RESEARCH ARTICLES

The Use of Functional Assessment and Frequency Building Procedures to Increase Product Knowledge and Data Entry Skills Among Foremen in a Construction Organization

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ABSTRACT. A functional assessment procedure, which was designed to identify insufficient skills that may have been responsible for employee performance problems, was administered to four foremen employed in a large construction organization. Results of this assessment procedure identified two skill areas, product knowledge and data entry, as deficient. Based on these results, an intervention targeting these performance deficits was implemented. During intervention, instructional and measurement procedures based on Precision Teaching and designed to increase rates of accurate responding were employed. A pair of multiple baseline designs across participants was used to evaluate intervention effectiveness. The intervention resulted in improved skills among all participants. Results suggest that the methods used in this study are a cost-effective way of empirically identifying performance deficits and training skills in organizations. Implications for the field of Organizational Behavior Management are discussed and suggestions for future research are provided.

KEYWORDS. Frequency building, functional assessment, performance analysis, precision teaching, training

When consulting in organizational settings, behavior analysts are often charged with accurately and efficiently identifying a performance problem and its causes, and then intervening on that problem in a cost-effective manner. Unfortunately, the technology available for the identification of problem function in organizational behavior management (OBM) is not well developed (Austin, Carr, & Agnew, 1999). In addition, although research on intervention techniques such as feedback is more advanced, research on specific methods of employee training has received little attention in the OBM literature. Thus, the purpose of this study was twofold: (a) to take a step towards conducting a functional assessment of an employee skill deficit in an applied, organizational setting and (b) to investigate the effectiveness of building response frequencies when training necessary skills to employees of an

organization. The introduction begins with a review of functional assessment in organizations. Next, a brief description of the concepts necessary for understanding frequency building is provided. Finally, research demonstrating the effectiveness of frequency building is discussed, followed by a description of the present study.

FUNCTIONAL ASSESSMENT IN ORGANIZATIONS

Functional assessment refers to methods used to identify the variables maintaining behavior (Mace, Lalli, & Lalli, 1991). Although functional assessment methodologies have been widely used in clinical areas of behavior analysis (e.g., Derby et al., 1992; Iwata, Dorsey, Slifer, Bauman, & Richman, 1982/1994) there exists a need for assessment strategies that are directly related to the development and selection of effective interventions within OBM. Despite the impact functional assessment technology has had in clinical areas, maintaining variables are rarely assessed or reported in the OBM literature (Austin et al., 1999). Austin et al. suggest that the lack of functional assessment research in OBM is due to three variables. First, OBM interventions are generally successful despite practitioners' inattention to maintaining variables. Second, because much of organizational behavior is rule governed, problems involving the accurate measurement of maintaining variables arise. Finally, the fact that OBM practitioners are generally interested in increasing, rather than decreasing, the frequency and rate of behavior presents methodological as well as conceptual difficulties for the conduct of functional assessments in organizations. Austin et al. suggest that measuring all of the variables maintaining organizational performance is a potentially major endeavor requiring considerable resources and planning. They conclude by advising OBM researchers to approximate complete functional assessment by measuring only the areas planned for intervention, after formal hypothesis generation.

Despite the aforementioned difficulties, in recent years there have been some organizational studies in which a form of pre-intervention

functional assessment was employed. Austin and LaFleur (1998) combined Gilbert's troubleshooting algorithm and Austin's performance diagnostic model (2000) to assess and subsequently improve the performance of a chimney service business. Austin and Warden (1998) used an interview method of assessment to determine an intervention to improve timeliness in a restaurant. Austin, Olson, and Wellisley (2001) used Gilbert's (1978/1996) Behavior Engineering Model to analyze and improve customer service at an insurance agency. Rohn, Austin, and Lutrey (2002) used a functional assessment to identify the reasons for recurring cash shortages in a retail store. Based on their assessment, an intervention package consisting of performance feedback and accountability was used to decrease cash shortages. Pampino, Heering, Wilder, Barton, and Burson (2003) used Austin's Performance Diagnostic Checklist (PDC) to identify insufficient antecedents and consequences as areas in need of intervention in a coffee shop. Based on the results of the PDC, task clarification, checklists for each shift (three per day) and a lottery were implemented to increase employees' completion of maintenance tasks. Finally, Pampino, MacDonald, Mullin, and Wilder (2003) used the PDC to assess performance problems in a retail framing and art store. They then used performance feedback to increase completion of store responsibilities by employees.

Although reports of the use of functional assessment procedures in organizational settings have increased in recent years, these studies have utilized informant or interview-based methods of assessment. While convenient, informant methods depend upon the employee's self-report of the performance problem itself and the context in which it occurs. Other methods of functional assessment, such as descriptive assessment, in which data are obtained via direct observation of the problem and the context in which it naturally occurs, and functional or experimental analysis, in which data are obtained via actual manipulation of variables hypothesized to maintain behavior, have not yet been reported in the OBM literature. One purpose of the present study was to design and utilize a non-informant-based functional assessment procedure to identify the cause of a performance deficit in an organizational setting.

Frequency Building as a Method of Training in OBM

According to the 2002 State of the Industry Report from the American Society for Training and Development (ASTD), companies are spending more on employee training, including outside training providers. ASTD's data show that despite a recent economic downturn, organizations are continuing to invest in employee training, and expect their expenditures to increase in the future. Investments in education and training are rapidly increasing, and the returns on these investments can be linked to overall business strategy and success.

Traditional approaches to product knowledge and other skill training (e.g., lectures, seminars, computer and internet courses) are widespread. Typically, these techniques do not require performance at a fluent level (mastery based on speed plus accuracy). In a discussion of research from several different fields, Binder and Bloom (1989) state that research findings suggest that in order to achieve true mastery, learners must have sufficient opportunities for practice, a component of the learning process that is sadly lacking in most training and educational programs. True mastery or fluent performance is the combination of accuracy plus speed of responding that characterizes competent performance (Binder, 1996). Increasing the frequency of one or more component skills contributes to fluent performance of composite, or combined, skills. Procedures designed to build or increase frequencies focus on the rate of performance or count in time, not simply count alone. Unfortunately, empirical literature on fluency or frequency building for employee training purposes is extremely limited.

Fluency and Frequency. Fluency is the ability to perform quickly, accurately, and without hesitation (Binder, 1996). Training to fluency ensures the mastery of basic foundational skills on which higher order skills can be based, making more advanced work easier rather than harder. Basic foundational skills are most commonly improved upon by increasing the accuracy and frequency of the desired response. Published and unpublished research has demonstrated that when desired frequencies of accurate performance are achieved, learners seem to retain and maintain what they have learned, remain on-task in the face of

distraction, and generalize those performances to new situations (Binder, 1996).

Bucklin, Dickinson, and Brethower (2000) demonstrated that fluency training, when compared to accuracy training, led to higher response rates and better performance on retention tests. In their study, 30 undergraduate students were randomly assigned to one of two groups. The accuracy-only group was required to achieve 100% correct performance (traditional mastery). The fluency-training group was required to achieve 100% correct performance and increase the frequency with which they responded at accurate levels (fluency). Participants learned associations between Hebrew symbols and nonsense syllables and between nonsense syllables and Arabic numerals. A group design was used to evaluate the teaching of the component skills (arbitrary associations) and measurement of composite skill performance (application). The associations between Hebrew symbols and Arabic numerals were not directly trained. Results showed that fluency training on component skills aided the acquisition of a composite skill and improved the retention of accuracy for both the composite and component skills.

Performance Aims. Haughton (1972) discusses the importance of time as a fundamental component of measuring the processes of change in a given curriculum. He states that in order to measure changes that indicate learning we must state a goal. Performance aims, stated in the form of frequency ranges (e.g., 100-120 per minute correct), are the precise and specific objectives of an overall goal. Determining and reaching proper performance aims guarantees a learner's proficient performance before advancing to the next stage of the curriculum. A common approach to estimating an aim range is to: (a) measure the behavior of a group of skilled individuals, and (b) use the rates of their response as a reference when setting the aim range. Another method of establishing an aim is to determine performance standards at levels that would ensure retention, endurance (attention to task in the face of distraction), and application (Haughton, 1980).

Learning Channels. The combined use of frequency building procedures, performance aims, and the philosophical position that the learner is always correct is often referred to as precision teaching (PT). Precision teachers use the concept of learning channels to describe stimuli (inputs) and responses (outputs). For example, seeing a stimulus (the input) and then writing a description of the stimulus seen (the response) would be described as the "See/Do" or "See/Write" learning channel.

