instructional Feedback Strategy Procedures**

The feedback strategy treatment included the following:

- The direct observation of study participants for data collection purposes began with their first semester of professional practice in their first professional position and continued on an every-other-week basis for four consecutive semesters.
- Sequential behavior feedback was administered as an instructional feedback treatment in a multiple-baseline format according to the baseline, prompt, and maintenance schedules presented in Figs. 1 to 5: baseline, unobtrusive observation with no instructional feedback of any kind; treatment, sequential behavior feedback provided 3 days per week at the end of one class period per day for each treatment week; maintenance, unobtrusive observation with no instructional feedback of any kind.
- SBF treatments consisted of approximately 30 minutes of observer and teacher discussion of SBA data records of the teaching performance. Talks occurred immediately after one Monday, one Wednesday, and one Friday class period, constituting one full week of treatment. Data contained in Figs. 1 to 5 for treatment phases represent Wednesdays, or treatment week midpoints. Talks included the following for both exposed and control participants: (1) teacher responses to what they felt went well with their instructional lessons; (2) teacher responses to what they felt was the most challenging aspects of their lessons and how they might improve next time; (3) observer presentations of the IO, AIA, OO, AOA, activity engagement, and off-task data with time for teacher questions; and (4) provision of one to three goals for improvement that specifically related to the data records that were shown and discussed.
- Social validation data were collected from all exposed and control participants at the end of the study.

**Treatment Implementation Training**

Four trained data observers and SBF strategy treatment providers took part in the experiment illustrated. Each participating treatment provider completed a one-semester doctoral level course in SBA and SBF methods. The course
TABLE 2
Social Validation Questionnaire

Open ended

1. What did you like most about the sequential behavior feedback and goal setting procedure?
   - Clear and complete descriptions of what I was doing in the classroom and what my students were doing.
   - A method for measuring in very specific ways my daily teaching practices.
   - The objectivity and measurability of this type of feedback.

2. What did you like least about the sequential behavior feedback and goal setting procedure?
   - Nothing; loved it and wish we could do more.
   - Takes time from the current structure of our teaching day.
   - Makes me a better teacher but is challenging when I get lazy.

3. What did you learn from participating in this study?
   - How inaccurate my initial perceptions were of just what I and my students were doing behaviorally. I became a much better monitor of daily classroom events.
   - How to target students who need my attention and become a quick study of what to do for them.
   - How much is going on in my classroom in terms of what students are doing and how to make better use of my time with respect to interacting with students.

Likert scale

<table>
<thead>
<tr>
<th>Strongly agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Rate the following questions:

1. Do you feel that the teaching behaviors targeted by the SBF procedure were important?
   - 1.00  
   - .87  
   - .13

2. Do you feel that the teaching behaviors targeted were effective in relation to student challenges?
   - 1.00

3. Would you incorporate the teaching behaviors targeted in your future classroom practice?
   - 1.00

4. Do you feel that you are more aware of student instructional challenges as a result of repeated exposure to SBF information?
   - 1.00

5. Do you feel that you are more aware of student organizational challenges as a result of repeated exposure to SBF information?
   - 1.00

6. Would you recommend the use of SBF as an ongoing instructional and evaluation tool for other teacher and public school administrator colleagues?
   - .87
   - .13

included mastery of applied behavior analysis and sequential behavior analysis principles in relation to teacher training and assessment, training to criterion in the use of the software programs that generated instructional feedback and
goal-setting data, and training to criterion in mock teacher feedback sessions with undergraduate student teachers who did not participate in this study. Each SBF provider in this study exited the course with an A and had ongoing graduate assistant responsibilities in the area of undergraduate practice teaching and student teacher supervision.

**Treatment Integrity**

An important, albeit little reported, feature of applied behavior analysis application and related data reporting is in the area of treatment integrity or treatment fidelity. Equally important to gathering reliable and accurate data when involved in direct observation activities is providing assurance in some data-supported way that a particular treatment is implemented in accordance with its operational description. To this end, and specific to the study contained in this chapter, a trained independent observer recorded numerical and duration data with respect to the SBA feedback procedure use during one feedback day (of the three days per treatment prompt phase) for each treatment phase for each study participant (33%). Table 3 provides a summary of treatment integrity data according to the observation system used for this purpose.

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>Treatment</th>
<th>Maintenance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Questioning, positive</td>
<td>.10</td>
<td>5.6</td>
<td>.11</td>
</tr>
<tr>
<td></td>
<td>(.00 to .48)</td>
<td>(4.9 to 6.8)</td>
<td>(.00 to .54)</td>
</tr>
<tr>
<td>Questioning, improvement</td>
<td>.00</td>
<td>6.8</td>
<td>.09</td>
</tr>
<tr>
<td></td>
<td>(.00 to .00)</td>
<td>(5.1 to 8.2)</td>
<td>(.00 to .51)</td>
</tr>
<tr>
<td>Data descriptions</td>
<td>.00</td>
<td>10.3</td>
<td>.00</td>
</tr>
<tr>
<td></td>
<td>(.00 to .00)</td>
<td>(9.2 to 12.8)</td>
<td>(.00 to .00)</td>
</tr>
<tr>
<td>Goal-setting</td>
<td>.00</td>
<td>8.4</td>
<td>.00</td>
</tr>
<tr>
<td></td>
<td>(.00 to .00)</td>
<td>(6.9 to 11.3)</td>
<td>(.00 to .00)</td>
</tr>
<tr>
<td>Interpersonal/other</td>
<td>6.8</td>
<td>2.4</td>
<td>5.4</td>
</tr>
<tr>
<td></td>
<td>(2.9 to 9.5)</td>
<td>(1.4 to 6.4)</td>
<td>(1.3 to 8.2)</td>
</tr>
<tr>
<td>Total post-class time</td>
<td>6.6</td>
<td>28.9</td>
<td>4.9</td>
</tr>
<tr>
<td></td>
<td>(2.9 to 9.5)</td>
<td>(27.6 to 39.6)</td>
<td>(1.3 to 8.5)</td>
</tr>
</tbody>
</table>

*Note. For a complete list of operational definitions contact the primary author.*
STUDY RESULTS

IO and AIA Data

Figure 1 presents IO and AIA data for the four study participants who were regularly exposed to SBF throughout their undergraduate program experience. Data are arranged as total number of IO incidents in relation to total number of AIA teacher responses to those IO incidents. Data are strikingly similar across each of the four exposed study participants. Baseline levels of IO were moderate for all participants with slightly lower AIA responses. With the exception of only a slight increase with the first maintenance phase for exposed teacher 1, a consistently sustained increase in both IO and AIA were evident across all participants for all consequent experimental phases. Specific to the sequential behavior focus of the SBA feedback strategy, the baseline to post-treatment exposure number of IOs that were not responded to with AIAs decreased markedly and were consistently maintained for all four teachers who were previously exposed to SBA feedback during their undergraduate activities.

Figure 2 presents IO and AIA data for the four study participants, termed controls, who received no exposure to SBF in their undergraduate preparation experiences prior to this study. The four control participants first showed a striking similarity in data patterns. In contrast to the data in Fig. 1, each control participant demonstrated markedly lower initial baseline IO and AIA data. With implementation of more frequent and extended exposure to the SBA feedback strategy than the exposed study participants received, all control participants exhibited a gradual increase over the course of the study in IO and AIA. However, IO and AIA improvement was much slower to reach levels similar to those for the Fig. 1 participants and required more frequent and more extended treatment exposure. In other words, familiarity with the SBF teacher and student-interaction information provided in treatment form was central to teacher reflection on and improvement of their interactions with their pupils in a variety of classroom situations. Control participant sequential data showed that the number of IOs that were not responded to with AIAs were greater during baseline for all participants when compared to the Fig. 1 data and relatively much more variable in improvement as a function of consequent treatment and maintenance phases.

