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ORIGINAL PAPER

Impact of a Teacher-as-Coach Model: Improving Paraprofessionals Fidelity of Implementation of Discrete Trial Training for Students with Moderate-to-Severe Developmental Disabilities

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Abstract Ensuring educational progress for students with moderate-to-severe developmental disabilities requires exposure to well executed evidence-based practices. This necessitates that the special education workforce, including paraprofessionals, be well-trained. Yet evidence regarding effective training mechanisms for paraprofessionals is limited. A multiple baseline design across five teachers was used to evaluate the impact of online instructional modules and a Practice-Based Coaching (PBC) model with teacher-as-coach on their paraprofessionals' fidelity of discrete trial training (DTT). Implementation of the instructional modules yielded little to no change in paraprofessionals' DTT fidelity, however, a clear functional relation between PBC and improvement in paraprofessionals' fidelity of implementation of DTT was demonstrated. Implications for future research and practice are discussed.

Keywords Paraprofessionals · Developmental disabilities · Autism · Coaching · Discrete trial training

Educational progress for students with moderate to severe developmental disabilities (MSDD), requires exposure to well executed evidence-based practices (EBP; Browder et al. 2014; Odom et al. 2013). When EBP are delivered poorly the outcome will likely be unfavorable including limited progress on educational objectives, increases in maladaptive behaviors, and increased dependence on others (West et al. 2013). Conversely, when evidence-based practices are delivered in concentrated doses with a high degree of procedural fidelity, students with MSDD demonstrate significant progress on academic, behavioral, and adaptive skills (Browder et al. 2014). Thus, those responsible for the education of students with MSDD must be well trained to deliver EBP.

Unfortunately this is not the case with the widespread use of paraprofessionals (paras) who assume their positions in the classroom with little to no training (Brock and Carter 2016). When training does occur, districts tend to rely on large group in-services and rarely have mechanisms in place to ensure instruction transfers to practice (Giangreco et al. 2010). Despite this lack of preparation, paras' scope of responsibilities is broad and they often serve as the main educator of students with MSDD (Giangreco et al. 2010), providing academic and behavioral instruction with minimal oversight (Breton 2010). Additionally, supervising teachers, who are required to oversee paras, are rarely trained to carry out this aspect of their job (Breton 2010). As a result, paras employ ineffective strategies or implement EBP with poor procedural fidelity (Rispoli et al. 2011) to the detriment of students' with MSDD.

Effective Training for Paras

Although scarce, a few studies demonstrate with effective professional development, paras can deliver EBP with fidelity (Brock and Carter 2016; Rispoli et al. 2011). This PD should include: (1) initial instruction to increase knowledge regarding the procedure, (2) modeling with opportunities to practice, and (3) coaching with performance feedback and progress monitoring (Brock and Carter 2013;

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Rispoli et al. 2011). Additionally, relevance to the context (e.g. student characteristics, setting) is necessary. However, research documenting the efficacy of this type of PD for paras is generally limited to researcher implemented training (Brock and Carter 2013). In practice, districts tend to rely on one-time, workshops and typically do not follow-up with the other components of effective training such as coaching and performance feedback (Simonsen et al. 2008). Limitations of resources including time and qualified personnel to provide ongoing feedback and follow-up impede implementation of evidence-based training.

One potential option for decreasing the amount of personnel time required to deliver initial instruction in EBP to paras is the use of online instructional modules. Although unlikely to yield sustainable changes in instructional practices when implemented alone, online learning modules could be utilized to provide the initial conceptual knowledge necessary for skill acquisition (Conroy et al. 2015; Range et al. 2011). Once created, modules are readily available, allow paras to learn at their own pace, and eliminate the need for the supervising teacher or other instructor to facilitate an in-service. The Autism Internet Modules (AIMS: http://www.autisminternetmodules.org) are freely available modules developed by Ohio Center for Autism and Low Incidence (OCALI: 2012) that provide training on the implementation of several EBP. The modules, which vary in length from 30 min to 3 h, include pre and post assessments, rational, video exemplars, and step-by-step instructions for implementation of the practice. Although the modules focus on interventions for students with autism, many of the strategies (e.g. discrete trial training, reinforcement, prompting, etc.) are applicable to students with other MSDD. To date, the authors are unaware of any studies evaluating the impact of these training modules to improve educators, including paras, fidelity of implementation of EBP. This is likely an underutilized resource that could assist districts in increasing the capacity of educators who support students with MSDD.

In addition to identifying more feasible methods for the delivery of the instructional component of effective PD, identifying typical agents within schools to provide modeling and ongoing coaching with performance feedback and progress monitor is necessary. Given special education teachers are responsible for supervising paras' delivery of services, they are likely the most reasonable option. Brock and Carter (2016) trained four special education teachers to instruct and subsequently coach four paras to deliver a peer-mediated interventions for students with intellectual disability and autism in general education classes. Supervising teachers provided a 2-h training on the intervention and then subsequently observed their paras implanting the strategy and provided a one-time coaching session using performance feedback delivered to the para. Although the paras demonstrated improvement in implementation of some components of the intervention, changes in all targeted steps increased only slightly with variability across participants. It is possible that more frequent coaching sessions that were shorter in duration and specifically focused on specific feedback and error correction may have resulted in improved procedural fidelity. Studies that evaluate the efficacy and feasibility of more frequent coaching sessions on paraprofessionals' performance are necessary.