Applications of Frequency Building Procedures

Although few in number, those studies that have evaluated frequency building techniques have shown impressive results (e.g., see Beck & Clement, 1991; Bell, Young, Salzberg, & West, 1991; Beneke, 1991; Thomas, 1993). As previously mentioned, the documentation of fluency in organizations is even more limited. Binder and Bloom (1989) described the use of fluency training to develop a product knowledge program for commercial bankers. Data were collected at two locations. A 4-minute timed multiple-choice, pre-test and post-test was administered to measure the results and participants were required to quickly match product definitions, customer needs, and features to product names. Methods to achieve fluency included brief and efficient timed practice of activities such as a three-step process of using Fluency Cards to acquire the facts, verbal recall exercises, and brief presentations. The results indicated improved accuracy and speed of responding for employees at both banks. Binder and Bloom suggest that the importance of the intervention lies in the participants' ability to respond quickly and accurately to customers' needs and concerns. Before achieving fluency, salespersons were responding in 10 to 11 seconds, while after fluency training salespersons were able to respond in about 3 to 4 seconds, thus possibly decreasing the likelihood of lost sales opportunities.

Binder and Sweeney (2002) describe a case study in which fluency training was applied to sales and customer service agents in a large wireless cell phone company. After determining what information the employees needed to know to effectively serve customers, the information was delivered using fluency-based techniques. After the workshop, average calls per hour by employees increased by 60%. Although no experimental design was employed, these data are suggestive of the large

benefits that can be obtained with fluency-based procedures in organizations.

The Present Study

The OBM literature lacks the demonstration of non-informant based functional assessment procedures that have proven to be useful in other areas of applied behavior analysis. In addition, building response frequencies has been shown to be very effective across a variety of skills and populations. However, although anecdotal description of the effect of fluency building technology with bank employees suggests that these techniques are useful as a method of training in organizational settings, the application of these techniques to skills training in organizations has yet to be empirically documented. Thus, the purpose of this study was (a) to conduct a non-informant based assessment of an employee skill deficit in an organizational setting and use the information obtained from the functional assessment to increase the identified performance deficits and (b) to investigate the effectiveness of building response frequencies when training necessary skills to employees of an organization.

METHOD

Setting

A large construction company located in the western United States served as the organizational setting for this study. The company's main activity was general construction site preparation for residential subdivisions and commercial developments. The company employed over 1,000 people during the construction season. The first author assisted in identifying possible areas of skill deficit while attending management meetings as a consultant. Sessions were conducted in the cabs of participants' trucks at job sites.

Participants

Number of PPTs, Sex, and Age Range. Company foremen were assigned to one of four departments within the organization. Participants were selected from a pool of nine employees working as foremen in the underground department. The underground department was the largest of the four departments and was considered the most crucial to project completion. Foremen were required to complete a daily *foreman diary* for each job that they supervised. Foremen diaries were daily records of job-specific productivity and were completed in a Microsoft Excel™ spreadsheet format. Foremen were required to keep track of the daily job site functions with the use of standard 4-digit operation codes. All work that could be completed within the organization had a distinct 4-digit operation code. Twenty-four of these 4-digit codes were used in this study. Management noted that they were having problems with the foremen's use of these codes. Foremen errors on the codes were frequent, and since each job was funded according to the 4-digit code, revenue may have been lost due to these errors. Subsequent follow-up interviews with the management team and foremen identified this as the target performance problem. Four of the nine foremen from the underground department were selected as participants based on the location of their job sites.

Functional Assessment

Following participant selection and before the start of baseline data collection, three assessments were administered to each participant in an attempt to identify the reason for the occurrence of the errors made in the foremen diaries. Three hypotheses about possible causes of the errors were developed. These three hypotheses were that errors could be due to (a) inaccurate remembering of 4-digit operation codes (b) a deficit in locating and transferring 4-digit codes into the spreadsheet and (c) inaccurate typing of code numbers into the spreadsheet. Each assessment was designed to examine one of these hypotheses. Frequency aims

for each of the three assessments were determined by (a) measuring the behaviors of a group of randomly chosen company office employees and non-employees (i.e., graduate students), and (b) using those rates of response as a reference for the participants' performance. One minute timings were used to measure the behaviors of the office employees and non-employees when establishing frequency aims. When participants (i.e., foremen) were administered assessments one and three (see below), 15-s timings were used. This was done so that timings with foremen would consume less of their time. In addition, some foremen claimed that 1 minute timings were "frustrating" and that 15-s timings were easier to complete. These 15-s timings were converted into a per minute count by multiplying the result of the timing by four. Each assessment consisted of one 15-s timing. Because of the relatively low frequencies involved in assessment number two, one minute timings were used with this assessment (thus, no conversion was necessary). The results of each assessment for each foreman participant were compared to the respective frequency aims.

The first assessment was designed to target See/Say 4-digit operation code descriptions. Demonstration of this skill required that the participant "See" the description on a flashcard and "Say" the corresponding 4-digit operation code. The pre-determined aim range was 25-40 correct 4-digit operation codes per min. Participants were given a list of operation code descriptions and asked to write as many corresponding 4-digit operation codes as possible (without access to the operation codes themselves) during a 15-s timing which was converted to a per minute count. The purpose of this assessment was to identify the extent to which the errors could be due to an inability to remember the 4-digit operation codes. Although all foremen carried with them a reference manual listing all of the 4-digit codes, most of the foremen reported that they did not use the manual because they had the most common codes "memorized."

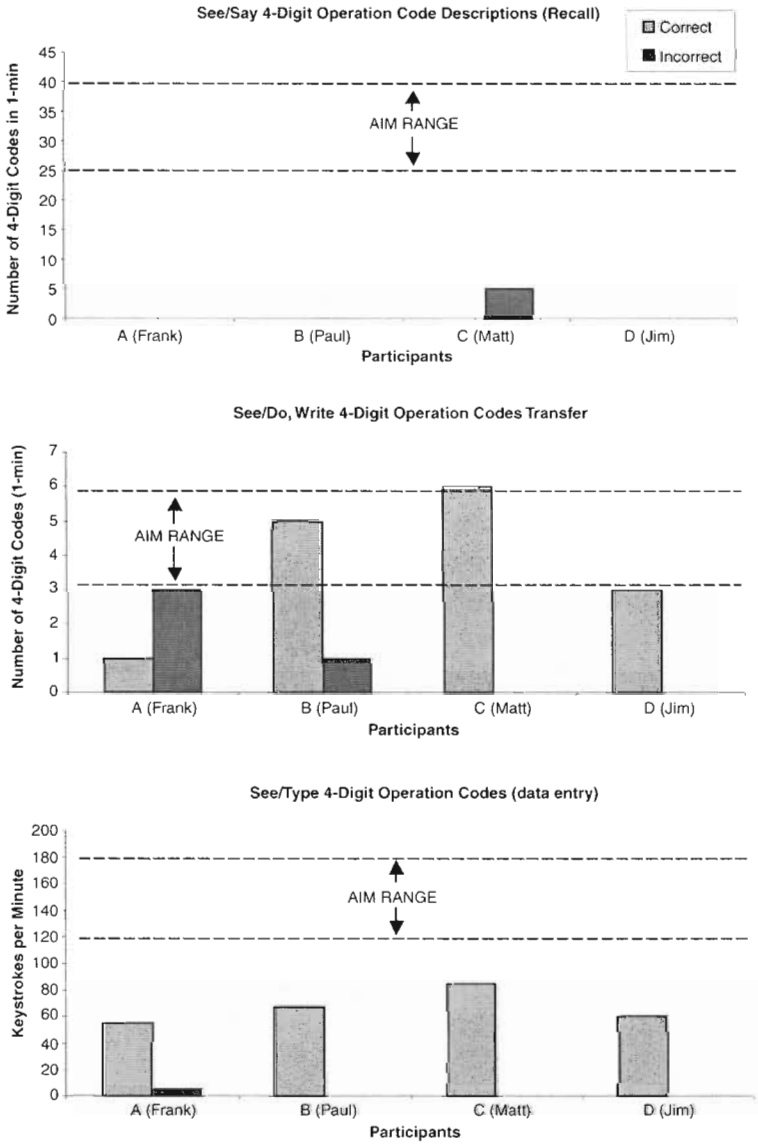
The second assessment (i.e., the See/Do assessment) was designed to assess the participants' ability to transfer information. The pre-determined aim range was 3-6 correct 4-digit operation codes per minute. Participants were given a list of operation code descriptions and asked to "look up" the 4-digit operation codes in a reference manual identical to the reference manual used on the job and then transfer the information to the test sheet during a one minute timing. The purpose of this assessment was to identify the extent to which errors could be due to an inability to locate and transfer numbers.

The final assessment was designed to assess the participants' See/Type 4-digit operation code (data entry) skills. The pre-determined aim range was 120-180 correct keystrokes per minute. Participants were given a list of 4-digit operation codes and asked to enter those operation codes in a spreadsheet formatted to simulate the foreman diary used on the job during a 15-s timing which was converted to a per minute count. The purpose of this assessment tool was to identify the extent to which errors could be due to an inability to correctly enter numbers into the spreadsheet using a laptop computer.

