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Training Teachers to Differentiate Instruction to Address Work Completion Problems in Math

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TRAINING TEACHERS TO DIFFERENTIATE INSTRUCTION TO ADDRESS WORK COMPLETION PROBLEMS IN MATH

by

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This dissertation investigated an adaptation of functional analysis methodology, performance deficit analysis (PDA), and its use in training teachers to differentiate instruction for students having difficulty completing independent math seatwork. Participants included three middle school teachers and one of their students who was referred for having difficulty completing his or her work. Behavioral skills training was used to individually train each teacher to interpret her student's PDA data, determine if the student had a skill or performance deficit, and select appropriate motivational and instructional strategies to increase the student's performance. To answer the research questions, a multiple-baseline-design across teachers was used to measure the effects of training on both teacher instructional behavior and student responding during independent seatwork tasks. During baseline and intervention, teachers were observed in their classroom to measure the percentage occurrence of instructional and motivational strategies provided to their target student during independent seatwork time. Instructional strategies were measured as antecedents and consequences. Results of the experimental analysis indicated that teachers immediately increased their use of instructional strategies relative to their baseline levels of responding. A staggered pattern of increases across teachers conformed to design requirements, indicating that experimental control was achieved. However, teachers displayed variability in their use of instructional strategies across the intervention phase and did not consistently implement key reinforcement strategies. Results did not generally confirm significant improvements in student work completion or accuracy. Teachers' ability to generalize training to a case example was also measured with mixed results. Limitations in terms of teacher training and environmental conditions are examined. Areas for future research are discussed.

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Chapter 1: Introduction and Literature Review

In 2017, only 40% of fourth-grade students met or exceeded proficiency standards in mathematics, and only 33% of eighth-grade students met these standards (NAEP; National Center for Educational Statistics, 2018). In reading, only 35% of fourth- and eighth- graders met or exceeded proficiency standards (NAEP, 2018). These national data indicated that poor achievement is common across grade levels. Students fail to attain proficiency for a variety of reasons, some instructional and some motivational (Daly, Witt, Martens, & Dool, 1997). Teachers are responsible for the learning of a diverse population of students with a variety of instructional needs. To increase student achievement, teachers must know which instructional and motivational strategies are appropriate according to each student's proficiency level, and they have to know how to apply those strategies and change them over time as students' proficiency improves (Kupzyk, Daly, Ihlo, & Young, 2012). Fortunately, considerable research has been conducted on elements of effective teaching and how to individually adapt instructional and motivational strategies to students' needs. A significant challenge, however, is accurately analyzing the student's instructional needs in a way that identifies strategies that can be used in the classroom for curricular assignments and that can be modified over time as students' learning increases.

Functional assessment methodology holds considerable promise for fueling research on assessment strategies that can help teachers select effective instructional and motivational strategies. Broadly, functional assessment methodologies are used to gather information about environmental events that are associated with specific behaviors, either occurring reliably before (antecedents) or after (consequences) a behavior. Functional analysis, one functional assessment method, aims to directly and systematically manipulate environmental variables to understand functional relationships between these variables and behavior (O'Neill, Albin, Storey, Horner, & Sprague, 2015). Functional analysis methodology will need to be adapted, however, to the demands and constraints of schools if it is to ever be used widely to help reduce the significant achievement deficits experienced by many students. The purpose of the present study was to examine an adaptation of functional analysis methodology (performance deficit analysis; PDA) and its use in training teachers to differentiate instruction for students having difficulties with independent seatwork math assignments, a type of instructional task that has significant effects on their future learning trajectory.

The following literature review will discuss how active student responding, learning trials, and work completion can be used in classrooms to promote students' academic achievement. The role of differential reinforcement in developing stimulus control and promoting skill progression will be emphasized. Research on explicit instruction and functional analyses will be reviewed. PDA will be discussed in terms of its potential utility for helping teachers to differentiate instruction across students in their classrooms. The review concludes by discussing a training model, behavioral skills training, that can be used to train teachers to interpret PDA data and differentiate instruction accordingly. The importance of programming for generalization of teacher training will also be discussed.

Promoting Learning Through Active Student Responding

Two significant variables that contribute to academic achievement are academic engagement and work completion. Researchers investigating effective teaching have found that actively engaging students to respond during instructional exercise is essential to increasing academic achievement (Greenwood, 1991; Rosenshine & Berliner, 1978; Simonsen, Fairbanks, Briesch, Myers, & Sugai, 2008; Sutherland, Alder, & Gunter, 2003). Some researchers have investigated active student responding as "opportunities to respond" (OTR; Delquadri, Greenwood, & Hall, 1979; Brophy & Good, 1986; Greenwood, Delquadri, & Hall, 1984; Haydon, MacSuga-Gage, Simonsen, & Hawkins, 2012; Kern & Clemens, 2007; Szadokierski & Burns, 2008; Scott, Hirn, & Alter, 2014; Stichter et al., 2009; Sutherland, Wehby, & Yoder, 2002). OTR refers to academic tasks that generate student responses, such as writing prompts and math worksheets. Increasing OTR has been shown to improve student engagement, accuracy, and reduce off-task behavior (MacSuga-Gage & Gage, 2015; MacSuga-Gage & Simonsen, 2015; Sutherland & Wehby, 2001). However, OTR is a time-based measure of the number of opportunities presented to students to respond, which does not provide a direct measure of how many student responses occur per instructional unit (Heward, 1994).

Active student responding (ASR), defined as a student's observable response to instructional stimuli (e.g., reading out loud; writing a sentence; solving a math problem; Heward, 1994), overcomes this limitation of OTR by emphasizing the amount (frequency, rate) of responding that occurs per unit of instruction as a measure of student learning. ASR also has the advantage that it can serve as a diagnostic tool for gauging the appropriateness of instruction (Greewood et al., 1984; Skinner, Belfiore, Mace, Williams, & Johns, 1997). When ASR is low, instruction needs to be modified. Researchers have suggested that providing students with 3 to 3.5 direct response opportunities per min (or more) may be ideal for increasing student achievement and engagement during teacher instruction (Stichter, Lewis, Ritcher, Johnson, & Bradley, 2006; MacSuga-Gage & Simonsen, 2015). However, actual classroom rates are likely lower—2.62 per minute on average (Stichter et al., 2009). Increasing ASR during instructional time is one of the simplest and most powerful tools teachers have to increase student achievement (Daly, Hofstadter, Martinez, & Anderson, 2010). Thus, when students are not meeting academic expectations a primary goal of instruction is for teachers to increase ASR during instructional time (Heward, 1994; Martens, Daly, & Ardoin, 2015).

Teachers assign independent seatwork as a common instructional arrangement for promoting ASR (Martens et al., 2015). Providing ample time for independent practice in the classroom is essential for building skill fluency and generalization (Binder, 1996; Burns, VanDerHeyden, & Zaslofsky, 2014; Gravois & Gickling, 2008; Swanson, 1999). The effective teaching literature has indicated that the benefits of independent practice time are maximized not only by increasing the number of responses per time unit (ASR), but also by providing assignments at an appropriate difficulty level that students can complete independently (Gersten, Carnine & Williams, 1981; Rosenshine & Stevens, 1986). Selecting assignments at the appropriate instructional level in which errors are low and correct responses are high is vital to improving students' skills (Betts, 1946; Burns et al., 2014; Council for Exceptional Children, 1987; Gickling & Armstrong, 1978). It is not beneficial for students to significantly increase ASR if they are not able to practice correct responses. In a review of the explicit instruction literature, Stichter et al. (2009) found that instructional tasks that students could complete with 90% accuracy were best for independent work. Work above (too easy) or below (too hard) that level is less beneficial for students (Burns et al., 2014). Appropriate instructional level assignments have other benefits like increased levels of on-task behavior, work completion within the allocated time, and good comprehension (Gickling & Armstrong, 1978; Treptow, Burns & McComas, 2007).

The Council for Exceptional Children (1987) recommended that to demonstrate an appropriate level of challenge during independent practice tasks, students should be able to obtain 90% accuracy and maintain eight to twelve responses per min during independent practice exercises. However, teachers often struggle to match materials to students' instructional levels (Gravois & Gickling, 2008) and may be assigning students practice tasks that are too difficult, generally at about 60% accuracy (Stichter et al., 2009). When work is too difficult, the tasks generate lower student ASR and accuracy levels. Students are also likely to become discouraged and unmotivated when their work is consistently too challenging for them (at their frustration level), which can further attenuate future efforts by students to complete their schoolwork (Betts, 1946; Gilbertson, Duhon, & Witt, Dufrene, 2008). This cycle can lead to cumulative skill deficits, making subsequent instructional assignments progressively harder to complete, causing these students to fall farther behind their peers (Binder, 1996; Howell & Shumann, 2010; Stanovich, 2000). Thus, teachers need to select assignments carefully on a student-by-student basis, and when a student is not progressing adequately, teachers must intervene to establish an increasing trajectory of ASR and student learning.

Increasing ASR Through Learning Trials

Applied behavior analysis has made significant contributions to conceptualizing how instruction can be used to increase ASR. One way to efficiently maximize ASR is to use learning trials, which have been described as the most basic unit of instruction (Greer, 1994). The learning trial is based on the behavior-analytic concept of the three-term contingency (Heward, 1994). The three-term contingency consists of a sequence of functionally related events: an antecedent that evokes behavior, the behavior, and a consequence that follows behavior and alters the future probability of occurrence of behavior (Miltenberger, 2016). In a classroom, a complete learning trial would consist of an instructional task provided by the teacher (i.e., antecedent), a student response (i.e., behavior), and the teacher's response or feedback (i.e., consequence; Burns et al., 2014; Heward, 1994; Skinner, Fletcher, & Henington, 1996). The consequences are typically (but not restricted to) praise for correct responses and corrective feedback for incorrect responses. For example, a teacher could ask students to spell "cat" on their whiteboards and have the students display their responses, and then respond with "Great job, you spelled cat!" or "Incorrect." You spelled it K-A-T and cat is spelled C-A-T. Spell the word again!"). Increasing the rate of learning trials has been found to increase accuracy (Albers & Greer, 1991) and frequency (Skinner, Turco, Baatty, & Rasavage, 1989) of student responses. Skinner et al. (1996) reviewed the research on instructional strategies that increase learning trials and in turn increase student responding. They pointed out that educators can increase the number of learning trials for a student without needing to allocate additional instructional time by choosing more time-efficient response topographies (e.g., giving oral versus written responses; Skinner et al., 1997), timing student work completion (Van Houten & Thomas, 1976; Derr & Shapiro, 1989), and providing goal setting and performance feedback (Van Houten, Hill, & Parsons, 1975; Van Houten, Morrison, Jarvis, & McDonald, 1974).

Within learning trials, the antecedent and consequence stimuli represent controlling variables when they reliably evoke and maintain behavior. Although the antecedents are critical for prompting a particular response, the consequence that follows student behavior is the most important variable, as consequences (not antecedents) *cause* behavior change for operant behavior (Miltenberger, 2016). A consequence that reliably increases a student's academic response has a functional relationship with the student's behavior and indicates *why* the behavior change is occurring (Daly et al., 2010). Antecedent variables come to assume stimulus control over the behavior only when they are consistently correlated with reinforcing consequences, which occurs through a process of differential reinforcement (Daly & Murdoch, 2000). Differential reinforcement involves reinforcing correct responses only in the presence of specific antecedent stimuli and withholding reinforcement for any other behavior (Miltenberger, 2016). When differential reinforcement is consistently applied in the presence of relevant antecedents (e.g., a math worksheet), the student's behavior eventually comes under the control of the antecedent stimuli, one of the most important objectives of instruction. For example, differentially reinforcing correct responses to multiplication problems on worksheets should lead to consistently correct answers when future multiplication problems are presented to the student. When this process is complete (i.e., correct responses occur reliably with the presentation of the antecedent), stimulus control is said to have developed and programmed reinforcement contingencies can be thinned (Martens et al., 2015). Stimulus control is a basic behavioral process that is a desired outcome of instruction. When it is achieved, ASR for the newly learned skill can occur with minimal instructional programming on the part of the teacher. The teacher can then alter instruction and instructional tasks to promote use of the skill under different conditions and with more difficult tasks (Martens et al., 2015). If stimulus control does not occur, the student will not progress successfully to more difficult skills. An indication that stimulus control is progressing is that student responding becomes more accurate and fluent with repeated exposure to the instructional stimuli (Daly, Martens, Barnett, Witt, & Olson, 2007). Thus, the use of differential reinforcement and complete learning trials is vital to increasing students' skill proficiency.

However, with some instructional tasks teachers cannot differentially reinforce correct responding because student accuracy is too low. In the initial stages of instruction, because responding is not under the control of the instructional antecedent, a correct response is not very likely. In this case, teachers need to rely on prompting strategies to evoke the behavior so that it can then be differentially reinforced (Daly, Lentz, & Boyer, 1996; Touchette, 1971). Teachers can use modeling, prompting, immediate feedback, and error correction to improve ASR (Daly, Neugebauer, Chafouleas, & Skinner, 2015; Kupzyk et al., 2012). Once these strategies evoke a correct response, teachers can provide differential reinforcement (Daly et al., 2010). Over time prompts can be faded and teachers can begin to focus on increasing rate of correct responding, otherwise known as skill fluency (Erchul & Martens, 2010). Teachers can increase fluency by providing frequent practice opportunities and differentially reinforcing an increased rate of responding (Burns et al., 2014; Martens et al., 2015). Performance feedback can also be helpful to motivate students to try to "beat their score" (Erchul & Martens, 2010).

As students increase accuracy and fluency, the probability of responding correctly under different or novel conditions (e.g., across academic subjects, settings, behavior, times) increases, otherwise known as stimulus generalization (Daly et al., 1996; Daly et al., 2007; Steege & Sullivan, 2009; Wolery, Baily, & Sugai, 1988). The ultimate goal of instruction is for students to learn more complex skills and eventually respond to real-world demands (e.g., working as an engineer; Cooper, Heron, & Heward, 2007; Daly et al., 1996). Stimulus generalization cannot occur, however, if stimulus control has not been established, which points to the importance of maximizing ASR through learning trials and strategic use of prompts initially, moving on to fluency instruction (repeated practice), and then programming for generalization of skill use to novel contexts and tasks. Teachers can promote generalization of academic skills by differentially reinforcing correct responding in the presence of diverse instructional stimuli that are different from (but contain similar stimulus properties) those used in training (Daly et al., 2015; Erchul & Martens, 2010; Luiselli, Reed, Martens, & 2010; Martens et al., 2015). Additionally, teachers can promote generalization by using multiple examples when teaching skills (Steege & Sullivan, 2009). For instance, when teaching students how to solve simple addition problems, the teacher may directly instruct students to add “1+2” and “3+4” on their whiteboards and then differentially reinforce students for solving “1+3” and “4+2” on their math worksheets.

The effective teaching literature has shown that instruction leads to the biggest gains in achievement when it is characterized by systematic practice paired with direct questions, student responses, and instructional feedback from the teacher (Archer & Hughes, 2011; Rosenshine & Berliner, 1978), all elements of the learning trial. The learning trial, which is essentially the three-term contingency applied to instruction, is a useful tool for operationalizing how to deliver instruction to maximize ASR as skill proficiency grows (Greer, 1994; Skinner et al., 1996). By increasing learning trials, a teacher increases the student's active student responding, which strengthens stimulus control and, with appropriate modifications over time, eventually produces generalized skill improvements (Stichter et al., 2009; Sutherland et al., 2003).

Differentiating Instruction across Students

The use of high-quality, explicit instruction as a method for improving student behavior and achievement has been supported in the literature for several decades (e.g., Archer & Hughes, 2011; Brophy & Good, 1986; Christenson, Ysseldyke, & Thurlow, 1989; Gage & Needles, 1989; Gersten, Baker, Pugach, Scanlan, & Chard, 2001; Gersten et al., 2009; Hattie, 2009; Rosenshine & Stevens, 1986; Sanders, 1998; Swanson, 1999; Vaughn, Gersten, & Chard, 2000; Wright, Horn, & Sanders, 1997). Hughes, Morris, Therrien, and Benson (2017) reviewed 68 publications between 2000 and 2016 on the topic of explicit instruction. As a widely acknowledged method of instruction across disciplines, Hughes et al. aimed to provide a concrete, universal definition of explicit instruction by identifying the most consistently used instructional components referred to as explicit instruction. As a result, Hughes et al. identified five "essential" instructional components which appeared in 75% of the reviewed publications: (a) making tasks manageable through segmenting skills, (b) promoting understanding through modeling, (c) prompting engagement with systematically faded prompts, (d) providing ample opportunities for students to respond and receive feedback, and (e) creating meaningful practice opportunities. Hughes et al. cut across instructional approaches by demonstrating through their review that effective instruction *is* explicit instruction. Hughes et al.'s general conclusion is that explicit instruction improves student performance by eliciting frequent, accurate active student responding while providing necessary supports and systematic performance feedback during structured practice opportunities (Hughes et al., 2017).

Teachers have been using methods of explicit instruction for decades (previously referred to as direct instruction), yet many students still fail to complete their work. Researchers have indicated that many students do not respond to instruction even when their teachers provide them with supplemental intervention (McMaster, Fuchs, Fuchs, & Compton, 2005; Vaughn, Linan-Thompson & Hickman, 2003). When students do not increase accurate responding over time, it may be because teachers lack skill in arranging optimal instructional contingencies or that they apply a "one-size-fits-all" approach to intervention (Gersten & Dimino, 2006, p. 103). Students display a continuum of proficiency and motivation levels in each classroom and teachers need to know how to differentiate instruction across students according to students' specific academic needs (Connor et al., 2009; Martens & Eckert, 2007). It appears that teachers' level of knowledge regarding explicit instruction strategies varies considerably (Piasta, McDonald Connor, Fishman, & Morrison, 2009) and many teachers simply do not know how to modify instruction for students who are not able to complete their work (Kupzyk et al., 2012).

The key to making independent practice productive for students is providing appropriate instructional-level material and knowing how to adjust instructional contingencies. Teachers should start with increasing complete learning trials and differentially apply modeling, prompting, and feedback according to students' instructional needs. Modeling and prompting strategies are most appropriate when students' accuracy is low and they cannot give the correct response without a prompt (Daly et al., 1996; Haring & Eaton, 1978; Touchette & Howard, 1984). Modeling correct responding by giving a behavioral demonstration of how to respond to an instructional item at the beginning of an assignment makes the process of completing the skill or solving a problem more explicit for the student (Martens et al., 2015). The use of modeling has been shown to have a significant effect on math (Gersten et al., 2009) and reading achievement (Chard, Vaughn, & Tyler, 2002; Daly et al., 1996; Daly & Martens, 1994). Modeling is a direct behavioral demonstration of the skill that serves as a prompt for how to respond. As responding increases in accuracy, teachers should shift to less-intrusive prompts like providing a partial model (verbal or visual) or a gestural prompt and systematically fading them over time (Swanson, 1999; Wolery, Ault, & Doyle, 1992). For instance, as a student is learning to read a word, a teacher may first fully model the word (e.g., "This word is HOP. What's this word?") and eventually provide a partial verbal prompt (e.g., "H-H-H What is this word?").

In addition to response prompts, there are also variations of time schedules for providing prompts. Time schedules are often varied as time-delay prompts in which the instructor lets either a constant amount of time (constant time delay) or a variable amount of time over sessions (progressive time delay) elapse between the presentation of an instructional item and a modeling prompt (Touchette, 1971; Wolery et al. 1992). Using a 0-s delay (or instantaneous prompt/model) can help teachers to evoke correct responses during initial instruction, which reduces student errors and increases opportunities to provide feedback for responding (O'Neill, McDowell, & Leslie, 2018). Such prompting strategies have been shown to increase academic performance in reading (Browder, Wakeman, Spooner, Ahlgrim-Delzell, & Algozzinexya, 2006; Daly et al., 2016; Gast, Ault, Wolery, & Belanger, 1988; Kupzyk, Daly, & Anderson, 2011), writing (Park, Weber, & McLaughlin, 2007; Pennington, Stenhoff, Gibson, & Ballou, 2012), spelling (Coleman-Martin & Heller, 2004; Mayfield, Glenn, & Vollmer, 2008), math (Everett & Edwards, 2007), and independent seatwork (Caldwell, Wolery, Werts, & Caldwell, 1996).

Teachers can also program performance feedback during independent practice to motivate students and improve their skill accuracy and fluency (Hughes et al., 2017). Feedback can be delivered verbally or in written form, as well as individually or displayed publicly (Eckert, Dunn, & Ardoin, 2006). Teacher feedback has been shown to be a critical part of explicit instruction regardless of student proficiency levels (Hattie & Timperley, 2007; Hughes, et al., 2017). However, the form and function of teachers' feedback should change as students' accuracy and fluency improve. An important type of feedback is corrective feedback (error correction) when students make errors (Chard, Vaughn, & Tyler, 2002; Eckert, Ardoin, Daly, & Martens, 2002; O'Shea, Munson, & O'Shea, 1984). Although there are a variety of error correction strategies, all generally include some form of identifying the incorrect response, modeling the correct response, and having the student repeat the correct response (Martens & Erchul, 2010). Error correction strategies have been found to be most effective when they are direct, immediate, and require the student to practice the correct response (Barbetta, Heward, Bradley, & Miller, 1994; Simonsen et al., 2008). In general, error correction is important because it helps teachers ensure that students do not practice mistakes.

Another important form of feedback is affirmative feedback (i.e., praise) contingent on correct responding, which may serve a positive reinforcement function (Kupzyk et al., 2012). Stichter et al. (2009) indicated that verbal praise is most effective when it is contingent on desired behavior, provides descriptive information about the desired behavior, and is delivered in a ratio of three or four praise statements for every instance corrective feedback. Additionally, providing students with explicit performance feedback on an aspect of their performance relating to a specific goal (e.g., oral reading rate, accuracy of addition problems) has been shown to improve performance in reading (Chafouleas, Martens, Dobson, Weinstein, & Gardner, 2004; Conte & Hintze, 2000; Eckert, Dunn, & Ardoin, 2006), math (Carson & Eckert, 2003; Codding, Lewandowski, & Eckert, 2005), spelling (Bourque, Dupuis, & VanHouten, 1986), and writing (Hier & Eckert, 2014; McCurdy, Skinner, Watson, & Shriver, 2008; Truckenmiller, Eckert, Codding, & Petscher, 2014). Lastly, frequency and immediacy of feedback are critical to differentiating instruction across students (Burns et al., 2014; Hattie & Timperley, 2007). Immediate feedback has been shown to be particularly helpful when students are making frequent errors in an academic skill and require error correction (Ardoin & Daly, 2007). However, when student responding is accurate, teachers may provide less frequent or delayed feedback to build fluency and avoid interrupting the students (Burns et al., 2014). Thus, teachers have at their disposal a variety of strategies that can help them differentiate instruction to meet the diverse instructional needs of students in their classrooms (Gersten & Dimino, 2006). A reliable and simple model for analyzing students' instructional and motivational needs would be useful for helping teachers to know which strategies to apply when students are not completing independent seatwork adequately.

Using Functional Analysis to Differentiate Instruction

To effectively differentiate instructional strategies across students and increase work completion, teachers would benefit from a valid method for determining which strategies are most appropriate for a given student and understanding that students' skill and motivational levels vary considerably. Given its emphasis on identifying controlling variables at an individual level, functional analysis may be a useful technology for differentiating explicit instruction. Functional analysis is a behavior-analytic methodology that facilitates the systematic identification of environmental variables (antecedents and consequences) that reliably predict and maintain problem behavior through the use of direct measures of behavior and experimental design elements that allow the investigator or practitioner to isolate the effects of treatment components (Ervin, Ehrhardt, & Poling, 2001; O'Neill et al., 2015). In the early 1980's, functional analysis was developed by applied researchers to treat self-injury and aggression in developmentally and intellectually disabled populations. Behaviors analysts sought to identify effective interventions to replace controversial and aversive punishment procedures for these populations (Iwata, Dorsey, Slifer, Bauman, & Richman, 1982/1994).

Carr (1977) recognized patterns in the research targeting self-injury and proposed that there was a connection between self-injury and types of reinforcing consequences that may differ from person to person as a function of prior reinforcement history. Specifically, he conceptualized self-injury as operant behavior that could be controlled by one or more directly alterable variables, including social attention (positive reinforcement), the removal of aversive conditions (negative reinforcement), and/or sensory stimulation. Carr suggested that the reinforcers maintaining self-injury may differ across persons. Carr's theoretical analysis provided the groundwork for the seminal study by Iwata et al. (1982/1994). Iwata et al. created test conditions for each type of reinforcement condition and experimentally analyzed which condition(s) led to the highest rate of responding in nine individuals with developmental disabilities. The functional analyses allowed Iwata et al. to identify controlling variables on an individual basis, with some participants displaying elevated levels of responding in one of the conditions (suggesting a unique controlling variable for that individual) and some participants displaying elevated levels of responding across multiple conditions (suggesting that their behavior was multiply controlled). The results underscored the need for assessing controlling variables on a case-by-case basis and provided a methodology for doing so with self-injury.

Over the last 30-plus years, functional analysis research has flourished. Hanley, Iwata, and McCord (2003) and Beavers, Iwata, and Lerman (2013) identified 435 functional analysis studies published from 1961 to 2013. Functional analysis studies have examined a wide variety of behaviors/response topographies, including aggression, vocalizations, self-injury, property destruction, disruption, elopement, non-compliance, stereotypy, tantrums, Pica, and other behavioral concerns (Beavers et al., 2013; Hanley et al., 2003). Across all of these response topographies, the common elements of functional analysis include single-case experimental design elements, direct observations of behavior, strategic manipulation of at least two environmental variables, and repeated measures of behavior within and across these conditions (Hanley et al., 2003; Kazdin, 2011). The advent of functional analysis was a major advance in informing treatment selection and developing systematic and individualized interventions across diverse individuals and behavior topographies (Beavers et al., 2013; Sugai et al., 2004). Functional analysis adds incremental value to treatment selection by providing a valid method for identifying controlling variables and developing function-based interventions (Alter, Conroy, Mancil,, & Haydon, 2008). When intervention is aligned with behavioral function, behavior change is more likely (Ervin et al., 2001). Strong evidence of functional analysis' utility has been documented not only across behavior topographies, but also across populations and settings (McComas, Vollner, & Kennedy, 2009). As such, researchers have come to recognize the viability of functional analysis in schools (Ervin et al., 2001; Repp, 1994). A number of functional analysis studies have been conducted in schools, expanding its application to a variety of problem behaviors that occur often in schools (e.g., calling out, off-task, out-of-seat; Anderson, Rodriguez, & Campbell, 2015; O'Neill et al., 2015; Lloyd, Weaver, & Staubitz, 2016). Using a functional approach to behavioral intervention has been shown to be an efficient and valid methodology for identifying effective classroom interventions (Broussard & Northup, 1995; Ervin et al., 2001; Kratochwill & McGivern, 1996).