OO and AOA Data

Figure 3 presents OO and AOA data for the four study participants who were regularly exposed to SBA feedback throughout their undergraduate program experience. Similar to Figs. 1 and 2, data are arranged as total number of OO incidents in relation to total number of AOA teacher responses to those OO incidents. Again, data were strikingly similar across each of the four exposed study participants. Baseline levels of OOds were low for all participants with...
FIGURE 1
Number of appropriate instructional actions (AIAs) relative to number of instructional opportunities (IOs) for exposed teachers (phase icons: B, baseline; P, prompt; M, maintenance).
FIGURE 2
Number of appropriate instructional actions (AIAs) relative to number of instructional opportunities (IOs) for control teachers (phase icons: B, baseline; P, prompt; M, maintenance).
FIGURE 3
Number of appropriate organizational actions (AOAs) relative to number of organizational opportunities (OOs) for exposed teachers (phase icons: B, baseline; P, prompt; M, maintenance).
slightly lower AOA responses. With exposure to SBA feedback, each participant's OO and AOA incidents decreased from initial baseline levels and maintained a decrease for the remainder of the experiment. Specific to the sequential behavior focus of the SBF strategy, the baseline to post-treatment exposure number of OOs that were not responded to with AOAs decreased markedly and were consistently maintained for all four teachers who were previously exposed to SBF during their undergraduate activities.

Figure 4 presents OO and AOA data for the four study participants who received no exposure to SBF prior to this study. Again, data were strikingly similar across control participants. In contrast to the data in Fig. 3, each control participant demonstrated markedly higher initial baseline OOs, though similar AOA data patterns. With more frequent and extended exposure to the SBA feedback strategy, all control participants exhibited a gradual decrease in OOs over the course of the study. Again, as for the instructionally focused data (IO and AIA), familiarity with SBF information clearly improved teacher reflection on and improvement of a variety of effective teacher–pupil classroom interactions. However, as with the IO and AIA data for these participants, improvement was much slower to reach levels similar to those seen in the Fig. 3 participants and required more frequent and more extended treatment exposure. Control participant sequential data showed that the number of OOs that were not responded to with AOAs was greater during baseline for all participants when compared to the Fig. 3 data. The data showed relatively more variable improvement as a function of consequent treatment prompting and maintenance phases.

Discrete Pupil Data

Figure 5 represents activity engagement and off-task data for matched exposed and control teachers' pupils (previously exposed, 1, and control, 1; previously exposed, 3, and control, 3). Only two matched participant pairs were represented, given the similarity of the IO, AIA, OO, and AOA data within previously exposed and control participant groups. The baseline percentage of time pupils spent in activity engagement was much higher for the classes taught by participants previously exposed to SBF strategies within their undergraduate preparation experiences than for those not previously exposed. A small increase in activity engagement percentages was also seen in the exposed participants' pupils as a function of repeated exposure to SBF. In contrast, a relatively large increase in activity engagement was seen in the control participants' pupils over the course of the study, but not reaching that of exposed participants' pupil levels. The off-task percentages in the control participants' class settings were much higher in baseline than those of their matched exposed counterparts. A small and consistent decrease in off-task percentages was seen over the course of the study in the exposed participants' students as a function of repeated exposure to SBF, and a relatively large (but comparatively
Number of appropriate organizational actions (AOAs) relative to number of organizational opportunities (OOs) for control teachers (phase icons: B, baseline; P, prompt; M, maintenance).
FIGURE 5
Comparison of exposed and control teachers on percentages of student classroom behavior as a function of the sequential behavior feedback (phase icons: B, baseline; P, prompt; M, maintenance).
slower to be realized) decrease in off-task behavior was seen in the control participants’ students over the course of the study.

Social Validation Data

Social validation data were provided to demonstrate the potential receptivity for the SBF strategy on the part of professional teachers. These data were felt to be important given the limited literature providing participant response information in potential support of an ongoing professional education experience. Response information was consistently supportive of SBA feedback as a continuing education instrument (see Table 2 for questionnaire format and related response data). The end-of-study response data contained in Table 2 show that all participants, regardless of prior exposure to SBA feedback strategies in their undergraduate teacher training program, were supportive of SBA feedback as an ongoing instructional tool. They felt that they benefited in a variety of ways from interaction with sequential behavior descriptions of their classroom practice and the related practices of their pupils. The following participant quote provides a characteristic response:

"Initially I was a bit leery of participation, not really knowing what would be expected of us. As I got involved in the activity, however, I found that the descriptions of my teaching in relation to what my students were doing and the challenges they experienced really helped me become a more accurate monitor of classroom activities, and really helped me improve what I did in the classroom in relation to how I interacted with my students."

IMPLICATIONS FOR EDUCATION AND PROFESSIONAL TRAINING

The data contained in this chapter were first designed to demonstrate the appealing long-term generalization effects of one sequential behavior instructional feedback strategy on previously exposed teacher-trainees once they began their first professional position in a public-school setting. A second purpose of these data representations was to compare the effects of exposure to the SBA feedback strategy on teachers who had been exposed previously versus teachers who had not when used as an on-the-job continuing education tool. Third, pupil data were represented to determine any collateral effects on the pupils being taught by teachers exposed to SBA feedback. While pupil behavior data are only a correlate with important subject-matter achievement measures, the pupil data nonetheless provide important information in support of the effectiveness of the teacher behavior changes documented. Finally, social validation data were collected to determine the relative receptivity of participants to the SBA feedback treatment.

The results of the data presented in this chapter add substantially to an existing line of research by providing strong support for the effects of a
specifically defined, sequential behavior instructional feedback and goal-setting procedure used within clinical professional practice settings. The preceding illustration demonstrated that teacher-trainees exposed to SBA feedback in their undergraduate practice-teaching experiences maintained the behavioral competencies initially learned when operating over long periods of time in their first professional teaching situations. This is an important finding in two respects. First, the data show that practicing teachers who had not been exposed to SBF during their undergraduate experiences did not exhibit the same levels of teaching practice in the context of IO and OO incidents. Second, the mainstream teacher-education literature points to the greatest challenge of teacher education programs being one of negative socialization. Negative socialization occurs when, upon exiting an undergraduate teacher preparation program, the new teacher tends not to demonstrate or utilize the teaching practices recommended within that preparation program (Lawson, 1991; Lawson & Stroot, 1993). In this regard, this study specifically points to the importance of behavior and sequential behavior instructional feedback strategies as a potential means of professional training to ensure the continued use of professional competencies well beyond the undergraduate preparatory setting.

The data presented in this chapter also demonstrate that the sequential behavior instructional feedback method, when used as an on-the-job continuing education activity, is an effective procedure in (1) improving upon previously exposed teachers' use of recommended behavioral strategies when faced with challenging instructional and organizational situations, and (2) improving the use of recommended behavioral strategies with those teachers who had received no SBA feedback exposure prior to their first job experience. This finding provides strong support for the use of specifically defined behavioral treatments for practicing professionals that are designed to continually improve their instructional performance when they are on the job. It also provides support for behavior-analytic strategies as appealing and productive methods for reversing what is perceived by much of the mainstream education literature as an insurmountable confound of negative socialization. This second finding is further supported by the social validation data that emphasized the consistent receptivity by all study participants for SBA feedback strategies when used as a continuing education activity.

The pupil data presented lend additional support for the effectiveness of the SBA feedback strategy when used as a continuing education activity. Our view is that while it is important to demonstrate long-term maintenance and generalization of professional practices as a function of a particular treatment, the ultimate indicator of the success of a treatment designed for professional practice improvement is in its corollary effects on the clients served (in this case, pupils taught) by those professionals who have been exposed to a particular treatment. In this regard, the consistent data changes in the areas of activity engagement and off-task behaviors in the indicated directions for all
pupils involved in this study provide such support. Given that off-task behaviors are an arguable impediment to the effectiveness of a learning situation and that activity engagement has a strong correlation with student learning (Barbetta, Heron, & Heward, 1993; Greenwood, Hart, Walker, & Risley, 1994; Miller et al., 1995), these findings are consistent with earlier research and reinforce the need for continuing-education activities that include a SBF component. Of interest to future study in this area is the importance of correlating the potential effects of SBF on pupil grades received and a variety of academic skill acquisition indicators as a function of demonstrated teacher and pupil behavior change.