Intervention Evaluation

Dependent Variables. Based on the results of the functional assessment procedure, two dependent variables were identified and targeted during the intervention evaluation. These two dependent variables were designed to measure two component skills, See/Say 4-digit operation code descriptions and See/Type 4-digit operation codes (data entry). Participant performance on transferring 4-digit operation codes (i.e., the second assessment or See/Do assessment of the functional assessment) was adequate, as determined by comparing each participant's performance to the frequency aims (see Figure 1); therefore, this was not a dependent variable during the intervention evaluation. In addition to the two component skills, the performance of a composite skill, described below, was assessed. For each of the three skills, performance (i.e., number of correct and incorrect responses) was measured during 15-s timings and the data were converted to a per minute count. Again, 15-s timings were used because the foremen reported that these were easier and consumed less time. These 15-s timings were converted into a per minute count by multiplying the result of the timing by 4.

FIGURE 1. *(top panel)* Results of the Functional Assessment, See/Say 4-digit operation code descriptions, recall; *(middle panel)* Results of the Functional Assessment, See/Do, Write 4-digit operation codes, locate/transfer; *(bottom panel)* Results of the Functional Assessment, See/Type 4-digit operation codes, data entry.



Component Skill #1. An experimenter observed a 15-s timing and then entered the data into a worksheet which automatically calculated the per minute rate to measure the rate of correct and incorrect See/Say 4-digit operation code descriptions. Demonstration of this skill required that the participant "See" the description on a flashcard and "Say" the corresponding 4-digit operation code.

Component Skill #2. A computer spreadsheet was used to measure the rate of correct and incorrect keystrokes to assess the behavior of See/Type 4-digit operation codes (data entry). Demonstration of this skill required that the participant "See" the 4-digit operation code and "Type" that operation code into the Excel™ spreadsheet that was formatted to simulate the foreman diary used on the job. The correct and incorrect keystrokes were automatically recorded and summed by the computer spreadsheet through the use of a predetermined formula that was entered into the spreadsheet.

Composite Skill. A third dependent variable was also evaluated. The composite skill consisted of a combination of the two component skills. Participants were given a list of job descriptions and entered as many of the operation codes as possible into a formatted Excel™ spreadsheet. As with component skill #2 (See/Type 4-digit operation codes), the correct and incorrect keystrokes were automatically recorded and summed by the spreadsheet.

Independent Variable. Frequency building for both component skills consisted of several elements from PT used together in a "package treatment." Participants engaged in frequent learning sessions that were conducted 3-5 times per week. Within those learning sessions, participants engaged in frequent practice with an emphasis on attaining accurate responding (n = 3-6 trials), as well as frequent timed practice (i.e., rate per min) with an emphasis on attaining speed of responding in conjunction with accurate responding or fluency (n = 9-12 trials). In addition, a measurement (i.e., 15-s timings) of the participants' rate of responding was administered to provide a measure of the dependent variable and to provide performance-based feedback to the participants. The participants were also assisted in charting their rate of responding on a Standard Celeration Chart and with interpreting the chart. Goal setting relevant to

previous performance was used with the participants (e.g., "let's try to beat your last score of 20 correct responses"), and verbal feedback (e.g., "great job, you beat the goal by 5 responses") was provided to participants based on their performance. In addition, an error correction procedure was utilized. The error correction procedure consisted of: (a) modeling the problem and the correct answer, and (b) re-testing the participant. If a participant did not surpass their previous performance, he was told what his performance was and that he could "do better next time."

Experimental Design. Because four participants from the underground department participated, two multiple baseline designs across participants were used to evaluate the effectiveness of the intervention. One design was used to evaluate See/Say 4-digit operation code descriptions and one was used to evaluate See/Type 4-digit operation codes (i.e., data entry). The order in which the component skills were taught was counterbalanced to control for any sequence effects on the composite skill (i.e., See/Say then See/Type for Participants A and C, See/Type then See/Say for Participants B and D). In addition, a pre-test (i.e., before teaching component Skill 1), mid-test (i.e., after teaching component Skill 1), and post-test (i.e., after teaching both component skills) was administered to measure and evaluate the combination of the component skills (i.e., the composite skill).

Intervention Evaluation Procedure

Composite skill pre-test (See Dependent Variables section for more detail). Before baseline sessions, a 15-s timing of the composite skill was administered to participants.

Baseline. During baseline, the two skills were taught to participants in a counterbalanced fashion. During phase 1, individual baseline sessions, consisting of three to seven 15-s timings, were administered to Participants A and C for component skill #1 (See/Say 4-digit operation code descriptions) and to Participants B and D for component skill #2 (See/Type 4-digit operation codes [data entry]). During phase 2, which followed the completion of phase 1 (i.e., baseline, intervention, and the

composite skill mid-test for the respective skill), another set of individual baseline sessions, again consisting of three to seven 15-s timings, were administered to Participants A and C for component skill #2 and to Participants B and D for component skill #1.

As indicated in the Dependent Variables section, for component skill #1, participants were shown flashcards with job descriptions and said the corresponding 4-digit code. They were instructed to say as many codes as they could during the 15-s timings. The numbers of correct and incorrect digits were recorded on a data collection form by a research assistant immediately after the timing. For component skill #2, participants typed as many 4-digit operation codes as they could into an Excel™ spreadsheet during the 15-s timings. The numbers of correct and incorrect digits were recorded according to a formula in the Excel™ spreadsheet.

Intervention. As indicated above, the intervention consisted of 15-20 min learning sessions conducted 3-5 times per week. During the sessions, participants practiced the relevant skill (i.e., saying the 4-digit codes when shown the job descriptions or typing the code into an Excel™ spreadsheet when shown the job descriptions). Within the session, emphasis was placed on accuracy for the initial trials (n = 3-6 trials) and then on speed of responding in conjunction with accuracy for the remaining trials (n = 9-12 trials).

At the end of each learning session, each participant completed one 15-s timing and the results were graphed on a daily per minute Standard Celeration Chart (SCC). The experimenter assisted the participants in graphing their performance and interpreting the SCC. The celeration (rate of learning) was monitored for each participant's performance during intervention and the intervention continued until the participants reached the aim range. Participants were considered fluent when they reached a criterion of four consecutive timings within the pre-specified aim range. As indicated in the Functional Assessment section above, the fluency aim range for See/Say 4-digit operation code descriptions (component skill #1) was 25-40 correct digits per minute. The fluency aim range for See/Type 4-digit operation codes (data entry) (component skill #2) was 120-180 correct keystrokes per minute, except for Participant

B (Paul), whose aim was set at 140-180 correct keystrokes per minute because his baseline performance was fairly high.

Composite Skill Mid-Test and Post-Test. After the intervention was completed for the first skill in Phase 1, a 15-s timing of the composite skill was again administered to participants. This mid-test served as a post-test for the first skill that was targeted and as a pre-test for the second skill that was targeted. After the intervention was completed for the second skill in Phase 2, another 15-s timing of the composite skill served as the post-test.

Interobserver Agreement

An independent observer recorded Interobserver Agreement (IOA) data on each participant's rate of correct and incorrect responses during the 15-s timings. This was done via audiotape for skill #1 (because participants were verbalizing codes) and by counting the number of correctly typed codes for skill #2. IOA data were calculated by dividing the number of agreements by the number of agreements plus disagreements and multiplying by 100%. IOA was obtained for 30% of all sessions conducted and agreement averaged 100% for all participants.

Independent Variable Integrity

An independent observer, trained by the experimenter, conducted independent variable integrity checks during 31% of sessions. The independent observer recorded the number of times the experimenter (a) used goal setting prior to the 15-s timing, (b) used an error correction procedure for incorrect responses after the 15-s timing, and (c) used the Standard Celeration Chart to record the participants' performance following the 15-s timing. Independent variable integrity was calculated by dividing the number of times each of these three procedures was implemented by the number of times that each of the three procedures should have been implemented and multiplying by 100%. The mean independent variable integrity value for all three measures was 100% for all participants.

RESULTS

Functional Assessment

See/Say 4-Digit Operation Code Descriptions. The top panel of Figure 1 displays the results for Participants A, B, C, and D. Correct responses ranged from 0 to 0 with a mean of 0 and incorrect responses ranged from 0 to 5 with a mean of 1.25. Based on participant performance on this assessment, this skill became a focus of the intervention evaluation.

See/Do, Write 4-Digit Operation Code Descriptions, Locate/Transfer. The middle panel of Figure 1 displays the results for Participants A, B, C, and D. Correct responses ranged from 1 to 6 with a mean of 3.8. Although Participant A did not perform well on this assessment, the mean of all four participants was above the performance aim (3 per minute), so this skill did not become a focus of the intervention evaluation.

See/Type 4-Digit Operation Codes, Data Entry. The bottom panel of Figure 1 displays the results for Participants A, B, C, and D. Correct responses ranged from 44 to 85 with a mean of 65 and incorrect responses ranged from 0 to 5 with a mean of 2. Based on participant performance on this assessment, this skill became a focus of the intervention evaluation.