While functional analysis holds great promise for application in the schools, it is not without its limitations. Despite the documented utility of functional analysis, school-based researchers face the difficulty of adapting traditional functional analysis for typical classroom use (Repp, 1994). Functional analysis's traditional focus on aberrant behavior and complexity have led investigators to develop and test variations of the methodology that may make it more adaptable to school-based use and thus more frequently used in the schools. One limitation to traditional functional analysis procedures is that most common difficulties in school are related to poor academic performance (Hofstadter & Daly, 2015). As an alternative to traditional functional analyses, Hofstadter and Daly (2015) developed a functional analysis targeting academic performance (math computation) that examined the same controlling variables commonly investigated in traditional functional analyses, and were able to identify function when task difficulty level was appropriate. Due to its complexity, a major recent push has been on developing simple yet effective functional analysis methods (O'Neill et al., 2015). In reality, experimental functional analyses are still typically done by researchers in isolated settings (Anderson et al, 2015; Lloyd et al., 2016; Roscoe, Phillips, Kelly, Garber, & Dube, 2015). Systematically extending functional analysis methodology to the demands and constraints of schools and developing training in its use should open the door to a powerful technology for identifying empirically derived, function-based treatments in schools.

Brief Experimental Analysis

Researchers have adapted the principles and strategies of functional analysis to address academic performance problems in a version that is referred to as Brief Experimental Analysis (BEA). BEA utilizes single-case design elements to directly test instructional and motivational strategies to improve academic performance (Daly et al., 2010). BEA researchers have utilized functional analysis methodology to delineate specific instructional variables that are functionally related to a student's academic performance and thus could be used to increase academic responding (Daly, Martens, Hamler, Dool, & Eckert, 1999; McComas et al., 1996). Researchers initially designed BEAs with the aim of increasing both the efficiency and effectiveness of interventions in resource-limited classrooms (Daly et al., 1999; McComas et al., 1996). For example, McComas et al. (1996) examined the differential effects of several instructional strategies on the accuracy of four students' spelling or reading comprehension. The authors measured baseline performance and then introduced one instructional prompt at a time, starting with the strategy that required the least adult assistance and ending with the strategy that required the most adult assistance. For instance, reading comprehension strategies started with students independently reviewing the main ideas of a passage, and then proceeded to the teacher outlining the main ideas if the student was not successful independently. The pre-determined instructional sequence was implemented with a student until the student displayed a performance increase notably greater than baseline and the previous strategy. For each student, one strategy clearly provided the most benefit over the others as evidenced by a large increase in responding in that condition relative to the others. The McComas et al. study illustrated that functional analysis methodology could be expanded to incorporate instructional as well as motivational variables. However, performance feedback and praise were provided to all students as a part of each condition, eliminating the possibility of evaluating the independent contribution of performance feedback and contingent reward on student performance.

In another study, Daly et al. (1999) added a reward-only condition to the least-to-most testing sequence. Daly et al. identified the most efficient combination of instructional strategies that could be used to improve four students' reading fluency, including just adding a contingent reward for increased performance. The condition was named a “reward” condition as opposed to a “reinforcement” condition because the stimuli had not yet been used to increase students’ performance, the necessary criterion for designating a consequence as a reinforcer. If student responding increased under contingent reward, no new conditions were administered. They simply replicated prior conditions briefly to examine the reliability of the findings. If contingent reward did not increase performance, interventions characterized by repeated practice, modeling of fluent reading, practice and modeling with additional passages, and finally easier materials were added sequentially until student responding increased. Daly et al. looked at conditions singly in this study, meaning that contingent reward was examined independently of the instructional conditions. As noted earlier, however, even if programmed reinforcement isn’t sufficient to independently increase student responding, reinforcement will still be a necessary component of intervention in order to strengthen stimulus control. Thus, contingent reinforcement should be incorporated into assessment of instructional strategies.

Jones and Wickstrom (2002) conducted brief analyses comparing the effect of rewards, repeated practice, increased learning trials, and easier reading materials on five students’ oral reading fluency. The purpose of this study was to analyze the stability and utility of identified treatment variables over time by conducting an extended experimental analysis of the BEA conditions using an alternating treatments design. Jones and Wickstrom identified an effective strategy for each student in the BEA and found that the selected strategy led to a higher mean reading fluency score for each student compared to baseline. Like prior BEA studies, Jones and Wickstrom conducted careful screenings of the participants to assure equal difficulty level of passages. To examine generalized treatment effects, they also measured effects in high word overlap passages that contained about 80% of the same words as the training passages. While the careful control and selection of materials increases the validity of the study results, it also increases the complexity and effort required to conduct BEAs, which turn out to be less brief than might otherwise appear to be the case.

Noell, Freeland, Witt, and Gansle (2001) also conducted a BEA along with an extended analysis to identify interventions for improving reading performance. However, instead of isolating the effect of multiple instructional variables separately, Noell et al. used a single instructional package (modeling, repeated practice, immediate feedback) in order to increase the brevity of the analysis. During the brief analysis, the experimenters systematically compared the effects of four conditions: baseline, contingent reward, the instructional package, and in cases in which contingent reward led to performance increases a condition that combined the instructional package *and* contingent reward. Noell et al. found that the empirically derived strategy identified in the brief analysis led to the highest treatment effects in the extended analysis in 83% of the cases. They also found that every student's reading fluency improved. These results demonstrated the utility of conducting brief functional analyses, using a minimum of treatment conditions (instruction, contingent reward, and their combined use) in guiding intervention selection. Use of the combined condition was consistent with the previously discussed need for including differential reinforcement when there is a stimulus control problem, as is the case with oral reading fluency difficulties. However, just as with prior studies, the time and effort it took to prepare, screen, and equate individualized materials before the brief analysis could be conducted (e.g., Daly, Bonfiglio, Mattson, Persampieri, & Foreman-

Yates, 2006; Daly et al., 2010) creates a potential barrier to its use in schools. As with functional analysis research, BEAs are probably carried out more often by researchers than practitioners.

Performance Deficit Analysis

Early BEA research was useful for developing an initial technology for applying functional analysis methodology to academic responding using common instructional and motivational variables. The results of the analyses reported in these studies held promise for isolating instructional and motivational strategies based on students' actual levels of skill proficiency. However, teachers rarely isolate single instructional factors and more frequently deliver instruction as a package that includes a number of instructional and motivational strategies (Martens et al., 2015). Additionally, with effective instruction skill acquisition should progress rather quickly, which means that the results of a BEA should be valid for only a brief period of time. For these reasons, functional analyses could be simplified by determining whether differential reinforcement of alternative behavior (DRA) is sufficient for increasing responding or whether instructional strategies might need to be added to DRA, meaning that a single condition may be necessary to determine the type of intervention a student might need. Daly et al. (1997) proposed a simple assessment strategy for differentiating between students who do not have the skills to complete a task (a skill deficit) and those who have the skills but lack the motivation to complete the task (a performance deficit). This analysis, which has come to be known as Performance Deficit Analysis (PDA; VanDerHeyden, 2014), could serve as a good starting point for analysis for students with work-completion difficulties. PDA is a relatively simple assessment process that involves offering a highly preferred consequence for improved completion and accuracy on a previously failed assignment. If the student’s performance increases with contingent reinforcement, then the student has a performance deficit. If the student’s performance does not improve, the student has a skill deficit (assuming that the contingent consequence was potent enough, another possible reason for a lack of performance increase; Martens et al., 2015).

A PDA efficiently assesses skill versus performance deficits on an individual basis. This distinction between skill and performance deficits can be traced back to Bandura (1969) in relation to social learning theory and Gresham (1981) in the context of children’s social skills (VanDerHeyden & Witt, 2008). In the academic intervention literature, Lentz (1988) hypothesized that "skill problems will require interventions that produce new behavior, performance problems may require interventions involving manipulation of ‘motivation’ through contingency management” (p. 354). In terms of principles of behavior, a skill deficit indicates that a student’s responding is not under the stimulus control of instructional stimuli, while a performance deficit indicates that the current reinforcement contingencies are simply not strong enough to produce the desired response from the student.

When a student has a skill deficit, the academic stimuli do not evoke the correct response and stimulus control must be strengthened in order for the student to respond correctly in the presence of instructional tasks (Daly et al., 2010). For the reasons described earlier, strategies like adjusting task difficulty level, OTR, prompting, modeling, corrective feedback, and differential reinforcement are needed to increase stimulus control and thus increase skill proficiency for students with skill deficits (Daly et al., 1996; Daly et al., 1997; Martens et al., 2015). Teachers may use these instructional strategies to provide guided practice during independent seatwork time when the student has a skill deficit. Collectively, these strategies can increase active student responding and evoke correct student responses that can then be differentially reinforced and strengthened over time.

When a student has a performance deficit, instructional strategies are not likely to increase responding to the desired level (Duhon et al., 2004). Sometimes students do not complete their work in the classroom because competing contingencies are more reinforcing than completing their work (Daly et al., 1997; Skinner, Pappas, & Davis, 2005). These concurrent contingencies maintain undesirable behavior because they are either offer more potent reinforcers or are easier to obtain than those offered for completing academic work (Martens et al., 2015). A PDA can be used to rule out the need for instructional strategies when student work completion and accuracy increases with a simple change in reinforcement contingencies. Duhon et al. (2004) developed and tested a class-wide PDA assessment protocol to directly test for skill and performance deficits in four general education students referred for poor academic performance. Duhon et al. established baselines using a single curriculum-based measurement probe with the entire classroom to obtain a measure of the students' responding under typical conditions and to provide a peer comparison. In the next assessment session, the experimenter offered contingent reinforcement to the four referred students for improving their baseline score by 50%. Students whose performance did not improve were hypothesized to have a skill deficit, and those whose performance did improve were hypothesized to have a performance deficit. An extended experimental analysis was then conducted. Duhon et al. (2004) had an initial goal-setting baseline phase in which performance goals were set and students were given feedback about their rate of responding. In the subsequent phase, they rapidly alternated a reinforcement-only condition with an instructional condition (consisting of pre-session practice, an organization aide, instructional assistance) to test their hypotheses (skill- or performance-deficit) for each referred student. In all cases, the results confirmed the empirically derived hypotheses. For the two students with skill deficits performance was superior in the instruction condition, and for the two students with performance deficits performance was superior in the contingent reinforcement condition. Duhon et al.'s results suggested that the interventions derived from PDAs may be useful to help teachers differentiate instruction for students with poor academic performance in their classroom.

When PDA results show that a student has a performance deficit, the results suggest that existing programmed consequences for work completion are not sufficiently potent and that strengthening reinforcement contingencies will improve performance in the classroom. Teachers can use these results for intervention-planning purposes by strategically using DRA with consequences that have been previously established to effectively increase behavior (Duhon et al., 2004). For example, for a student who consistently avoids her math work by doodling on her worksheet, the teacher might allow the student to play her favorite game on an iPad for 5 minutes contingent on completing her math worksheet on time. Alternately, when the PDA results suggest a skill deficit, the teacher can plan the intervention to include instructional strategies in addition to DRA. As noted earlier, one other possible outcome of a PDA is that a lack of performance increase may signal insufficiently potent contingent consequences and not a stimulus control problem. In order to account for this limitation, future research could incorporate structured preference assessments into PDA.

Structured preference assessments have been repeatedly shown to be an effective assessment strategy for identifying stimuli (e.g., tangible items, edibles, activity changes) that can be used to improve behavior as programmed consequences (Cannella, O'Reilly, & Lancioni, 2005; DeLeon & Iwata, 1996; Fisher et al., 1992; Piazza, Fisher, Hagopian, Bownman, & Toole, 1996; Kang et al., 2013; Pace, Ivancic, Edwards, Iwata, & Page, 1985). There are multiple methods of preference assessments (e.g., paired-stimulus, multiple stimulus with replacement, multiple stimulus without replacement), which generally identify potential reinforcers by offering stimuli to individuals and allowing them to choose the item they most prefer. Stimuli are often ranked in order of effectiveness by the frequency and order with which individuals choose specific stimuli relative to other items across sessions. The multiple stimulus without replacement preference assessment method (MSWO; Cannella et al., 2005) is efficient (DeLeon & Iwata, 1996) and has also shown to be useful in school-based applications (Daly et al., 2009; King, 2016). With the MSWO method, an adult presents a student with a linear array of potential reinforcers (written on index cards for older students, or pictures for younger students). The adult then asks the student to choose which item they are most willing to work for. After the student selects an item, the adult removes it from the array and prompts the student to choose which remaining item he/she would be most willing to work for. The adult continues this process until one item remains and all items are ranked. This process is repeated two more times to determine the median ranking across several days. DeLeon and Iwata (1996) found that more potential reinforcers are identified when items are removed from the array after they are chosen. Structured preference assessments could be incorporated into PDA analyses to both distinguish between skill- versus performance-deficits and identify the highest preference items among competing stimuli. By administering the PDA multiple times across days and systematically testing different consequences in each session, performance could then be compared across sessions to determine which stimuli could serve as the most potent programmed reinforcement, the very information one derives from a preference assessment, while testing the reliability of the decision (skill- or performance-deficit) through repeated measures over sessions. This assessment strategy may help teachers to differentiate instruction through a rigorous test of skill- versus performance-deficit while simultaneously increasing the potency of DRA interventions by identifying a range of potentially effective reinforcers.

Training Teachers to Differentiate Instruction

Providing teachers with assessment data may be particularly helpful, as it appears that teachers often have inaccurate perceptions about student progress when asked to make judgments about low-achieving students' academic abilities (Begeny, Eckert, Montarello, & Storie, 2008; Begeny, Krouse, Brown, & Mann, 2011; Eckert, Dunn, Codding, Begeny, & Kleinmann, 2006; Hamilton & Shinn, 2003; Feinberg & Shapiro, 2009). Teachers tend to overestimate the progress of low-achieving students (Bates & Nettelbeck, 2001; Graney, 2008), which could perpetuate ineffective instructional practices for these students. While teacher decisions based on functional analysis data could improve decision making relative to teacher judgment alone (Wagner, Coolong-Chaffin, & Deris, 2017), it appears that many educators are not equipped to independently interpret and use student assessment data to make decisions on instructional modification (Gersten & Dimino, 2006). According to a study conducted by the U.S. Department of Education, teachers are more likely to use data to inform instruction if they feel confident about their knowledge and skills in data analysis and interpretation (Gallagher, Means, & Padilla, 2008). However, teacher training typically does not address data-based decision making, and over half of the 1,799 teachers surveyed indicated that they needed additional training on how to modify instruction based on student data (Gallagher et al., 2008). Furthermore, despite 30 years of functional assessment research advancements in schools (Beavers et al., 2013), the number of teachers implementing functional analysis (direct manipulation of environmental variables) appears to remain quite low and teachers do not typically receive training in the application of these results (Flynn & Lo, 2016). Providing teachers with instruction and practice regarding how to analyze student assessment data could improve their ability to differentiate instruction and accommodate diverse student needs (Means, Chen, DeBarger, & Padilla, 2011).

An effective and efficient training method is needed to adequately train teachers. Researchers have indicated that "workshop" training alone may not lead to adequate program implementation in schools, and so training should include one-on-one coaching and classroom-based support for teachers (Brock & Carter, 2017; Joyce & Showers, 2002). One effective, efficient, and well-validated method of helping individuals acquire specific behavioral skills is Behavioral Skills Training (BST; Sarokoff & Sturmey, 2004; Lavie & Sturmey; 2002). BST has been used to effectively teach behavioral skills to various adults without previous Applied Behavior Analysis training (e.g., teachers, parents, para-educators; e.g., Flynn & Lo, 2016; Hogan, Knez, & Kahng, 2015; Iwata et al., 2000; Moore et al., 2002; Shayne & Miltenberger, 2014; Wallace, Doney, Mintz-Resudek, & Tarbox, 2004). BST combines instructions, modeling, rehearsal, and feedback across training sessions, an empirically supported training model very similar to Hughes et al.'s (2017) description of explicit instruction. In a meta-analysis of 118 studies measuring the efficacy of practitioner training on implementation of special education practices, the explicit use of BST was associated with greater improvements in trainees' implementation fidelity compared to other types of training like independent use of BST components, self-monitoring, and study groups (Brock et al., 2017).

BST training begins with providing *instructions* to trainees. Trainers provide instructions that describe the skills to be taught during training and provide a rationale for learning these skills (Miltenberger, 2016). For example, during the instruction component of one study, trainers provided teachers with a written copy of a student's behavior intervention plan and explained exactly what implementing a DRA component would require (e.g., provide a token after every correct response to the instructional prompt, provide a prize for every five tokens; Hogan et al., 2015). Brock et al. (2017) found that incorporating written instructions or a checklist for implementation significantly improved implementation fidelity (Brock et al., 2017). Next, BST training proceeds with *modeling* how to correctly implement the targeted skills for the trainees. For example, a trainer may demonstrate for a teacher exactly how to complete each step of DRA, highlighting important components such as how to ignore off-task behavior and how to descriptively praise active engagement (Hogan et al., 2015). Modeling and having the trainee repeatedly perform the desired behavior until correct have also been shown to significantly improve implementation (Brock et al., 2017; Hogan et al., 2015).

After modeling, BST training provides trainees with opportunities for *rehearsal* of the targeted skills. Rehearsal consists of having the learner imitate and practice the behavior under the supervision of a trainer (Hogan et al., 2015). Rehearsal is often designed for the trainee/teacher to experience success, starting with modeling prompts and then fading modeling while having individuals practice repeatedly as they become more independent over time (Miltenberger, 2016). Finally, with BST the trainer delivers *feedback* to trainees when they rehearse the targeted skills. Feedback in a training context includes delivery of praise or descriptive positive feedback for correct responses (e.g., “Great job modeling the passage at a moderate pace!”), and delivery of corrective feedback and additional instruction when a given behavior is performed incorrectly (e.g., “Not quite, instead of just telling the student the missed word, model the word, then prompt the student to repeat it;” Luck, Lerman, Wai-Ling, Dupuis, & Hussein, 2018), just as one does with a student in a classroom.

Performance feedback is a particularly critical component to successful training of teachers (Luck et al., 2018; Noell et al., 2014; Scheeler, 2008; Solomon, Klein, & Politylo, 2012). Trainees have been shown to experience more success when they rehearse the skills and receive feedback about their performance in addition to instruction and modeling (Beck, Miltenberger, & Ninness, 2009; Flynn & Lo, 2016; Gatheridge et al., 2004; Himle, Miltenberger, Flessner, & Gatheridge, 2004). In BST, trainers typically teach specific behavior skills to mastery, meaning that modeling and feedback occur in a cycle until the learner can accurately and independently demonstrate the skill several times in a row (e.g., Hogan et al., 2015; Sarokoff & Sturmey, 2004; Wallace et al., 2004). Training to mastery means carrying out training and providing feedback until skills are both accurate and more fluent, which also increases the likelihood of generalization (Engelmann, 1988; Rose & Church, 1998; Sheeler, 2008). Performance feedback has been repeatedly shown to improve treatment integrity in the classroom (Brock & Carter, 2017; Codding, Feinberg, Dunn, & Pace, 2005; DiGennaro, Martens, & McIntyre, 2005; Flynn & Lo, 2016; Gilbertson, Witt, LaFleur Singletary, & VanDerHeyden, 2007; McKenney, Waldron, & Conroy, 2013; Noell, Witt, Gilbertson, Ranier, & Freeland, 1997, Noell et al., 2000, 2005; Witt, Noell, La Fleur, & Mortenson, 1997). Good treatment integrity is essential to delivering the “active ingredients” (functional variables) that are responsible for behavior change (Yeaton & Sechrest, 1981). Codding, Feinberg, et al. (2005) provided performance feedback to special education teachers regarding their implementation of behavior support plans. To do this, the experimenters observed the teachers implementing the interventions and then provided feedback on all of the key components (antecedent and consequence intervention components) that were observed. Feedback consisted of praising teachers for components that were implemented as instructed and providing constructive feedback for components that were not correctly implemented or not implemented at all. The experimenters reviewed components with low integrity and provided further instruction on how to implement them. They found that performance feedback increased teachers’ treatment integrity of antecedent components for four of five teachers and consequence components for all five teachers and that the results were maintained for up to 15 weeks. These results demonstrate that performance feedback can be an effective method of ensuring that teachers implement key components of individualized intervention plans.

Noell et al. (2005) investigated the difference between weekly follow-up meetings, weekly follow-up meetings with emphasis on commitment to implement treatment, and performance feedback on treatment plan implementation and child behavior outcomes following consultation. Forty-five teacher-student dyads were referred due to students' poor academic performance and/or behavior issues in the classroom and were randomly assigned to one of the three conditions. The weekly follow-up meeting consisted of a brief interview in which the consult asked about the extent of the teacher's implementation and the degree to which the student was progressing on goals. The commitment emphasis condition was designed to measure the impact of social influence on weekly follow-up meetings, supplementing the interview with five discussion points related to the importance of treatment implementation and strategies to support implementation. Performance feedback consisted of reviewing student work, graphing student behavior, and graphing intervention implementation. The consultants in the performance feedback condition praised teachers for steps they completed and provided constructive feedback and problem-solving regarding steps that were skipped or not implemented correctly. Performance feedback was provided every day until the teacher implemented all steps of the intervention with 100% integrity, and it was then faded to every other day, and then once per week. Child behavior outcomes were estimated with a student behavior change index which summarized direct observational assessment data across diverse behaviors on a common metric. Mean treatment implementation for the three weeks following consultation was 75.2% for performance feedback, compared to

45.8% and 23.1% for commitment emphasis and weekly follow-up meetings, respectively. These results indicated that without performance feedback, treatment implementation was significantly weaker and deteriorated over time. The mean percentage of student behavior change was 96% for the performance feedback condition compared to a 2% change in the weekly follow-up condition and 37% change in the commitment emphasis condition. There was a moderate relationship between teacher treatment implementation and child behavior outcomes overall, with significantly stronger treatment effects for teacher-student dyads in the performance feedback condition. The results of this study indicate that frequent, repeated performance feedback in the initial stages of treatment plan implementation is probably necessary for maintaining treatment implementation and treatment effects over time, and that just checking in with teachers and encouraging treatment implementation is probably insufficient.

Several other factors have also been found to increase the effectiveness of performance feedback. Feedback provided to teachers in written text, vocally, and vocally-plus-video feedback appear to be similarly effective at increasing correct responding when training teachers (Luck et al., 2018). It appears that feedback is most commonly provided to educators vocally or via written text (Fallon, Collier-Meek, Maggin, Sanetti, & Johnson, 2015); however, teachers report vocal feedback, or a combination of vocal and written feedback to be most beneficial (Luck et al., 2018). Regardless of form, feedback has been found most helpful to teachers acquiring new skills when it is provided immediately after the desired behavior is rehearsed. Immediate feedback allows trainers to eliminate errors and omissions and provide an immediate opportunity for the teacher to use the skill correctly and receive reinforcement (Sheeler, 2008). Several studies have also demonstrated that performance feedback is more effective when it includes a visual graph of the teacher's performance and treatment implementation (Balcazar, Hopkins, & Sherman, 1986; Noell, Duhon, Gatti, & Connell, 2002).

Generalized Training Effects

While skill acquisition and strong treatment implementation are important goals of training, teachers must also learn to adequately generalize newly learned skills across settings, academic subjects, and students who vary considerably in terms of proficiency and motivation levels. From a behavior-analytic perspective, differentiated instruction is a matter of stimulus generalization. After a treatment plan comes under strong stimulus control through training and performance feedback, the teacher will benefit significantly if he or she can correctly apply the plan to other students whose circumstances will differ to one degree or another. However, it is commonly recognized that generalization rarely occurs naturally and that explicitly programming for it is the best method for making it more likely in future applications (Erchul & Martens, 2010; Stokes & Baer, 1977; Baer, Wolf, & Risley, 1968).

Fortunately, BST can be readily designed to incorporate two strategies commonly used to program for generalization. First, programming common stimuli by making the training and generalization (i.e., classroom) settings as similar as possible makes the discriminative stimuli that should evoke appropriate teacher behavior more salient across relevant settings and thus increases the desired behavior's probability of occurrence across settings (Scheeler, 2008; Steege & Sullivan, 2009; Stokes & Baer, 1977).

Scheeler, Bruno, Grubb, and Seavey (2009) found that when teachers were trained to criterion on direct instruction during practicum without programming for generalization they did not maintain good implementation when they later were student teaching. However, when they had the teachers bring items from their student teaching classrooms into their new classrooms to serve as discriminative stimuli and cue skills learned in training, the new teachers were able to maintain and generalize skills from student teaching to their own classrooms (Scheeler et al., 2009). A second method of programming for generalization that may be readily incorporated into BST is training sufficient exemplars, which refers to training repeatedly and with sufficient diversity of training items (including a variety of stimulus conditions) until generalization occurs (Pennington, Simacek, McComas, McMaster, & Elmquist, 2018; Stokes & Baer, 1977). Himle et al. (2004) combined BST and training sufficient exemplars to teach gun safety skills to children. The experimenters programmed for generalization by having students practice gun safety in five different scenarios, including multiple settings, with multiple props and disabled guns, and with various adults giving different instructions. To increase generalization of instructional skills, teachers could benefit from receiving training exemplars that reflect a range of potential student profiles and instructional needs.