With provision of initial training in EBP, such as what could be provided via online learning modules, supervising teachers could allocate more time for coaching, including performance feedback and progress monitoring, for paras. Practice-Based Coaching (PBC; Snyder et al. 2015) is an empirically supported method for increasing educators' accurate implementation of a given practice with minimal resources (Metz et al. 2013; Sutherland et al. 2014). PBC includes development of an action plan and goal-setting, direct observation focused on the targeted skill, and ongoing feedback and reflection (Snyder et al. 2015). PBC is embedded in a collaborative partnership, guided by the needs of the learner, and applicable to training for any EBP (Snyder et al. 2015). Although PBC has been implemented to improve teachers' use of a variety of instructional practices (Snyder et al. 2015), there are no studies implementing PBC with "teacher-as-coach" to train paras. Unlike previous studies that provided a one-time coaching session with feedback to paras (Brock and Carter 2016), PBC provides an opportunity to provide ongoing coaching sessions with shorter duration. Additionally, a teacher-as-coach model would provide a consistent method to train paras as well as provide teachers with a framework for supervising paras.

Discrete Trial Training

Discrete trial training (DTT), or massed trials, has been identified as an EBP for students with MSDD (Browder et al. 2014; Odom et al. 2010; Wong et al. 2015) to improve a variety of educational outcomes across a range of settings (Courtade et al. 2015; Browder et al. 2014; Spooner et al. 2012). This adult-directed, response-prompting procedure is designed to be implemented with one student rather than in a group format and typically results in rapid acquisition of novel discrete skills and discrimination tasks (Odom et al. 2010).

Like other focused intervention practices, implementation of DTT requires the delivery agent to follow very precise, clearly defined steps (Wong et al. 2015). DTT involves repeated delivery of trials which begin with presentation of instructions by the implementer. Following the student response, consequences, either reinforcement or error

correction, are implemented and then the next trial begins. Although DTT has been identified as an EBP for students with MSDD, the impact is restricted by procedural integrity, or accuracy, with which it is implemented (Garland et al. 2012; DiGennaro-Reed et al. 2011). Given the role of DTT for teaching novel tasks and the importance of high procedural integrity to ensure desired outcomes, training paras to implement with fidelity is warranted.

Purpose and Research Questions

The purpose of this study was to evaluate the efficacy of both the AIMS module and teacher-implemented coaching to improve paras' procedural fidelity of DTT with students with MSDD. Research questions included: (1) Is there a functional relation between implementation of the AIMS DTT module and improvements in paras' procedural fidelity, as measured by percentage of DTT steps completed accurately, with students with MSDD? and (2) Is there a functional relation between implementation of teacher-delivered coaching and increased procedural fidelity of DTT for paras working with students with MSDD?

Method

Participants, Settings, and Materials

The study included three Title I elementary schools, serving grades K-5 with an average enrollment of 394 students, in a large urban school district in the Midwest. Across the three schools, the average percentage of minority and economically disadvantage enrollment was 82 and 90% respectively. Additionally, the average percent of children with disabilities across the three schools was 16%.

Participants

Human subjects approval was sought from the university and district, then recruitment began. To be included in the study both teachers and paras had to provide educational services for elementary students with MSDD. Additionally, teachers had to be responsible for supervision of at least one para and trained to fidelity in DTT implementation as evidenced by accurate completion of 85% or higher of DTT steps. Paras had to be supervised by a special education teacher who had consented to participate in the study. First, teacher participants were recruited from a group of teachers who had previously participated in DTT training. Once the parameters of the study were explained to the eligible supervising teachers, interested teachers met with their paras to explain the study and determine if they would be interested in participating. A total of 5 supervising teachers and 11 paras (2 paras each for 4 of the teachers and 3 for the 5th teacher) consented to participate in the study. All participants were female and assigned to self-contained special education classrooms with students with MSDD.

Descriptive data for participating teachers and paras is reported in Table 1. Average years of experience for participating teachers and paras was 6 (range 1–16) and 11 years (range 1–32) respectively. Kallie, Nancy, and Ella as well as their paras were all assigned to classrooms for students with ASD in grades Kindergarten, 1st–2nd, and 4th–5th respectively. Both Tonya and Teresa and their paras were assigned to classrooms with students with MSDD in grades Kindergarten-4th and 4th–5th respectively. All classrooms had a total of six students with the exception of Kallie's class which had seven students.

Setting and Materials

The study was conducted in each teacher's classroom in areas generally reserved for 1:1 instructional activities. All paras and students worked at small tables with the para sitting beside or across from the target student. Materials utilized were those typically utilized for DTT based on the educational skill being addressed during the session. These included color, shape, number, alphabet, and sight word cards as well as coins for those students working on coin identification. Tonya's paras, Betsy and Chloe, did not use any other materials when working on imitation skills as

Table 1 Teacher and para demographics

Teacher	Para	Age	Ethnicity	Education	Years of experience
Kallie		31	White	Master's	8
	Kris	32	White	Associate's	9
	Tish	51	Black	HS	13
Nancy		29	White	Master's	3
	Alex	24	Black	Bachelor's	1
	Octavia	67	Black	Bachelor's	15
Ella		26	White	Bachelor's	3
	Ruby	28	Black	Bachelor's	1
	Esther	35	Hispanic	Master's	10
	Grace	64	Black	Bachelor's	4
Tonya		24	White	Master's	1
	Betsy	64	White	HS	31
	Chloe	46	Black	Bachelor's	3
Teresa		48	White	Bachelor's	16
	Patsy	50	Black	Associate's	14
	Lucy	38	Black	Bachelor's	14

HS high school, *ASD* autism spectrum disorder, *ID* intellectual disability, *MD* multiple disabilities, *K* kindergarten

they did body movements (e.g. "Do this" as they clapped their hands). When working on one-step directions, preferred toys were utilized.