Intervention Evaluation

Phase 1: See/Say 4-Digit Operation Code Descriptions (Component Skill #1). All sessions administered for component skill #1 measured the number of correct and incorrect responses recorded during 15-s timings and were converted to a per minute count.

The top panel of Figure 2 displays the results for Participant A (Frank). During baseline sessions, correct responses ranged from 0 to 0 with a mean of 0 (SD = 0.0) and incorrect responses ranged from 16 to 20 with a mean of 17 (SD = 2.3). During intervention sessions, correct responses ranged from 20 to 32 with a mean of 25 (SD = 4.4) and incorrect responses ranged from 0 to 4 with a mean of 2.2 (SD = 2.1).

The bottom panel of Figure 2 displays the results for Participant C (Matt). During baseline sessions, correct responses ranged from 0 to 0 with a mean of 0 (SD = 0.0) and the incorrect responses ranged from 24 to 80 with a mean of 44 (SD = 19.3). During intervention sessions, correct responses ranged from 20 to 32 with a mean of 27 (SD = 5.5) and incorrect responses ranged from 0 to 4 with a mean of 1.1 (SD = 2.0).

Phase 1: See/Type 4-Digit Operation Codes, Data Entry (Component Skill #2). All sessions administered for component skill #2 measured the number of correct and incorrect keystrokes recorded during 15-s timings and were converted to a per minute count.

The top panel of Figure 3 displays the results for Participant B (Paul). During baseline sessions, correct keystrokes ranged from 96 to 112 with a mean of 104 (SD = 8.0) and incorrect keystrokes ranged from 0 to 0 with a mean of 0 (SD = 0.0). During intervention sessions, correct keystrokes ranged from 104 to 164 with a mean of 140 (SD = 16.9) and incorrect keystrokes ranged from 0 to 8 with a mean of 0.5 (SD = 2.1).

The bottom panel of Figure 3 displays the results for Participant D (Jim). During baseline sessions, correct keystrokes ranged from 76 to 92 with a mean of 84 (SD = 6.5) and incorrect keystrokes ranged from 0 to 8 with a mean of 1.1 (SD = 3.0). During intervention sessions, correct keystrokes ranged from 84 to 136 with a mean of 108 (SD = 18.7) and incorrect keystrokes ranged from 0 to 4 with a mean of 1.3 (SD = 2.0).

Phase 2: See/Say 4-Digit Operation Code Descriptions, Recall (Component Skill #1). The top panel of Figure 4 displays the results for Participant B (Paul). During baseline sessions, correct responses ranged from 0 to 4 with a mean of 1 (SD = 2.0) and incorrect responses ranged from 16 to 24 with a mean of 20 (SD = 3.3). During intervention sessions, correct responses ranged from 8 to 28 with a mean of 23 (SD =

FIGURE 2. Results of Phase 1: See/Say 4-digit operation code descriptions (component skill #1). The top panel displays the number of correct and incorrect responses per minute for Participant A (Frank). The bottom panel displays the number of correct and incorrect responses for Participant C (Matt).

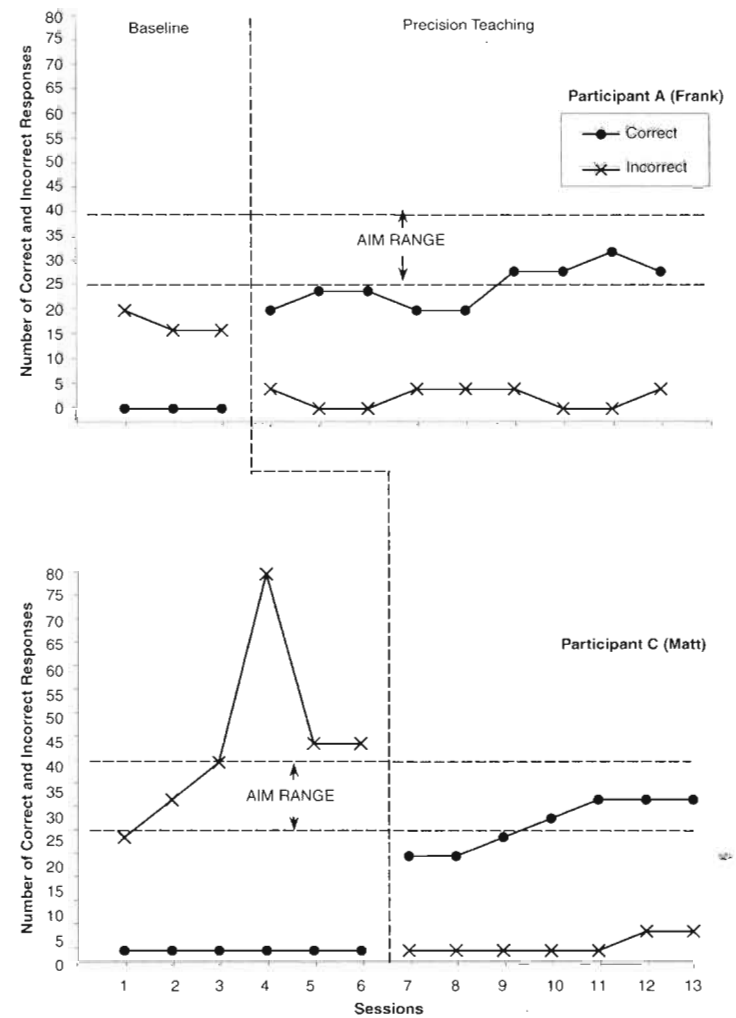
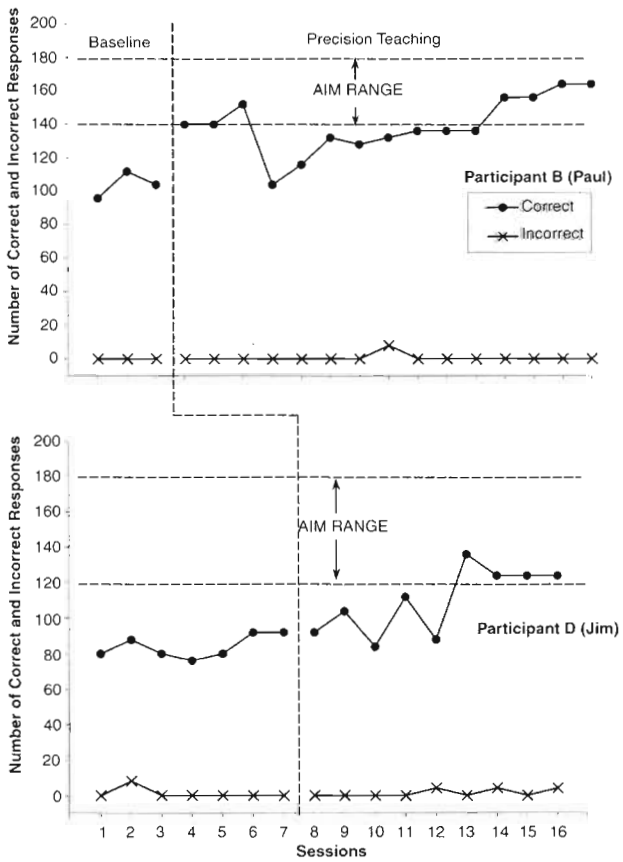


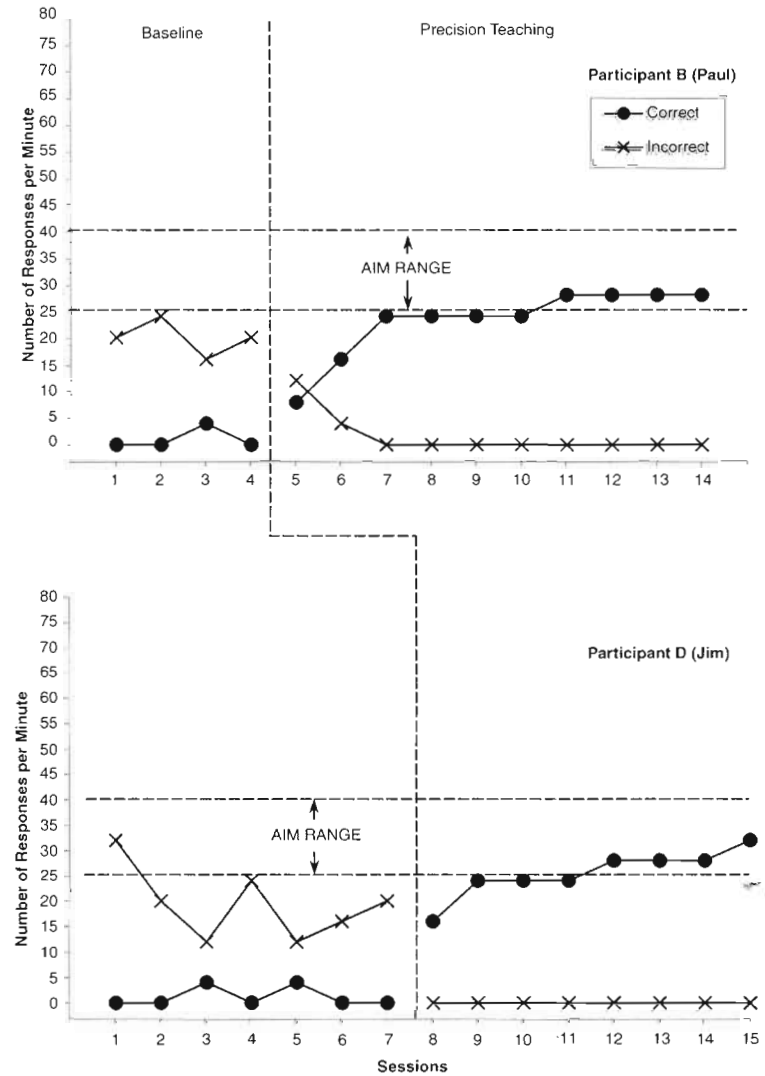
FIGURE 3. Results of Phase 1: See/Type 4-digit operation codes, data entry (component skill #2). The top panel displays the number of correct and incorrect keystrokes per minute for Participant B (Paul). The bottom panel displays the number of correct and incorrect keystrokes for Participant D (Jim).