Flynn and Lo (2016) examined the combined effects of BST and both generalization strategies—programming common stimuli and training sufficient exemplars on teachers' reliable implementation of trial-based functional assessment (TBFA) and DRA. Three teachers and two of their students (six total) demonstrating challenging and disruptive behavior participated in the study. The experimenters used BST to train teachers in how to implement TBFA and DRA. Within training, they emphasized immediate and ongoing feedback and programming for generalization. Flynn and Lo programmed common stimuli by conducting training in the teachers' classroom, using reinforcers during training that were typically used in the classroom, and posting treatment descriptions used during training on the walls. Flynn and Lo also trained sufficient exemplars by providing teachers with multiple examples of possible student responses to antecedents, different topographies of behavior that serve the same behavioral function, and several examples of extinction bursts. After providing BST on TBFA (didactic instruction, video modeling, role play, feedback until mastery), the teachers were instructed to implement TBFA with their first student. The experimenters then provided performance feedback and additional practice until the teachers met mastery. After completing TBFA with student A, the teachers were then prompted to implement TBFA independently with student B in order to test generalized skill use. The same training process was then applied to train the teachers to implement DRA interventions, including direct instructional training with one student and independent implementation for a second student. All three teachers were able to implement TBFA and DRA with high procedural integrity following training and performance feedback. Two of three teachers successfully generalized TBFA and DRA skills learned during BST to a second student with at least 90% accuracy. Flynn and Lo indicated that in addition to programming common stimuli and training sufficient exemplars, providing teachers with immediate feedback (positive and negative), training skills to mastery, and allowing teachers to contact natural reinforcement (i.e., student behavior improvements) may also have contributed to generalized skill use to the second set of students. Furthermore, Flynn and Lo suggested that the third teacher who failed to generalize the skills (i.e., low treatment implementation for second student) likely needed ongoing performance feedback and booster sessions (Flynn & Lo, 2016; Shayne & Miltenberger, 2014). In summary, BST with explicit generalization training strategies appears to be an excellent training framework for teaching teachers how to differentiate instruction for independent seatwork assignments based on PDA results.

Purpose of Current Study

Independent seatwork is a fundamental element of classroom learning. Assigning proper instructional exercises during independent seatwork time is essential to evoking the kind of active student responding necessary to build skill accuracy, fluency, and generalization (Binder, 1996; Daly et al., 1996; Daly et al., 2007; Gickling & Armstrong, 1978; Howell & Nolet, 2000; Lentz & Shapiro, 1986; Treptow et al., 2007). However, not all students can complete their work independently, and some may require additional guidance and support from their teachers (Linan-Thompson & Vaughn, 2010). When students are not completing their independent seatwork, a variety of factors may limit their performance, including task difficulty and competing reinforcement contingencies. The diversity of proficiency and motivational levels in a classroom requires teachers to differentiate instruction across students to maximize the effects of instructional time for each student (Howell & Nolet, 2000). Teachers can use explicit instruction strategies to differentiate instruction across students, including prompting, modeling, error correction, performance feedback, and reinforcement contingencies with the objective of building accurate and fluent skill repertoires.

In order for teachers to differentiate instruction appropriately, teachers must know when to apply specific instructional strategies. PDA has proven to be a useful tool for differentiating between skill- and performance-deficits (Duhon et al., 2004; VanDerHeyden & Witt, 2008). PDA is a relatively simple assessment method for determining whether a student's measured performance accurately reflects skill or motivation problems (VanDerHeyden, 2014). To further improve PDA, it can be configured to incorporate elements of the MSWO preference assessment (including repeated comparisons of potential reinforcers across sessions). Doing so will likely increase the reliability of identifying skill- versus performance-deficits while also validating multiple items and/or events as appropriate programmed reinforcement for remedial intervention plans. Students who have skill deficits will require guided practice (e.g., prompting, modeling, feedback, error correction) and DRA. Students with performance deficits will need more powerful consequences, which, having identified them through the PDA, teachers can then deliver them through DRA interventions. Because teachers receive little to no training in functional assessment, teachers likely will benefit from robust training in how to interpret PDA results to differentiate instruction across students experiencing problems with work completion in their classrooms.

The purpose of this study was to train teachers to effectively differentiate instruction to address work-completion problems across students. Specifically, the study addressed three research questions. First, does training teachers in the use of PDA results lead them to effectively differentiate instruction for a target student referred for poor work completion in math during independent seatwork exercises? Second, do changes in instructional strategies following training lead to increases in student work completion during independent seatwork exercises? Third, after teachers modify instruction based on PDA results for their first student, will they select appropriate empirically derived interventions for a case example that includes PDA results, thereby generalizing newly learned skills? It was hypothesized that training teachers in the use of PDA results would increase their application of instructional and motivational strategies to differentiate instruction to address work completion problems in students referred for intervention (research questions 1 and 3). It was also expected that each student's work completion would improve if teachers appropriately differentiate instruction according to the results of the PDA (research questions 2).

To answer these research questions, a multiple-baseline-across-participants design was used to measure both teacher behavior and student responding on independent seatwork tasks. Participants included three teachers and three students (one in each teacher's classroom) who were referred for having difficulty completing their work, particularly during independent seatwork time. Treatment implementation was staggered across teachers in order to establish experimental control. During baseline, the experimenter observed teacher behavior for the presence of various instructional and motivational strategies used in the classroom that have been shown to promote work completion (e.g., instructions, modeling/prompting, error correction, praise, performance feedback, programmed reinforcement, modifying task difficulty). Baseline data were collected on teacher instruction and student work completion (rate and accuracy) with all three teacher-student dyads.

Following baseline, components of BST were used to provide teachers with didactic training on instructional and motivational variables that should be differentially promoted to increase work completion for students that have skill- and performance-deficits. Training instructed teachers in how to use the results of PDA to determine if they need to increase the potency of DRA interventions and/or implement instructional strategies (modeling, prompting, error correction, praise) to improve skill acquisition and fluency. Strategies to program for generalization of instructional skills included training sufficient exemplars (multiple case examples in analogue form), programming common stimuli (e.g., providing training handouts), and training in the natural environment (in the teachers' classrooms). Training was conducted until teachers demonstrate mastery on a knowledge quiz designed to test their conceptual understanding of skill- and performance- deficits and demonstrate the appropriate application of results to differentiate instruction for multiple case examples. During training, the experimenter provided the results of their student's PDA to the teachers. After reviewing student data, the teachers were prompted to choose which strategies to use with their student during independent work time. In order to probe for generalization effects, following teacher training and intervention with their student, teachers were given PDA results from a case example and prompted to answer questions about how to differentiate instruction for this hypothetical student. Finally, student work completion accuracy and rate during independent seatwork were assessed for each student throughout the study (baseline and intervention) to measure the impact of their teachers' instructional modification.

Chapter 2: Method

Participants and Setting

The current study took place at a middle school located in the Midwest. Approval for this study was obtained from the Human Subjects IRB (IRB Number 20181218734 EX). Teachers and primary caregivers of all referred students signed IRB-approved consent forms. Additionally, an approved protocol by the Institutional Review Board was used to gain child assent. Participants were three teachers and three students. The students were all referred for poor work completion in math. Annie was a 6th grade, white Hispanic female. Clay was a 7th grade, biracial (white, Alaskan) male. Kyle was an 8th grade, biracial (white, black) male. All three students received special education services and had individual education plans with math goals. Annie and Kyle were verified under Other Health Impaired (with ADHD diagnosis) and Clay was verified under Speech-Language Impairment. All three teachers were white and female. Kyle and Clay's teachers were their general education teacher and Annie's teacher was her resource teacher who assisted students in their general education math classroom. All observations, teacher training, and treatment implementation occurred within the teachers' classrooms. The PDAs were performed in the school's media center.

Materials

Classroom Observation Form

In order to compare teacher and student behavior before and after intervention, a classroom observation form (Appendix A) was used to collect data regarding teacher instruction (described below) and student active academic responding during the targeted instructional time. The observation form included a list of behavioral definitions.

Programmed Reinforcement

Tangible items (e.g., small toys, stickers) and activities (e.g., iPad time, game time with a friend, playing basketball in the gym) nominated by teachers were used in the PDA.

Permanent Products

Student work products were gathered following target independent work time. For all three target students, Aimsweb® Math Computation progress monitoring probes at the appropriate grade level were provided for independent work time and were used as permanent products.

Teacher Training Materials

PowerPoint® Presentation. Teacher training materials included a PowerPoint® presentation (Appendix G) used for didactic instruction. The PowerPoint® presentation included definitions, explanations, visual aids, and multiple exemplars to aid in generalization.

Handouts. Handouts (Appendix C) included: (a) a decision tree for analyzing student data, (b) a visual aide for selecting strategies, (c) descriptions of each strategy, and (d) sample universal intervention protocols that describe how to combine and use the instructional strategies. The universal intervention protocols described the essential steps to implementing the strategies, including clarifying contingencies, providing instructions, modeling/prompting, praise, error correction, performance feedback, delivering contingent rewards, and changing instructional levels.

Knowledge Quiz. A knowledge quiz was provided to teachers following training via Qualtrics. The quiz contained 15 multiple-choice questions, including conceptual definitions and case example application problems (Appendix D).

Case Application Probes. In order to measure the application of training knowledge before and after training, as well as generalization of knowledge, each teacher was given three similar, brief probes at three different time points during the study. The probes were sent to teachers as surveys on Qualtrics® and consisted of a graphic of PDA results and questions assessing their interpterion of the data and how they would use it to differentiate instruction for that student. The case application probes consisted of one probe after baseline and before teacher training based on a made-up case example, a second probe with individualized student data for each teacher's target student, and a third probe with a generalization case example to probe maintenance and generalization of knowledge. All probes contained the same questions but varied in the data presented. An example case application probe can be found in Appendix E.

Measurement of Dependent Variables

The dependent variables in this study included teachers' instructional behavior, student rate of work completion and accuracy, and student classroom behavior (active student responding).

Teacher Instructional Behavior

The primary dependent variable for this study was teacher implementation of instructional strategies during targeted instructional time. This variable was measured using a partial-interval recording format with 20-s intervals. Teacher and student dyads were instructed to have the student work on completing each probe for around 7 minutes during baseline as a general guideline. Teachers were given more flexibility in choosing how long a student could work on a probe during the intervention phase in order to allow them to differentiate instruction as they deemed appropriate. Thus, the total length of each recording session was around 7 minutes. In addition, for both baseline and intervention observation sessions, the total time or number of 20-s interval completed was recorded and later used to calculate rate of work completion, which allowed for variability in implementation in the classroom. Within each 20-s interval, each of the teachers' instructional behaviors was recorded as either an antecedent instructional behavior that prompted a new academic response (controlling prompts, modeling) or a consequence instructional behavior that followed a student's academic response (modeling, error correction, response repetition, or praise). Results were scored as percentage occurrence by dividing the number of intervals in which antecedents or consequences occurred by the total number of intervals for the session and multiplying the result by 100.

Observers also recorded whether several other instructional behaviors occurred during each observation, including whether the teacher: (a) provided the student with directions to complete the assignment, (b) offered a reward for work completion at the beginning of the exercise, (c) provided performance feedback, and/or (d) allowed access to a programmed contingency at the end of the exercise.

Work Completion and Accuracy

Rate of work completion and accuracy of problem completion were measured via permanent products (grade-level Aimsweb® math computation probes) completed during the targeted instructional time. To standardize the instructional tasks across baseline and intervention phases, Aimsweb® math computation probes were used. While teachers may have prompted verbal responses during independent seatwork exercises, only written responses that could be reviewed on the permanent products were used to measure student outcomes (research questions #2). For this study, a completed response was considered to be a written response to an academic prompt, question, or problem on a worksheet (Aimsweb® math computation probes). Specifically, for the math probes, responses with an identifiable number written in the designated location (i.e., under the equals line) were counted as completed problems. Rate of work completion per min was calculated by dividing the number of completed responses by the time it took the student to complete the task in seconds and multiplying the result by 60 to obtain a measure of rate per min. Accuracy of problem completion was calculated as percentage of correct math problems on the math probe. An accurate response was defined as a correctly written response in the proper location on the math probe. The number of correct problems was divided by the total number of problems attempted, and the result was multiplied by 100 to obtain a percentage. If a teacher assisted a student with solving a problem, the answer was counted as accurate.

Academic Responding

Active Student Responding (ASR) was recorded using a 20-s partial-interval recording system. ASR is defined as reading aloud, answering an academic question (verbally, in writing, or on a keyboard), asking an academic question, or writing a response. The definition did not include reading silently or looking at an assignment. Results were scored as percentage occurrence by dividing the number of intervals in which ASR occurred by the total number of intervals for the session, and then multiplying the result by 100. ASR was measured concurrently with teacher instructional behavior on the classroom observation form.

Due the extended time frame of the study and naturalistic classroom conditions, the first two participants moved into a generalization phase in which the students were observed for ASR during the target independent work time while completing either naturalistic classroom assignments or Aimsweb® math probes, depending on the teachers' preference. During observations in which the Aimseweb® probes were not used, permanent products were not collected or scored. This occurred for two of Annie's sessions and four of Kyle's sessions.

Interobserver agreement

To measure interobserver agreement (IOA), a second observer independently and simultaneously observed teacher and student behavior for at least 33% of sessions. To obtain a percentage agreement between observers for teacher and student behavior, the number of agreements for behavioral occurrence or non-occurrence was divided by the total number of agreements and disagreements, and then multiplied by 100 (i.e., point-by-point agreement ratio; Kazdin, 2011).

For classroom observation, two observers stood several feet away from each other while observing behavior to ensure they did not see what the other was observer was recorded. IOA was calculated for 46% (n=6) of Annie's classroom observation sessions. Average IOA across all sessions and categories was 95.60% (SD = 5.99). Average IOA for active responding across sessions was 96.48% (SD = 5.46). Average IOA was for teacher use of instructional strategies was 95.50% (SD = 7.03) for use of antecedent strategies and 94.81% (SD = 8.51) for use of consequence strategies.

IOA was calculated for 35% (n=6) of Kyle's classroom observation sessions. Average IOA across all sessions and categories was 95.24% (SD = 2.89). Average IOA for active responding across sessions was 92.76% (SD = 5.73). Average IOA for teacher use of instructional strategies was 96.82% (SD = 4.58) for use of antecedent strategies and 96.15% (SD = 4.99) for use of consequence strategies.

IOA was calculated for 44% (n=7) of Clay's classroom observation sessions. Average IOA across all sessions and categories was 99.08% (SD = 0.87). Average IOA for active responding was 97.96% (SD = 2.57). Average IOA for teacher use of instructional strategies was 99.29% (SD = 1.89) for use of antecedent strategies and 100% for use of consequence strategies.

Interrater agreement was also calculated for accuracy for at least 33% of the permanent products. To calculate agreement for accuracy, permanent products were scored by two independent observers. For accuracy, the total number of agreements for both correct and incorrect problems was divided by the total number of problems, and the result was multiplied by 100 to produce percentage agreement.

For work products, a second observer received copies of the permanent products and independently scored them following conclusion of the study. Any marks from teachers indicating correct or incorrect problem completion were removed before the second observer scored the permanent products. For Annie's completed permanent product probes, interobserver agreement was completed for 46% of probes (n=6) across baseline and intervention sessions. Percentage agreement across these probes was 99.12%. For Kyle's completed permanent product probes, interobserver agreement was completed for 54% of probes (n=7) across baseline and intervention sessions. Percentage agreement across these probes was 96.43%. For Clay's completed permanent product probes, interobserver agreement was completed for 56% of probes (n=9) across baseline and intervention sessions. Percentage agreement across these probes was 99.48%.

Experimental Design

A multiple-baseline across participants (teachers) design was used. Teacher and student behavior were measured continuously in baseline and intervention phases during classroom observations. Intervention (i.e., teacher training) was staggered across teachers to isolate treatment effects. Student behavior (active responding), rate of work completion, and accuracy were measured to examine teacher effects on student behavior. Results were analyzed for each student to test training effects directly (research question #2) and then a case example was administered along with application questions to each teacher to probe for potential generalization of skills (research question #3).

Procedures

Screening

Screening was conducted to identify students for inclusion in the study. The experimenter met with teachers to discuss and examine work samples from the referred students in order to confirm low levels of work completion and/or accuracy. For inclusion in the study and to avoid possible ceiling effects, the experimenter examined worked samples with each teacher to ensure that work completion and/or accuracy were generally below 80% for each of the target students and that there was room for improvement.

Baseline

During baseline, the teachers were instructed to follow their typical classroom procedures and to provide instruction as they usually would for the target students. As such, apart from the fact that standardized computation tasks were used, it was a "business-as-usual" condition. Teacher received no further directions or feedback for instruction. If teachers asked for further directions regarding student support, the experimenter reminded the teachers to provide the same support they would typically have provided for the target student during independent work time.

Performance Deficit Analyses

The experimenters conducted individualized PDAs with each target student. Each teacher was first asked to nominate items and/or activities that she would be willing to use as possible programmed reinforcers in the classroom. Assessment sessions included a baseline session, a training session, and four contingent-reward sessions (each described below). The results were used to determine whether the student had a skill- or performance-deficit, as well as identify multiple activities or items that could serve as programmed reinforcers as part of a DRA intervention.

Baseline. For baseline, the experimenter administered instructions in a typical classroom manner (e.g., "Here is a worksheet with addition and subtraction problems. When I tell you to start, I would like you to start at the beginning, go in order and keep working until I tell you to stop. If you do not know an answer you can skip it, but make sure to try your best"). The experimenter then prompted the student to complete the worksheet for 7 min. The student did not receive any additional instructions or programmed reinforcement for completing the worksheet during the baseline session.

Reward training session. A brief training session was conducted in order to ensure that each student understood the programmed reinforcement contingency prior to contingent-reward sessions with typical instructional tasks. The experimenter presented a reward menu containing items nominated by the teacher to the student, explained what each reward was, and told the student that he or she would have the opportunity to earn a reward for meeting a mystery performance criterion. The student was prompted to choose a reward and then was presented with a simple academic task. An easy instructional task (single-digit addition problems) was used to maximize the likelihood that each student would earn access to the programmed reinforcer in this session. This step was taken to forestall possible extinction effects when harder, grade-level tasks were used in subsequent sessions, should the participants not earn the rewards. The experimenter then instructed the student to complete the addition problems for 1 min. After 1 min, the experimenter counted the student's score and provided performance feedback to the student on the number of problems correctly completed, revealed the criterion for performance, and told the student whether he or she met the performance criterion. The reward was then presented to the student contingent on meeting the predetermined performance criterion. The reward was either immediately provided to the student (e.g., candy, small toy) or was written on a coupon to receive later if not immediately feasible (e.g., gym time, game with a friend). The item selected during this session was returned to the reward menu until it was selected during the contingent reward condition.

Contingent-reward condition. In this condition, students had the opportunity to earn a reward contingent on meeting a predetermined performance criterion. The target behavior was number of completed, accurate problems. For each session, the experimenter selected a performance criterion between [baseline score +1] and [baseline score x 1.5] using a random number generator prior to the session. At the beginning of each session, the experimenter presented the reward menu to the student and prompted the student to select the reward he or she would like to work for. If the student pointed to a reward without verbally selecting one, the experimenter asked the student to confirm the choice (e.g., “You would like to work for iPad time today, is that correct?”). Next, the experimenter held up a 4X6 index card with a mystery performance criterion written on the back. The experimenter told the student that he or she would be able to earn the selected reward if their performance met or exceeded the criterion written on the card. After asking the student if he or she has any questions, the experimenter presented the instructional task to the student and prompted them to begin working. When the work session was complete, the experimenter scored the assignment and provided feedback to the student on their performance relative to the performance criterion. If the student met or exceeded the criterion, the reward would be delivered to the student or the student would be given a coupon indicating that he or she earned the reward that could be accessed in the classroom. If the student did not meet the criterion, the experimenter indicated that the student did not earn the reward but would have more chances to earn a reward in the future. These reward sessions were conducted four times with each student. After each session, the selected reward was eliminated from the reward menu in subsequent sessions regardless of whether the student earned the reward.

The results of the contingent-reward condition were compared to baseline to determine whether each student had a skill- or performance- deficit. The results were also used to identify potentially effective programmed consequences for the teacher to use during the targeted instructional period. If student performance increased relative to baseline when provided with access to contingent reinforcement, the student was determined to have a performance deficit, which indicated that DRA was the appropriate intervention strategy. If student performance did not increase significantly or consistently relative to baseline, the student was determined to have a skill deficit, which meant that an intervention containing both DRA and instruction was necessary.

Teacher Training

Behavior Skills Training. The experimenter used BST components (instructions, modeling, rehearsal, feedback) to train the teachers on how to interpret PDA data and modify instruction. First, the experimenter met with the teacher to provide didactic instruction on the conceptual distinction between skill and performance deficits, how to interpret PDA results, and which instructional variables should be promoted for students with each type of deficit. The experimenter utilized a PowerPoint® presentation to provide objective definitions and demonstrate relevant examples for each concept or instructional strategy. The experimenter provided the teachers with handouts that included a decision tree designed to guide interpretation of PDA results and a chart to guide selection of strategies based on PDA results. Handouts also included explanations of each of the targeted instructional strategies, visual aides/graphics from the training presentation, and example universal protocols outlining how a teacher could implement the strategies.

Next, the experimenter presented two hypothetical case examples to the teacher that included demographic information, targeted classroom setting and exercises, and PDA results. The experimenter modeled how to use the handouts to interpret the PDA results and then select intervention strategies based on a skill- or performance- deficit determination. Following modeling, the experimenter had the teacher practice (rehearsal) completing three other case examples. The experimenter provided feedback to the teacher, including descriptive praise for correct application of training and error correction for mistakes. The experimenter continued providing modeling, rehearsal, and feedback until the teacher demonstrated correct understanding for all case examples, providing multiple exemplar training. The experimenter then discussed how these strategies could be combined to increase work completion for the target student. Altogether, BST took place over a 1-hour training session with each teacher. The experimenter programmed common stimuli by conducting training in the teacher's classroom, using grade-appropriate tasks, and using programmed reinforcers the teacher nominated as acceptable in his or her classroom. Additionally, during the intervention phase, the experimenter prompted the teachers to refer to training materials in order to support each student in accurately completing the assigned task.

Knowledge quiz. After didactic training, the experimenter provided a knowledge quiz to the teacher in order to provide additional practice applying skills and concepts learned in training and in order to check for skill mastery. The quiz consisted of 15 multiple-choice questions, including conceptual definitions and case example application problems (Appendix C). The experimenter scored the results for accuracy. If teachers scored 100% on the knowledge quiz they were provided with their score and prompted to begin instructional modification. If teachers scored below 100% then the experimenters provided the teachers with performance feedback. The experimenter reviewed incorrect questions with the teacher by modeling how to answer the missed items and reviewing any relevant conceptual material. Following this feedback, the teacher was asked to verbally re-answer missed questions and describe why that answer is correct. This process was completed until the teacher reached mastery, which was 100% accuracy across items.

Instructional modification. Following training and the knowledge quiz, teachers were prompted to use their target student's data to differentiate instruction according to the PDA results. In order to ensure accurate evaluation of their target student's PDA results, each teacher was given a brief, 5-question case application probe for the target student via Qualtrics. The probe included their student's PDA results and questions about interpreting the results. The final question in the survey prompted the teacher to select which instructional and/or motivational strategies she would implement based on her decision about whether the student had a skill- or performance- deficit. The experimenter provided feedback to each teacher if their initial responses to this question were not deemed adequate to appropriately differentiate instruction for the target student. Teachers were then asked to implement the selected strategies during the targeted instructional time.

At the end of the intervention phase, each teacher was given the final Qualtrics case application probe which included a PDA results of a made-up generalization case and prompted the teacher to interpret the data and decide what kinds of modification the student might need.

Treatment Integrity

To evaluate whether the procedures were implemented as designed by the experimenters, independent observers listened to audio recordings of at least 33% of the PDA sessions that were implemented by other experimenters. The independent observers followed the same protocol (Appendix E) that the experimenters used and indicated which steps were completed and which steps were not completed. Results were scored as percentage of steps completed by dividing the number of steps implemented correctly by the total number of steps, and then multiplying the result by 100.

For Annie's PDA sessions, including training, baseline, and reward sessions, the experimenters completed on average 94.44% of the steps (SD = 8.61). The experimenters completed 100% of the steps correctly for the training session, 100% for the baseline session, and an average of 91.67% for the reward sessions (SD = 9.62). In two of the four reward sessions, only 5 of 6 steps were completed accurately due to insufficient time being provided to Annie to complete the probe. Due to an administration error, 3 min were provided instead of 7 min.

For Kyles' PDA sessions, including training, baseline, and reward sessions, the experimenters completed on average 97.22% of the steps (SD = 6.80). The experimenters completed 100% of the steps correctly for the training session, 100% for the baseline session, and an average of 95.83% for the reward sessions (SD = 8.33). In one of the four reward sessions, only 5 of 6 steps were completed accurately due to insufficient time being provided to Kyle to complete the probe. Due to an administration error, 3 min were provided instead of 7 min.

For Clay's PDA sessions, including training, baseline, and reward sessions, the experimenters completed on average 94.44% of the steps (SD = 8.61). The experimenters completed 100% of the steps correctly for the training session, 100% for the baseline session, and an average of 91.67% for the reward sessions (SD = 9.62). In two of the four reward sessions, only 5 of 6 steps were completed accurately due to insufficient time being provided to Clay to complete the probe. Due to an administration error, 3 min were provided instead of 7 min.

In addition, two independent observers listened to audio recordings of each teacher's training session in which the experimenter delivered training to the teacher. The independent observers were given a protocol (Appendix F) with 12 topics that were supposed to be addressed by the experimenter during each training. Observers scored the sessions for four training factors that should have occurred for each topic: *introduced*, *explained*, *discussed*, and *examples given*. Specifically, they were asked to mark YES or NO to indicate whether the experimenter: (a) *introduced* the topic, (b) *explained* the topic, (c) supported the concept with *examples*, and (d) *discussed* the topic to check for understanding and respond to consultee contributions in the session. At a minimum, each topic needed to be *introduced* and *explained* in order to be considered addressed in training. The number of topics addressed was marked and the percentage of topics addressed out of 12 was calculated by dividing the observed number of topics recorded by 12 and multiplying the result by 100 to obtain a percentage. The lower of the two scores between the raters for each of the four training topics was taken as the score for the session. The results indicate that the experimenter introduced and described all 12 topics appropriately in 100% of the training sessions, meeting the minimum requirement for addressing each topic. They also indicate that across teacher training sessions the experimenter provided examples on 53.78% of the topics on average (SD = 12.73), and discussed topics in greater detail on 20.83% of the topics on average (SD = 9.62) across teachers.