Of final importance, the data presented in this chapter lend additional support to the continued development of sequentially based behavior analysis methods designed to counter the technocratic criticisms of behavior analysis approaches to professional training, in general, and teacher training, specifically, that frequent the mainstream teacher education literature (Doyle, 1990). Consistent with earlier referenced studies conducted within this line of research, this chapter's data demonstrate that providing SBA feedback to teacher professionals working in public school settings is effective in increasing their targeting of, and responding to, challenging instructional and organizational pupil needs. When coupled with the generalization findings of the initial baselines of the previously exposed participants, a strong case is made for the effectiveness of SBF feedback in teaching teachers to recognize and ameliorate particular pupil situations. These data do not simply demonstrate isolated behaviors in an unconnected or potentially inappropriate manner, but rather are consistent with recommendations that connections between teacher and pupil practices in particular instructional situations be made explicit when developing teacher feedback strategies (Browder, Liberty, Heller, D'Huyvetters, 1986; Hawkins & Sharpe, 1992). Taking an illustration from Sharpe and Lounsbury (1998), stopping with the successful training of a teacher to criterion in the use of physical signals may ensure that a teacher consistently uses this behavior but may do little to ensure that this behavior is used at appropriate times and to the most effective result with regard to challenging pupil behavior. A representation, therefore, of how often a teacher takes appropriate action in a classroom in the context of particular pupil challenges is also needed.

Data findings represented in this chapter have several implications for future research and instructional activity when preparing professionals to acquire skills necessary to effective professional functioning. First, additional research is necessary to determine the relative effectiveness of SBF procedures for a variety of professionals when learning their respectively necessary behavioral skills in deliberate practice or residency-based practical situations. Second, longer range studies should be conducted to determine the differential time frames for optimal exposure and withdrawal of SBA feedback when used as a continuing education strategy. Questions of when SBA feedback is no longer necessary and how often this strategy should be used for optimal effects remain unanswered. Third, studies that correlate the effects of SBA feedback...
on teacher and pupil classroom behaviors with pupil subject-matter achievement measures are necessary to determine the relative effects of this strategy on measures of pupil learning. In relation to this recommendation, it is necessary to use an SBA method specifically to map the form and character of different teacher responses to IO and OO incidents to explicitly determine the relationship between particular pupil challenges that occur in particular situations and just what a teacher does to ameliorate those challenges.

A FUTURE FOR SEQUENTIAL BEHAVIOR ANALYSIS

Using teacher education as an illustration, we hope we have presented an appealing data-based case for the use of a sequential behavior instructional feedback strategy when training undergraduates in practical settings and for the continued use of this strategy when providing continuing education for practicing teacher professionals. We find this strategy to be of potential appeal for a variety of professional training situations in which a deliberate practice or a specifically supervised residency-based component is necessary for effective professional preparation. Extrapolating from our teacher-training exemplar, we suggest that a case may readily be made for use of sequential behavior strategies in professional training areas such as medicine, school and clinical psychology, special education and rehabilitation, and a variety of other professional training areas that place a primary focus on ensuring the demonstrated and generalized use of interactive skills critical to effective professional practice. Additionally, we feel that a sequential behavior direct observation approach is amenable to a variety of other educational activities when preparing professionals for effective practice with the clientele they are being trained to serve. Appealing education opportunities include video-based and computer-supported laboratory experiences in which trainees learn to collect and analyze sequential data to (1) become accurate monitors of their potential professional surroundings, (2) reflect upon relatively effective versus ineffective practices in certain situations, and (3) formulate best-practice behavioral repertoires for use in actual professional practice settings. Another potential application is the development and implementation of simulated practical settings via video and computer technologies, in which professionals may participate in a virtual and predictive-choice laboratory reflecting the types of professional settings in which they will ultimately operate. Ray (Ray & Delprato, 1989; Ray, 1992) for example, has pioneered this second potential application with great success, with these developments discussed in detail in another chapter of this text.

What remains to us, and what we hope we have articulated, is that much remains to the thoroughgoing discovery and application of sequential behavior data in relationship to interactive settings, in general, and educational settings specifically. When endeavoring toward a new way of thinking—in this case,
focusing on the temporal form of behaviors and events as they occur and recur over time—many opportunities for new discoveries of functional relationships among behaviors and events in effective and not-so-effective interactive situations are possible. With the advent of computer technologies designed to facilitate such data collection and analysis in user-friendly and time-efficient ways, what Barker presented over 30 years ago in his text, *The Stream of Behavior: Explorations of Its Structure and Content*, may become a reality in mainstream applied-science communities.

**Acknowledgments**

We would like to thank the many teachers and coaches in the Lincoln, NE, Public School; Tippecanoe County, IN, Public School; and Clark County, NV, Public School districts for their receptivity and enthusiasm to our approach to teacher training. Tom Sharpe, Ed.D., is the Sports Education and Leadership Program Coordinator and Professor at the University of Nevada, Las Vegas. Daniel Balderson is a doctoral student in the Sports Education and Leadership Program at the University of Nevada, Las Vegas. Hosung So, Ph.D., is an Assistant Professor in the Department of Kinesiology at California State University, San Bernardino.

**References**


Language is a cracked kettle on which we tap out crude rhythms for bears to dance to while we long to make music that will melt the stars. —Gustave Flaubert, Madame Bovary

NEGLECTED WRITING SKILLS

We have now had two decades of educational reform, focusing on two of the basic three R's, reading and arithmetic. The second R, writing, was left far behind. Most children in our elementary and middle schools are not fluent in grammatical usage and punctuation; they cannot spell, their vocabularies are poor, and they do not know the parts of speech well enough to take full advantage of a dictionary. But, perhaps we should not be surprised. Most students rarely write in school. Even the tradition of writing a research paper, once a rite of passage for high school seniors, is rarely observed. College professors and employers are alarmed and fear further consequences: The failure of American students to acquire proficient writing skills will affect every aspect of their lives—and ours.

In their report confirming the neglect of writing instruction, a prestigious panel of educators (National Commission on Writing in America’s Schools and Colleges, 2003) has recommended that schools double the amount of time students spend on writing and that educators look for new ways to teach writing skills. A compelling concern is that both of the major college-entrance
examinations, the SAT and the ACT, are being revised to include writing tests in 2005.

Yes, increased writing practice is essential, as are new teaching strategies. This chapter describes an approach in which the principles of behavioral science and the larger construct of performance are applied to improve instruction in both the process of writing and in its underpinnings of grammar, punctuation, mechanics, and style. Of the many valuable outcomes this application produces, two are major: First, writers learn a strategy for detecting errors or weaknesses in their own writing. Because few writers are lucky enough to have their own editors, self-editing is a critical skill. Second, writers become fluent in the underlying basic writing skills of grammar and punctuation.

Mastery of any discipline requires fluency in the basic skills, yet we educators allow many students to advance before ensuring they have acquired this degree of expertise. Behaviorists define fluency as a level of proficiency in which the skill is so well practiced that it is performed effortlessly and almost automatically (K. Johnson, personal communication). When students are fluent in the use of grammar and punctuation, they write with grammatical precision, and they punctuate their first drafts correctly as they write. In reading their drafts aloud afterward, they can discern an awkward phrase or confusing pronoun reference and make the revision. Any part of an essay that would confuse or mislead readers—or induce sleep—is called here a reading alarm. With enough practice, the number of reading alarms for punctuation and grammar diminishes, and writers write faster and more effectively. But, the primary value of fluency in basic writing skills is that it frees writers to explore the language so they can fit their message to their readers and convey it with some grace.

The principles of behavioral science were applied in earlier books on writing (Gilbert, 1984) and in a writing-improvement program (Gilbert, 1992) for Penn State University students employed as technical writers and course developers at a Salem, NJ, nuclear power plant. The principles and practices described here are applied in writing workshops for teachers of English in secondary schools.