6.5) and incorrect responses ranged from 0 to 12 with a mean of 1.6 (SD = 3.9).

The bottom panel of Figure 4 displays the results for Participant D (Jim). During baseline sessions, correct responses ranged from 0 to 4 with a mean of 1.1 (SD = 2.0) and incorrect responses ranged from 12 to 32 with a mean of 19 (SD = 7.1). During intervention sessions, correct

FIGURE 4. Results of Phase 2: See/Say 4-digit operation code descriptions (component skill #1). The top panel displays the number of correct and incorrect responses per minute for Participant B (Paul). The bottom panel displays the number of correct and incorrect responses for Participant D (Jim).



responses ranged from 16 to 32 with a mean of 26 (SD = 4.8) and incorrect responses ranged from 0 to 0 with a mean of 0 (SD = 0.0).

Phase 2: See/Type 4-Digit Operation Codes, Data Entry (Component Skill #2). The top panel of Figure 5 displays the results for Participant A (Frank). During baseline sessions, correct keystrokes ranged from 76 to 76 with a mean of 76 (SD = 0.0) and incorrect keystrokes ranged from 0 to 4 with a mean of 1.3 (SD = 2.3). During intervention sessions, correct keystrokes ranged from 88 to 112 with a mean of 100 (SD = 17.0) and incorrect keystrokes ranged from 0 to 4 with a mean of 2 (SD = 2.8). Participant A (Frank) withdrew from the intervention after two learning sessions due to job requirements.

The bottom panel of Figure 5 displays the results for Participant C (Matt). During baseline sessions, correct keystrokes ranged from 40 to 76 with a mean of 55 (SD = 12.0) and incorrect keystrokes ranged from 0 to 8 with a mean of 3.3 (SD = 3.9). During intervention sessions, correct keystrokes ranged from 116 to 128 with a mean of 125 (SD = 5.2) and incorrect keystrokes ranged from 0 to 4 with a mean of 0.8 (SD = 1.8).

Standard Celeration Charts. Figures 6 and 7 display the results of the functional assessment, the pre-test, phase 1 (See/Say 4-digit operation codes [recall]), the mid-test, phase 2 (See/Type 4-digit operation codes [data entry]), and the post-test on the Standard Celeration Chart for Participants A (Frank) and C (Matt), respectively.

Standard Celeration Charts. Figures 8 and 9 display the results of the functional assessment, the pre-test, phase 1 (See/Type 4-digit operation codes [data entry]), the mid-test, phase 2 (See/Say 4-digit operation codes [recall]), and the post-test on the Standard Celeration Chart for Participants B (Paul) and D (Jim), respectively.

Composite Skill

The composite skill was measured before Phase 1, repeated before Phase 2, and then measured again immediately following the completion of Phase 2 for each participant. The top panel of Figure 10 displays the pre-test, mid-test, and post-test scores for Participants A (Frank) and

FIGURE 5. Results of Phase 2: See/Type 4-digit operation codes, data entry (component skill #2). The top panel displays the number of correct and incorrect keystrokes per minute for Participant A (Frank). The bottom panel displays the number of correct and incorrect keystrokes for Participant C (Matt).

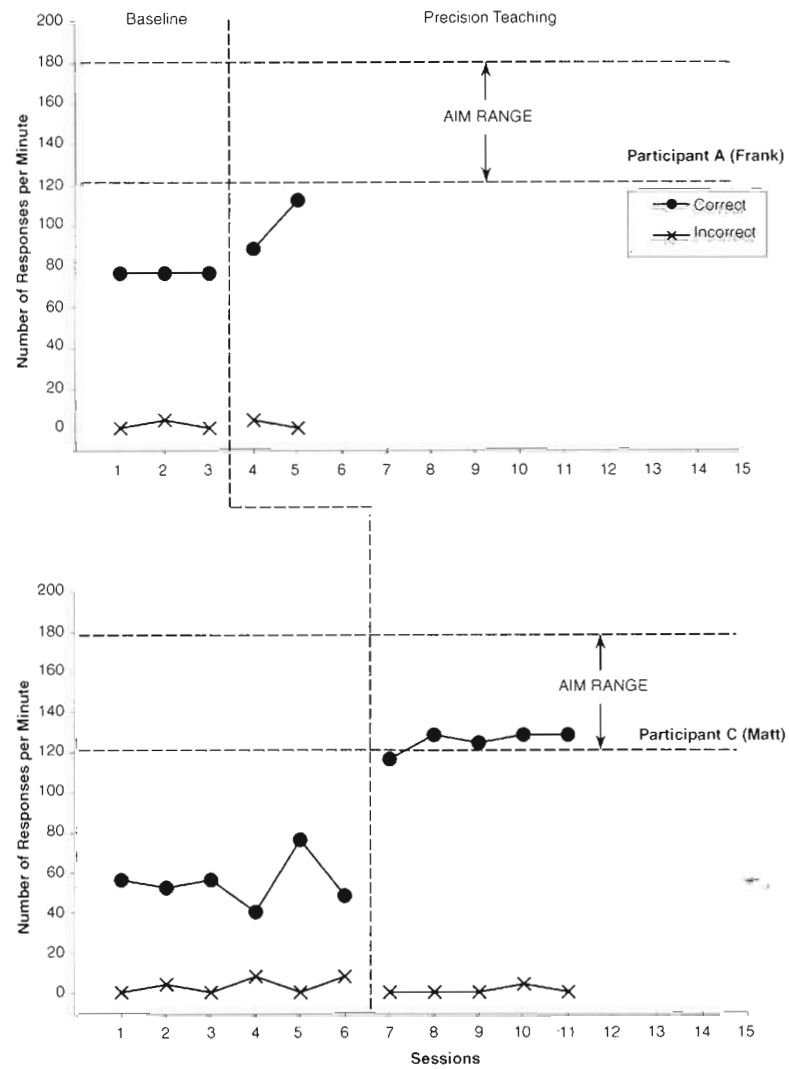


FIGURE 6. Results in the Standard Celeration Chart Format. Display of the functional assessment, the pre-test, phase 1 (See/Say 4-digit operation codes, recall), the mid-test, phase 2 (See/Type 4-digit operation codes, data entry), and the post-test for Participant A (Frank).

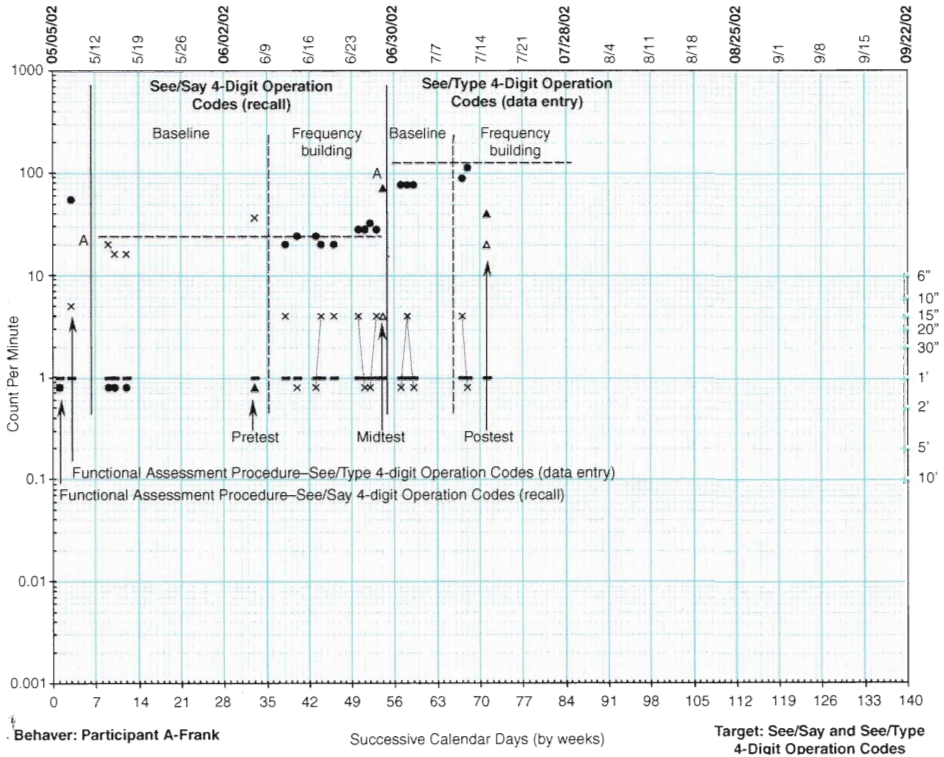


FIGURE 7. Results in the Standard Celeration Chart Format. Display of the functional assessment, the pre-test, phase 1 (See/Say 4-digit operation codes, recall), the mid-test, phase 2 (See/Type 4-digit operation codes, data entry), and the post-test for Participant C (Matt).