Data Analysis

Visual Inspection

Data were displayed on graphs and analyzed using visual inspection. Specifically, data were inspected for changes in level (i.e., magnitude of responding), trend (i.e., slope; systematic increases or decreases in responding), and variability (i.e., consistency of responding) between baseline and intervention phases (Kazdin, 2011). In the multiple-baseline design data display, results were also inspected for presence of staggered behavior change. If each teacher demonstrated increases in performance only after her introduction to intervention while subsequent baselines remain stable, one can conclude that the intervention rather than extraneous variables led to the change, thereby establishing experimental control (Kazdin, 2011).

Effect Size

While visual inspection remains the gold standard for interpreting single case design data, statistical tests of significance are often used to supplement visual analysis (Kazdin, 2011). The addition of an effect size can serve to standardize results to evaluate evidence-based practices, as well as increase credibility and reliability of results (Vannest & Ninci, 2015). Baseline Corrected Tau (Tarlow, 2017) was used to supplement visual analysis for the current intervention due to its utility with pre- and post-treatment designs and its ability to detect and correct for, only if necessary, baseline trends (Tarlow, 2017). This analysis was conducted using a web-based calculator for Baseline Corrected Tau (http://ktarlow.com/stats/tau/; Tarlow, 2016). Baseline Corrected Tau estimates effect sizes for AB single-case design studies using a two-step process. First, data for baseline (A) and intervention (B) phases were entered into the calculator to test for evidence of baseline trend. If a statistically significant baseline trend was present, a nonparametric

Theil-sen estimator corrected the trend across both A and B phases. The calculator then recommended whether to estimate the effect size with an uncorrected Tau analysis or with a Baseline Correct Tau. Once the correct effect size estimator was selected, the calculator displayed the resulting effect size. The effect size was bound between -1 and +1, which indicates the strength and direction of the effect. If the Tau value is greater than zero, it indicates that there is a positive association between treatment and the outcome variables. If the p value is less than .05 it is considered to be a significant change in behavior across phases (i.e., the intervention increased rates of teacher behavior, increased student accuracy and/or work completion). Tau can be further interpreted as a small change (.00 - .20), moderate change (.20 - .60), large change (.60 - .80), or very large change (.80 – 1.00; Vannest & Ninci, 2015). This procedure was used for each of the teacher's individual baselines and intervention phases, as well as with each of the students' baseline and intervention phases for rate of work completion and accuracy. Notably, while each of these baselines were evaluated for baseline trend using the web-based calculator, no corrections were indicated for any of the calculations. Thus, a traditional Tau analysis was conducted with the calculator.

Chapter 3: Results

Performance Deficit Analyses

Figures 1 through 3 display the results of the performance deficit analysis (PDA) for each student. A single baseline session followed by multiple reward sessions appears in each figure. Results are displayed first as the number of correct problems (top panel in the figure) and then as the rate of correct problems (bottom panel in the figure). Due to an administrative error, several sessions were conducted for 3 min instead of 7 min. These sessions are indicated with an asterisk (*) in the figure. Due to the error, rate of responding (correct problems per min) was reported for all sessions to standardize the results. The session names along the horizontal axes describe either baseline or the item chosen by the participant for that session. The reward criterion for each reward session is indicated by the horizontal line appearing above the horizontal axis in each Figure.

Annie

Figure 1 displays Annie's PDA results. Annie increased her performance relative to baseline for two reward sessions (small toy/desk supply, computer time), returned to the baseline level for one session (break/free time), and decreased her performance for one reward session (drawing) relative to baseline. Annie met the performance criterion and was provided contingent access to reinforcement for one reward session, earning access to a small toy or desk supply. Annie displayed an increasingly higher rate of correct problems per min across reward sessions. Annie's average score for correct problems (M = 12, range = 8 – 19) and correct problems per min (M = 2.71, range = 1.14 – 3.67) were higher than her baseline scores of 10 correct problems and 1.43 correct problems per min. Although Annie increased her number of correct problems relative to baseline during two sessions, her performance in the other sessions was at or below baseline levels, indicating that Annie had a skill deficit that needed to be remediated through an intervention that contained both instruction and DRA. The results also suggested that a small toy/desk supply (due to increased performance) and drawing (due to first choice) could have been effective rewards for a DRA intervention.

Kyle

Figure 2 displays Kyle's PDA results. Kyle increased his performance on the math computation probes relative to baseline for all four reward sessions. Additionally, Kyle met the performance criterion and was provided contingent access to reinforcement during each session, earning access to gym time, music, walk, and free time. Kyle's average score for correct problems (8.25, range = 8 – 9) and correct problems per min (1.56, range = 1.14 – 2.66) were higher than his baseline scores of 6 correct problems and 0.86 correct problems per min. While Kyle's performance increased relative to baseline for each reward session, the magnitude of change was low, indicating that Kyle had a skill deficit that needed to be remediated through an intervention that contained both instruction and DRA. Kyle's increase in performance during each session suggested that all of these rewards could have been an effective during intervention.

Clay

Figure 3 displays Clay's PDA results. Clay increased his performance relative to baseline for two reward sessions (music; small toy) and decreased his performance for two reward sessions (homework pass; candy) relative to baseline. Clay did not meet the performance criteria for any reward session and thus was not provided with contingent access to reinforcement. Clay's average score for correct problems (8.25, range = 2 – 13) was lower than his baseline score of 10 correct problems. Clay's average score for correct problems per min (1.61, range = 0.67 – 2.33) was higher than his baseline score of 1.43 correct problems per min. Clay increased his number of correct problems for two reward sessions and increased his rate of correct responding for three reward sessions, however he displayed small magnitudes of improvement and he did not meet any of the performance criterion, indicating that Clay had a skill deficit that needed to be remediated through an intervention that contained both instruction and DRA. The results also suggested that a small toy, music, or homework pass (largest increase in rate) could have been an effective reward for DRA intervention.

The PDA results reveal that all three participants had skill deficits. Any increases relative to baseline were either small (e.g., Kyle and Clay) or inconsistent (Annie), indicating the need for instruction plus DRA during independent seatwork. Therefore, the empirically derived intervention for each participant was instruction plus DRA.

While scoring treatment integrity, it was discovered that in one to two sessions per participant, the experimenter incorrectly terminated the session after 3 min instead of 7 min, which is why problems correct per min was also reported. Unfortunately, the participants did not reach the criterion and thus did not earn the reward in these sessions (except for Kyle), which might have affected the results for the subsequent sessions by extinguishing student engagement and led to an incorrect conclusion regarding skill versus performance deficits. However, performance increased in subsequent sessions following each 3 min session (albeit not substantially) for Kyle and Clay, which should perhaps reduce concern about this possible confound. For Annie, it was the final two reward sessions which were terminated early. Annie did display an increase in rate across sessions, however this does not reflect a possible ceiling effect for Annie at 3 min given that she skipped many complex problems on the probes and completed easier problems first. That said, the empirically derived interventions may have included unnecessary instructional components.

Instructional Modification

The results for teachers' use of explicit instruction strategies for increasing students' work completion appear in Figure 4. Descriptive statistics and effect size outcomes appear in Tables 1 and 2. During baseline, Annie's teacher displayed low levels of responding and a decreasing trend for both antecedent strategies and consequence strategies. Following training, Annie's teacher displayed levels of responding that remained stable with initial baseline levels. However, during the second intervention session Annie's teacher displayed a large increase in her level of antecedent and consequence strategies which were well above baseline levels. For four sessions, Annie's teacher displayed levels of antecedent and consequence strategies that were variable, but remained above baseline levels. Annie's teacher then displayed a decrease in her level of responding for both strategies for the remainder of sessions, with stable levels of responding that returned to and overlapped with baseline levels. Including, two generalization sessions following a large gap in treatment implementation. For the majority of individual sessions, Annie's teacher displayed similar levels of each strategy with a relatively higher percentage occurrence of antecedent strategies compared to consequence strategies. Overall, Annie's teacher's mean intervention percentage occurrence during the intervention phase for both antecedents (M = 36.26%, SD = 29.46) and consequences (M = 29.53%, SD = 22.82) was higher than her baseline use of antecedent strategies (M = 13.70%; SD = 15.17) and consequence strategies (M = 10.37%; SD = 5.04). Of note, Annie's teacher displayed a decrease in level of responding shortly after Kyle's teacher was introduced to the intervention phase.

During baseline, Kyle's teacher displayed stable, low levels of responding for both antecedent and consequence strategies, including when Annie's teacher was moved into the intervention phase. Following training, Kyle's teacher displayed an immediate and large increase in her use of both antecedent and consequence strategies which did not overlap with respective baseline levels. Kyle's teacher displayed variable levels of responding during the intervention phase for both antecedent and consequence strategies, but they remained higher than baseline levels for the majority of sessions. Within the majority of individual sessions, Kyle's teacher displayed similar levels of each strategy with a relatively higher percentage occurrence of antecedent strategies compared to consequence strategies. During the final four sessions of intervention Kyle's teacher moved into a generalization phase, in which she initially increased her level of both strategies above all previous sessions. She then displayed a decrease in consequence strategies that returned to baseline levels and then gradually increased her use of consequence strategies for the final two sessions. For antecedent strategies during the generalization phase, Kyle's teacher displayed decreasing levels, fell to baseline levels, and then increased again for the final session. Overall, Kyle's teacher's mean intervention percentage occurrence during the intervention phase for both antecedents (M = 29.70%, SD = 18.89) and consequences (M = 21.03%, SD = 17.98) was higher than her baseline use of antecedent strategies (M = 5.35%, SD = 6.33) and consequence strategies (M = 1.51%, SD = 2.58).

During baseline, Clay's teacher displayed low levels of responding and a decreasing trend for both antecedent and consequence strategies. Her responding remained low as Annie and Kyle's teachers moved into the intervention phase. Following training, Clay's teacher displayed an immediate and large increase in her level of both antecedent and consequence strategies which did not overlap with respective baseline levels. For the remaining intervention sessions, Clay's teacher displayed a stable level of antecedent and consequence strategies that were significantly lower than the first intervention session but still above baseline levels for the majority of sessions. Within the majority of individual sessions, Clay's teacher displayed similar levels of each strategy with a relatively higher percentage occurrence of consequence strategies compared to antecedent strategies. Overall, Clay's teacher's mean intervention percentage occurrence during the intervention phase for both antecedents (M = 25.20%, SD = 22.91) and consequences (M = 31.98%, SD = 22.52) was higher than her baseline use of antecedent strategies (M = 3.03%, SD = 4.84) and consequence strategies (M = 1.53%, SD = 3.41).

All three teachers displayed immediate increases in percentage occurrence of instructional strategies above baseline levels only once they completed their individual training session and they were moved to the intervention phase. Although each teacher's use of instructional strategies increased above baseline levels during the intervention phase, they each displayed a decrease in responding over the course of the intervention phase. Despite some instability in intervention use throughout the phase, the results were characterized by initial treatment effects for all participants accompanied by stability in subsequent baselines for the first two subjects, an indication that experimental control was achieved and that common threats to interpretation such as history, maturation, and repeated testing did not influence the results. According to effect size estimates, teacher training did not increase Annie's teacher's use of antecedent (Tau = 0.337, p = 0.202) and consequence (Tau = 0.377, p = 0.150) instructional strategies. However, teacher training had a large, significant effect on Kyle's and Clay's teachers' instructional modifications, with Kyle's teacher significantly increasing her use of both antecedent (Tau = 0.658, p = 0.002) and consequence strategies (Tau = 0.663, p = 0.003). Clay's teacher also significantly increased her use of both antecedent (Tau = 0.710, p = 0.001) and consequence strategies (Tau = 0.808, p = 0.001).

Student Outcomes

Active Student Responding

The results for students' active student responding (ASR) before and after teacher training appear in Figure 4. Descriptive statistics and effect size outcomes appear in Tables 3 and 4. Annie displayed a high-level of ASR during baseline, which remained stable with an overall increasing trend, reaching 100% in the last session. Following intervention, Annie's overall level of ASR (M = 90.58%, SD = 6.06) fell below baseline levels (M = 96.48%, SD = 3.06), but still remained above 80%. Kyle displayed moderate to low levels of ASR during baseline, which were highly variable and ended with a decreasing trend. Following intervention, Kyle's behavior was entirely overlapping with baseline levels. Although, his mean level of ASR during intervention (M = 49.89%, SD = 20.42) was slightly higher than his mean level during baseline (M = 42.44% = SD = 17.39). Clay displayed a high-level of ASR during baseline, which remained stable. Following intervention, Clay maintained his high rate of ASR for two intervention sessions and then displayed a decreasing trend for the remainder of the sessions. Overall, Clay's level of ASR during intervention (M = 89.37%, SD = 9.02) had a stable decreasing trend that was slightly lower and overlapped entirely with baseline levels (M = 92.07%, SD = 8.61).

Overall, only Annie displayed an immediate and discernable change in ASR following intervention. However, the results were mostly overlapping between baseline and intervention phases, especially for Kyle and Clay. Effect size estimates also indicate that teacher modifications did not lead to significant changes in active responding for Annie (Tau = -0.363, p = 0.173), Kyle (Tau = 0.113, p = 0.625), or Clay (Tau = -.125, p = 0.619).

Work Completion

The results of teacher's instructional modification on students' rate of work completion and accuracy appear in Figures 5 – 10. Descriptive statistics and effect size outcomes appear in Tables 5 - 7.

Annie. For rate of total work completion (Figure 5), Annie displayed an increasing trend during baseline. Following intervention, Annie displayed an immediate decrease in level of responding compared to baseline and then gradually increased her responding back to baseline levels. Overall, she displayed lower rates of total work completion during intervention (M = 1.65, SD = 0.57) than in baseline (M = 2.51, SD = 0.28). For rate of correct work completion, Annie displayed a low but increasing trend during baseline. Following intervention, Annie displayed an immediate decrease in level of responding and then gradually increased her responding; the results overlapped entirely with baseline levels. Annie ended the intervention phase with a decreasing trend in rate of correct work completion. Overall, she displayed overlapping and slightly lower average rates of correct work completion in intervention (M = 1.40, SD = 0.49) than in baseline (M = 1.76, SD = .053). For rate of incorrect work completion, Annie displayed an overall decreasing rate during baseline. Following intervention, errors continued to decrease, stabilized for a period at very low levels, and then increased toward the end of the intervention phase, forming a U-curve shape. Overall, Annie's average rate of incorrect work completion during intervention (M = 0.25, SD = 0.34) was lower than the baseline average (M = 0.75, SD = 0.27).

For accuracy of problem completion (Figure 6), Annie displayed a steep increasing trend during baseline. Following intervention, Annie's level of accuracy dropped immediately, increased to a level above baseline (reaching 100% during session 3), and then began to descend by the end of the phase. Annie displayed a higher overall average accuracy of problem completion during intervention (M = 86.44%, SD =14.94) than in baseline (M = 74.19%, SD = 15.75). There was, however, a considerable amount of overlapping data between baseline and intervention.

Effect size estimates indicate that Annie's teacher's instructional modifications had a moderate but, significant effect on Annie's rate of total work completion (Tau = -0.549, $p = 0.042$), but no significant effect on Annie's rate of correct work completion (Tau = -0.282, $p = 0.273$), rate of incorrect work completion (Tau = -0.500; $p = 0.082$), or accuracy of problem completion (Tau = 0.346, $p = 0.187$).

Kyle. For rate of total work completion, Kyle's responding in baseline was variable without a clear trend (M = 1.52 total problems per min, SD = 0.62). Following intervention, Kyle's overlapped entirely with baseline and was on average lower than baseline (M = 0.91, SD = 0.46). For rate of correct work completion, Kyle's level of responding during baseline was low with a slight increasing trend (M = 0.89, SD = .43). Following intervention, Kyle's responding was entirely overlapping with baseline and on average slightly lower (M = 0.50, SD = 0.33). For rate of incorrect work completion, Kyle displayed an overall low and slightly decreasing rate in baseline (M = 0.64, SD = .34). Following intervention, Kyle's responding was entirely overlapping with baseline and slightly lower on average (M = 0.40, SD = 0.30) compared to baseline.

For accuracy of problem completion (Figure 8), Kyle displayed an increasing trend during baseline (M = 58.49% accuracy, SD = 18.41). Following intervention, his responding was entirely overlapping with baseline and his average accuracy during intervention slightly lower (M = 55.91%, SD = 25.17) than baseline.

Effect size estimates indicate that Kyle's teacher's instructional modifications did not have a significant effect on his performance in any of the four outcome measures, including total rate of work completion (Tau = -0.314, p = 0.225), rate of correct work completion (Tau = -0.387, p = 0.133), rate of incorrect work completion (Tau = -0.280, p = 0.284), and accuracy of problem completion (Tau= -0.021, p = 1.000).

***Clay*.** For rate of total work completion, Clay's responding was variable with an overall increasing trend during baseline (M = 3.27, SD = 0.61). Following intervention, Clay's responding decreased throughout the intervention phase. Overall, Clay displayed a lower average rate of total work completion during intervention (M = 1.99, SD = 0.97) than in baseline. For rate of correct work completion, Clay displayed a low and stable rate of responding during baseline (M = 1.24, SD = 0.30). Following intervention, there was not a clear change in responding, as most of the data was overlapping with baseline. However, following intervention Clay's responding was slightly higher on average (M =

1.52, SD = 0.78) than baseline. For rate of incorrect work completion, Clay's responding increased over time during baseline (M = .95, SD = 0.45). Following intervention, Clay's responding decreased relative to baseline, did not overlap with baseline, and was lower on average (M = 0.47, SD = .41) than baseline.

For accuracy of problem completion (Figure 10), Clay's accuracy was low and stable during baseline (M = 38.19%, SD = 6.33). Following intervention, Clay displayed an immediate increase in accuracy which had an increasing trend and did not overlap with baseline levels. Overall, Clay displayed a higher average accuracy of problem completion during intervention (M = 77.26%, SD = 16.83) than baseline.

Effect size estimates indicate that Clay teacher's instructional modifications had a moderate and significant negative effect on Clay's total rate of work completion (Tau = -.523, $p = 0.02$). Clay teacher's instructional modifications had a large, significant effect on Clay's incorrect rate of work completion (Tau = -.707; p = 0.001) and accuracy of problem completion (Tau = 0.707, $p = 0.001$). However, Clay's teacher's instructional modifications did not have a significant effect on his rate of correct work completion (Tau = 0.193, $p = 0.415$).

Conceptual Knowledge and Application

The results of the knowledge quiz and case application probes are displayed in Table 8. The knowledge quiz was assigned to each teacher immediately after completing training in order to ensure the teachers had an adequate grasp of the concepts before they began instructional modification. Case application probes were provided prior to training, immediately following training (target student data), and after the intervention (generalization) in order to measure their ability to apply conceptual knowledge from training to interpret PDA results and guide instruction. For teachers who scored less than 100% on the knowledge quiz and/or target-student application probe, the consultant and teachers discussed missed items prior to beginning intervention and the teachers verbally re-answered missed items.

Annie's teacher scored 80% (12/15) on the knowledge quiz. Her scores on the case application probes were 66.67% (4/6) for pre-training, 88.33% (5/6) for target-student or post-training, and 100% (6/6) for generalization or post-treatment. Kyle's teacher scored 100% (15/15) on the knowledge quiz. Her scores on the case application probes were 50% (3/6) for pre-training, 100% (6/6) for target-student or post-training, and 83% (5/6) for generalization or post-treatment. Clay's teacher scored 93.33% (15/16) on the knowledge quiz. Her scores on the case application probes were 33% (2/6) for pre-training, 83.33% (5/6) for target-student or post-training, and 16.67% (1/6) for generalization or post-treatment. All teachers scored higher on target-student or post-training application probes compared to pre-training probes. Annie's teacher received her highest score on the generalization probe. Kyle and Clay's teachers received lower scores on the generalization application probes compared to their target-student application probe.

Other Instructional Behavior

In addition to teachers' rate of antecedent and consequence strategies, the experimenters observed for other instructional behavior that were representative of explicit instruction and were discussed in training during independent work time. These results are displayed in Table 9. Annie's teacher provided Annie with directions at the beginning of independent work time during 67% of baseline sessions and increased to

100% during intervention sessions. Annie's teacher established an explicit reinforcement contingency for Annie during 0% of baseline sessions and increased to 30% during intervention sessions. Annie's teacher provided Annie with performance feedback at the end of independent work time during 0% of baseline sessions and increased to 70% during intervention sessions. Annie's teacher provided Annie with reinforcement following independent work time during 0% of baseline sessions and increased to 50% during intervention sessions.

Kyle's teacher provided Kyle with directions at the beginning of independent work time during 0% of baseline sessions and increased to 88% during intervention sessions. Kyle's teacher established an explicit reinforcement contingency for Kyle during 0% of baseline sessions and increased to 44% during intervention sessions. Kyle's teacher provided Kyle with performance feedback at the end of the independent work time during 0% of baseline sessions and increased to 78% during intervention sessions. Kyle's teacher provided Kyle with reinforcement following independent work time during 0% of baseline sessions and increased to 44% during intervention sessions.

Clay's teacher provided directions at the beginning of independent work time during 10% of baseline sessions and increased to 100% during intervention sessions. Clay's teacher established an explicit reinforcement contingency for Clay during 0% of baseline sessions and increased to 17% during intervention sessions. Clay's teacher provided Clay with performance feedback at the end of the independent work time during 0% of baseline sessions and increased to 33% during intervention sessions. Clay's teacher provided Clay with reinforcement following independent work time during 0% of baseline sessions and increased to 17% during intervention sessions.

Chapter 4: Discussion

The purpose of this study was to examine whether training three middle-school teachers to differentiate instruction for students referred for work-completion problems based on the results of a PDA would change the pattern of strategies they used to manage the students' behavior during independent seatwork time. BST was used to train the teachers. The PDA assessment is based conceptually on a heuristic that distinguishes skill- from performance-deficits. According to this heuristic, teachers should alter their patterns of interactions according to whether students have a skill- or a performance-deficit. In both cases, differential reinforcement is called for. In the case of skill deficits, teachers should also add instructional antecedents like prompting and modeling as well as consequences like error correction. Notably, the PDA may inform teachers that there is a stimulus control problem, but it does not specify which skills are deficient for a particular student. PDA results indicated that all three students had skill-deficits, meaning that they would need both differential reinforcement and instructional (e.g., modeling, prompting, error correction) strategies. It was hypothesized that training in the conceptual model followed by assessment results for their students would influence the kinds of interactions (antecedents and consequences) the teachers would have with their students and also increase students' active engagement and work completion. The study was designed to address three research questions. First, does training teachers to use PDA results lead them to differentiate instruction for a target student referred for poor work completion during independent seatwork exercises? Second, do changes in teachers' use of instructional strategies following training lead to increases in student work completion during independent seatwork exercises? Third, after teachers modify instruction for their first student, will they then select appropriate instructional supports for a case example presented after student intervention, thereby generalizing newly learned skills? It was hypothesized that training teachers in the use of PDA results would increase their differentiation of instruction for a student in their class in terms of instructional and motivational strategies according to whether their students had skill- or performance-deficits (research question 1). It was also expected that each student's work completion would improve if teachers appropriately differentiated instruction according to the results of the PDA (research question 2). Finally, It was hypothesized that training teachers in the use of PDA results and applying them in their classroom to a student would lead them to differentiate instructional and motivational strategies for a case example according to whether the case example student had a skill- or performance-deficit, thereby generalizing what they learned from the training and application (research question 3). To answer these research questions, a multiple-baseline-across-participants design was used to measure the effects of training on both teacher instructional behavior and student responding during independent seatwork tasks. Participants included three teachers and one of their students who was referred for having difficulty completing his or her work, particularly during independent seatwork time.

Research Question #1

This study aimed to determine if teachers trained to interpret PDA data would change and individualize instruction for their target student during independent seatwork time, adding relevant antecedent and consequence strategies as informed by the PDA. It was hypothesized that training teachers in the use of PDA results would increase their application of instructional and motivational strategies to differentiate instruction to address work completion problems in students referred for intervention. Overall, the results provided moderate support for the first hypothesis. This hypothesis was tested in three ways. On the knowledge quizzes, teachers demonstrated adequate comprehension of training material (80-100% accuracy) and verbally expressed understanding of missed items during feedback discussions. Second, when presented with the PDA results for their respective students following training, each teacher interpreted the PDA data accurately, identifying the kinds of instructional and/or motivational strategies their student needed according to the model. All teachers interpreted PDA results and selected relevant strategies with increased accuracy following training compared to pre-training. Furthermore, when observed in the classroom the teachers immediately increased their use of instructional strategies (within one or two sessions) relative to their low baseline levels of responding (infrequent use of antecedents and consequences). Finally, the staggered patterns of increases across teachers conformed to design requirements for the multiple-baseline design, indicating that experimental control was achieved. The results of this study are encouraging and suggest that BST followed by the presentation of PDA results can be used to differentiate instruction by changing the patterns of interactions with their students in terms of frequency and types of interactions.

This study contributes to the research literature on school-based functional analysis which has sought to adapt it to classroom settings by simplifying it and using the results of functional analyses to train teachers to use the results to guide their instruction (Flynn & Lo, 2016; O'Neill et al., 2015). Specifically, this study extends previous PDA research (Duhon et al., 2004) by demonstrating that teachers can be trained to comprehend how to differentiate instruction according to the model (knowledge) and then change the strategies they use while managing students' behavior during independent seatwork following a PDA (application).

One interesting finding of the study was that the teachers increased prompting, modeling, and error correction during intervention, strategies commonly associated with explicit instruction (Hughes et al., 2017) and in line with the skill-deficits the students displayed in the PDAs. However, they did not consistently increase their use of reinforcement contingencies. For instance, Kyle's PDA suggested that programmed reinforcement would probably increase his responding. Kyle's teacher displayed a significant increase in both antecedent and consequence instructional behavior following training, yet she provided programmed reinforcement contingencies during less than half of the sessions. In fact, all of the teachers provided programmed reinforcement contingencies during less than half of the sessions. So, although they increased the use of consequences relative to baseline, the teachers were not consistent in using them according to the treatment recommendations given during training. Therefore, it is difficult to conclude that the teachers consistently differentiated instruction for their students based on PDA results.