METHODS OF TEACHING WRITING

Some educators contend that reading and writing are best taught together from kindergarten upward. This was the philosophy of R. B. Spalding in The Writing Road to Reading (Spalding & North, 2003), now promoted as the Spalding Method. Gilbert developed a program (1969) in which pre-kindergarten children were taught reading and writing together. He maintained that if children are taught to write, they will also know how to read, but that the reverse is not true; that is, children taught only to read will not also be able to write. Yet, most
Americans learn to read first and to write later. By the time they reach middle or high school, students with assorted writing skills show up in the same classroom. For teachers, the challenge is to manage this motley group so well that no one is left behind.

Traditionally, instruction in the process of writing and instruction in grammar and punctuation proceed as two separate activities. Because the writing activity is a management nightmare, however, teachers tend to make few writing assignments. When students do write original compositions, teachers may cover the papers in a jumble of red. Since they generally do not return the corrections until many days later, writers may not learn how well they have done until it is too late to matter. In some programs, students learn to use copyediting marks; with the teacher's guidance, they edit their writing and apply the changes in their rewrites. But, even those students do not write or edit their own work by themselves nearly often enough to learn how to write effectively.

Traditional instruction in the basic skills of grammar and punctuation follows an equally ineffective pattern. Students learn a series of actions to take, or responses (the grammar rules), for using each punctuation mark and each point of grammar. They learn to use commas to separate words in series, nouns in apposition, introductory words, city from state, and so on—one rule at a time. Next, they apply a rule to workbook examples and take a test afterward. When the rules for commas are exhausted, students proceed to rules for semicolons and repeat the process, rule after rule. Their instruction, however, does not provide them any direction for identifying the trouble spots these rules are expected to fix. This omission explains why so many students cannot make the leap to their own writing, and why they can apply only the most frequent usages of grammar and punctuation.

This labored instruction has other unwelcome consequences: It promotes repetitive sentence patterns, because students play it safe. If they are not confident about using a semicolon, they will not venture a structure they fear might require one. They will not delete cluttered or overblown text because they will not recognize it. Instead, they will rely on the clichés that come readily to mind.

An approach based on the principles of science turns the usual instructional methodology around 180 degrees. Students learn how logic can explain those conventions of usage and punctuation that seemed arbitrary when reduced to rules. First, they learn to review their own writing and recognize each reading alarm—the antecedent prompting a potential need: then they learn how to treat it. Some of the basic reading alarms are subject and verb pair, name, title of creative work, end quote with other punctuation, negative tone, wordy of phrase, and wordy who, which, or that clause.

Here is the caveat: The tags for these antecedents must be meaningful to the students' experience. For example, students encountering Toledo Ohio in their own work may not recognize it as a match to the reading alarm two
unrelated groups to define. They may not have a clear view of the meaning of define in this context. They must also regard a city and its state as state as separate groups. Groups to separate might work better even though it is not as precise. So, tags for reading alarms are not meant to be set in stone; students may devise their own personal prompts.

The reading alarm groups to separate generalizes to four punctuation needs: separating the day from the year in a date, the city from the state, two nouns in apposition, and a noun in direct address from the rest of the sentence. All four are traditionally taught as individual rules to learn. With a behavioral or functional approach, one reading alarm often covers several specific occasions, thereby reducing the number of actions to master. This efficiency of fewer actions to memorize will also produce more effective learning.

**WRITING AS A PERFORMANCE**

Before applying the principles of behavior analysis to writing instruction, however, we must view the subject matter through the larger lens of performance so we can state exactly what we want to accomplish. Gilbert (1996) defines performance as a transaction between behavior and its accomplishment. Performance is behavior that produces an outcome we value—an accomplishment. Once this valued outcome is established, we can search for the behavior that can best produce it. In this chapter, the accomplishment can be an essay that makes its intended point with the emphasis needed to engage its readers. The standards we set are that this essay will be accurate, it will be complete, and it will be readable. The behavior required to produce this accomplishment to these standards is fluency in the set of basic writing skills discussed here and the means for identifying the rough spots in one's own writing.

**The Behavioral Paradigm**

The late B. F. Skinner did not invent the stimulus and the response. Skinner invented a functional statement of their relationship, known as the *behavioral paradigm*, which is invaluable to basic laboratory research and to its applications in schools and businesses everywhere. By applying this model to writing instruction, we can design a course based on the functions of the writing process and the writing skills rather than on content alone, as happens in traditional writing programs.

The behavioral paradigm forces us to define the antecedents of actions that students need to identify, and it reminds us to arrange the conditions so that students' efforts will be meaningful to them. Figure 1 is an example of a behavioral paradigm describing the main steps—called the *operants*—of the
writing process. It expresses environment–behavior relationships with a three- 
term contingency, which, for this chapter, would include (1) the antecedent 
stimulus, (2) the response, and (3) the consequence of the behavior. For those 
readers unfamiliar with these notations, the $S^D$ stands for discriminative stimu-
lus and represents the antecedent stimulus that prompts some action; in this 
case, the student writer discriminates the topic selected. The $R$ represents th e 
student’s action, or response (here, the action to write freely). The $S_r$ stands for 
reinforcing stimulus and represents the reinforcing outcome (here, the rough 
first draft, which we can call a free-write). Because this free-write is not expected 
to be perfect, it is also considered a discriminative stimulus that prompts the 
student writer to pursue a search for reading alarms to fix. These may be lapses 
in content, sequencing disorders, awkward phrasings, confusing details, incor-
rect punctuation, clarification needs, confusing references, cluttered prose,
unnecessary commas or adjectives, or unorthodox sentence fragments.
A careful writer checks everything, and each discovered alarm needs to 
be addressed.

Reading alarms are not necessarily instances of error, but they are always 
instances to check. For example, one reading alarm that writers are asked to 
examine is owner/contraction, which is intended to prompt a check of a possess-
sive form. Because some possessives are often confused with contractions, 
students must determine if ownership or a contraction is intended and it is 
handled correctly. Writers must become reading detectives, searching their 
drafts for text that matches a reading alarm. As students become confident, 
you can address the basic alarms without effort, and they can move on; 
however, they must continue to look for flaws in content, style, clutter—and 
the mechanics—in everything they write. Anyone who has ever written any-
thing will tell you this: Writing, like any art, can always be improved.

**BEHAVIORAL STRATEGIES**

Several principles and practices of behavioral science can be applied to the 
design of the writing instruction to make it more efficient and therefore more 
effective.
Shaping

The principal method of a behavioral approach to writing instruction is **shaping**, as it is in the instruction of many other highly developed behaviors in both animals and people. Shaping is defined as reinforced successive approximations to a desired outcome. In teaching a dog to jump to reach a line drawn high on the wall, for example, psychologists shape the dog's behavior by reinforcing (rewarding) smaller "accidental" behaviors first. When the dog scurries about and raises itself to reach a low point on the wall, experimenters immediately reinforce the behavior with food, but they withhold later reinforcement until the dog makes higher and higher jumps and finally reaches the goal. In writing, instructors do not seek some absolute of perfection, whatever that might be. Instead, instructors must shape their instruction so their students will come successively closer to their goal of writing proficiency.

Measurement

Measuring the performance of writing is not a simple task, however. In most writing instruction, teachers measure the results of students' tests on grammar rules, not on their proficiency in applying these rules to their own writing. Teachers may also evaluate students' compositions, but their evaluations tend to be subjective. In the early 1960s, the Indiana University satellite in Indianapolis conducted an experiment in which all instructors of English Composition 101 graded the same freshman composition. The grades they assigned to this essay ranged from A to F. Other English departments might have similar results. Since instructors are rarely given system-wide standards for measuring student achievement in writing.

The saying goes, "You get what you measure." We could measure accuracy alone and perhaps count the number of undetected writing flaws, but then we risk raising timid writers who are afraid to try out new arrangements or to play with words. We need firm evidence showing us how well our students have met our goals. For example, we can measure whether a student's essay has made its point. We can also evaluate how well the writing presents this point. Does it capture the reader's attention and hold it? We can also monitor and evaluate continued improvement in this student's writing skills.