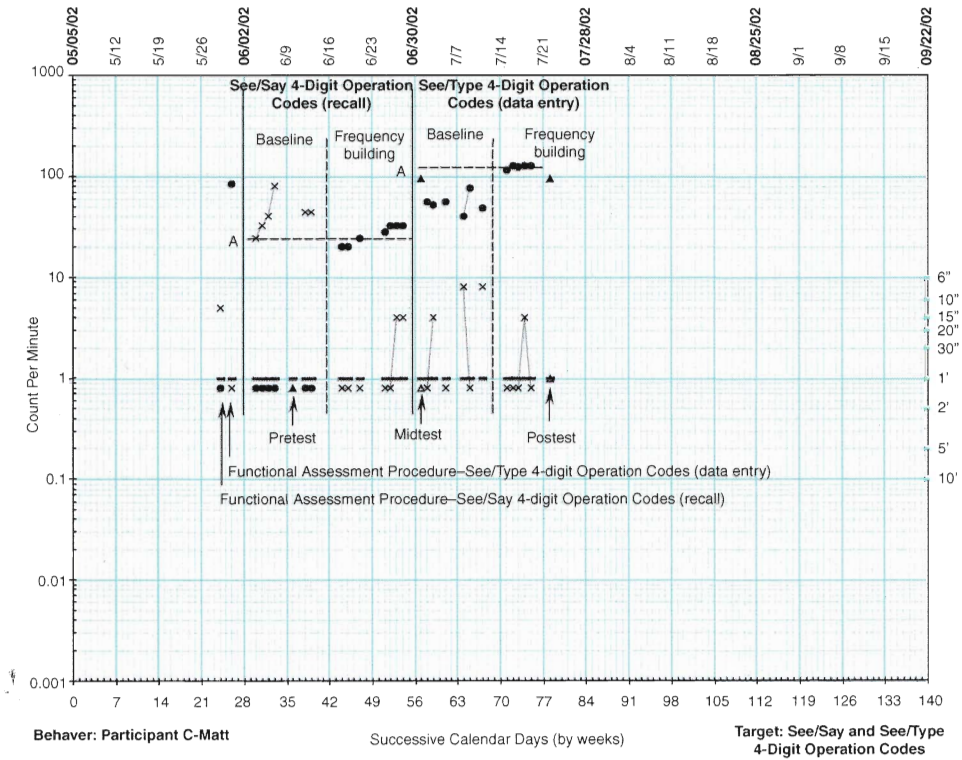


FIGURE 8. Results in the Standard Celeration Chart Format. Display of the functional assessment, the pre-test, phase 1 (See/Type 4-digit operation codes, data entry), the mid-test, phase 2 (See/Say 4-digit operation codes, recall), and the post-test for Participant B (Paul).

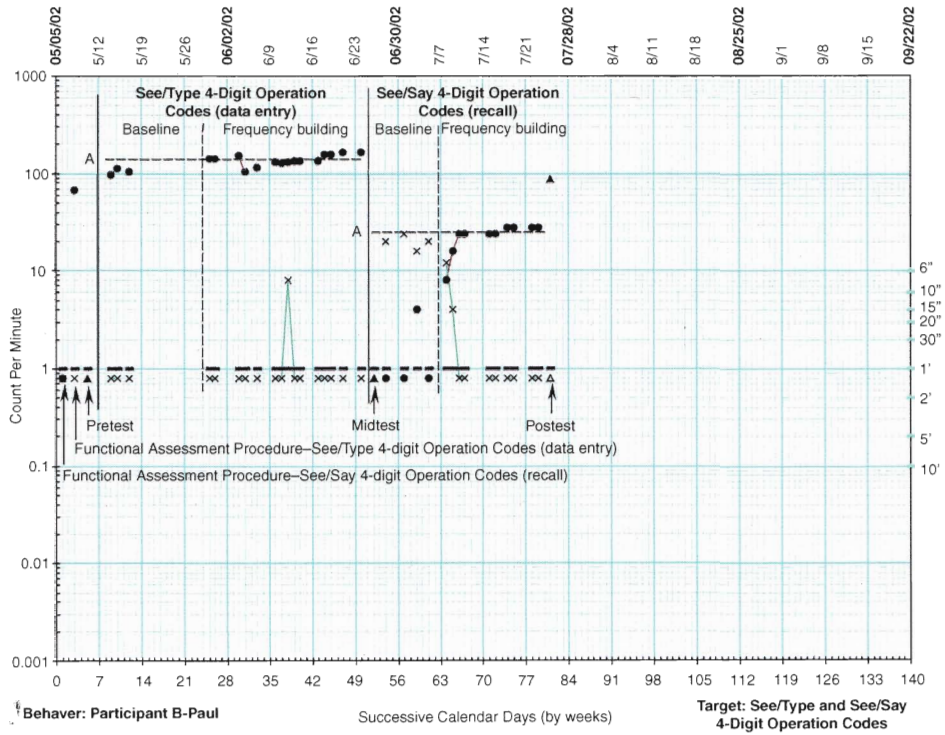


FIGURE 9. Results in the Standard Celeration Chart Format. Display of the functional assessment, the pre-test, phase 1 (See/Type 4-digit operation codes, data entry), the mid-test, phase 2 (See/Say 4-digit operation codes, recall), and the post-test for Participant D (Jim).

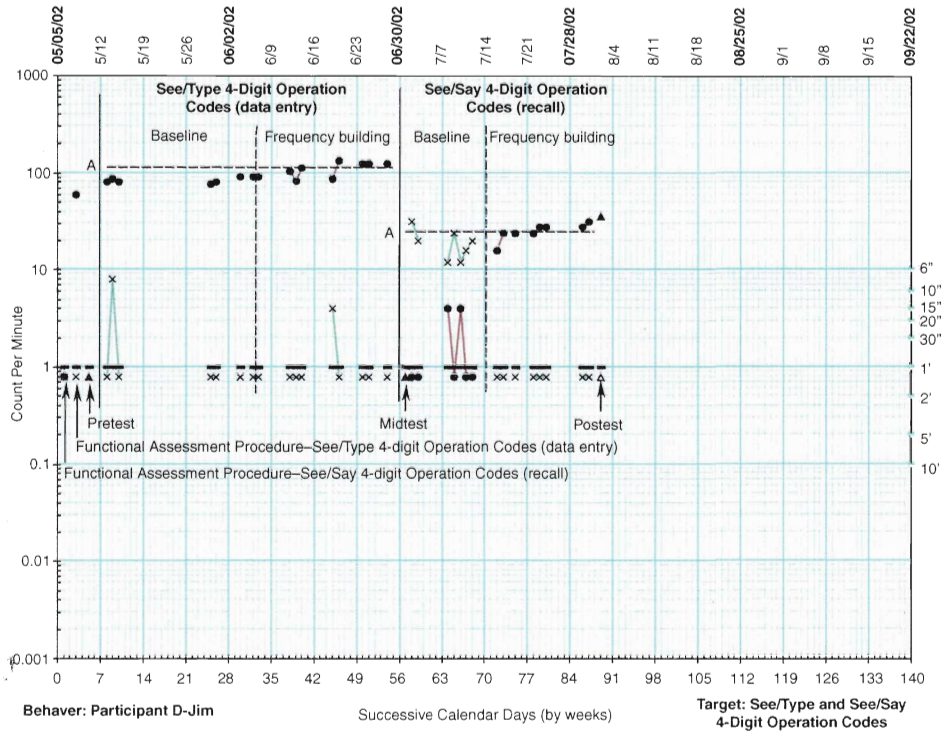
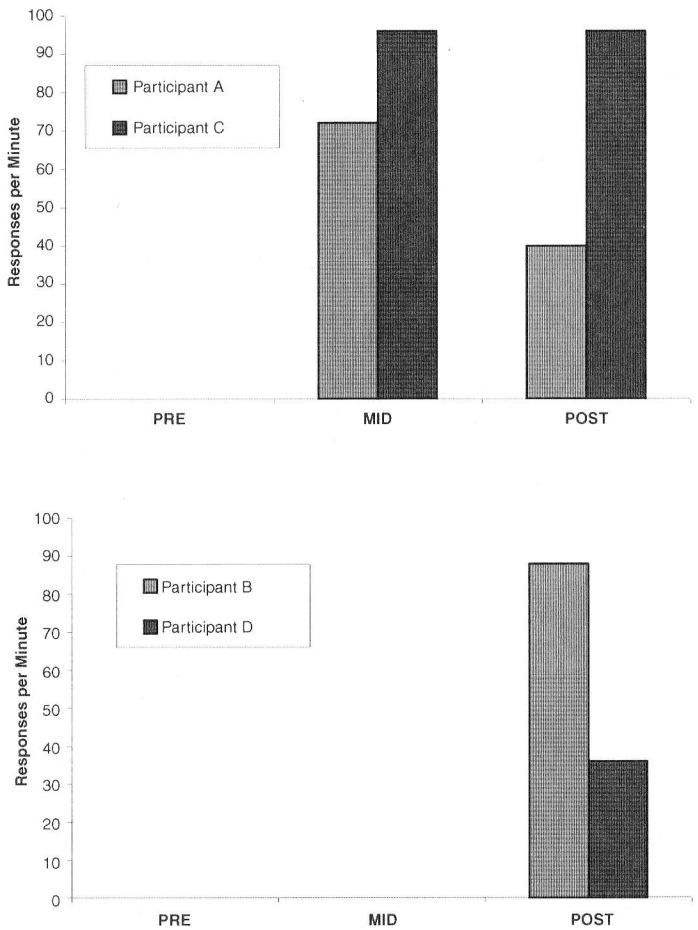