The teachers' inconsistent use of DRA may have contributed to another problem. It appears that the programmed reinforcement that Kyle's teacher provided may not have competed effectively with competing reinforcement contingencies. Kyle was observed to frequently gain access to peer attention and escape from task demands by displaying disruptive behavior. Previous research has indicated that competing contingencies in classrooms can have an adverse effect on work completion (Daly et al., 1997; Skinner et al., 2005). It is possible and perhaps likely that the inconsistent use of empirically derived reinforcers produced only a weak effect relative to existing, concurrent reinforcement schedules. Kyle's teacher may have also inadvertently extinguished the behavior before intervention began. During baseline, Kyle earned a reward for his training session and all four reward sessions. His teacher and resource teachers agreed to provide access to these rewards during class-time. However, he only received one reward and the delivery of the reward was significantly delayed. Reinforcement contingencies are likely to be ineffective if teachers fail to deliver them reliably (Martens et al., 2015). If teachers in the current study did not consistently follow through on reinforcement delivery, the limited student effects are not surprising. In future studies, strengthening the training by emphasizing the importance of consistency in delivering reinforcement contingencies and its role in competing effectively with concurrent schedules of reinforcement for competing behavior may produce stronger and more consistent treatment effects. Training can also be strengthened by teaching teachers why and how to manage competing contingencies.

One effect of the training and exposure to PDA results should be to increase the number of learning trials teachers deliver when students have skill-deficits. Learning trials were strongly emphasized during training, as previous research has supported their use in improving students' skill proficiency (Burns et al., 2014; Heward, 1994; Skinner et al., 1996) and they are consistent with an explicit instruction approach (Hughes et al., 2017). A complete learning trial requires both an instructional antecedent (e.g., modeling, prompting) to evoke responses and corrective feedback to differentially reinforce responding and bring it under stimulus control (Daly et al., 2010). Although it is consequences (reinforcement, punishment, extinction) that cause behavior change, programmed antecedents as discriminative stimuli or motivating operations are vital to improving responding (Daly & Murdoch, 2000). This is true especially in the case of skill deficits because students are unlikely to emit a correct response that can then be reinforced. In the current study, all three teachers increased their use of antecedent and consequence strategies relative to baseline, suggesting that more learning trials were delivered. However, the data are quite variable for all three teachers, suggesting that teachers' use of complete learning trials was inconsistent, just as it was with the use of reinforcement contingencies. Incomplete or an inconsistent use of learning trials may attenuate learning effects (Daly et al., 2007), and may have also been partially responsible for the limited student effects in this study. Therefore, although teachers' use of both antecedents and consequences increased, they may not have been high and consistent enough to produce better student outcomes.

The pattern of findings in this study has implications for future research. It is possible that the critical role of DRA and increasing learning trials for skill deficits were not salient enough during training. In the future, researchers should strengthen training about the role of DRA in improving students' work completion, regardless of whether they have a skill- or a performance-deficit. Previous research has indicated that if teachers fail to make potent reinforcers easily accessible to students for completing academic work, competing contingencies for undesired behavior are likely to have a more powerful effect on behavior (Martens et al., 2015). Thus, teachers would likely benefit from more training and practice than was used in this study with creating strong DRA plans that compete effectively with other ongoing reinforcement contingencies that may be effectively suppressing desired behavior (academic engagement and work completion). It is likely that teachers will need more training and support in how to identify competing contingencies in the first place. More emphasis should also be placed on the necessity of delivering these plans consistently.

An additional factor that may affect the strength of the reinforcement contingencies may be related to the instructional tasks themselves. If the tasks are hard and students fail to achieve the criterion for reinforcement, the teachers may essentially be extinguishing the students' engagement and work completion. Future research on PDA assessments should also examine the possible role of task difficulty level in treatment recommendations. The current study accounted for task difficulty level by identifying the students as having skill-deficits and prompting teachers to use instructional strategies, but this was probably insufficient. The students may have needed more intense task alterations (e.g., changes to difficulty level, problem type) to improve responding to meet the criterion for reinforcement. Altering task difficulty was reviewed as a suggested instructional modification during training, but none of the teachers chose easier tasks for students. It would also be helpful for future studies to include measurement of teacher integrity in terms of offering their students reinforcers that are informed by PDA results and punctually delivering earned reinforcement, both of which are critical for DRA intervention to be effective.

Another important finding of the study was that teachers did not demonstrate stability in their behavior change, all teachers demonstrated decreases or variability in their use of antecedent and consequence strategies throughout the intervention phase. However, this may not be entirely negative. Differentiating instruction effectively may necessitate a decrease in the use of some strategies over time as students increase their skill level and require less frequent support (Burns et al., 2014). In the current study, teachers' changes in instructional strategy use did seem to correspond with changes in student behavior. For instance, after Annie displayed an increase in accuracy, her teacher decreased her use of instructional strategies, perhaps according to Annie's increasing success. Unfortunately, Annie's teacher did not subsequently increase her use of strategies as Annie's accuracy waned toward the end of the intervention phase. These results suggest that the current training and use of assessment results were perhaps not strong enough to help the teachers respond over time to changes in student behavior. Training consisted of only a single session, which was mostly didactic. Future studies should incorporate the kinds of ongoing coaching and support that prior research has examined for improving treatment integrity (Becker, Bradshaw, Domitrovich, & Ialongo, 2013; Kretlow & Bartholomew, 2010). Strategies that would be worth examining include performance feedback (Luck et al., 2018; Noell et al., 2014; Scheeler, 2008; Solomon et al., 2012) and instruction and modeling (Beck et al., 2009; Flynn & Lo, 2016; Gatheridge et al., 2004; Himle et al., 2004). Noell et al. (2005) found that performance feedback not only led to better treatment implementation and maintenance over time, but it also led to improved child outcomes. In the future, researchers should consider extending the training beyond the one-time training session and include ongoing performance feedback and coaching to support consistent implementation as well as help teachers to change their own behavior as student behavior changes over time.

The current study was essentially a treatment-integrity study, but differed from previous research on treatment integrity in that it did not involve a scripted treatment protocol. The study was designed to provide training in a heuristic for selecting classroom interventions based on results of a student assessment and then observe what would happen in the classroom. Hypotheses were generated about changes in teacher behavior without specifying precisely what they should do in a step-by-step protocol form. This approach created challenges for measuring teacher behavior, making it more difficult to measure point-by-point correspondence between expected behaviors and actual teacher behaviors. This problem was resolved by measuring teacher behavior more precisely in terms of specific antecedents and consequences that should change based on PDA results following training. Future studies should consider additional measures that would provide more insight into teachers' behavior, such as having teachers complete daily or weekly surveys indicating how they plan to differentiate instruction and what strategies they think their student would benefit from based on their previous performance. This would also likely serve to strengthen intervention and provide content to review during coaching. In addition, future studies could consider using a video or audio recording of teachers during independent work time in order to allow for coding of teacher behavior. This method of data collection may allow for more minute analyses of behavior sequences, which might permit the quantification of the number of complete learning trials.

The current study was less explicitly prescriptive than other treatment-integrity studies. The study was designed to examine an alternate approach in which a robust intervention heuristic allowed teachers more control over how they fit the intervention into their existing classroom structure. Previous research has indicated that teachers may be more likely to adopt an intervention and continue its use over time if they feel that it "fits" their teaching style (Domitrovich et al., 2015; Han & Weiss, 2005). Andersen and

Daly (2013) found that treatment integrity for function-based interventions that teachers chose was superior to function-based interventions prescribed by an expert, even though both improved child behavior. The results of the current study are encouraging but obviously inconclusive. The current study's method for training was apparently not sufficiently strong to promote consistent and responsive differentiation by the teachers as noted earlier. Future studies could strengthen the kind of support provided to teachers during the intervention phase to examine whether this less prescriptive approach might be worthwhile and perhaps even preferred by teachers to the standard protocol approach.

Not only was training delivered in a single session, but the PDA results were only gathered once in the current study. The results of the PDA were expected to be helpful for indicating useful strategies for improving students' engagement and completion, but only up to a certain point. As students' proficiency improves the results should be less useful over time. This may have been what was happening for Annie's teacher. Future studies should examine strategies for helping teachers to be responsive to student changes over time. Investigators could examine whether updating PDA results throughout intervention could be helpful to teachers. However, a better approach might be to empower teachers to test the contingencies directly themselves by strategically manipulating their own use of consequences and antecedents and observing the results in their students. In this study, the teachers were passive recipients of assessment results. A productive line of research might be to teach teachers directly how to "test" students' behavior and skill proficiency over time as a means of helping them to differentiate instruction appropriately. Again, they will probably need ongoing coaching and support with this approach as well.

Research Question #2

This study also examined whether teacher training and PDA results would increase students' ASR and accurate work completion during independent seatwork time. It was hypothesized that each student's work completion would increase if teachers appropriately differentiated instruction according to the results of the PDA. Overall, the results did not generally confirm the hypothesis. Two findings are significant. First, following intervention, there were no significant changes to their ASR. Second, following intervention there was little change to their work completion and accuracy overall. It seems likely that the weaknesses to the training described above attenuated student effects.

One interesting pattern in the student data, however, is how intervention may have affected work completion for the students with high engagement during baseline. Both Annie and Clay demonstrated high rates of ASR during baseline. However, both students also had skill deficits, displaying high error rates. Interestingly, the effect sizes for these students were negative, indicating that there were decreases in total work completion even if the teachers were managing antecedents and consequences better, albeit inconsistently. But, this finding might not be as negative as it seems. High rates of ASR during independent seatwork are probably not beneficial if students are making errors (Burns et al., 2014, Stitcher et al., 2009). It is possible that the teachers' more active management of the independent seatwork time slowed the students down to pay more careful attention to their work. Although the current findings cannot confirm that this was the case, this would be an interesting question to examine in future research, along with careful measurement of student accuracy. Future studies that include more minute analysis of the students' ASR, work completion, work completion accuracy, and teacher behavior may reveal covariations that prove useful to building stronger skill repertoires, even if there are temporary decreases in some behaviors. It would be interesting to examine patterns of student behavior and work completion and their interactions with changing tasks and teacher behavior over time. There is probably a dynamic relationship between these variables that the current study was not able to capture with its measurement systems.

Kyle displayed limited responsivity to the reinforcement contingencies. Again, Kyle did not demonstrate any significant changes in his performance and displayed low, variable engagement across both phases. It seems that inconsistent use of programmed reinforcement coupled with easily accessible peer attention and escape from task demands may have competed effectively with the weak programmed reinforcement contingencies. There may also be a developmental factor affecting the results. For younger students (preschool and elementary school), simple things like teacher praise, stickers, and other small rewards can be quite effective. As students get older, it is harder for teachers to identify potential reinforcers that can compete as effectively with the expanded range and availability of other sources of reinforcement available to students. In Kyle's case, an abundance of competing stimuli (e.g., peer attention, access to phones, being sent out of the classroom for disruptive behavior) were present and may have been more influential than contingent access to activities like walking around the school with a preferred teacher or gym time with a friend.

Competing contingencies can be understood in terms of motivating operations (MOs) that temporarily alter the effectiveness of reinforcement (Langthorne & McGill, 2009; Laraway, Snycerski, Michael, & Poling, 2003). Under the umbrella of MOs, abolishing operations are antecedents that temporarily decrease the effectiveness of reinforcement through satiation, whereas establishing operations are antecedents that temporarily increase the effectiveness of reinforcement through deprivation (Laraway et al., 2003; Michael, 1982). Previous research has suggested that social dynamics in the classroom have ongoing MO effects (Farmer et al., 2018). As students enter adolescence, peer relationships become increasingly salient and more reinforcing (Brown & Larson, 2009; Ryan, 2001; Tierno, 1991). Thus, peer attention in middle school classrooms may grow to become an especially powerful reinforcer relative to other sources of reinforcement (Lee, 2018). The skill- versus performance-deficit heuristic and PDA assessment do not explicitly or systematically account for possible MO effects that result from concurrent reinforcement schedules other than attempt to identify the most powerful reinforcers teachers agree to use in the classroom based on a PDA. The skill- versus performance-deficit heuristic and PDA assessment strategy could be improved in the future by completing the PDA in the classroom environment during independent seatwork time. This would probably provide a more accurate representation of how well teacher-approved reinforcers compete with other contingencies in the classroom. As well as how DRA plans might be further strengthened through the addition of strategies like choice, task alterations, and altering response effort (Kruger et al., 2016), along with other MO strategies like controlling access to preferred stimuli and timing reinforcement delivery to maximize reinforcement strength. It may also be necessary for teachers to learn how to identify competing sources of reinforcement and to add an extinction component for these competing contingencies.

Research Question #3

This study also aimed to examine whether generalization of skills would occur for teachers following training, exposure to PDA assessment results for their students, and application in their classrooms. Specifically, they were asked to select instructional and reinforcement strategies for a hypothetical case study. It was hypothesized that they would select strategies appropriately according to the model used for training. The results provided some, albeit weak, support for the third hypothesis. Annie and Kyle’s teachers scored highly on the generalized case example, while Clay’s teacher had a low score. One limitation of the generalization measure was that the data displayed in the case example were ambiguous, yet did not allow teachers to provide additional explanation for their dichotomous answer choices. Clay’s teacher interpreted that data as a “skill deficit” and not as a “performance deficit” according to the expected response, but then answered all subsequent questions correctly based on her interpretation of the data. Thus, it is possible that she had a strong conceptualization of what strategies are needed for each deficit, but instead needed more support interpreting ambiguous student data. Future studies should consider incorporating more instruction and practice regarding how to interpret equivocal data. Overall, the results are somewhat encouraging and have additional implications for future efforts to promote generalization of teacher training in the future.

The need to explicitly program for generalization has been well-documented in previous research (Erchul & Martens, 2010; Stokes & Baer, 1977; Baer et al., 1968). The current study incorporated two strategies during training in order to promote generalization. First, an attempt was made to train sufficient exemplars by providing practice interpreting PDA data and selecting intervention strategies for multiple case examples during didactic training (Pennington et al., 2018, Stokes & Baer, 1977). Second, the study was designed to program common stimuli by conducting training in each teacher's classroom and providing training materials that would serve as discriminative stimuli if teachers used them during intervention and the case examples (Scheeler, 2008, Steege & Sullivanm 2009, Stokes & Baer, 1977). These strategies may have been a good start, but clearly more is needed. Future studies should utilize ongoing coaching as a modality to strengthen these elements of generalization training. Providing coaching and feedback throughout intervention with a target student would likely increase generalization to future students or case examples by allowing for more opportunities to incorporate strategies shown to promote generalization. Such as, providing extensive training in the natural environment, as well as many more opportunities to program common stimuli and provide sufficient exemplars of how to apply the heuristic and modify instruction based on idiosyncratic student performance (Flynn and Lo, 2016; Pennington et al., 2018, Scheeler et al., 2009).

One obvious limitation of the current study is that teachers' conceptual knowledge and verbal report may not correspond to what they would actually do in the classroom with additional students (a phenomenon further confirmed by this study's results). In order to implement these procedures, the treatment plan must come under strong stimulus control through training and performance feedback, and then the teachers must receive enough generalization training to be able to apply the treatment under different conditions (i.e., other students, assignments). Future studies can build on the current study by having teachers go beyond selecting strategies for hypothetical case studies to selecting them for students in their classrooms, which would provide a more valid test of generalization. Indeed, this approach was the original plan for this study. However, the teacher participants were unable to identify a second student in their classrooms that would be appropriate for participation with the time that remained for the completion of the study, making it impossible to pursue this kind of generalization. In future studies, researchers could select teachers to participate who have initially referred at least two students for poor work completion. Teachers could receive explicit training, coaching, and feedback while delivering instruction for the first student, but would be expected to implement the intervention independently for the second student once PDA results were delivered. Teachers behavior could be measured for both students throughout the study with the second student serving as the test for generalization of effects. Once stable treatment effects are achieved with the first student, a PDA could be conducted with the second student and the results could be shared with the teacher to see how he or she reacts to the data.

Further Limitations

As was previously mentioned, an administration error occurred for several of the PDA reward sessions for all three students. PDA results from 7-min baseline sessions were compared to 3-min to complete probes during several reward sessions. This error may have skewed results given to teachers and used to determine if students had skill or performance deficits, as well as which rewards would be most effective for each student. Students' motivation may have been confounded if they felt that earning rewards was unattainable or unpredictable. However, based on overall pattern of results, particularly students' performance throughout the study and their rate of correct problems per min during PDA sessions, the results do seem to suggest that each student had a skill deficit that required instruction and DRA intervention.

In addition, there were several limitations with implementing this study in the classroom. A variety of factors interfered with data collection and intervention, including student behavior, absences, and school schedules, especially state testing. These factors and design requirements for the multiple-baseline design created complications for the study. Unfortunately, Kyle and Clay were held in baseline for longer than desired, which led them to practice problems incorrectly for an extended period. This also led to an extended delay before they could access reinforcement for work completion, which may have affected their motivation to work to earn rewards for completing work when they were finally moved into intervention. Future researchers may consider alternative designs that would allow students to move into intervention in a timely manner, such as alternating treatments design or a multiple-baseline design across student skills (e.g., start with multiplication problems, move to division after there is an improvement in performance).

It is also possible that the length of the study, its demands, and the nature of the tasks perhaps led to waning engagement on the part of the teachers over the course of the study. To standardize the measurement of students' outcomes, the teacher-student duos completed the same worksheet for most of the study. By the end of the study, it appeared that teachers were not very motivated to continuing spending class time on the math probes. All teachers' responding decreased towards the end of intervention, which may be in part due to these factors. In the future, researchers should work with teachers to select independent seatwork that they would feel motivated to prioritize throughout the intervention.

Finally, the math classrooms in the current study did not have consistent independent work time for students. Thus, the intervention was often implemented for the target student while the rest of the classroom participated in an instructional lesson or classroom activity. During baseline the teachers, especially Kyle and Clay's teachers, gave almost no instructional support to their students despite prompts to "provide support as you usually would during independent work time." The results may have accurately represented natural patterns of teacher behavior in baseline or they may have been due to another factor. For example, teachers might have chosen to prioritize more typical curriculum tasks over helping their students to complete the worksheets better during baseline. Thus, it is not clear how representative teacher behavior was of actual independent work completion time during baseline. Teachers may have supported the target students less than was typical of other assignments during baseline. If the near-zero baseline levels were not representative of typical teacher behavior, the effects of the intervention on teacher behavior may be overestimated. An effort was made initially to use typical classroom exercises in this study. However, this proved to be impossible because the teachers did not provide consistent independent seatwork tasks and the tasks that they did provide in class tended to be class-wide activities and computer work rather than traditional worksheets, which created standardization problems for measurement. Researchers should configure future studies to assure that natural classroom assignments that are valued by the teachers are chosen while finding a way to balance the demands of rigorous measurement of results.

Conclusions

Teachers would benefit from easy and effective methods to help differentiate instruction for students based on skill proficiency and motivational levels. The current findings have important implications for training teachers to interpret PDA data and use skill- versus performance-deficit heuristic to differentiate instruction for students with poor work completion. Teachers successfully interpreted PDA data and increased their use of instructional strategies based on the data. Teachers applied the conceptual framework provided in training to make individualized, instructional decisions regarding independent seatwork to some degree. However, teachers in the current study did not maintain high levels of instructional modification and appeared to have difficulty providing consistent consequences and establishing effective reinforcement contingencies. Difficulties with reinforcement delivery and maintenance of intervention delivery point to the need for stronger training, ongoing coaching, and performance feedback for teachers during intervention.

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Tables

Table 1

Means and Standard Deviations of Teacher's Use of Instructional Strategies

Participant	Baseline				Intervention			
	Antecedents		Consequences		Antecedents		Consequences	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Annie's Teacher	13.70	15.17	10.37	5.04	36.26	29.46	29.53	22.82
Kyle's Teacher	5.35	6.33	1.51	2.58	29.70	18.89	21.03	17.98
Clay's Teacher	3.03	4.84	1.53	3.41	25.02	22.91	31.98	22.52

Note. SD = Standard Deviation. Means and standard deviations reflect percentage occurrence of teachers' use of instructional strategies during independent work time.

Table 2

Results of Training on Teachers' Instructional Modification

Participant				
	Effect Size			
	Antecedents		Consequences	
	Tau	*p*	Tau	*p*
Annie's Teacher	0.337	0.202	0.377	0.150
Kyle's Teacher	0.658	0.002	0.663	0.003
Clay's Teacher	0.710	0.001	0.808	0.001

Note. Traditional Tau analysis was used. A baseline correction was not indicated for any of the participants.

Table 3

Means and Standard Deviations of Students' Active Student Responding

Participant				
	Baseline		Intervention	
	Mean	SD	Mean	SD
Annie	96.38	3.06	90.58	6.06
Kyle	42.44	17.39	49.89	20.42
Clay	92.07	8.61	89.37	0.02

Note. SD = Standard Deviation. Means and standard deviations reflect percentage occurrence of active student responding.

Table 4

Results of Teacher Training on Students' Active Responding

Participant	Effect Size	
	Tau	*p*
Annie	-0.363	0.173
Kyle	0.113	0.625
Clay	-.125	0.619

Note. Traditional Tau analysis was used. A baseline correction was not indicated for any of the participants.

Table 5

Means and Standard Deviations of Students' Rate of Work Completion

Participant	Baseline						Intervention					
	Total Rate		Correct Rate		Incorrect Rate		Total Rate		Correct Rate		Incorrect Rate	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Annie	2.51	0.28	1.76	0.53	0.75	0.27	1.65	0.57	1.40	0.49	0.25	0.34
Kyle	1.52	0.62	0.89	0.43	0.64	0.34	0.91	0.46	0.50	0.33	0.40	0.30
Clay	3.27	0.61	1.24	0.30	1.97	0.45	1.99	0.97	1.52	0.78	0.47	0.41

Note. M = Mean. SD = Standard Deviation. Means and standard deviations reflect number of problems per min.

Table 6

Means and Standard Deviations of Students' Accuracy

Participant				
	Baseline		Intervention	
	Mean	SD	Mean	SD
Annie	74.19	15.75	86.44	14.94
Kyle	58.49	18.41	55.91	25.17
Clay	38.19	6.33	77.26	16.38

Note. SD = Standard Deviation. Means and standard deviations reflect percentage accuracy on Aimsweb® math probes.

Table 7

Results of Training on Students Rate and Accuracy of Work Completion

Participant	Effect Size							
	Total Rate		Correct Rate		Incorrect Rate		% Accuracy	
	Tau	*p*	Tau	*p*	Tau	*p*	Tau	*p*
Annie	-0.549	0.042	-0.282	0.273	-0.500	0.082	0.346	0.187
Kyle	-0.324	0.225	-0.387	0.284	-0.280	0.284	-0.021	1.000
Clay	-0.523	0.020	0.193	0.415	-0.707	0.001	0.707	0.001

Note. Traditional Tau analysis was used. A baseline correction was not indicated for any of the participants.

Table 8

Teacher Scores on Knowledge Quiz and Application Probes

Participant	Knowledge Quiz	Pre-Training Probe	Post-Training Probe	Generalization Probe
	n (%)	n (%)	n (%)	n (%)
Annie's Teacher	12 (80.00)	4 (66.67)	5 (83.33)	6 (100.00)
Kyle's Teacher	15 (100.00)	3 (50.00)	6 (100.00)	5 (83.33)
Clay's Teacher	14 (93.33)	2 (33.33)	5 (83.33)	1 (16.67)

Note. % = Initial percentage accuracy. Knowledge Quiz had 15 items. Each probe had 6 items.

Table 9

Percentage of Observations with Teachers' Use of Other Instructional Behavior

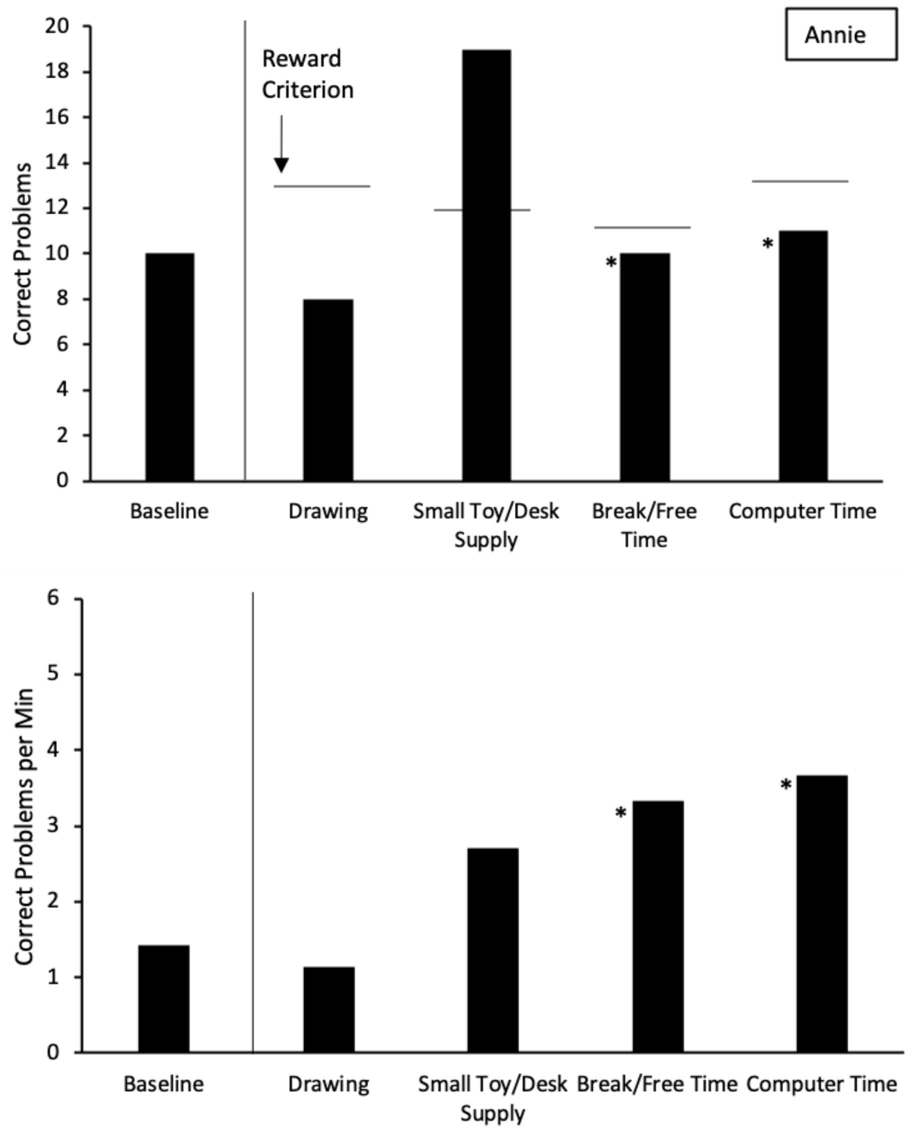
Participant	Baseline				Intervention			
	1	2	3	4	1	2	3	4
	%	%	%	%	%	%	%	%
Annie's Teacher	13.70	15.17	10.37	5.04	36.26	29.46	29.53	22.82
Kyle's Teacher	5.35	6.33	1.51	2.58	29.70	18.89	21.03	17.98
Clay's Teacher	3.03	4.84	1.53	3.41	25.02	22.91	31.98	22.52

Note. Percentages reflect the percentage of sessions in baseline or intervention that the behavior was observed for each teacher. 1 = Directions Provided. 2 = Reinforcement Contingency Established. 3 = Performance Feedback Provided. 4 = Reinforcement Provided.