Three 12.9-inch iPad Pros were used to video-record data collection sessions. Prior to each data collection session, the research assistants set up the iPads to record the paras engaged in DTT with the student. Once the session was recorded, the videos were uploaded onto a password-encrypted server to allow for scoring. One digital video a week of each para performing DTT was shared with the supervising teacher so she could review and provide feedback on each para's fidelity during coaching sessions.

The DTT AIMS module, which took approximately 1.5 h to complete, was completed on either a school computer or the para's personal computer. The module included a pre and post-test, overview of DTT, step-by-step instructions for implementation of DTT, case study exemplars, and frequently asked questions. Completion of the module required access to internet service.

In order to provide positive exemplars of implementation of DTT, each teacher was provided with a video model of herself engaged in DTT instruction to use during coaching sessions. The video models, which were created by research staff, were obtained from videos collected during the teacher DTT training. Videos were created using iMovie on an Apple Macbook. The video models included embedded text describing the step being implemented along with the video exemplar of the teacher implementing the step. In addition to the video model, teachers utilized a Coaching Log to plan and document information discussed during each coaching session. The Coaching Log provided sections for the teacher to document each para's current fidelity, areas improved from last session, steps reviewed, questions asked by paras, and presence of any challenges during the coaching session.

Experimental Design and Measurement

Design

A multiple-baseline design across teachers to evaluate the effect of the AIMS modules and the PBC teacher-as-coach intervention on the paras' fidelity of implementation of DTT was used. This design demonstrated experimental control and strong internal validity with systematic introduction of the AIMs modules and PBC intervention at five separate instances each. The study was carried out over the course of 2 months with a maximum of two PBC sessions and 2–3 observation sessions per week. School-wide events, holidays, and personnel absences (e.g. illness, vacation, personal leave) caused some variation in the number of sessions delivered per week. All PBC sessions were recorded by the supervising teacher and then given to the research team. Observations occurred when the participating para was scheduled to engage in one-on-one, DTT instruction with a student 2–3 times per week. Data collection sessions varied in duration, but were required to have a minimum of five trials per session (e.g., five instructional demands or questions). Each session was video-recorded and paras' fidelity was scored from the video-recordings.

Dependent Variable Measure

The primary dependent variable was the para's implementation fidelity of DTT as measured by percentage of DTT steps completed accurately. A 26-item instrument, *Paras' DTT Implementation Fidelity* (available from the first author), was utilized to measure the accuracy of DTT implementation. The DTT Fidelity was divided into four sections including: (1) Setup and reinforcement selection (7 steps); (2) Delivering trial (7 steps); (3) error correction (8 steps), and (4) Other (4 steps) which included items relevant to all other sections (i.e. inter-trial interval, fast-paced, mixed instructional tasks, and followed through with demand when challenging behavior occurred). Each step was scored with either a 0, 1, 2, or "not applicable." A score of "0" was entered if the para did not implement the given step for any of the trials during the session. Implementation of a step for at least one but not all of the trials during a session was scored as "1". A score of 2 was entered if the step was implemented for all trials in the session. If there was no opportunity to implement a step, the step was scored as "NA". Fidelity of implementation was calculated by dividing the total score (sum of response numbers) by points possible, given applicable items, and multiplying by 100.

PBC Fidelity

A 9-item *PBC Fidelity Checklist* (adapted from Hemmeter et al. 2016) was used to ensure the coaching intervention was implemented as prescribed as indicated by percentage of steps implemented. The items included: (1) opened with a positive greeting; (2) reviewed current DTT goal; (3) shared data on the average DTT fidelity; (4) provided supportive feedback on para's DTT fidelity results (i.e. noted steps completed accurately and improvements); (5) provided suggestions/feedback on steps to work on to meet DTT goal; (6) provided video model example of steps missed; (7) asked the paras if had any questions and/or concerns; (8) answered any questions; and (9) scheduled next session. Each item was scored "yes" if the step was implemented, "no" if it was not implemented, and "NA" if there was not an opportunity to implement the step (e.g. if the paras did not have any questions, "Teacher answered any

questions," was scored as "NA"). The second author, who was trained in the PBC procedure, reviewed video recorded coaching sessions and scored fidelity utilizing the checklist for at least 20% (R = 20–33%) of sessions for each participant. Fidelity was calculated by dividing the number of steps implemented by the total number of steps and multiplying by 100. Average procedural fidelity across teachers was 95% (R = 90–100).

Interobserver Agreement

Interobsever agreement was assessed on paras' implementation of DTT and on coaching sessions.

Paras' Implementation Fidelity of DTT

Two research team members trained to reliability in data collection separately viewed and scored at least 20% of sessions for each para in each phase. Agreement was defined by both raters indicating the same score (e.g. 0, 1, 2 or NA) for a given step on the *Para DTT Implementation Fidelity*. Exact IOA was calculated by dividing the total number of exact agreements for each item by total number of items and multiplying by 100. Table 2 indicates the mean IOA in each phase by teachers and overall average IOA for each phase. The overall average IOA was 92% (R = 82–97%).