FIGURE 10. Results of the pre/mid/post-test (composite skill measure). The top panel displays the results of the pre-test, mid-test, and post-test for Participants A (Frank) and C (Matt). The bottom panel displays the results of the pre-test, mid-test, and post-test for Participants B (Paul) and D (Jim).



C (Matt). These participants received training on component skill #1 (See/Say 4-digit operation code descriptions [recall]) prior to receiving training on component skill #2 (See/Type 4-digit operation codes [data entry]). Participant A's (Frank's) scores for the pre-test, mid-test, and post-tests were 0, 72, and 40 keystrokes per minute, respectively. Participant C's (Matt's) respective scores were 0, 96, and 96 keystrokes per minute.

The bottom panel of Figure 10 displays the pre-test, mid-test, and post-test scores for Participants B (Paul) and D (Jim). These participants received training on component skill #2 (See/Type 4-digit operation codes, data entry) prior to receiving training on component skill #1 (See/Say 4-digit operation code descriptions, recall). Participant B's (Paul's) scores for the pre-test, mid-test, and post-tests were 0, 0, and 88 keystrokes per minute, respectively. Participant D's (Jim's) respective scores were 0, 0, and 36 keystrokes per minute.

DISCUSSION

The purpose of this study was to (a) conduct a non informant-based assessment of an employee skill deficit in an organizational setting, and (b) to investigate the effectiveness of building response frequencies when training necessary skills to employees of an organization. The results of the three functional assessment procedures revealed two areas of insufficient skill, See/Say 4-digit operation code descriptions (recall) and See/Type 4-digit operation codes (data entry) skills. These two skills served as the focus of the intervention. The third assessment procedure, which tested the participants' ability to transfer information from a reference manual using the *See/Do, Write* learning channel yielded performances that were close to or within the aim range for three out of four participants. Thus, this skill did not warrant attention during the intervention evaluation.

The functional assessment procedure used in the current study proved to be a useful method of determining the variables that contribute to a performance problem in an organization. Unlike informant methods of assessment, this assessment technique relied on actual employee performance, as opposed to a self-report of performance difficulties, to determine what to focus on during intervention. Although conducting a functional assessment in an organization may require extra time and en-

ergy, we believe that it may insure a more focused intervention, as opposed to a broad training approach that might overlook necessary, or train unnecessary, skills.

It should be noted that the assessment conducted in the current study may not be considered to be a "functional assessment" by some. That is, the term functional assessment, at least as it has been used in the clinical behavior analytic literature, refers to procedures which identify variables maintaining behavior. In the current study, the assessment procedure that was employed was used to identify skills in need of improvement. Thus, a better term for the assessment procedure employed might be "performance analysis." On the other hand, some may argue that a skill deficit is a variable that may be responsible for the occurrence or lack of occurrence of a socially significant behavior, and therefore the use of the term "functional assessment" is appropriate. We chose to use the term "functional assessment" because it has been used previously in the OBM literature, but recognize that "performance analysis" may be preferred by some in the field.

The intervention evaluation employed methods based on PT to train specific skills to foremen. The data suggest that these methods are an effective method of teaching information to employees of an organization. The intervention was also efficient; each phase was completed in 12-18 learning sessions lasting no more than 20 minutes each. The mean amount of time necessary to complete the intervention (i.e., 12-18 learning sessions) was 2 hours.

Participant C (Matt) experienced a sharp increase in performance at the start of intervention for both phases of the study. The remaining participants experienced a sharp or modest increase in performance at the start of intervention for at least one of the two phases of the study. These sharp increases can be attributed to the fact that the dependent variable measure was administered after the learning sessions were completed.

According to the Composite skill tests (pre-test/mid-test/post-test), training See/Say 4-digit operation codes, recall (component skill #1) before See/Type 4-digit operation codes, data entry (component skill #2) had a substantial effect on the performances of the participants that received the training in that order (i.e., Participants A and C). Training

See/Type 4-digit operation codes, data entry (component skill #2) before See/Say 4-digit operation codes, recall (component skill #1) had little or no effect on the performances of the participants that received the training in that order (i.e., Participants B and D). Although all participants except Participant A (Frank) became fluent in keystrokes per minute during learning sessions according to the performance aim, the nature of component skill #1 most likely required 2-3 private operations (i.e., perhaps rehearsing and recall) before emitting a response. This could have slowed the participants' typing performance.

This study makes a number of contributions to the OBM literature. First, although functional assessment methodologies have been widely used in clinical areas, there exists a need for assessment strategies that are directly related to the development and selection of effective interventions within organizational behavior management. This study employed a functional assessment procedure which involved direct observation of performance to help select and develop the intervention.

The second major contribution of this study was the use of PT methods in an organizational setting. There are few published studies of this nature. This study further extends the PT and OBM literature by effectively using components of PT with fluency-based training to improve the skills and knowledge of organizational employees. Demonstrating the effectiveness of PT with fluency-based training for skills and knowledge training is an important step in exploring the potential impact of these techniques on the business world. However, it should be noted that no comparison with non-PT training was made, so the value of PT relative to other methods of training in organizations is unclear.

The use of the Standard Celeration Chart (SCC) to graph performance is often a component of PT. In the current study, the SCC was used to graph performance and to provide feedback to the foreman. Thus, an additional contribution of this study is the use of the Standard Celeration Chart (SCC) in OBM. The SCC is a six-cycle, "semi-logarithmic" chart. The SCC covers a full range of human behavior frequencies–from one a day, to 1000 per minute and it has a multiply (logarithmic) scale up the left for frequencies–and an add (arithmetic) scale across the bottom for days of the week (Lindsley, 1997) (see Fig-

ures 6-9 for examples of SCCs). The SCC is a standard display of frequency as count per minute, count per week, count per month, or count per year. Frequency is displayed "up the left" of the chart (y-axis). Calendar time as days, weeks, months, or years is presented "across the bottom" of the chart (x-axis). What makes the chart standard is its display of celeration–which is a linear measure of behavior change across time. Celeration is the next derivative of frequency (rate of response) and is measured as a factor by which frequency multiplies or divides over the celeration period (Potts, Eshleman, & Cooper, 1993).

A third contribution of this study involves the level of the organization at which the intervention was applied. Although there have been several studies in the OBM literature that were conducted with the use of front-line or lower level employees as participants (e.g., Austin, Kessler, Riccobono, & Bailey, 1996; Jessup & Stahelski, 1999; Olson & Austin, 2001), few have used managerial level employees as participants. The participants in the current study were foremen or supervisors of front-line employees. In this particular organization, foremen are considered to be managerial level employees and thus assume more responsibilities than their subordinates.

Cost/Benefit Analysis

Currently, the company requires that all foremen (28) participate in in-house computer training to teach them how to enter, save, and manipulate the 4-digit codes that were the focus of this study. The duration of the training ranges from 2 to 6 hours with a mean of 4. During this training the foremen are paid their hourly wage of $33.92. In addition, the company provides all foremen with an 8-hour computer skills training session conducted by an outside training service. The fee for this service, paid for by the company, is $230 per foreman. The cost of training each foreman averages $365.68 (4 hours × $33.92 + $230.00). Currently, the total cost of training all foremen averages $10,239.04 ($365.68 × 28 foremen).