Figures

Figure 1

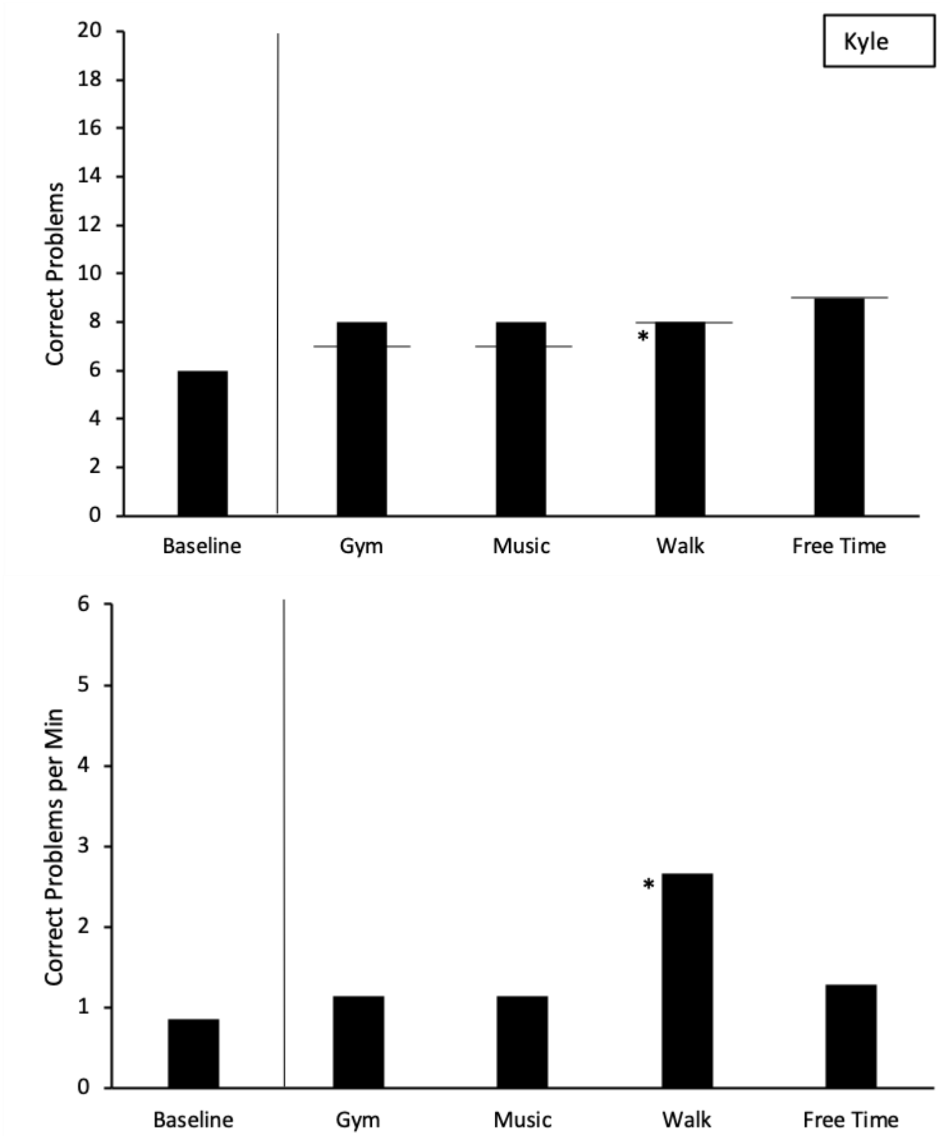
Annie's Performance Deficit Analysis



Note. * = Instructional task was administered for 3 min instead of 7 min

Figure 2

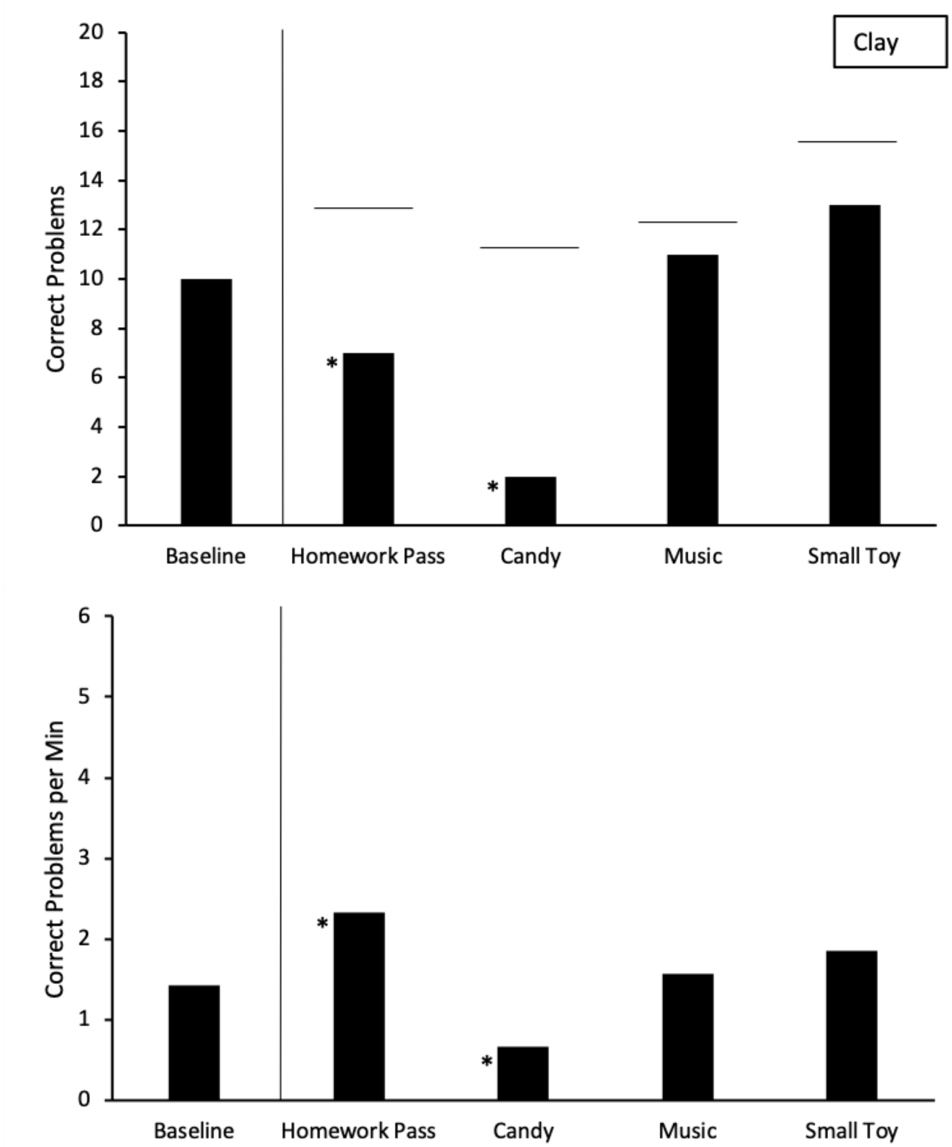
Kyle's Performance Deficit Analysis



Note. * = Instructional task was administered for 3 min instead of 7 min

Figure 3

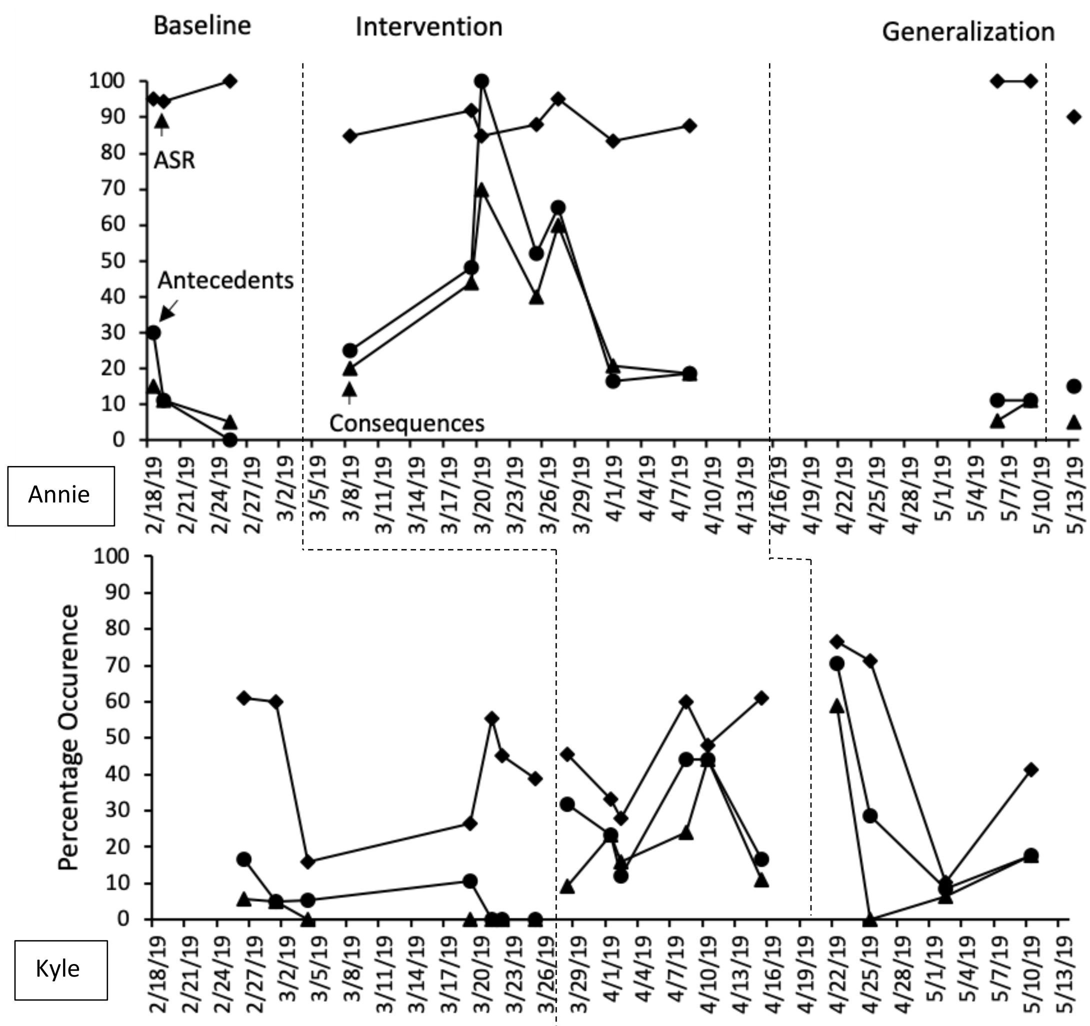
Clay's Performance Deficit Analysis



Note. * = Instructional task was administered for 3 min instead of 7 min

Figure 4

Teachers' Instructional Modification and Active Student Responding



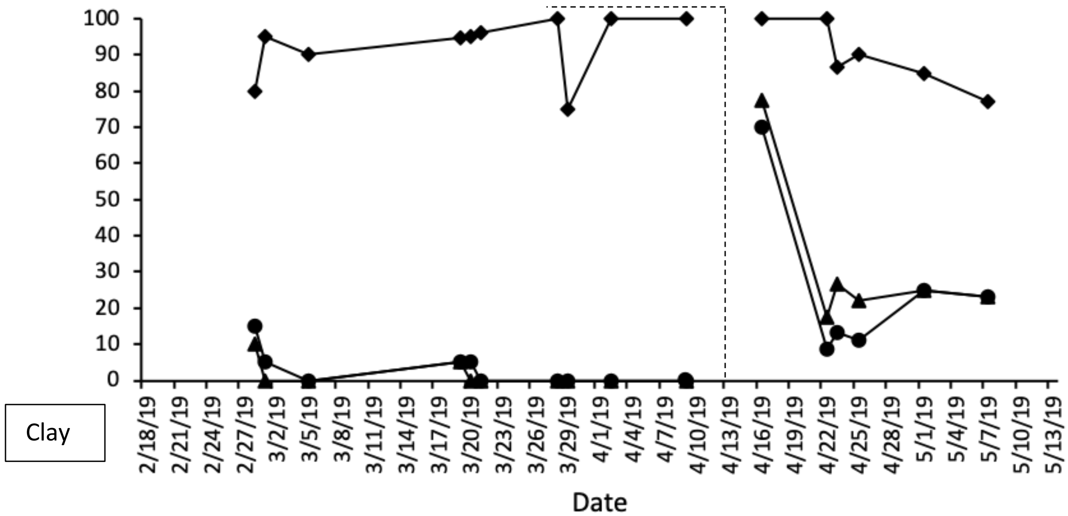

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Figure 5

Annie's Rate of Work Completion

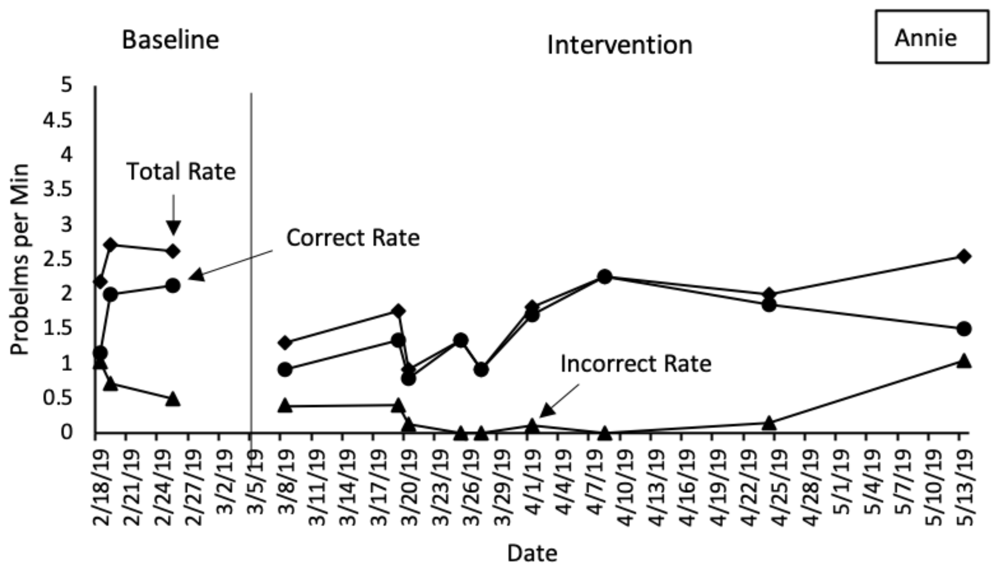


Figure 6

Annie's Percentage Accuracy

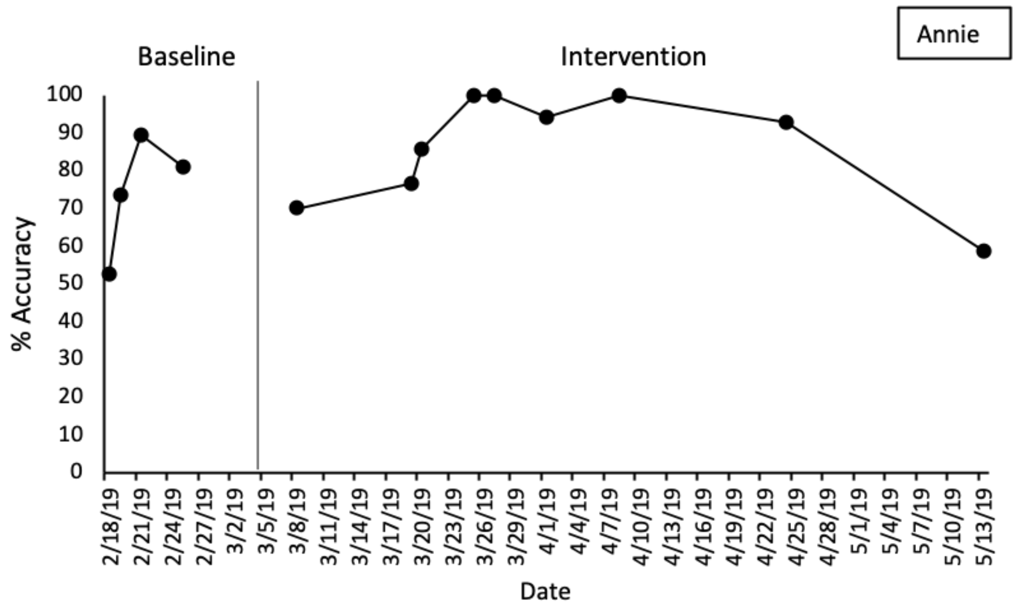


Figure 7

Kyle's Rate of Work Completion

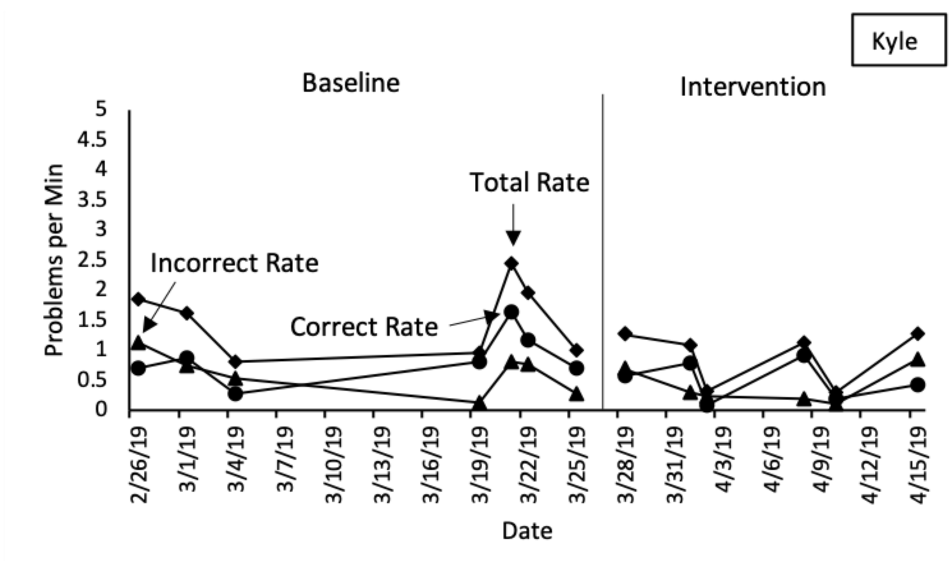


Figure 8

Kyle's Percentage Accuracy

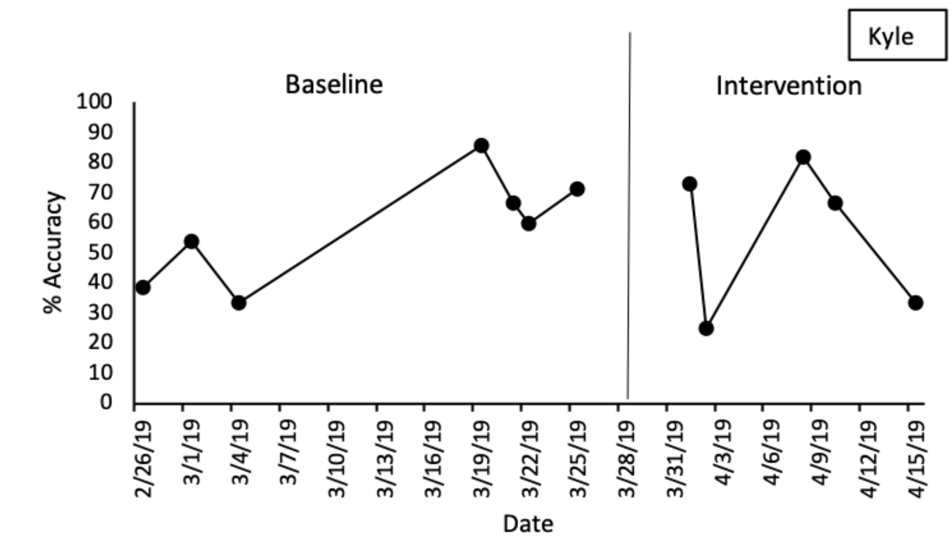


Figure 9

Clay's Rate of Work Completion

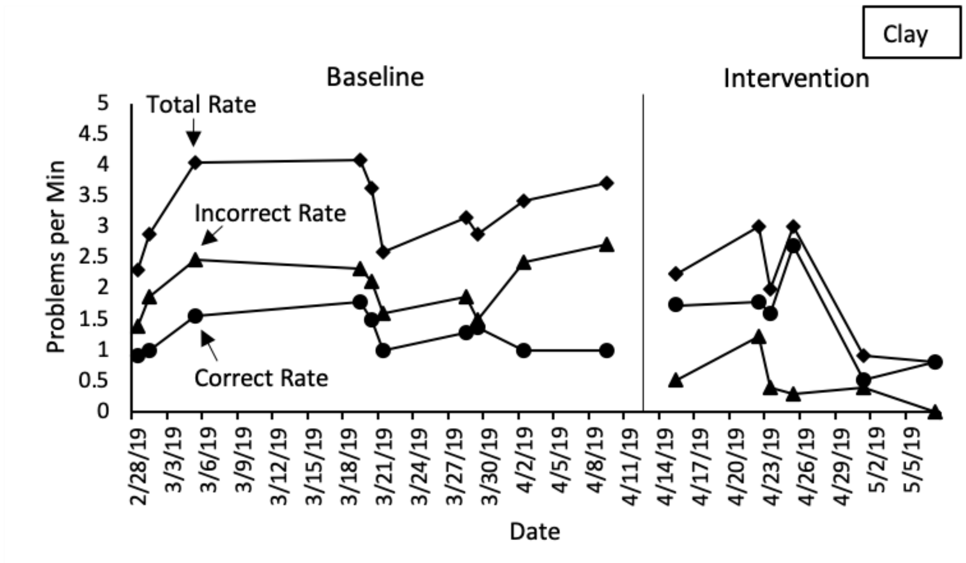
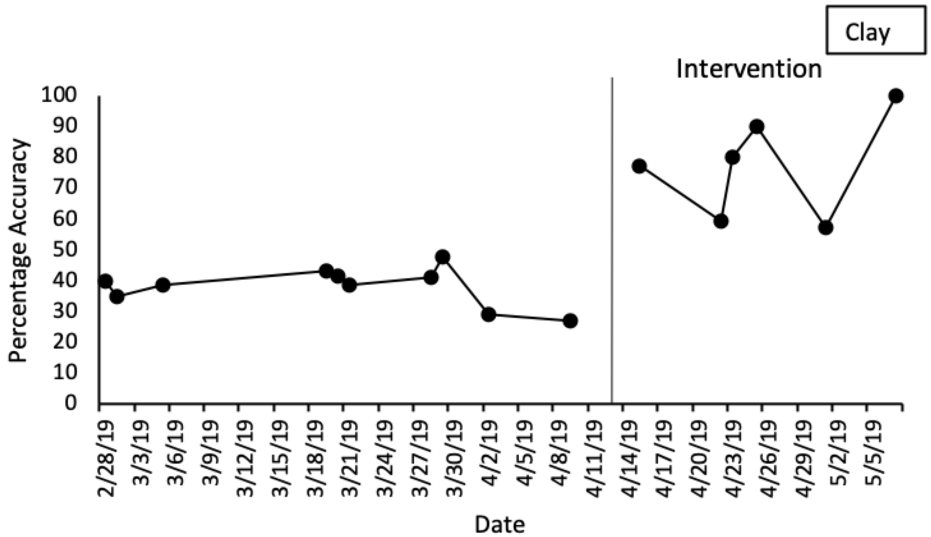


Figure 10

Clay's Percentage Accuracy



Appendixes

Appendix A

Behavior Observation Form

Teacher:
Student:
Date:

Time of Observation:
Observer:
Title of Task:

Target			Target			Target			Target			Target			Peer		
1-20			21-40			41-1 MIN			1-20			21-40			41-2 MIN		
A	AR	C	A	AR	C	A	AR	C	A	AR	C	A	AR	C	A	AR	C
1-20			21-40			41-3 MIN			1-20			21-40			41-4 MIN		
A	AR	C	A	AR	C	A	AR	C	A	AR	C	A	AR	C	A	AR	C
1-20			21-40			41-5 MIN			1-20			21-40			41-6 MIN		
A	AR	C	A	AR	C	A	AR	C	A	AR	C	A	AR	C	A	AR	C
1-20			21-40			41-7 MIN			1-20			21-40			41-8 MIN		
A	AR	C	A	AR	C	A	AR	C	A	AR	C	A	AR	C	A	AR	C
1-20			21-40			41-9 MIN			1-20			21-40			41-10 MIN		
A	AR	C	A	AR	C	A	AR	C	A	AR	C	A	AR	C	A	AR	C
1-20			21-40			41-11 MIN			1-20			21-40			41-12 MIN		
A	AR	C	A	AR	C	A	AR	C	A	AR	C	A	AR	C	A	AR	C
1-20			21-40			41-13 MIN			1-20			21-40			41-14 MIN		
A	AR	C	A	AR	C	A	AR	C	A	AR	C	A	AR	C	A	AR	C
1-20			21-40			41-15 MIN			1-20			21-40			41-16 MIN		
A	AR	C	A	AR	C	A	AR	C	A	AR	C	A	AR	C	A	AR	C

Frequency
Target Student : # Antecedents _____ / _____ # Consequences _____ / _____
Target Student: # Active Responding _____ / _____
Peer : # Antecedents _____ / _____ # Consequences _____ / _____
Peer: # Active Responding _____ / _____

Behavioral Observation:

Session Overview of Teacher Behavior

Please circle if the following steps occurred during the session:

1. Did the teacher provide instructions at the beginnning of the task? YES NO

2. Did the teacher explain the reinforcement contingency? YES NO

3. Did the teacher provide performance feedback at the end of the assignment? YES NO

4. Did the teacher provide programmed reinforcement if the goal was met? YES NO

Notes:

Behavioral Definitions

STUDENT BEHAVIOR

Academic Responding (AR): Record any active response to curricular material, including reading aloud, answering an academic question (verbally, in writing, or on a keyboard), asking an academic question, writing a response, discussing an assignment with the teacher or a peer, and/or consulting a reference work (e.g., looking for a word in the dictionary).