Reliability of PBC Fidelity

A graduate research assistant trained in the PBC fidelity scoring procedure, watched and scored 20% of sessions coded for primary PBC fidelity. Agreement was defined by both raters indicating the same score for a given step on the *PBC Fidelity Checklist*. Exact IOA was calculated by dividing the total number of exact agreements for each item by total number of items and multiplying by 100. The overall average IOA for PBC fidelity was 100%.

Social Validity

Three measures were utilized to assess the social validity of the AIMS modules and the PBC teacher-as-coach intervention. The *AIMS Social Validity Questionnaire* was 10, 5-pt *Likert*-type items that paras used to rate the usefulness, effectiveness, and ease-of-use of the AIMS modules. The 5-pt scale ranged from 1-strongly disagree to 5-strongly agree. Additionally, the questionnaire included one open ended question, "The AIMS module would be better if"… to elicit further feedback. In addition, participating paras also completed the *DTT Para PBC Social Validity Questionnaire-Paras* and teachers completed the *DTT Para PBC Social Validity Questionnaire-Teachers*. Both questionnaires used a 5-point *Likert*-type scale, the same as the AIMS Questionnaire, allowing respondents to provide feedback on the usefulness, effectiveness, and efficiency of both the coaching procedures and the DTT intervention. The para and teacher questionnaire also included three open-ended questions to elicit further information regarding specific aspects they liked about the coaching intervention and what modifications would improve its usefulness. The Para questionnaire was 11 items, 7 of which pertained to the coaching intervention and 4 specific to the DTT intervention. The teacher questionnaire included 13 items, 9 of which specifically addressed the coaching intervention and 4 items addressed the DTT intervention. Social validity questionnaires are available from the first author.

Procedures

Baseline

Baseline data were collected in the classroom during times when paras were scheduled to provide one-to-one, DTT instruction. The teacher selected the target skills implemented in each DTT session based on the child's skills and IEP objectives. Paras previously worked with the students and had provided instruction on the target skills. Thus,

Table 2 Average IOA for paras' fidelity of implementation of massed trials

Teacher	Baseline mean (range[a])	AIMS module mean (range[a])	Coaching mean (range[a])	Overall mean (%)
Kallie	86.5% (85–88%)	86.5% (85–88%)	96% (88–100%)	89.67
Nancy	91.25% (85–100%)	94% (92–96%)	97% (96–100%)	94.08
Tonya	88.5% (85–96%)	89.5% (88–91%)	96% (92–100%)	91.33
Ella	91% (85–100%)	98.67% (96–100%)	98% (96–100%)	95.89
Teresa	86.75% (81–96%)	88% (88%)	93.75% (87–100%)	89.5
Overall average IOA	88.8% (81–100%)	92% (85–100%)	96.15% (87–100%)	92.44

[a]Ranges represent the range in reliability scores across paras within each area (e.g., baseline, aims, coaching)

paras were familiar with all objectives and educational materials. A member of the research team instructed the para to conduct the session as they normally would. No further instructions or training were provided to the para. The observation, which was recorded, continued until the para completed a minimum of 5 discrete trials per session.

AIMS Module

Once the first teacher-para group (i.e., each para in the group) demonstrated a stable pattern of responding, without an increasing trend, and with at least three data points in the baseline, the AIMS DTT module was introduced. Participants were provided instructions for accessing and completing the DTT AIMS module, which was estimated to take approximately 1.5 h to complete. Paras were instructed to complete the module within 2 days following receipt of the instructions and to email a copy of their post-assessment results to the first author. Once receipt of the post-assessment occurred, data collection, following the same procedures as baseline began. Data collection for each para in a given classroom continued for a minimum of three data points and demonstration of a stable pattern of responding.

Teacher-as-Coach PBC Training

Following a minimum of 3 data points and evidence of stable levels of responding during the AIMS module, teachers were trained individually in PBC. The second author delivered the training utilizing a script and PBC fidelity protocol designed by us. The trainer used PowerPoint slides to guide the in-person PBC teacher-as-coach training that lasted an average of 49 min (R = 35–58) across teachers. The teachers were trained to use an adaptation of PBC to coach their paras that included: collaborative goal setting, focused observations, and data-based feedback. The adapted PBC framework was presented and in-depth discussions with videos were used to train the teachers on each PBC component. Teachers practiced implementing PBC for DTT and the trainer provided feedback.

PBC Intervention

Once teachers were trained to coach their paras, they began PBC on DTT procedures, with coaching sessions 2 times a week. Each coaching session followed a structured protocol. The first coaching sessions included a review of all steps in the DTT procedure and lasted approximately 60 min. In all subsequent PBC sessions, teachers provided feedback to paras on their implementation of DTT in the classroom during sessions that lasted between 15 and 45 min.