Short-Term Feedback

As they learn to write, students should always know how well they are doing: what they are doing right, and what they could do better and how to do it. **Short-term feedback** (WISE), delivered in a positive tone, is critical:

- **W** stands for the need to focus on the **writing** itself rather than on other characteristics (i.e., poor handwriting or sloppy-looking corrections).
• I stands for *immediate* feedback following the self-editing process.
• S stands for *specific* and *selective*, with feedback directed to the positive changes and two or three undetected reading alarms.
• E stands for an *educational* focus on the two or three alarms.

Teachers of writing can have a big stake in their students' progress by reviewing their work, noting and appreciating their small improvements, and teaching them new techniques. Their enthusiasm for the pursuit of writing improvement can be infectious. Students may continue to make errors and poor choices as they learn to discriminate between good and better changes, but they accept the challenge if they see their progress.

**Long-Term Feedback**

Because the acquisition of fluent writing skills is a long-term affair, students also need a larger view of their progress. To this end, student writers keep records of their achievements. One example of a student record is the progress plotter, which can have many different formats. Gilbert (1962a) described a simple progress plotter in which students plot the rising curve of their skill graphically to see their rate of progress toward a mastery criterion. Behaviorists emphasize the need to measure fluency by rate of response as well as by accuracy. In the approach to writing instruction presented here, however, a simplified matrix is used. The antecedents to grammar and punctuation needs are listed vertically: the horizontal axis shows the dates when students were taught each skill and when this teaching was reflected in their free-writes. This matrix is not a purely scientific assessment, and it does not measure rate of response; but it is an indicator of individual student success.

**Discrimination Training**

Results can be amusing when students confuse the punctuation rules. A letter from a car salesperson once addressed me as follows: *Dear, Marilyn* (comma before, not after, *Marilyn*). I guessed that the writer was taught two stylized rules: *Use a comma before a noun in direct address* and *Use a comma after a person addressed in a letter*. He obviously had not learned how to discriminate the stimulus for each rule. I would further guess that he had never confronted this discrimination.

Grammar and punctuation rules are just a huge group of *discriminations*, meaning similar stimuli that differ and so are treated in different ways. All behaviorists do not agree about how best to teach discriminations. I follow the logic that similar stimuli are best taught together so their differences are easy to identify. Students may also need some mediation—a mnemonic or other instructive device—to help them identify differences in the options to discriminate, so they can select the one that best fits. One example of a discrimination
badly in need of a mediator is the set of mathematical symbols $>$ and $<$, meaning greater than and less than. If these symbols are presented together, their differences are clear, but how can we ever remember what each symbol means? If we examine the graphics, however, we can see that more than was initially designed as wide going to narrow and less than was designed to expand. Once we notice the designs, the meanings are clear. The same holds for grammatical discriminations.

Whoever designed English composition had a logical Framework in mind. Grammar rules may have masked this logic, but a behavioral approach restores it. As an example, suppose we are teaching students to attend to the reading alarm two simple sentences in a row, since this pattern can sound dull or choppy. More important, these sentences may have some significant relationship that is not apparent when they stand alone. By joining them, we can reveal this relationship. Do the two sentences provide separate or contrasting views? Does one sentence show cause and the other show effect? Does one sentence explains the other? Once students learn the logic, their choice is clear.

To teach responses to the discriminations, educators can look to the animal laboratory. Gilbert (1996) describes how to teach a rat to press a lever to get food whenever a light in its cage is turned on, but not to press the lever when the light is off. The sequence is first to teach the animal to discriminate the consequences of behavior: pressing the lever produces a click leading to food $(S_r)$. Gilbert refers to this stage as inductive, because the animal is led (induced) into training and given a way of knowing the consequences of bar pressing. The second step is to teach the animal to discriminate the occasion (the light turned on) for responding successfully. This is the skill, or discriminative, stage of the training.

For training human beings, however, a step is missing. The rat performs in nearly unvarying situations—the cage and the light stay pretty much the same at all times. The rat has only two choices: when the light is on, it presses a lever; when the light is off, it does not press the lever. But, for human performance, occasions for responding in a specific way may occur in many forms. For illustration, suppose a lawyer is interpreting a legal contract. If the two parties agree on the terms of the contract, the contract is likely considered valid; otherwise, it is not. Although the situations facing the rat and the law student differ greatly in complexity, the discriminations are fundamentally identical—except in one respect. For the rat, the light is nearly always the same when it comes on, but legal contracts vary tremendously, both in form and style. Because the factors making a contract clear are not always obvious, the person has to develop a concept (generalization) for making the interpretation. Contracts have so many variants that not even experienced lawyers are expected to memorize them all. Something else is needed that will mediate the situation and the responses and will help lawyers remember
or reason which response is correct. So, if law students are taught the intermediate behavior of checking whether the contract adheres to a set of general rules, they will be able to generalize such responses to many specific situations. Human beings need a concept to mediate their learning.

Let us return to our earlier example to see how we can teach the discriminations in constructing a compound sentence by joining two simple sentences and forming a compound sentence. Figure 2 shows the exercise model. By teaching students the differences in their options—with comma, semicolon, or colon—and addressing them, they can select the one that best fits their message. They can also choose the emphasis they wish to convey.

After presenting the inductive and the concept and demonstrating the skill, the instructor prompts students to punctuate several compound sentences from sets of simple sentences. Students then perform unaided. They may be asked to show how two clauses are related by joining them in each of the specific ways they learned, for example. The happy news is that after guided practice, students will not need to make these tedious decisions because the skills will be fluent.

---

**[Inductive]** Instead of writing two simple sentences (or independent clauses) in a row, writers can make their writing more interesting and informative by tying the sentences together. **[Concept]** The specific joiner writers select can tell readers how the two clauses are related—and how important the information is.

**[Skill]** EXAMPLE: Mary saves stamps. Jose saves coins.

1. To show that the two simple sentences show separate detail, use the joiner *and* with a comma first. To be more formal or emphatic, use a semicolon alone. Or to be even more formal, use the very formal joiner *moreover* or *furthermore*.
   a) Mary saves stamps, and Jose saves coins.
   b) Mary saves stamps; Jose saves coins.
   c) Mary saves stamps; furthermore, Jose saves coins.

2. To show that the clauses have contrasting viewpoints, use the joiner *but* with a comma first. To be more formal or emphatic, use the joiner *however* with a semicolon first and a comma after.
   a) Mary saves stamps, but Jose saves coins.
   b) Mary saves stamps; however, Jose saves coins.

3. To show that the viewpoints in the two clauses are related by cause and effect, use *therefore* (or *consequently*) with a semicolon before and a comma after.
   a) Mary saves stamps; therefore, Jose saves coins. [She’s "Mary, Mary, quite contrary."]

4. To show one sentence explaining the other, add a summary sentence and a colon. The first word after the colon isn’t capitalized unless it is a proper noun or starts a quotation.
   a) Mary and Jose are collectors: Mary saves stamps, and Jose saves coins.

**FIGURE 2**

An exercise model for joining two simple sentences, or independent clauses.
These steps summarize the teaching of discriminations (Gilbert, 2003c):

- Introduce the skill, explaining what will be accomplished and why the skill is important to learn—and, sometimes, the consequence of not learning it. (Inductive.)
- Create a metaphor or generalized concept related to this skill that will serve as a framework guiding responses to particular instances (concept.)
- Use Gilbert's exercise model (1962c) of demonstrate, prompt, and release. Teachers may say, "I do it, we do it, you do it." (skill).
- Apply this learning in a real-world context—in this case, to one's own writing. (Application.)

As the behaviorists have always said (C. Ferster, personal communication), some good teachers may develop good teaching strategies on their own, because good strategies are often common sense and they are always logical. The value of a system of strategies is that all teachers can be more effective and all students will have the benefits.

**Competition Analysis**

A curriculum for teaching writing skills includes multiple discriminations, thereby raising many questions about how to arrange them in the best instructional sequence. Some decisions here were obvious, such as teaching prerequisite reading alarms first. But, a long list of infrequent skills is not practical. Students need some instruction for recognizing infrequent stimuli in their own work. If they forget a treatment, they can consult a good style manual (Sabin, 2001).