In the current study, the participants reached the desired aim range (fluency) within 5 to 10 sessions with a mean of 8. Each session was

15-20 min in duration. The mean amount of time necessary to complete the intervention was 2 hours. The total cost of training using the methods described in this study averaged $67.84 ($33.92 × 2 hours) per foreman or $1,899.52 total ($67.84 × 28 foremen, if all 28 had participated). Replacing the existing methods of training with the methods described in this study would save the company approximately $297.84 per foreman or $8,339.52 ($297.84 × 28 foremen) on monies paid for training costs.

Gilbert (1978/1996) proposed a variant for calculating the worth of an intervention: the worth of an intervention equals the value of the improvement produced by the intervention minus the cost of the intervention. The true value of the intervention must be discussed in terms of prevention. Prevention of errors involving 4-digit operation codes is extremely important to the effectiveness and efficiency of the pricing of future projects for this organization. All of the costs within a project have a 4-digit operation code to which they are assigned. The cumulative cost of completing future projects is based on the historical cost of similar completed projects. Therefore, any error involving the 4-digit operation codes can inflate or deflate the historical costs, which will produce an overestimation or underestimation of the company's financial ability to complete that project as well as future projects. Insuring the accuracy of the 4-digit operation codes on a daily basis is critical for the organization.

Limitations and Future Research

Due to the limited number of participants, replications across materials, subject matter, and organizations must be explored. Also, the limited and narrow scope of this study (twenty-four 4-digit operation codes) requires that future research focus on a wider range of applications within organizations.

A second limitation of the study is the measurement error that is likely introduced when 15-s timings are converted into responses per minute. As mentioned above, 15-s timings are often used for efficiency in precision teaching but are then reported as responses per minute. The con-

version process (i.e., multiplying responding by 4) introduces some error into the measurement process. Future research on frequency building procedures should directly employ one minute timings when measuring the dependent variable.

Another limitation concerns intervention Phase 2. Participant A (Frank) was forced to withdraw from the study after two intervention sessions due to the start of a new project that required all of his time during the workday. This incident further demonstrates the level of difficulty associated with conducting a study with managerial level employees. At the managerial level, employees have many competing responsibilities and time may be more limited.

Future research should focus on refining these, or identifying alternative, procedures so that skills training practitioners within organizations develop more cost-efficient and effective methodologies. More specifically, research on Precision Teaching and its components is needed in organizational settings. As previously mentioned, there are few published studies involving PT and its application to business settings.

The current study was conducted during the workday, on the job site, and in the cab of the participants' truck. This was done to reduce the response effort required of the participants by meeting them at their respective project sites. However, the participants were sometimes easily distracted and interrupted during learning sessions. Future research should be conducted in a more controlled setting providing less distraction and insuring full participation and concentration on behalf of the participants.

Although the current study involved a higher level of management than previous studies, further research is necessary with upper level or executive level personnel. During the course of the current study, after only a few learning sessions, several participants anecdotally observed 4-digit operation code errors in company documents that were made by their superiors. In other words, the superiors were providing incorrect information that would have been counted as errors had the foreman committed them.

REFERENCES

American Society for Training and Development (2002). State of the industry: ASTD's annual review of trends in employer-provided training in the United States [Electronic version]. Retrieved November 19, 2002 from *http://www.astd.org/virtualcommunity/research/pdf/2002sirexecutivesummary*

Austin, J. (2000). Performance analysis and performance diagnostics. In J. Austin & J. E. Carr (Eds.), *Handbook of applied behavior analysis* (pp. 321-349). Reno, NV: Context Press.

Austin, J., Carr, J. E., & Agnew, J. L. (1999). The need for assessment of maintaining variables in OBM. *Journal of Organizational Behavior Management, 19*(2), 59-87.

Austin, J., Kessler, M. L., Riccobono, J. E., & Bailey, J. S. (1996). Using feedback and reinforcement to improve the performance and safety of a roofing crew. *Journal of Organizational Behavior Management, 16*(1), 49-75.

Austin, J., & LaFleur, D. (1998, May). *Functional assessment in organizations: A case study*. Paper presented at the 24th Meeting of the Association for Applied Behavior Analysis, International, Orlando, FL.

Austin, J., Olson, R., & Wellisley, J. A. (2001). The behavior engineering model at work on a small scale: Using task clarification, self-monitoring, and public posting to improve customer service. *Performance Improvement Quarterly, 14*, 53-76.

Austin, J., & Warden, K. (1998, March). Using a function-based least-intrusive intervention to improve service behaviors in a restaurant setting. In J. Austin (Chair), *Improving the performance and safety of organizational members and consumers*. Symposium conducted at the 12th Annual Convention of the Behavior Analysis Association of Michigan, Ypsilanti, MI.

Beck, R., & Clement, R. (1991). The Great Falls precision teaching project: An historical examination. *Journal of Precision Teaching, 8*, 8-12.

Bell, K. E., Young, K. R., Salzberg, C. L., & West, R. P. (1991). High school driver education using peer tutors, direct instruction, and precision teaching. *Journal of Applied Behavior Analysis, 24*, 45-51.

Beneke, W. M. (1991). Precision teaching to enhance reading skills of introductory psychology students. *Journal of Precision Teaching, 8*, 37-43.

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

Binder, C., & Bloom, C. (1989). Fluent product knowledge: Application in the financial services industry. *Performance and Instruction, 28*, 17-21.

Binder, C., & Sweeney, L. (2002). Building fluent performance in a customer call center. *Performance Improvement, 41*, 29-37.

Bucklin, B. R., Dickinson, A. M., & Brethower, D. M. (2000). A comparison of the effects of fluency training and accuracy training on application and retention. *Performance Improvement Quarterly, 13*, 140-163.

Derby, K. M., Wacker, D. P., Sasso, G., Steege, M., Northrup, J., & Cigrand, K. (1992). Brief functional assessment techniques to evaluate aberrant behavior in an outpatient setting: A summary of 79 cases. *Journal of Applied Behavior Analysis, 25*, 713-721.

Gilbert, T. (1978, 1996). *Human competence: Engineering worthy performance*. Amherst, MA: HRD Press.

Haughton, E. (1972). Aims: Growing and sharing. In J. B. Jordan & L. S. Robbins (Eds.), *Let's try doing something else kind of thing* (pp. 20-39). Arlington, VA: Council on Exceptional Children.

Haughton, E. C. (1980). Practicing practices: Learning by activity. *Journal of Precision Teaching, 1*, 3-20

Iwata, B. A., Dorsey, M. F., Slifer, K. J., Bauman, K. E., & Richman, G. S. (1982, 1994). Toward a functional analysis of self injury. *Journal of Applied Behavior Analysis, 27*, 197-209. (Reprinted from *Analysis and Intervention in Developmental Disabilities, 2*, 3-20, 1982)

Jessup, P. A., & Stahelski, A. J. (1999). The effects of a combined goal setting, feedback and incentive intervention on job performance on a manufacturing environment. *Journal of Organizational Behavior Management, 19*(3), 5-26.

Lindsley, O.R. (1997). Precise instructional design: Guidelines from precision teaching. In C.R. Dills & A.J. Romiszowski (Eds.), *Instructional development paradigms* (pp. 537-554). Englewood Cliffs, NJ: Educational Technology.

Mace, F. C., Lalli, J. S., & Lalli, E. P. (1991). Functional analysis and treatment of aberrant behavior. *Research in Developmental Disabilities, 12*, 155-180.

Olson, R., & Austin, J. (2001). Behavior-based safety and working alone: The effects of a self-monitoring package on the safe performance of bus operators. *Journal of Organizational Behavior Management, 21*(3), 5-43.

Pampino, R. N., Heering, P. W., Wilder, D. A., Barton, C. G., & Burson, L. M. (2003). The use of the performance diagnostic checklist to guide intervention selection in an independently owned coffee shop. *Journal of Organizational Behavior Management, 23*(2/3), 5-20.

Pampino, R., MacDonald, J., Mullin, J., & Wilder, D. (2003). Daily vs. weekly feedback: An application in retail. *Journal of Organizational Behavior Management, 23*(2/3), 21-43.

Pennypacker, H. S., Koenig, C. H., & Lindsley, O. R. (1972). *Handbook of the standard behavior chart*. Kansas City, MO: Behavior Research Company.

Potts, L., Eshleman, J. W., & Cooper, J. O. (1993). Ogden R. Lindsley and the historical development of precision teaching. *The Behavior Analyst, 16*, 177-189.

Rohn, D., Austin, J., & Lutrey, S. M. (2002). Using feedback and performance accountability to decrease cash register shortages. *Journal of Organizational Behavior Management, 22*(1), 33-46.

Thomas, E. W. (1993). Performance prediction and enhancement in an introductory physics course for engineers. *Journal of Engineering Education, 82*, 152-156.