Prior to each PBC session, the coaches received the recorded videos, via a password protected online cloud server, of the paras' implementing DTT as well as each paras DTT fidelity of implementation as scored by us. The teachers were also required to watch one video of each para before each PBC session to find points where the paras were implementing or not implementing DTT procedures to guide feedback to their paras. PBC sessions occurred in para groups within a classroom. Coaches began each session stating the individual goal of reaching 80% fidelity of DTT implementation for three consecutive sessions. The coaches used performance feedback, in person and video modeling, role play, and guided practice to increase the para's skills. The coaches recorded each session and completed a coaching log after each session including the number of participants, length of session, goals for the session, steps to accomplish goal, next meeting date, and any questions that the paras had. PBC sessions were conducted until each para reached 80% fidelity of DTT for at least 3 sessions. Paras required 3.5 (R = 3–5) coaching sessions on average to meet the criteria. PBC sessions continued until all paras in a teacher-para group reached criterion.

Data Analysis

Visual and statistical analyses were utilized to assess the functional relation between implementation of the AIMS module and subsequent coaching intervention and improvements in paras' implementation fidelity of DTT. For visual analysis, a graphical display of data was analyzed to identify changes in variability, mean, and trend within and across supervising teachers. Additionally, the first author calculated Tau to quantify the degree of change between baseline and implementation of the AIMS module and between the AIMS module and implementation of coaching. Tau, an effect size appropriate for single-case design (Parker and Vannest 2012), is calculated by comparing all data points in a given phase to all data points in the proceeding phase, yielding a proportion of non-overlapping pairs.

Results

Paras' DTT Fidelity

Visual Analysis

Figure 1 is a graphical display of the percentage of fidelity of DTT for Kallie, Nancy, Tonya, Ella, and Teresa's paras during baseline, AIMS, and coaching phases. The y-axis indicates the percent of DTT fidelity, as measured by number of DTT steps completed accurately, and the

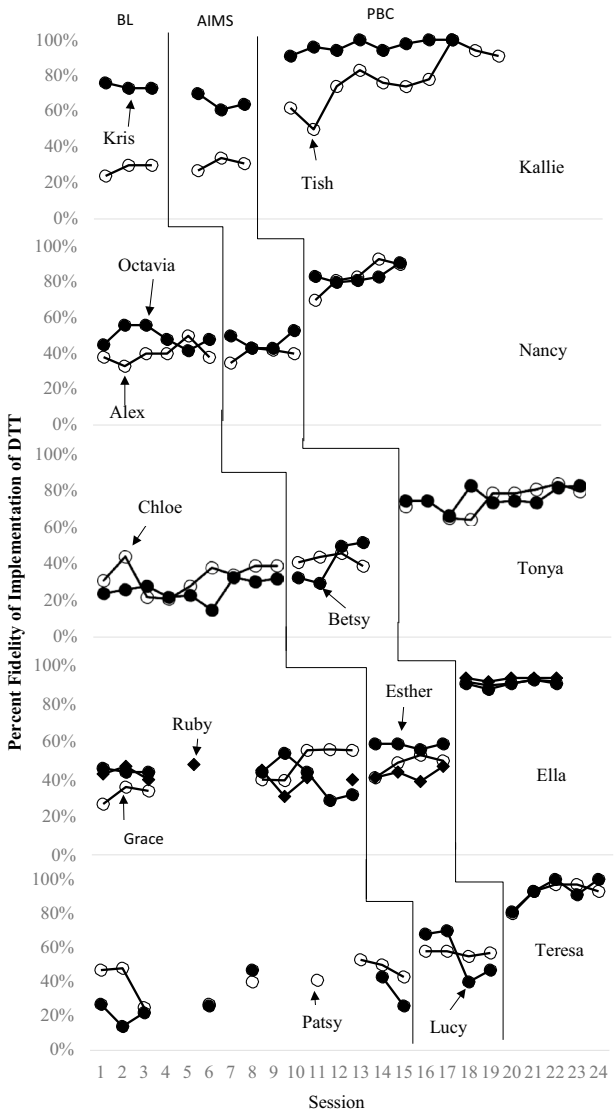

Fig. 1 Graphical display of paraprofessionals DTT fidelity across teachers for Baseline, AIMS, and PBC phases

x-axis indicates the session. Table 3 provides the mean and range of fidelity for each para as well as the combined average within teacher for each phase of the study. Both the AIMS module and PBC were methodically introduced to the supervising teachers' paras. The study demonstrates strong experimental control as is evidenced by systematic introduction of the interventions at different points in time, and five demonstrations of change across teachers with the introduction of the PBC intervention (Kratochwill et al. 2014).

Overall visual analysis indicates comparable patterns of fidelity within conditions and tiers for all paras across all teachers. With the exception of Kallie's paras (Fig. 1, top tier), paras in each tier exhibited very similar data patterns across each phase of the study as is evident by the close

Table 3 Paras average DTT fidelity by phase

Participants		Baseline	AIMS module	Coaching
Teacher	Para			
Kallie	Kris	74% (73–76)	65% (61–70)	97% (91–100)
	Tish	28% (24–30)	31% (27–34)	78% (50–100)
	Combined	51% (24–76)	48% (27–70)	87% (50–100)
Nancy	Octavia	49% (42–56)	47% (43–53)	84% (80–91)
	Alex	40% (33–50)	40% (35–43)	83% (70–93)
	Combined	44% (33–56)	44% (35–53)	84% (70–93)
Tonya	Betsy	26% (15–33)	41% (30–52)	76% (67–83)
	Chloe	33% (21–44)	42% (39–46)	76% (65–84)
	Combined	29% (15–44)	42% (30–52)	76% (65–84)
Ella	Ruby	42% (31–48)	43% (39–47)	94% (92–94)
	Esther	42% (29–54)	66% (56–91)	91% (88–93)
	Grace	43% (27–56)	48% (41–53)	92% (90–93)
	Combined	42% (27–56)	52% (39–91)	92% (88–94)
Teresa	Patsy	42% (25–53)	57% (55–58)	92% (80–97)
	Lucy	30% (14–47)	56% (40–70)	93% (81–100)
	Combined	36% (14–53)	57% (40–70)	92% (80–100)