In designing an instructional sequence, Gilbert's (1962b) informal dictum was to "teach the hard things first, whenever possible." The logic for this principle is that it minimizes the competition for memory and the hard things become easier to learn and remember. So, what are the hard things? Gilbert described sources of competition, which he said was the primary cause of forgetting. To determine the sequence of instruction, as well as the tactic, Gilbert would set up a matrix of all the operants to be learned. He would then analyze their interactions—examine each operant and assess whether it would compete with or facilitate the learning of each of the other operants. My analysis for the instructional sequence of the reading alarms was more intuitive. The instruction described here favors early teaching of those reading alarms with a high potential for increasing the scope and variety of the students' writing, but a closer analysis of an instructional sequence for the reading alarms would be useful.
THE PROCESS OF WRITING

Ideally, perhaps, all grammatical usage, punctuation, mechanics, and style would be taught through the sentences that students write. But appropriate reading alarms do not show up naturally in a classroom setting or even in one-on-one tutorials. Teachers must initiate the learning by teaching parts and structures of grammar and their attendant punctuation first and then encouraging students to use the new features in their writing afterward. With the process of writing paired with instruction in writing skills, students are always practicing what they are taught.

My experience with writing programs has been with adults and in books, workshops, and classrooms; but the same principles apply with children—only the pace and tactics are different. Young children start with the definition of a sentence and then learn to discriminate between sentences and sentence fragments or run-ons. They write their own examples, thereby prompting the punctuation and mechanics needed to inform readers when a sentence begins and ends. Gradually, they learn to use phrases and other features within the simple sentence, and they check their writings for the reading alarms they learned. Once they can build simple sentences, they learn to build paragraphs. They also learn new sentence structures and the attendant punctuation. All along, they practice trimming their content and firming up their skills to fluency.

With older students and adults, the instruction follows a more accelerated path and it can be more individualized. My tactic with the Penn State students was to give them a diagnostic test with at least two examples of the simpler and more frequent grammatical and punctuation reading alarms to identify and address. Students recorded the results of this test on progress plotters, so that instruction could proceed from individual baselines. But a diagnostic is not essential, however. Students may start by assessing their audience and writing a statement of the point they wish to make in a free-write, which they then produce. In a subsequent session, they self-edit their work by looking for matches to a list of reading alarms, and then making appropriate adjustments. Students can plot these results on progress plotters. Their prior experience is acknowledged, and no student will start the new writing program at zero.

Free-writing is a widespread practice intended to loosen people up and is often celebrated as a cure for writer’s block. In Seattle, aspiring writers of fiction visit a special writing place—the Richard Hugo House on Capitol Hill—to free-write for a few hours once or twice a week. In a structured writing program, the objective of a free-write is to induce students to relax and let their thoughts take charge. Students have a stated period of time to produce a rough draft on a topic based on their studies or other interests. Their drafts are brief at first but become longer with practice. The term free
means that students can write freely, without worry about anyone's opinion, as
they apply whatever wording, grammar, or punctuation is fluent.

Using this free-write or working draft, students proceed to the self-edit, but
not immediately. As many have observed, time is the best editor. Writers need
time to reverse direction so they can review their work as if they are now
readers. What makes readers so smart? They have had considerably more
practice in reading than in writing. Readers come to rely on the consistent
signals of composition they find in printed matter. If they do not get the signals
they expect, they will stumble over the text.

As readers now, students start the self-edit by checking content and para-
graphing—marking where each new idea starts and then shifts to something
different. Next, they check to ensure that each idea is fully developed, with
adequate examples. They check that paragraphs are in the proper sequence, as
are the sentences in each paragraph, and they apply the edits needed. With
content now secure, the objective is to note whether sentences are grammat-
ically correct and whether some fat can be trimmed so wordings are sharpened.
This closer look may require two or three readings. If possible, all readings
should be aloud, so students can catch their own rhythm—hear whether the
flow is smooth or labored. If they stumble as they read, they must stop to
consider why they stumbled and what they can do about it. Afterward, the
instructor reviews the changes and also teaches one or two new skills. Students
then produce another free-write—this time, using the new techniques. The
process is repeated, so that students are always learning new skills and
practicing the old.

In doing their self-edits, students learn to use copyediting marks for editing
hard copy or the Track Changes feature in the Tools menu of Word, for
example, if they work on computers. Either way, the teacher demonstrates
the method first, prompts the practice, and then lets students perform
unaided.

Although free-writes are a major strategy for writing instruction, they are not
the only source of writing practice. Students might write an essay intended for
several diverse audiences, or all the students in the group might write from the
same prepared outline of a familiar topic. Teachers will be surprised at both the
differences and similarities in the resulting compositions. Another exercise for
students is to write in the style of a specific author they are reading in school.
High school students 50 or 60 years ago read and modeled the Roger de
Coverley papers. Now, students can invent new adventures for Holden Caulfield
and Harry Potter. Shorter practice exercises in key skills are beneficial—such as
shortening sentences so they are more effective, expressing one idea in several
different ways, or using some of the fine points of style. A challenging exercise is
to cut the word count of an edited draft by half while maintaining its point. With
usability gurus and information architects advising that Web writing should
be 50% shorter than its print counterpart, severe word cuts do not sound so
radical. Chances are that many students and adults will write on-line text, and learning to trim verbiage while maintaining the point and emphasis of the message is a worthy pursuit.

The Internet offers a multitude of opportunities to write; e-mail, of course, is one—even with its overall disdain for the grammar police. A more educational writing activity available to Web users is called Fan Press (formerly Fan Fiction). Teens write stories and post them on the Internet. Readers may ask their favorite authors to write on a special topic. Several other Websites (e.g., Scholastic’s) also publish student writing so that teens can see what others in their age group write. For the first time, they get rapid feedback from their peers. It is all great practice and an incentive for teens to write more often and to write better.

No setup for conducting a writing exercise works well with a really large group unless instructors make some accommodations. Instructors must be flexible managers—perhaps arrange for one group to write while another learns a new skill and a third self-edits. Instructors may encourage peer editing and use prepared editing and writing exercises. Quick fluency can pep up the class while firming their skills. The goal is keeping all students engaged. The finest achievement for any writing instructor may be to produce students who appreciate the beauty and elegance of language and like to experiment with words.

A LAST WORD

Few of us are as articulate in our oral communications as we can learn to be when we write. Writers must select the words and grammatical links that best convey their meaning. At the same time, writers must capture the nuances of speech—the smile, the frown, the indignation, the surprise, or the look-you-in-the-face confrontation. Writing is a dance between writers and their readers. Writers lead, and if their message is clear and gracefully constructed their readers will follow. Critics may say that writing is not like mathematics, and that a scientific approach to writing is too clinical. I believe that mathematicians, or at least a engineers, must have organized our grammatical structure from the Latin, and we benefit by learning the logic they applied. The behavioral principles help writers organize the conventions for translating oral speech into writing. They do not prevent writers from seeking full command of the English language so they can control the effects they elicit in their readers. That kind of mastery comes from knowing their readers, from achieving fluency in writing skills, from the ability to self-edit, from reading good writing, from learning about many different subjects, and from the leisure and desire to experiment. Our job as writing instructors is to encourage all students to learn the craft of writing. How they choose to use this craft will define them as artists.
References


Abstraction, 154
Acceleration of behavior, 54, 57
Accountability, 61, 68
Accuracy, 149, 159, 160, 164
Active learning, 241
Adaptive, 131, 151, 152, 154, 169
  educational programming, 151
  instruction, 149, 151, 164
  instructional systems, 131, 152, 153,
     154, 155, 164, 165
  content presentation, 155
  control, 151
  computer-based programming, 131, 150
  programmed instruction, 159
  systems, control systems, 150, 152,
     153, 166
  tutorial, 151, 161
  testing, 151, 153, 154, 157
AimChart internet Precision Teaching
  application, 67, 73, 75
AimStar, definition and use of, 55, 67
Application, 64, 176, 255–258, 367–370
Arbitrarily applicable relational
  responding, 279, 281
Artificial intelligence, 149, 154, 155, 157,
     165, 242
Assessment, 150, 161
  instruments, 153
  materials, 151
  reliability, 156
  self, 160
  services, 161
Associated terms, 156, 158
Associate, 157
  questions, 158
  word, 157
  verbal, 157, 158
Asynchronous testing, 229, 235
Autism, 71–72
Automated instruction, see also software
  considerations, 138
  effectiveness, 134–137
  evaluation, 137–138