Behavior Sampling Plan: Partial Interval Recording with a 20-s format. If the student emits an active academic response within the 20-s interval, note a checkmark in the middle column of the interval (Under "AR").

TEACHER BEHAVIOR

Antecedent (A): Any instructional strategy that prompts a new academic response (i.e., comes before), such as a controlling prompt (verbal or gestural cue; e.g., "What word is this? C-C-C?") or modeling (verbal and/or physical demonstration of a correct academic response; This word is Cat. Cat).

Consequence (C): Any instructional strategy that follows a student response, such as an error identification/correction ("No. The word is Cat"), model following student response ("Cat"), prompting a response repitition (e.g., "What word?"), or praise ("Great job, it says cat!").

Behavior Sampling Plan: Partial Interval Recording with a 20-s format for each antecedent and consequence instructional strategies. If the teacher emits an antecedent strategy within a 20-s interval, note a checkmark in the left column of the interval (Under "A"). If the teacher emits a consequence strategy within a 20-s interval, note a checkmark in the right column of the interval (Under "C").

Appendix B

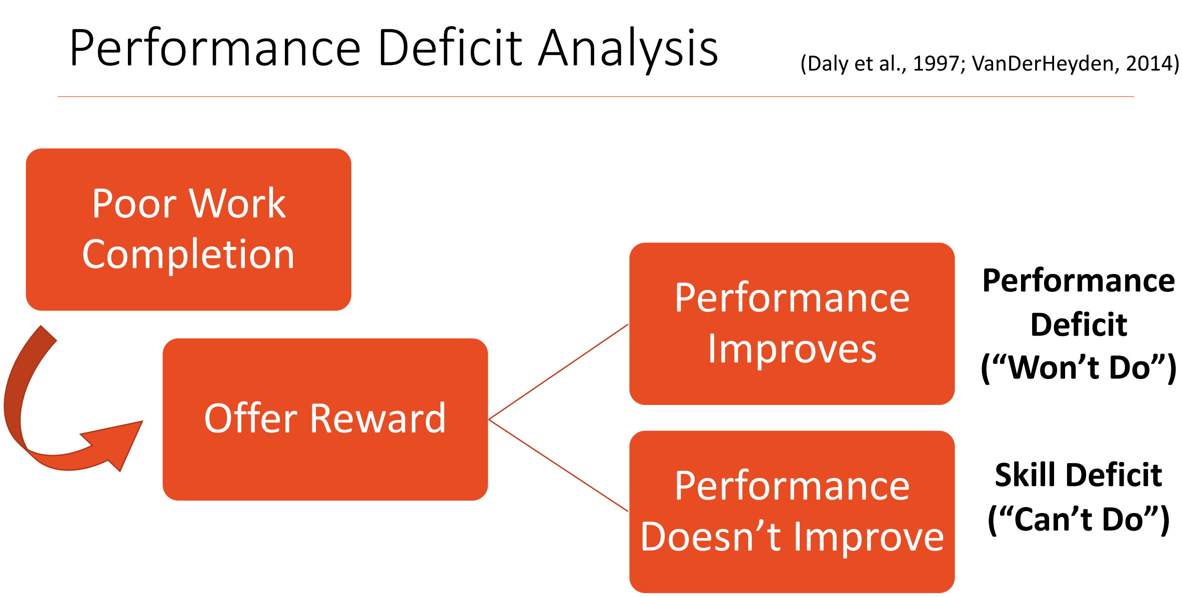
Teacher Training Handouts

Differentiating Skill and Performance Deficits

Performance Deficit: "Won't Do" problem requiring modifications to reward plan. Student appears to have the prerequisite skills to complete instructional assignments and may complete his/her work accurately on some occasions.

Skill Deficit: "Can't Do" problem requiring modifications to instructional strategies and then providing reward. Student's difficulties with completing work appear to stem from skill deficits that will not be remediated through just rewards.

Performance Deficit Analysis: Simple test to determine if the student will improve their work completion or accuracy if a reward is available. Also identifies desired and effective rewards.



Performance Deficit

- Motivational Deficit
- TX: **More Potent Rewards**

Skill Deficit

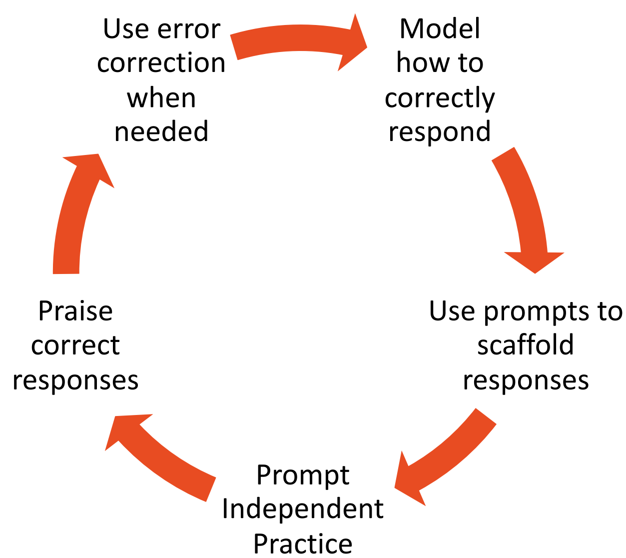
- Skill Problem
- TX: **Instruction + Reward**

PERFORMANCE DEFICIT	SKILL DEFICIT
	REDUCE TASK DIFFICULTY
	ERROR CORRECTION
	PROMPTING
	MODELING
	CLEARER INSTRUCTIONS
DELIVER CONTINGENT REWARD	DELIVER CONTINGENT REWARD
PERFORMANCE FEEDBACK	PERFORMANCE FEEDBACK
PRAISE	PRAISE
ESTABLISH CRITERION	ESTABLISH CRITERION

Maximizing Motivation

- Offer choice
- Provide performance feedback
- Use most powerful rewards
- Ensure early success
- Add Mystery
- Consistency over time

Improving Skill



Improving Skill

Begin with clear, explicit instructions for task
Use modeling and prompting to help the student get correct answer
Segment independent work
Provide **frequent** and **immediate** feedback (Praise and Error Correction)
Consider when task difficulty needs to be reduced

Instructional Strategy Descriptions

Clearer Instructions - When a student does not have the skills to complete a worksheet or problem, it is important to provide explicit instructions on what an assignment entails and how the student should complete an problems or tasks within the assignment.

Establish Criterion – It is helpful to tell students exactly what is expected of them in order for them to receive contingent reward. At the beginning of the lesson, tell the student what they must do during the instructional period in order to earn a reward. Rewards are typically more powerful if you let the student select from a menu (providing choice). It is helpful to start students out by experiencing success (obtainable criteria), and then increasing difficulty as skills and motivation improve.

Provide Prompting/Modeling – In addition to instructions, prompting or modeling of how to correctly complete problems on an assignment is very beneficial for students that lack the skills to complete their work. Accurate models increase the chance that the student will be able to complete the assignment correctly and receive differential reward. Prompting and modeling can be used to scaffold correct student responses, such as at first having students copy your model, then fade to partial prompts (e.g., sounding out the first letter of a word), and then allowing them to do it independently.

Provide Praise – Verbal praise is an easy tool to reinforce and strengthen behaviors we want to see more of. Praise should be immediate and behavior specific. For example, a student can be praised for working quietly, for finishing a worksheet, or for getting an answer correct.

Provide Error Correction – Error correction procedures are used to help students identify when they are making mistakes and then show them how to practice it correctly so that it can be done correctly in the future. Error correction procedures should include identification of error, a correct model, practicing correct responding in isolation and/or practicing correct responding in context.

Provide Performance Feedback – Performance feedback can serve a motivating condition that will help students monitor their own progress and rate of work completion. Performance feedback may be related to speed of work completion or accuracy of work completion. It is ideal for performance feedback be tied to behavior contingencies for earning reward. Performance feedback can also be graphed for students to visually see their progress over time.

Provide Contingent Reward - Strengthening programmed consequences (rewards) for desired behavior (work completion) while attempting to weaken the consequences for competing behavior (e.g., off-task, disruptive behavior) can help increase work completion. The skills versus performance deficit analysis identified potentially effective rewards that could be used as a part of a programmed reward program. These rewards can be provided to students if they meet their response criteria that was set up when clarifying behavioral contingencies.

Decrease Task Difficulty – If a student is not able to complete their work and continues to have many errors, the task may be too difficult for the student. When assignments are at a student's frustration level, they are less likely to benefit from instruction or experience success due to less opportunities for active responding and potential loss of motivation. When appropriate difficulty levels are assigned, students are more on-task, can increase their accuracy and fluency, and will display more task comprehension. Try lowering the difficulty of the skills incorporated in the assignment, and then difficulty can be increased over time once the student is more accurate.

Universal Intervention Protocols

Below are examples of how these strategies may be used together for students with skill and/or performance deficits. There is not one correct way to combine and use these strategies, the key is to look at student performance data and modify instruction to meet each student's proficiency and motivational needs.

Remember - programmed rewards are helpful for increasing behaviors that we want to see more of, but students with skill deficits need extra support so they can correctly respond first (and then receive reward).

Reward Plan

Steps	M	T	W	TR	F
1. Present the assignment and tell the student that he can receive a reward for completing it. Present the reward menu and ask him to choose one thing to work for. After he chooses, tell him that if he completes it (or other criteria, e.g., % accuracy, mystery number), he will earn the reward.	☐	☐	☐	☐	☐
2. Routinely go to student, give praise for appropriate behavior trying to increase. Continue until he finishes the assignment or time is up.	☐	☐	☐	☐	☐
3. At the end, check his work for completion and give the student feedback regarding whether or not he met his goal and earned the reward. His performance is graphed to show progress.	☐	☐	☐	☐	☐
4. If he finished his work, praise him. If he earned his reward, allow him access to the chosen reward. If he did not earn his reward, remind him that he will get another chance next time if he completes all of his work.	☐	☐	☐	☐	☐

Guided Skill Practice and Reward Plan

Steps	M	T	W	TR	F
1. Present the assignment and tell the student that he can receive a reward for completing it. Present the reward menu and ask him to choose one item to work for. After he chooses, tell him that if he completes it (or other criteria, e.g., % accuracy), he will earn the reward.	☐	☐	☐	☐	☐
2. Model how to do the first two problems.	☐	☐	☐	☐	☐
3. Have the student do the next two problems under your supervision. Provide prompts and error correction as necessary. Praise responses and effort.	☐	☐	☐	☐	☐
4. Ask him to do the next 3 problems and to call you over to check his work. E.g., "Raise your hand when you are done with problem 7. I'll come over and check to see how you are doing."	☐	☐	☐	☐	☐
5. Each time he calls you over, give feedback, including praise and error correction. Continue until he finishes the assignment or time is up.	☐	☐	☐	☐	☐
6. At the end, check his work for completion and tell him whether he earned the reward or not. If he finished his work, praise him. If he earned his reward, allow him access to the chosen reward. If he did not earn his reward, remind him that he will get another chance next time if he completes all of his work.	☐	☐	☐	☐	☐

Appendix C

Knowledge Quiz

Training Comprehension Check

Start of Block: Default Question Block

Q23 **Your Name:**

____

Q1 **A skill-deficit indicates that a student likely _____ do his/her work until he/she receives more ____.**

○ won't; reward (1)

○ won't; instruction and reward (2)

X can't; instruction and reward (3)

○ can't; reward (4)

Q2 A performance-deficit indicates that a student likely ___ do his/her work until he/she receives more ____.

X won't; reward (1)

○ won't; instruction and reward (2)

○ can't; instruction and reward (3)

○ can't; reward (4)

Q3 When a student displays poor accuracy, _____ will need to be used before _____ is effective.

- (X) prompting and modeling; reward (1)
- ( ) reward; prompting and modeling (2)
- ( ) directions; reward (3)
- ( ) directions; performance feedback (4)

Q4 If a student significantly improves his/her performance when provided contingent reinforcement, he/she likely has a

- ( ) Skill deficit (1)
- (X) Performance deficit (2)

Q5 If a student improved his/her score when provided contingent reinforcement, but still has a high rate of errors, the student likely need

- ( ) more practice (1)
- ( ) programmed rewards (2)
- ( ) modeling, prompting, error correction (3)
- (X) all of the above (4)

Q6 ___causes behavior change.

- ○ antecedents (1)
- ⊗ consequences (3)
- ○ motivation (2)
- ○ instruction (4)

Q7 When should you reduce task difficulty?

- ○ 1. If the student has a high error rate (1)
- ○ 2. If the student lacks motivation to complete the task (2)
- ○ 3. If the student completes problems really slowly and appears frustrated (3)
- ⊗ 1 and 3 (4)
- ○ all of the above (5)

Q8 Use the following example for the next two questions:
David is performing poorly in math and not able to complete his multiplication worksheets during independent seatwork time. He will often complete one or two problems accurately and then will become off-task. He often becomes disruptive when he is prompted to complete his worksheet. When the school psychologist conducts a performance deficit analysis with David and provides contingent reinforcement for increasing the number of accurate, completed problems, he is able to complete 14 problems in 5 min.

Q9 David likely has a ____.

◯ Skill deficit (1)

ⓧ Performance deficit (2)

Q10 Given your previous answer, what set of strategies may be most useful for this student?

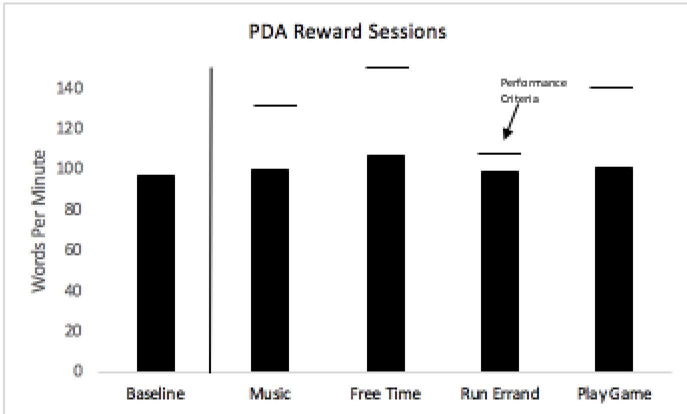
◯ Providing additional instruction, modeling how to complete the problems independently, and praising the student for correct answers. (1)

ⓧ Explaining expectations to the student at the beginning of independent seat work and informing the student that if he completes 10 problems correctly by the end of class he can choose an item from the reward menu. (2)

◯ Telling the student that he knows how to complete the worksheet and that you expect for him to complete all of the problems by the end of class. If he completes all of his problems, you praise him and tell him he can read silently at his desk. (3)

Q11 Use the following example and graph for the next two questions:
Adrianne struggles during independent work time when she is expected to read a short story and answer simple comprehension questions. She often appears frustrated while reading and rarely finishes the comprehension questions. When given an oral reading fluency probe, Adrianne is only reading 97 words per minute (7th grade norm is 130-150). She has fairly high accuracy, but her fluency is very low. The school psychologist completes a performance deficit analysis with Adrianne, offering her highly preferred items for improved oral reading fluency. Her data is below.

Q12



Q13 According to this graph, does Adrianne likely have a skill or performance deficit?

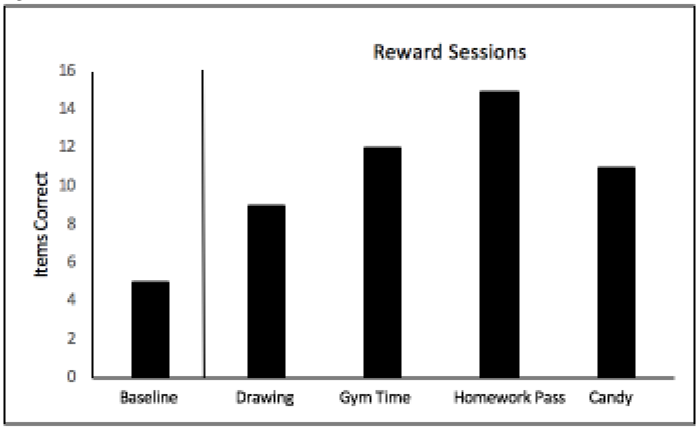
- [x] Skill Deficit (1)
- [ ] Performance Deficit (2)

Q14 Given your previous answer, what set of strategies may be most useful for Adrianne?

- [ ] Clarify contingences for Adrianne at the beginning of reading time and inform her that she can choose a reward from the menu if she gets five comprehension questions correctly. (1)
- [ ] Clarify contingences for Adrianne at the beginning of reading time and inform her that she can choose a reward from the menu if she increases her oral reading rate to 115 words per minute. Graph and share her progress each day. (2)
- [x] Reduce the reading level and length of the passage. Review the instructions and then model a fluent reading rate. Prompt her to try, provide error correction if needed, and praise her for reading fluently. Instruct her to practice reading the passage independently to herself. Check in with Adrianne periodically, provide error correction, modeling, and praise as appropriate. (3)

Q15 Use the following graph for the next two questions:

Q16



Q17 Does this student likely have a skill or performance deficit?

◯ Skill deficit (1)

Ⓧ Performance Deficit (2)

Q18 What rewards might be the most powerful for changing student motivation?

◯ Drawing, Candy (1)

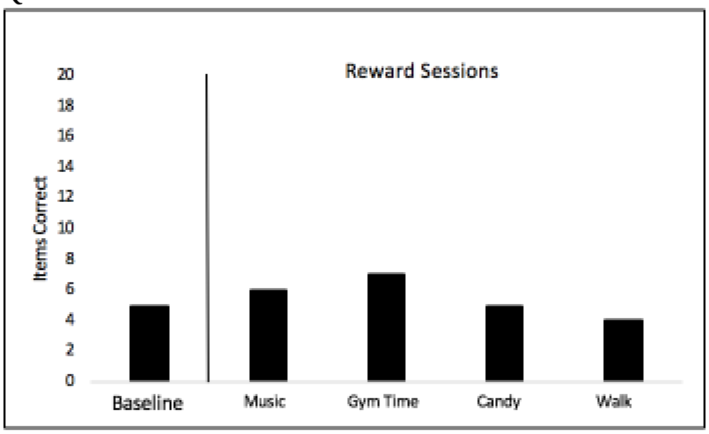
◯ Drawing, Homework Pass (2)

◯ Gym Time, Candy (3)

Ⓧ Gym Time, Homework Pass (4)

Q19 Use the following graph for the next two questions:

Q20



Q21 For the above student, reward is likely ____.

- ◯ strong enough to change behavior. (1)
- ⊗ important, but other instructional strategies are needed first. (2)
- ◯ not needed because the student has a skill deficit. (3)

Q22 Compared to the student in the previous example, this student will likely need

- ⊗ more frequent feedback and support during independent work time. (1)
- ◯ the same amount of feedback and support during independent work time. (2)
- ◯ less frequent feedback and support during independent work time. (3)

End of Block: Default Question Block

Appendix D

Case Application Probe Sample

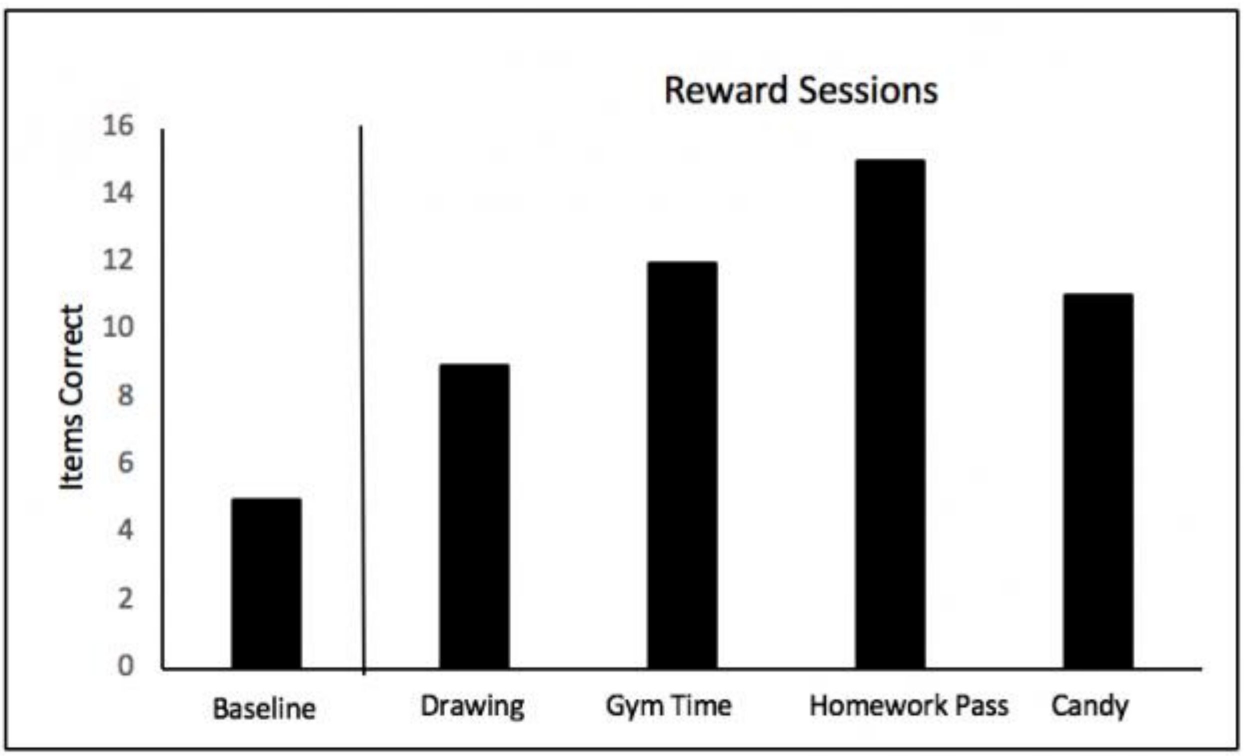
Training Preview Questions

Start of Block: Case Example Questions

Your Name:

____

Please answer the following questions based off of training discussions and the data presented below.



Q1 **According to this data, this student likely has a**

- ◯ skill deficit. (1)
- ⓧ performance deficit. (2)

Q2 **This student likely ____ do his/her work until he/she receives more _____.**

- ⓧ won’t; reward (1)
- ◯ won’t; instruction and reward (2)
- ◯ can’t; instruction and reward (3)
- ◯ can’t; reward (4)

Q3 According to this data, reward is

- ⓧ sufficient (1)
- ◯ necessary, but insufficient (2)
- ◯ unnecessary (3)

Q4 According to this data, which reward could be most powerful for this student?

- ○ Drawing (1)
- ○ Gym Time (2)
- (X) Homework Pass (3)
- ○ Candy (4)

Q5 **What strategies might you use with this student during independent seatwork?**

- [X] Establish performance criterion (1)
- [X] Contingent reward (2)
- [ ] Modeling (3)
- [ ] Clearer instructions (4)
- [X] Praise correct answers (5)
- [ ] Prompting (6)
- [ ] Error Correction (7)
- [X] Performance feedback (8)
- [ ] Reduce task difficulty (9)

Q6 This student likely needs

○ Frequent support during independent seat work time to practice the right answers. (1)

⊗ Less frequent support during independent seatwork time to practice the right answers. (2)

End of Block: Case Example Questions

Appendix E

Performance Deficit Analysis Protocols

PDA Baseline

Materials and Preparation

- ❑ Academic task
- ❑ Writing utensils for the student
- ❑ Timer

Procedures

- ❑ 1. Present academic task to student using typical classroom instructions and procedures.

- ❑ 2. After the session, collect the academic task and label it “RV Baseline”.

- ❑ 3. Independent observer or experimenter will take a photo of the work product.

PDA Training Session

Materials

- ❑ Simple academic task
- ❑ Reward Menu containing all 8 items identified by teacher
- ❑ Writing utensils for the student and examiner
- ❑ Timer

Preparation

- ❑ Place the reward menu on the table where the student can see it.

Procedures

- ❑ 1. Say, ***"You can earn a reward for doing your work this time. This menu of rewards lists all of the items that you can earn access to for completing academic work. These items include ______*** [READ EACH ITEM TO THE STUDENT]. ***Do you have any questions about what any of those items are?"*** Answer student questions if they arise. If the student has no questions proceed to step 2.

- ❑ 2. Say, ***"Today, you are going to practice using the menu to choose which item you want to work for. Which item would you like to work for today?*** [PRESENT MENU OF REWARDS]. ***You have selected _______*** [STATE SELECTED ITEM], ***is that correct?*** [OBTAIN STUDENT CONFIRMATION].

- ❑ 3. Present the simplified task, and say, ***"If you complete this academic task, you will earn access to ______*** [STATE SELECTED ITEM] ***for __ minutes. Do you have any questions?"*** Answer student questions then proceed to step 4.

- ❑ 4. Say, ***"You may begin working."***

- ❑ 5. After the student completes the task, give feedback to the student saying, ***"You completed the task and earned the reward. Good job! You will have access to ______ for _____ minutes."***

- ❑ 6. Deliver the reward or allow access to the chosen activity if the student met the goal.

- ❑ 7. Collect the academic task and label it "RV Training." Independent observer or experimenter will take a photo of the work product.

PDA Reward Session (Full Menu)

Materials

- ❑ Academic task
- ❑ Reward Menu containing all eight items identified by teacher
- ❑ Index card with criterion number to earn a reward (see directions below)
- ❑ Writing utensils for the student and examiner
- ❑ Timer

Preparation

- ❑ To select the criterion number of math problems needed to earn a reward, randomly select a number between the following two numbers:
  - (1) the [baseline score + 1] and (2) [the baseline score * 1.5]
  - Randomization can be done through a random number generator app or Microsoft Excel®

- ❑ Prepare the index card with the daily criterion for performance.