and/or overlapping data series. During baseline DTT fidelity was well below 80% fidelity for all paras across all teachers with the exception of Kris, one of Kallie's paras, whose baseline fidelity was much higher with an average fidelity of 74% (Table 3). As can be seen in Fig. 1, introduction of the AIMS module yielded little to no initial change in fidelity of DTT, as is evident by the lack of intercept gap, with stable patterns of responding throughout the AIMS phase for Kallie, Nancy, and Tonya's paras One of Ella's paras (Ruby; 4th tier) and both of Teresa's paras (5th tier) did demonstrate an initial increase in fidelity of DTT. Introduction of PBC resulted in an immediate improvement for all paras across all tiers. As can be seen in Table 3, the combined average fidelity across all teachers increased nearly 40% during the coaching phase when compared to the AIMS phase.

Kallie

As seen in Fig. 1, Kallie's paras (top tier), Kris and Tish, demonstrated rather diversified patterns of DTT fidelity, although the gap in the data series narrowed once coaching was introduced. Introduction of the AIMS module yielded slight decreases in fidelity for both paras, which continued to be at or below baseline levels throughout the phase. Introduction of coaching yielded an immediate increase in fidelity for both paras. Kris exceeded criterion with the first coaching session and remained above 90%. Tish also demonstrated an immediate increase in fidelity with an increasing trend throughout the phase, reaching 80% fidelity by the 4th coaching session.

Nancy

Octavia and Alex, demonstrated very similar patterns of responding throughout all phases of the intervention. During baseline data for both is somewhat variable, however, the mean fidelity remained below 50% (Table 3). As is noted by the lack of intercept gap, introduction of the AIMS module did not result in a notable change in fidelity for Alex and Octavia, and all data in the AIMS phase overlaps with baseline data for both paras. Upon introduction of PBC there was an immediate increase in level of fidelity, as is evident by the large intercept gap for the data series for each of Nancy's paras. Although Alex's initial data point during the PBC phase was at 70% she reached criterion by the second session. Both paras reached criterion of 3 data points above 80% by the fourth observation, after only 2 PBC sessions with a combined average of 84% fidelity during the PBC phase (Table 3).

Tonya

Chloe and Betsy, were well below the 80% criterion with a baseline mean of 29% (see Table 3). During baseline, both initially demonstrated some variability which stabilized around the 7th observation (Fig. 1; 3rd level from the top), yet remaining below 40% fidelity. Initial introduction of the AIMS module did not yield notable changes in fidelity as is evidenced by the lack of intercept gap between the baseline and AIMs phase. Betsy demonstrated a slight a somewhat sharp increase in DTT fidelity for the third AIMS session (See Fig. 1), stabilizing around 50% fidelity. All data for Chloe during AIMS phase overlapped with baseline data whereas overlap was noted for only 50% of Betsy's data. The combined mean fidelity for both of Tonya's paras during the AIMS phase was 42% (Table 3). For both paras, introduction of the coaching yielded profound and immediate improvement in DTT fidelity, as is noted by the clear intercept gap and increase in level, when compared to the AIMS phase. However, Chloe and Betsy remained below 80% fidelity until the remained below 80% fidelity until the 6th and 8th observation session respectively, with the average DTT fidelity during the PBC phase below 80% for both (Table 3).

Ella

Ruby demonstrated a relatively stable pattern of DTT fidelity during baseline (M = 42%), whereas Esther's fidelity decreased around the 7th observation session, stabilizing around 30%, while Grace's DTT fidelity increased, stabilizing at 56% fidelity for the last two data points. Upon introduction of the AIMS DTT module Ruth's DTT fidelity remained stable with her baseline performance, with all AIMS data points overlapping with her baseline data points. Grace demonstrated an immediate decrease in level as is evident by the immediate intercept gap below her last three baseline data points, however, all but one of her AIMS data points also overlapped with her baseline performance. As can be seen in Fig. 1 (fourth level), Esther's data demonstrates a clear intercept gap with an increase in level upon introduction of the AIMS module which remained stable throughout the phase. Introduction of PBC resulted in an immediate increase in level and a stable pattern of responding, with DTT fidelity above 90% for all three of Ella's paras.

Teresa

Baseline data for Teresa's paras, whose data is displayed in the bottom level, was variable and remained low throughout baseline with a descending trend prior to the introduction of the AIMS module. Introduction of the AIMS module yielded a clear intercept gap and increase in level for both paras, with Patsy demonstrating a stable pattern of responding throughout the AIMS phase. Lucy's response pattern however indicates a decrease in fidelity, returning to baseline performance, by the third observation session. Both demonstrated an average fidelity below 60% throughout the AIMS phase. Introduction of PBC yielded an immediate increase in level with an increasing trend in DTT fidelity for both of Teresa's paras. Both remained above 90% fidelity after the first observation session during the PBC phase.