Behavior Research Company, 74
Behavioral Anchor, 98
Behavioral consequences, 132, 147,
     148
Behavioral paradigm, 364–365
Bidirectional stimulus relations/bi-
  directional responding, 280
Big ideas, 82
Big Six basic hand movements, 64–65,
     71
Blame the learner, 49, 74
Bloom's taxonomy, 97, 100, 105, 201–202,
     230–231, 234, 236
Bounce (variability), classification of
  changes in, 65
Bounce (variability) in Precision
  Teaching Charts, 53, 58, 65
Brain injury rehabilitation, 70
Index

CABAS®, 29, 30, 31, 37, 38, 39, 40, 41
CAPSI, see Computer-Aided Personalized System of Instruction
Carroll's model for school learning, 202
Celeration, 57, 68
definition, 57, 65
classifications, 65
Celeration charts, see Chart
Certification, 159, 161, 162, 163, 167
mastery, 160, 164
mode(s), 159, 160
questions, 166
score, 164
tests (testing), 156, 160, 161, 162, 164, 166
Center for Personalized Instruction, 205
Chart
types of, 49, 51, 54, 56, 69, 73
date synchronization, 52
definition and standard features, 52, 58
how to read, 52–53
Standard Celeration, 14, 49, 51, 54, 56, 69, 73, 257, 262
Chartshares, 58, 66
Cheating, see Plagiarism
Choral Responding, 97
Combinatorial entailment, 280–281, 289
Comfort pairs, 65
Competition analysis, 370
Component-composite organization of behavior, 64–65
Component-composite teaching tactics, 64–65
Composite behavior defined, 64
Computerized Precision Teaching Charts, 74–76
Computer-Aided Personalized System of Instruction, 223–243
Computer-mediated communications, 242
Computer-mediated instruction, 230; see also Computer-Aided Personalized System of Instruction
Concept(s), 146, 148, 149, 150, 154, 156, 157, 166, 167
map (mapping), 157, 167
primary, 158
properties, 148
presentations, 156
Conditional probability, 338
Consequences
behavioral, 132, 147, 148
reinforcing, 147
Constructivism, 206
Content analysis, 252, 254
Contextual cues, 280, 281, 290
Contingency adduction, 177, 251, 259
Contingency Managed, 337
Continuous measurement, 256
Control, 152
adaptive, 151, 152
hormonal, 144
instructor, 160
systems, 150, 152
Corrections, 90–91
Creativity, 231, 234
Criterion based, 336
Critical thinking, 224, 230, 251
Cultural bias, Precision Teaching and, 67
Cumulative learning, Precision Teaching and, 58
Curriculum evaluation, data-driven decision-making, 59, 67
Curriculum sequencing and component-composite behavior, 65
Cybernetic(s), 152

Daily report card, 248, 262
Data-driven decision-making, 49, 59, 67
Data storage, 225, 229
Deceleration of behavior, 54, 57
Decision protocol, 32, 38
Decision support, Precision Teaching Charts and, 53
Decision tree, 34
Delayed prompting, 270
and learning efficiency, 270, 274
and errors, 274
Deliberate Practice, 338
Demonstration, 336, 338
Derived relational responding, 279, 283
Dimensions of behavior, 65
Direct Instruction, 13, 15–17, 81–94, 255–256
big ideas, 82
Direct Instruction, Precision Teaching and, 59
Disability accommodation, 67, 70–74, 230
Disability, 70–74, 230
Discovery, 336–338
Discrimination training, 367–370
exercise model, 369–370
steps, 371
Distance education, 225
DOS 225, 237
Down syndrome, 70
Drill-and-Practice, 128
Dynamical system, 228

Education, 151, 161, 162, 167, 169
adapting systems, 152
computers in, 151
goals, 153, 166, 168
higher, 143, 145, 165
Effective instruction, 9
Efficiency in teaching, 55–58
E-mail, 224–225
Empowerment of learners, 49, 50, 53, 61
Endurance of performance, fluency and, 64, 71
Engaged learners, 49, 89
Error, 152, 157
Error correction, 156, 274
Ethics, Precision Teaching and, 60–61
Evaluation
formative, 179–181
summative, 179–181
Evidence (definition), 4
Evidence-based education (definition), 4
Exams, 105
Expert, 167
image, map(s), concept map(s), 157, 168
knowledge systems, 149
reading skills, 149
system, 168
verbal associate network(s), 165
Explicit Instruction, 95–96
Expository verbal behavior, 228
Extrinsic reinforcement, 13
Fade (faded, fading), 131, 147, 148, 150, 154, 158
Fads in education, 61
Failure to teach, as ethical lapse, 61
accuracy, 234, 239
asynchronous, 229
behaviorally-based feedback, 335, 336
consequential, 149
cybernetic, 152
effectiveness, 242
instructional feedback, 335
promptness, 234–235
reinforcing, 148, 153, 156, 158
rich, 238
supplemental, 157
sequential behavior, 339, 344, 354
substantive, 238
Fluency, 6–7, 10, 14, 64, 65, 101, 149, 159, 174, 178, 256, 362, 367, 369, 371, 373
blockers, 60, 64, 65
builders, 60, 64, 65
fluency acronym (SARGE), 64
definition, 64
standards, 60, 64, 65
Formal Assessments, 105–106
Free-write, 365, 371–372
Frequency of behavior, 49, 57, 59, 64, 65, 67, 71
Functional individualization, 49
Index

Generalization of learning, 64, 81–82
Generative (generativity; generatively), 64, 153–154, 251, 259, 262
of language, relational frames, 278
Gilbert's program, see Teaching reading and writing together
Goal(s), 145, 147, 148, 152, 153, 154
behavior(al), 147
educational, 153, 166, 168
fluctuating, 151
homeostatic, 152
instructional, 152
mastery, 152
setting(s), 152, 153
state, 153
static, 153
Goal Setting, 335
Group unison response (see Choral Responding), 89–90
Grouping, 88–9

Higher education, 224
Higher-order thinking, 224, 230, 234, 242
Homeostasis (homeostatic), 151
balance, 152
characteristics, 152
goals, 152
needs, 153
systems, 152

Incentives, see Reinforcers
Increased educational efficiency, Precision Teaching and, 55–58
Independent Practice, 105
Individualized Educational Plans (IEP), Precision Teaching and, 67
Individuals with Disabilities Education Act (IDEA), Precision Teaching and, 66, 67
Information, 151, 157, 159, 161
Instructional design, 251, 254
Instructional opportunity, 341

Intelligence, artificial, 149, 154, 155, 157, 165
Interactions
student-instructor, 242
student-student, 227, 242
Internet (resources), 74–76, 149, 155, 161, 165, 166, 169, 172, 183, 224
Intervention effects of Precision Teaching classified, 65
Iowa Test of Basic Skills, Precision Teaching outcomes and, 48–49

Language bias, Precision Teaching and, 67
Law of Effect, 147, 157
Lean (leaning), 147, 148, 149, 154, 158
reinforcement, 158
Learn unit context, 29, 30, 33, 34, 38
Learning channel, 65, 253, 255
Learning curves, 53
Learning efficiency, 268–269
causes of, 269
recording sheet, 272
Learning for mastery, see also Mastery, 202, 207
Learning outcomes, 253–255
Learning pictures, 55, 76
Learning streams, 65
Learning time, 268–269
Learner verified, 249, 263
Lecture(s), 144, 163, 165
Lemon, definition of, 53
Linguistics, 167
Local Area Network (LAN), 225

Manding (derived), 284–287
Mastery, 11, 13, 15, 16, 18, 20, 21, 49, 64, 65, 85, 144, 146, 152, 156, 160, 162, 176,
Outcomes
  learning, 253–255
  reading, 185
  general students, 48–49, 66
  special education students, 48–49, 66