- ❑ Place the reward menu on the table where the student can see it.

Procedures

- ❑ 1. Say, **"*You can earn a reward for doing your work this time. Which item would you like to work for today?*** [PRESENT MENU OF REWARDS]. ***You have selected _______*** [STATE SELECTED ITEM], ***is that correct?*** [OBTAIN STUDENT CONFIRMATION]. ***At the end of the session, I will present an index card*** [POINT TO THE INDEX CARD] ***with a number on it. If you complete at least as much work as the number on the other side of the card, you will earn access to _______*** [STATE SELECTED ITEM] ***for ___ minutes. Do you have any questions?"*** [ANSWER STUDENT QUESTIONS].

- ❑ 2. Present the daily academic assignment to the student saying, **"*You may begin working"*** and start the timer.

- ❑ 3. If the student asks for help or seeks your attention, say, **"*Just do your best.*"**

- ❑ 4. At the end of the session, the independent observer or experimenter will score the total work completed.

Performance Feedback and Reward Delivery

- ❑ 5. Tell the student how much work he or she completed. Turn over the card and state the number for the student, pointing to the card.
  - Compare the criterion to the number completed by the student, pointing out which is larger (the criterion or the amount of work completed by the student) or if they are equivalent.

- ❑ 6. Give feedback to the student saying:
  - Met or exceeded the goal – **"*You met the goal and earned the reward. Good job! You will have access to ______ for ___ minutes."***

- Did not meet the goal- ***"I'm sorry, but you did not meet the goal today. You will get another chance to earn a reward of your choice another time."***

- ❑ 7. Deliver the reward or allow access to the chosen activity if the student met the goal.

- ❑ 8. Collect the worksheet(s) and label it "PDA Session 1". Independent observer or experimenter will take a photo of the work product

PDA Reward Session (Limited Menu)

Materials

- ❑ Daily academic assignment
- ❑ Reward Menu containing only items from the preference assessment that were not selected in previous reward sessions
- ❑ Index card with criterion number to earn a reward (see directions below)
- ❑ Writing utensils for the student and examiner
- ❑ Timer

Preparation

- ❑ To select the criterion number of math problems needed to earn a reward, randomly select a number between the following two numbers:
  - (1) the [baseline score + 1] and (2) [the baseline score * 1.5]
  - Randomization can be done through a random number generator app or Microsoft Excel®
- ❑ Prepare the index card with the daily criterion for performance.
- ❑ Place the reward menu on the table where the student can see it.

Procedures

- ❑ 1. Say, **"*You can earn a reward for doing your work this time. Which item would you like to work for today?*** [PRESENT MENU OF REWARDS]. ***You have selected _______*** [STATE SELECTED ITEM], ***is that correct?*** [OBTAIN STUDENT CONFIRMATION]. ***At the end of the session, I will present an index card*** [POINT TO THE INDEX CARD] ***with a number on it. If you complete at least as much work as the number on the other side of the card, you will earn access to _______*** [STATE SELECTED ITEM] ***for ___ minutes. Do you have any questions?"*** [ANSWER STUDENT QUESTIONS].
- ❑ 2. Present the daily academic assignment to the student saying, **"*You may begin working"*** and start the timer.
- ❑ 3. If the student asks for help or seeks your attention, say, **"*Just do your best.*"**
- ❑ 4. At the end of the session, the independent observer or experimenter will score the total work completed.

Performance Feedback and Reward Delivery

- ❑ 5. Tell the student how much work he or she completed. Turn over the card and state the number for the student, pointing to the card.
  - Compare the criterion to the number completed by the student, pointing out which is larger (the criterion or the amount of work completed by the student) or if they are equivalent.
- ❑ 6. Give feedback to the student saying:

- Met or exceeded the goal – ***"You met the goal and earned the reward. Good job! You will have access to ______ for ___ minutes."***
- Did not meet the goal- ***"I'm sorry, but you did not meet the goal today. You will get another chance to earn a reward of your choice another time."***

❑ 7. Deliver the reward or allow access to the chosen activity if the student met the goal.

❑ 8. Collect the worksheet(s) and label it "PDA Session [SESSION NUMBER]". Independent observer or experimenter will take a photo of the work product

Appendix F

Teacher Training Treatment Integrity Protocol

Listen to the audio recording for these four training factors: **introduced**, **explained**, **examples**, and **discussion**:

- Specifically pay attention to if each topic was **introduced** and described by the consultant. If key concepts were **explained** and supported with **examples**. If the consultant engaged in **discussion** by checking for understanding, asking the consultee for examples, and/or responding to consultee contributions (i.e., provide feedback).
- At a *minimum* each topic needs to be **introduced** and **explained** in order to ensure that the teacher understands the concept. Some topics may be more complicated and may also require **examples** and **discussion**.

Write YES or NO next to "*Topic addressed?*" for all 12 topics and then fill out the bottom portion indicating the total number/percentage of topics addressed. Feel free to add comments explaining your scoring or indicating questions you have.

1. Factors that contribute to academic achievement (1-2)
   - ❑ Introduced
   - ❑ Explained
   - ❑ Examples
   - ❑ Discussion
   - o Topic addressed?
   - o Comments:

2. Student Engagement vs Active Student Responding (3)
   - ❑ Introduced
   - ❑ Explained
   - ❑ Examples
   - ❑ Discussion
   - o Topic addressed?
   - o Comments:

3. Learning Trials and role of teacher feedback (4-5)
   - ❑ Introduced
   - ❑ Explained
   - ❑ Examples
   - ❑ Discussion
   - o Topic addressed?
   - o Comments:

4. Need Differentiated Instruction when there is poor work completion (6-7)
   - ❑ Introduced
   - ❑ Explained
   - ❑ Examples

- ❑ Discussion
- o Topic addressed?
- o Comments:

5. Skill vs Performance Deficit Distinction (8)
   - ❑ Introduced
   - ❑ Explained
   - ❑ Examples
   - ❑ Discussion
   - o Topic addressed?
   - o Comments:

6. Performance Deficit Analysis (PDA) (9-14)
   - ❑ Introduced
   - ❑ Explained
   - ❑ Examples
   - ❑ Discussion
   - o Topic addressed?
   - o Comments:

7. Overview of strategies for performance deficit vs. skill deficit (15-17)
   - ❑ Introduced
   - ❑ Explained
   - ❑ Examples
   - ❑ Discussion
   - o Topic addressed?
   - o Comments:

8. Tips for maximizing motivation (18-21)
   - ❑ Introduced
   - ❑ Explained
   - ❑ Examples
   - ❑ Discussion
   - o Topic addressed?
   - o Comments:

9. Walk through case example for performance deficit (22-25)
   - ❑ Introduced
   - ❑ Explained
   - ❑ Examples
   - ❑ Discussion
   - o Topic addressed?
   - o Comments:

10. Tips for improving skill (26-29)
    - ❑ Introduced
    - ❑ Explained
    - ❑ Examples

- ❑ Discussion
- o Topic addressed?
- o Comments:

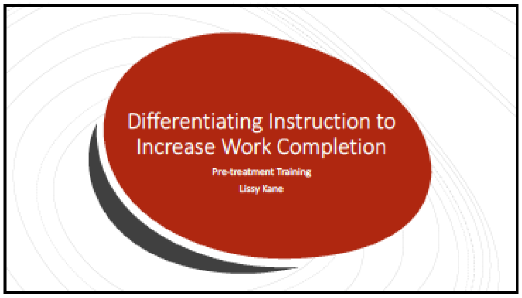
11. Walk through case example for skill deficit (30-34)
    - ❑ Introduced
    - ❑ Explained
    - ❑ Examples
    - ❑ Discussion
    - o Topic addressed?
    - o Comments:

12. Go through multiple case examples and provide feedback as needed (38-44)
    - ❑ Introduced
    - ❑ Explained
    - ❑ Examples
    - ❑ Discussion
    - o Topic addressed?
    - o Comments:

- # Topics Addressed:
- Percentage Addressed [(# topics addressed / 12) * 100]:

Appendix G

Teacher Training PowerPoint Presentation



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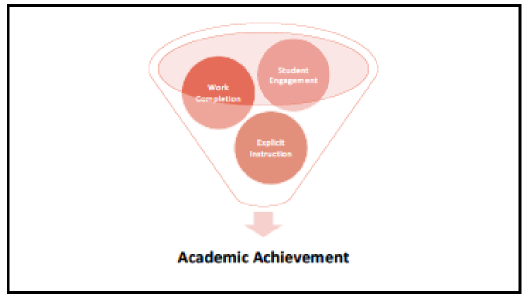

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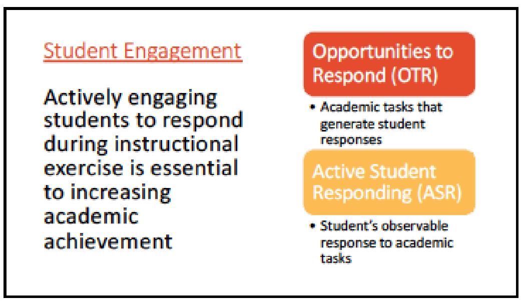

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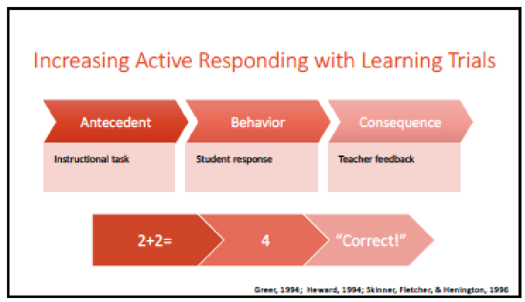

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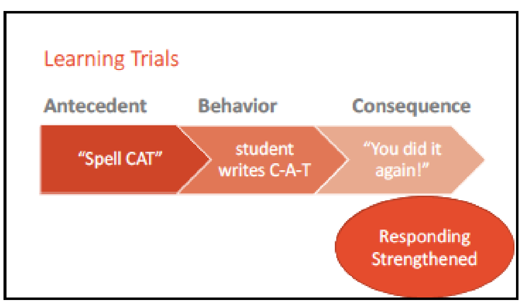

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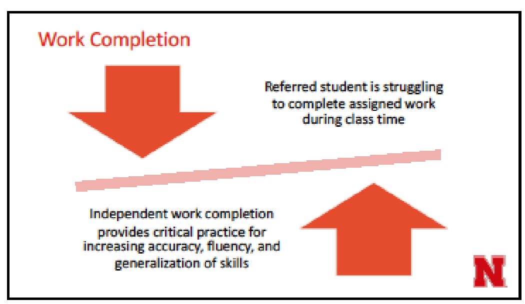

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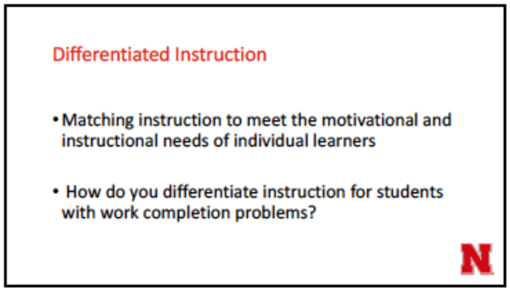
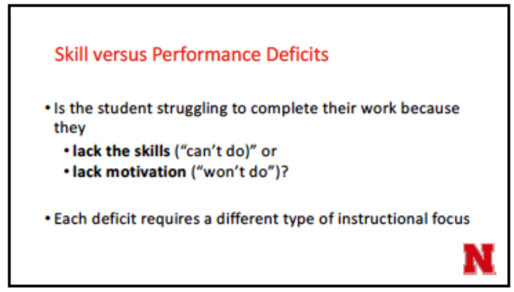
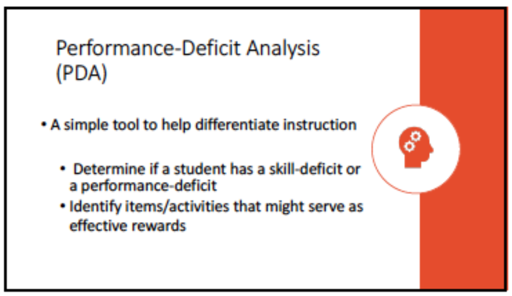

Differentiated Instruction
• Matching instruction to meet the motivational and instructional needs of individual learners
• How do you differentiate instruction for students with work completion problems?

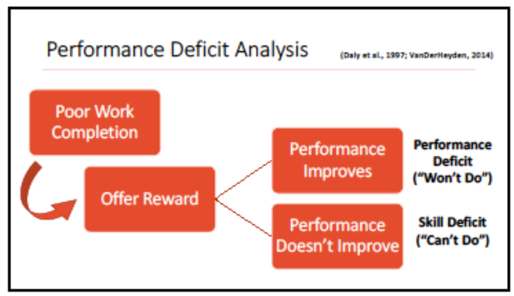
7


Skill versus Performance Deficits
• Is the student struggling to complete their work because they
• lack the skills ("can't do)" or
• lack motivation ("won't do")?
• Each deficit requires a different type of instructional focus

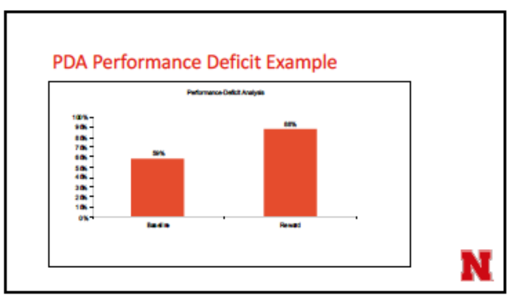
8


Performance-Deficit Analysis (PDA)
• A simple tool to help differentiate instruction
• Determine if a student has a skill-deficit or a performance-deficit
• Identify items/activities that might serve as effective rewards

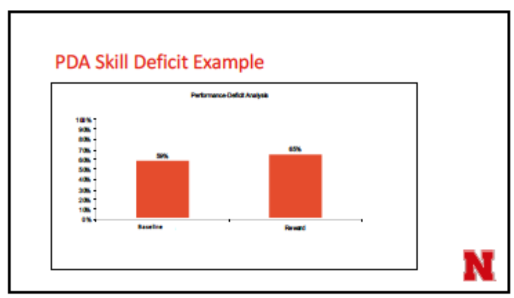
9


Performance Deficit Analysis
(Daly et al., 1997; VanDerHeyden, 2014)
Poor Work Completion
Offer Reward
Performance Improves
Performance Deficit ("Won't Do")
Performance Doesn't Improve
Skill Deficit ("Can't Do")

10


PDA Performance Deficit Example
Performance Deficit Analysis

11


PDA Skill Deficit Example
Performance Deficit Analysis

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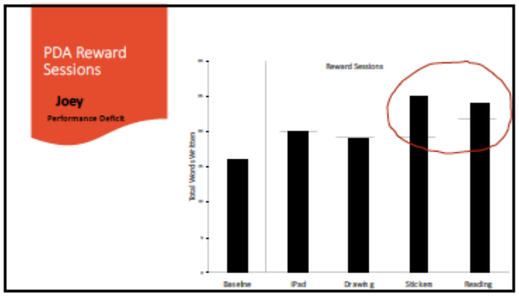

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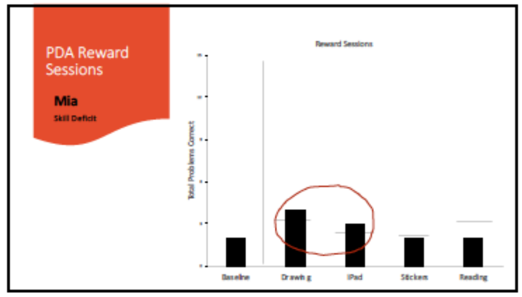

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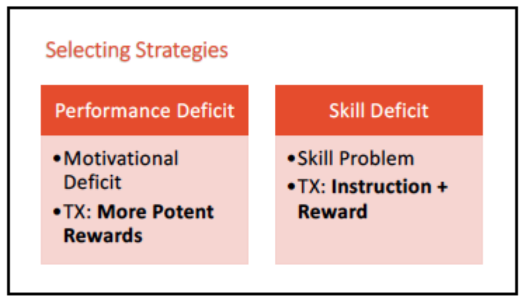

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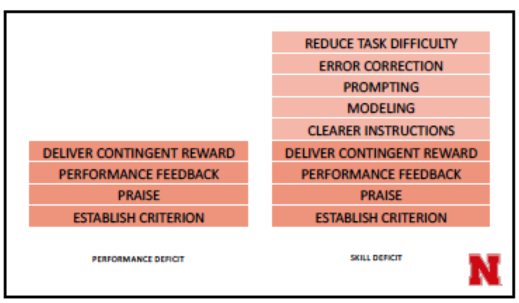

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18

Performance Deficit

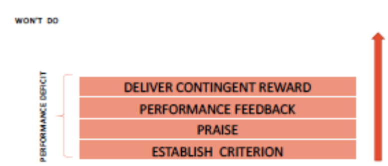
Competing for Student's Attention

- Antecedent — Behavior — Consequence

Writing Prompt → Academic response → "Good, keep going."

Excitable peer → Pokes peer → "Ouch! Stop that!"

19



20

Maximizing Motivation

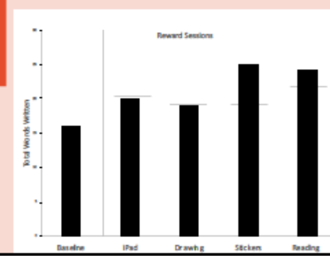
- Offer choice
- Use most powerful rewards
- Provide performance feedback
- Ensure early success
- Add Mystery
- Consistency over time

21

PDA Reward Sessions

Joey

Performance Deficit



22

Joey – Establish Criterion

- ❑ The teacher presents a writing assignment and basic instructions.
- ❑ Tells Joey how many words he wrote the previous day and that he can earn a reward for beating the mystery criterion.
- ❑ She offers a choice of rewards to work for and then prompts him to begin.

23

Joey – Provide Praise & Feedback to Responding

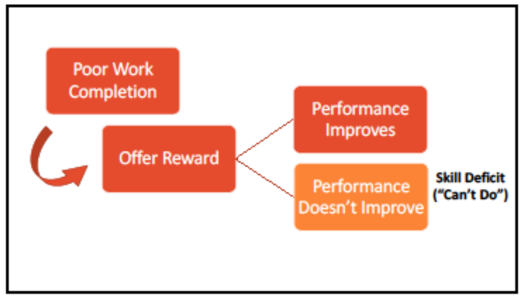
- ❑ Teacher provides specific praise when Joey is working silently.
- ❑ At the end, she praises him and scores his work.
- ❑ She helps him graph his performance. She praises his improvement.

24

Joey - Provide Contingent Reinforcement

- Teacher reveals mystery number.
- Provides praise for beating the number and gives access to reward.

25



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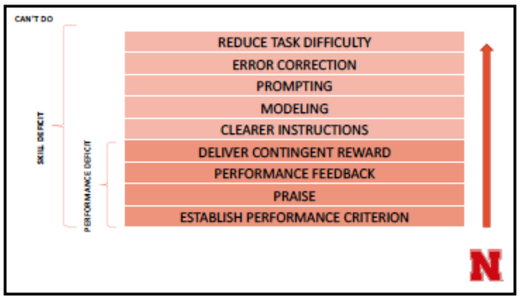

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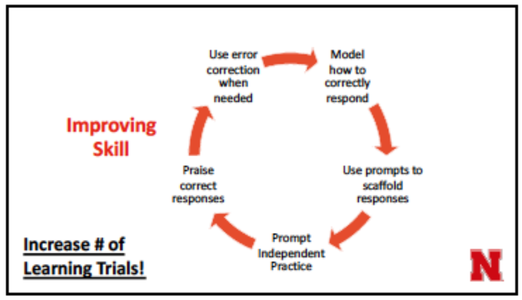
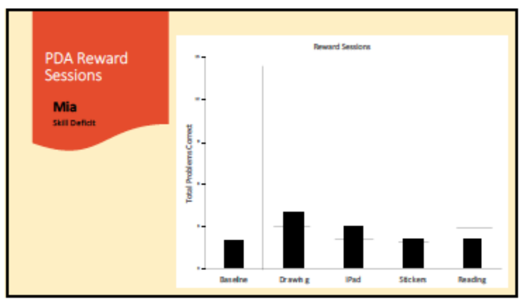


28

Improving Skill

Begin with clear, explicit instructions for task
Use modeling and prompting to help the student get correct answer
Segment independent work
Provide **frequent** and **immediate** feedback (Praise and Error Correction)
Consider when task difficulty needs to be reduced

29



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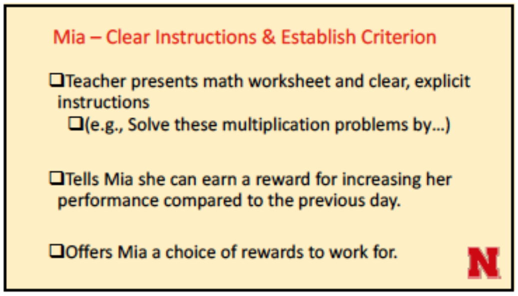

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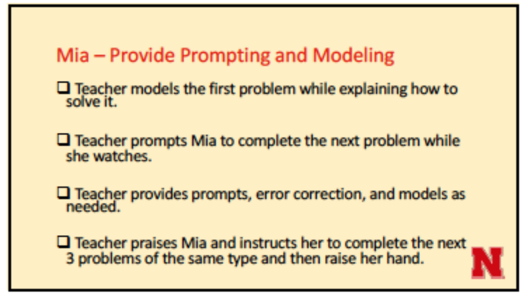

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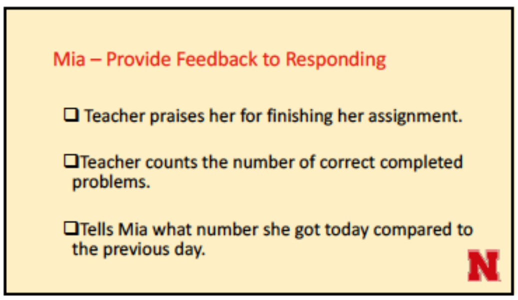

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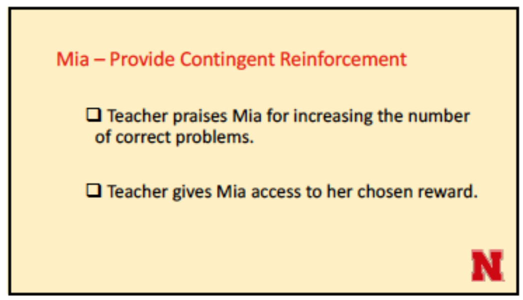

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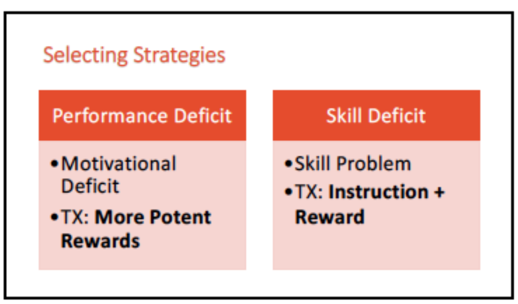

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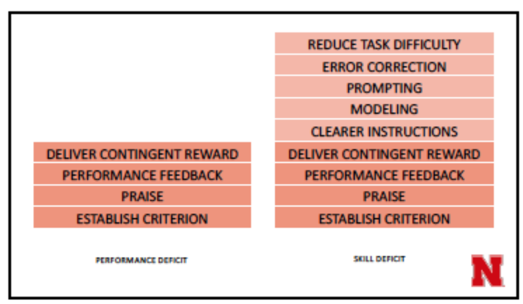

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Case Example - Josh

- Josh is a 6th grader that is struggling to complete his work during independent writing time. He typically starts engaging in problem behavior a couple minutes after starting. He talks to and distracts his peers, complains loudly, and sometimes throws objects. He has been sent out of the classroom multiple times for being disruptive.

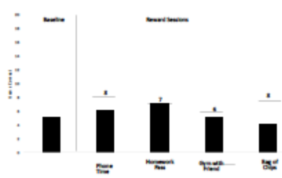
38

Case Example - Josh

- Working on vocabulary word identification and using them in a sentence
- Given a 20 problem matching worksheet and five minutes to complete the probe
- Josh gets 5 problems correct and 8 problems incorrect
- Experimenter implements 4 PDA reward sessions

39

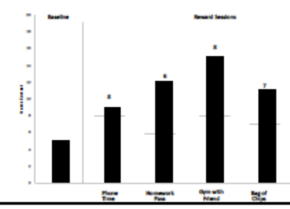
Case Example – Josh



1. Did performance increase?
2. Skill or performance deficit?
3. Potential reinforcers?
4. What strategies do we need?

40

Case Example – Josh (#2)



1. Did performance increase?
2. Skill or performance deficit?
3. Potential reinforcers?
4. What strategies do we need?

41

Case Example – Katie

- Katie is a 7th grader that struggles to complete her work correctly during independent math seatwork. She has done well in math in the past, but recently doesn't finish her work in the classroom or she finishes it quickly with mostly incorrect answers. She often doesn't bring back completed homework, and her test grades are starting to drop as well. When in class she either chats with her friends or doodles. When re-directed she finishes quickly (with errors) and reads a book.

42

Case Example – Katie

- Working on pre-algebra order of operations problems
- Given a 25 problem worksheet and five minutes
- Katie finishes 10 problems and gets them all correct
- Experimenter implements 4 PDA reward sessions

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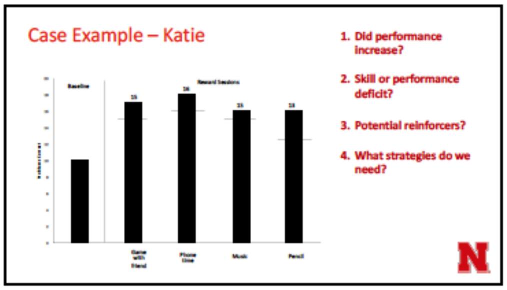
Case Example – Katie
1. Did performance increase?
2. Skill or performance deficit?
3. Potential reinforcers?
4. What strategies do we need?
44


Questions/
Discussion?
45