Statistical Analysis

To quantify changes in fidelity between baseline and AIMs phases as well as between AIMS and PBC phases Tau was calculated for each para. The effect sizes were combined, first by teacher and then overall weighted average was calculated for each of the contrasted phases (Table 4). Consistent with visual analysis, the obtained Tau effect sizes for the Baseline-AIMs contrasts varied considerably with combined Tau ES ranging from −0.22 (Kallie) to 0.91 (Teresa). Although results were only statistically significant for Tonya and Teresa's paras. The obtained overall Tau for the Baseline-Aims contrast, 0.43, indicates the AIMS module did yield minimal, yet statistically significant ($p = .05$) improvements in fidelity of implementation of DTT. The combined Tau for paras within teachers for the AIMS-PBC contrast yielded a Tau of 1 for all teachers as well as for the overall weighted effect size. The statistically significant results (Table 4) are consistent with visual analysis for the AIMs-PBC contrast.

Table 4 Paraprofessionals Tau effect size and relevant 95% confidence intervals by teacher for baseline-AIMs contrast and AIMs-Coaching contrast

Teacher	Baseline-AIMs contrast				AIMS-coaching contrast			
	Tau	p value	95% CI		Tau	p value	95% CI	
			Lower limit	Upper limit			Lower limit	Upper limit
Kallie	−0.22	NS	−0.92	0.70	1	<0.001	0.44	1
Nancy	0.04	NS	−0.50	0.58	1	<0.001	0.43	1
Tonya	0.81	0.001	0.32	1	1	<0.001	0.49	1
Ella	0.42	NS	0.00	0.83	1	<0.001	0.54	1
Teresa	0.91	<0.001	0.24	0.67	1	<0.001	0.77	1
Overall	0.43	<0.001	0.19	0.68	1	<0.000	0.76	1

Social Validity

All 11 paras completed the *AIMS Social Validity Questionnaire*. On average the respondents strongly agreed ($M=5$) that the module was "easy to understand and complete" and they would "recommend the module to other paras." The responses indicated the paras agreed ($M=4$) the module increased understanding of DTT, was more useful than other training methods they had experienced, and took a reasonable amount of time to complete. Additionally, responses indicated the paras agreed that the modules had sufficient examples and they understood how to implement DTT following completion of the modules.

Following completion of the coaching intervention participants completed the *Coaching Social Validity Questionnaires* (Teacher and Para version). Paras "strongly" agreed feedback on actual performance, suggestions they received from their teacher, and review of their fidelity data was helpful. All paras and teachers indicated they strongly agreed (5) or agreed (4) PBC was effective and more useful than other types of training. All paras indicated they would like PBC to improve other practices they use in the classroom and all but one teacher, who indicated she neither agreed nor disagreed, indicated they would use PBC in the future. For the item "the frequency of PBC sessions was manageable with my other work demands" responses were more variable with one teacher disagreeing. Most agreed or strongly agreed that the frequency of PBC was sufficient to change paras' practices, although a few paras and teachers commented PBC would be more effective if more time was allotted for sessions. Paras commented they preferred PBC because they received specific feedback on performance of the skill, learned something new to improve job performance, and learned from someone they knew. Teachers commented that PBC provided them with a structured method to train their paras. On items related specifically related to DTT all respondents agreed or strongly agreed that DTT was a helpful teaching strategy. All paras strongly agreed (5) that their students benefitted from DTT with the exception of 1 para who rated the item as "3." All respondents agreed or strongly agreed that they would use DTT in the future.

Discussion

Delivering high-quality EBP to students with MSDD requires well-trained education personnel (Browder et al. 2014). However, paras now comprise a significant portion of the education workforce for students with MSDD, often serving as the primary instructor despite their lack of preparation for the task (Rispoli et al. 2011). Thus, there is an urgent need to identify effective and efficient mechanisms for ensuring paras are able to deliver EBP, such as DTT, with high procedural integrity. The purpose of this study was to evaluate the efficacy of the AIMS online DTT learning module and PBC with teacher-as-coach to improve paras' procedural fidelity of DTT with students with MSDD.

Results of the study did not indicate a functional relation between introduction of the AIMS module and improvements in the implementation fidelity of DTT. Paras for only one teacher, Teresa, demonstrated notable improvement from baseline with the introduction of the AIMS module as well as one of Ella's paras, Esther. The impact of the AIMS module across all other teachers indicted little to no change in DTT fidelity and none of the participating paras achieved criterion. Results are consistent with previous literature indicating provision of instruction including the conceptual framework and knowledge of a practice is a necessary, first-step, component to improving performance, yet minimally effective when implemented alone (Simonsen et al. 2008). However, all para's rated the AIMS modules as helpful, reported they completed the modules as intended, and had an increased sense of competence after completing the modules.

The second purpose of this study was to examine the functional relation between the implementation of an adapted PBC model (Snyder et al. 2015) with teacher-as-coach and increased procedural fidelity of DTT for paras

working with students with MSDD. Results of the study did indicate a clear functional relation based on five demonstrations of change at different points in time across all teachers and for all participating paras with all paras reaching 80% fidelity by the conclusion of the study.