Peach, definition of, 53
Peer observers, 295, 300, 308, 309, 312, 314, 330
Peer review, 234, 236–237
effects on teacher performance, 298
effects on tutees, 294, 296, 300, 308, 320, 312, 315, 318, 319, 320–323, 325, 330
effects on tutors, 301, 303, 308, 310, 315, 318, 319, 320, 321, 323, 325, 330
as effective instruction, 295, 296, 301, 330
Performance improvement, 268–269
Personalized system of instruction (PSI) 13, 18–21, 202–216, 150, 162, 163, 164, 223, 228
components, see key features
course completion rates, 207, 208
current use, 205, 209–216
deciding to use, 210–211
decline, 205–206
effectiveness, 206–208
flexibility, 208–209
history, 202–206
immediate feedback, 203, 204, 210, 212, 215
instructional materials, 203, 204, 208, 210, 212, 214–215
Personalized Instruction, Journal of, 205
key features updated and revised, 211–216
lectures, 203, 204, 206, 210, 212
mastery requirement, 203–204, 212–213
outcome studies, see research support

N
amining, 280, 284
National Commission on Writing in America's Schools and Colleges, 361
National education standards, 29, 31, 32, 39, 40
National Reading Panel, 91
Natural reinforcement, 13, 17
Negative Socialization, 355
Network
  semantic, 153
  verbal associate, 157, 158, 165
No Child Left Behind, 4–6, 23, 37, 42, 67, 179, 195, 264, 330
Non-arbitrary relations, 279, 289
North Central Regional Educational Lab (NCREL), 76

O
jectives, 98, 167
course, 167
educational, 167
teaching, 146
Online teaching, 224, see also Computer-Aided Personalized System of Instruction
Organizational opportunity, 341
Personalized Instruction (Continued)
  proctoring, 203, 204, 210, 212, 215–216
  (see also Peer tutoring)
  PSI newsletter, 205
  research support, 206–208
  pacing, 203, 204, 206, 212, 213–214
  student satisfaction, 206, 207
  technology, 202, 209–210, 212,
  214–215
  time commitment, 205–206, 210–211
  unit size, 213
  variations, 204, 211–212
  Perspective-taking, 282, 290–292
  Placement tests, 87–88
  Plagiarism, 235
  Practice, 85, 176, 250, 254, 256, 257, 259,
  263
  Precision Teaching, 13–15, 47–78, 256,
  262
  definition of, 48, 50, 59
  Problem solving, 248, 256–261
  Procrastination, 213–214
  Programmed Instruction 13, 17–18, 148,
  149, 150, 154, 155
  adaptive 159
  Progress plotter, 367, 371
  Project Follow Through, 6, 91–92
  Progressive education, 251
  Prompt, prompting, prompted, 131,
  147–152, 154–159, 167
  Stimulus, 156
  delayed, 270
  and learning efficiency, 270, 274
  and errors, 274
  PSI, see Personalized system of
  instruction

Racial bias, 67
Rate of responding, 14, 131
Reading, 143, 144, 146, 149, 155, 158
  assigned, 144, 145
  comprehension, 145, 148–150, 153,
  155, 174
  errors, 175
  fluency, 174
  preparatory, 145
  proficiency, 171
  outcomes, 185
  skill(s), 146, 148, 149, 150, 155, 172
  strategies, 172
  textbook, 143, 145, 159, 161, 166
Reading alarms, 362, 363–364, 365, 371
Real time recording, 343
Recombinitant teaching, 182
Reinforcement, 147, 148, 157, 228, 234
Continuous, 148
  density, densities, 147, 148
  leaned, 158
Relational database, 229
Relational (frames) framing, 168, 281,
  283, 284
Remedial (remediation), 145, 146, 149,
  277
Repertoires, 25
  student, 25, 28, 31, 32
  teacher, 33, 34, 38, 39
Restricted-answer questions, 226, 228
Retention of learning, 64, 72
Rule, procedures for teaching, 83

Sacajawea School, Precision Teaching
  outcomes and, 48–49
SAFMEDS 50–52, 55–57, 68, 72, 74
  chart of student’s use, 51, 56
  definition, 50
  use in class, 50–52, 55–57, 68, 72, 74
SARGE fluency acronym defined, 64
Scaffolding, 84–85, 146, 147, 148
School phobia, 47
Scripts, 86
Self-editing, 362, 372
Semantic networks, 153

Question (questioning), 144–146, 148,
  149, 151, 153–160, 164, 167
  assess mode, 160
  certification, 166
  multiple choice, 166
  tutorial, 160
  types, 158, 160, 161, 163, 166
  verbal associate, 167
Selectionist philosophy, 250
Sequential Behavior, 336, 339
Sequential Behavior Analysis, 337–339, 357
Sequence of instruction, 84
Shape (shaping), 146–149, 153–158, 166, 366
Signals, 90
Simulations, 129
Skills
  component, 182
  composite, 182
Social contingencies, 235
Software, 149, 151, 154, 155, 165, 166, 169
design, 132–134, 150–151
features, 130–132, 150–151
instructional, 152, 153
navigation aids, 132
organizational structure, 133
research, 161
text characteristics, 133
types, 128–130
Spalding Method, see Teaching reading and writing together
Special Education, Precision Teaching and, 66, 67
Sprint (academic), 71
Stability of behavior, fluency and, 64, 72
Stacks of Charts, 66, 68, 69
Standard Celeration Chart, see Chart
Standard learning efficiency chart, 271, 273
Standardized test scores, Precision Teaching and, 47
State and national education standards, 29, 31, 32, 39, 40
Stimulus equivalence(s), 168
Stroke rehabilitation, 70
Student assistants, 223, 224, see also Peer review
Student-instructor interactions, 242
Student-student interactions, 227, 242
Study objectives, 223–224, 230
Study questions, 225–226, 229, 234–236, 241, 271
Study units, 225, 229, 236
Study skill(s), 148, 150, 158
Style manuals, 370
Successive approximation(s), 147, 148, 149, 154, 156, 157, 158
Symmetry, 283–284
Systems, 151, 152, 161, 165, 166, 168, 169
  adaptive 131, 152, 153
  adaptive instruction 152, 153
  air conditioning 152
  behavioral 155
  control 150, 152
  cybernetic 152
  expert 149
  general 152
  guidance 151
  hierarchical 152
  homeostatic 152
  knowledge 149
  software 152, 153
technology 24, 37, 38, 41
tutoring 151, 155, 167, 168
Social Validation, 354, 355

TAPS, 260
Target behavior(s), 146
Task Analysis, 98, 147
Teacher effectiveness research, 91
Teaching reading and writing together, 362
Teaching routines, 177–178
Telnet, 225
Testing
  field, 179
  learner, 178
  validation, 179
Textbook, 143, 145, 150, 155, 156, 158–162, 164, 166, 167
  assignment(s), 143
  reading(s), 143
Theories of education, evaluation of, 49
Theories of learning, evaluation of, 49
Thinking aloud problem solving, 260
Time bar, definition of, 55
Time savings, Precision Teaching and, 55–58
Tool skills, 10
TPRA 309, 310, 324
Tracks, 86–87
Trained tutors, 296, 303
Transformation of stimulus functions, 280, 281, 283–284
Treatment Integrity, 346
Tutorial, 128, 151, 160–161
Tutoring, 148, 149, 151, 157, 161, 162
assessment, 158
levels of, 156, 161, 163, 166
required, 161, 163
services, 155
system(s), 155, 160, 164, 167, 168
time, 165

Unison responses, see Group unison responses
University of Chicago's laboratory school, 202

Verbal behavior, 223–224, 227–228, 241–242
Verbal associate(s), 157, 158
network(s), 157, 158, 165
question, 167
Verbal behavior, 167
Verbal operants, 277, 278
Verbal skills, see Verbal behavior

Waste in education, 61, 67, 68
Websites, student writers and, 373
Winnetka Plan, 202
Workload dynamics, 237–238
World Wide Web, 224, 237
Writing instruction, 365–370
traditional, 363
Writing practice, 361, 362, 371–373
Word associate(s), 157

Zone of proximal development, 146