This study adds to a previous study indicating teachers can effectively utilize a coaching model to increase paras' fidelity of implementation (Brock and Carter 2016), and provides some preliminary evidence that more frequent goal-directed coaching sessions, such as conducted with a PBC model may lead to a faster rate of acquisition of targeted skills than was achieved in the previous study which included a one-time only coaching session (Brock and Carter 2016). Given that time and resources are often barriers to effective supervision and training of paras, implementation of PBC with teacher-as-coach is a model that can be utilized to support the development of paras'. In addition, both teacher and para participants indicated coaching was an effective, preferred method of training. PBC is also advantageous due to the individual nature of the PBC model. Although each teacher was implementing the PBC model, each teacher's focus during coaching sessions was based on her paras' individual fidelity data and those specific steps which they had not mastered. Additionally, exemplars and questions were directly focused on the specific classroom context to which they were assigned. Based on what is known regarding adult learning, this increases the meaningfulness and applicability of the training, thereby increasing the likelihood of application and sustainability (Gregson and Sturko 2007). Additionally, this may resolve other challenges that occur with training paras due to differences in education and experience.

Limitations

As with every study this one is not without limitations. First, the AIMS phase was not continued for 5 data points as recommended by What Works Clearinghouse (WWC: Kratochwill et al. 2014) to meet expectations of rigorous research. The WWC criteria, however do indicate that if there is a compelling reason to change and a clear pattern of responding has been established then a minimum of 3 data points is acceptable. As this research was conducted in partnership with the school district and conceptualized based on needs identified by the teachers and paras, motivation to change practice was high necessitating some changes in our typical research protocol. Specifically, the teachers, were eager to learn the coaching protocol and train their paras to fidelity, particularly the last two teachers. Thus, it became increasingly difficult to delay introduction of PBC for the last two teachers, Ella and Teresa, for whom treatment was delayed the longest. As the authors did not expect paras to achieve criterion with the AIMS module alone, the minimal number of data points necessary to establish a pattern of responding during the AIMS phase in an effort to increase the rate at which all teachers would be able to begin PBC was used. This highlights the complexity of partnering with schools, which requires researchers to create designs that maintain the rigor and quality necessary to determine efficacy of interventions while also meeting the needs of the district.

Additionally, as the AIMs module was implemented prior to the implementation of PBC, the significant improvement in paras' fidelity of implementation of DTT cannot be attributed to PBC alone. The significant differentiation between fidelity of implementation in baseline compared to the PBC phase may be attributed to the combination of both the AIMs module and PBC effects. The AIMs module may have provided the paras with foundational information on DTT that alone was not sufficient to yield improvements in fidelity of implementation, yet necessary for the benefits of PBC.

Another limitation of this study, particularly as it relates to implementation is that the researchers actually scored each paras' fidelity rather than the teacher. This task would definitely decrease the feasibility of PBC for teachers given the time intensity of scoring DTT fidelity and, would likely affect the social validity of the intervention. Future research should evaluate the feasibility of teachers being able to score fidelity in addition to implementing the PBC. Additionally, identifying other methods for collecting fidelity data such as para self-monitoring or video feedback are recommended.

The lack of generalization and maintenance data is also a limitation. The implementation of the study lasted until the end of the school year, precluding the ability to collect maintenance data. Assessing the degree to which fidelity of implementation maintains following a coaching intervention is an imperative direction for future research.

Future Research

In addition to evaluating paras' maintenance and generalization of fidelity of a given practice following exposure to PBC with teacher-as-coach and identifying feasible methods for teachers to evaluate paras' fidelity, there are other areas that would be beneficial to address in future research. The first area is addressing the necessity for instruction prior to introduction of PBC. Given the very direct, specific, and focused nature of PBC, it is plausible that PBC alone may yield desired outcomes further increasing the utility of providing training to paras. Along those lines, the DTT AIMS module is rather lengthy and thus attention and focus may have been compromised. Further, some of the paras completed the module on their own time as their workday responsibilities did not afford time for this

learning opportunity. Perhaps, shorter, more discrete modules that provide basic information on the practice and a few context specific examples would yield similar or better results with decreased investment of paras' time.

As is common with the paraprofessional workforce, the education, previous training, and years of experience varied considerably across both the teachers and paras. Research that investigates differential effects of learning modules and/or PBC with teacher-as-coach based on learner characteristics would provide additional evidence to guide practitioners in differentiation of training. Additionally, as PBC is based on individual learner progress, the number of coaching sessions required to reach the fidelity of implementation criterion varied (2–5) across paras both within and across teachers. Research that evaluates dosage, including length, frequency, and duration of coaching based on learner characteristics and skill difficulty is needed to guide implementation.

Implications for Practice

This study has several implications for practice related to both the supervision and training of paras. Supervision of paras by certified teachers is expected (Individuals with Disabilities Education Act, 2006) yet many teachers report lacking the skills, knowledge, and time to effectively carry out this task (Kratz et al. 2014). Training teachers in effective coaching strategies, such as PBC, may be one mechanism to address these barriers. Additionally, having several teachers in a district trained to coach paras to deliver EBP would greatly build capacity to increase the quality of the workforce and thus, increase students' with MSDD exposure to EBP. Additionally, group coaching, similar to this study, would also increase the efficiency with which paras can be trained while also promoting collaboration among peers.

Teachers often feel ill- equipped to supervise paras and paras historically receive little training to increase their skills in implementing EBP. This places children at risk for poor educational instruction and outcomes, particularly students with MSDD. The results of this study provide initial evidence of PBC as an effective PD framework for teachers to increase paras' skills through provision of ongoing training and feedback.

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