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A Review of the Evidence for Real-Time Performance Feedback to Improve Instructional Practice

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Abstract

In this comprehensive review, 32 studies were identified in which researchers investigated the effect of real-time performance feedback delivered via technology on interventionist implementation of instructional practices. Studies were evaluated for methodological rigor with quality indicators from the Council for Exceptional Children. Twenty-two single case designs and one group design met all quality indicators. The single case designs were analyzed using visual analysis and given success estimates calculated as a ratio of the number of demonstrated effects to potential demonstrations of effect. Methodologically sound evidence indicates that real-time performance feedback is an evidence-based practice for changing interventionist behavior during intervention sessions. Implications for research and practice are discussed.

Keywords

real-time performance feedback, coaching, bug-in-ear, teacher behavior

The purpose of special education is to provide individualized instruction through the incorporation of evidence-based practices (EBPs). The Individuals With Disabilities Education Act (IDEA, 2006) requires EBPs in the instruction of students with disabilities (SWDs), "to the extent practicable." Special education researchers and policy makers generally agree on the utility of EBPs to improve outcomes for SWDs and have developed resources for educators to increase their use in practice (Cook & Cook, 2011). Despite efforts to disseminate research findings, effective interventions identified through scientific inquiry are too often not implemented with frequency or fidelity in practice (Burns & Ysseldyke, 2009).

A promising method to close the research to practice gap and improve student outcomes may be improving the training and support educators receive related to implementation of effective instructional practices (Fallon, Collier-Meek, Maggin, Sanetti, & Johnson, 2015). Coaching is one means of providing individualized, continued support to interventionists as they implement EBPs. Researchers have identified several components of effective coaching including engaging initial training, continued observations, and specific feedback that includes observation data or modeling (Kretlow & Bartholomew, 2010). Special education researchers have identified similar components through reviews of effective practitioner training and found behavioral skills training, a combination of modeling, practice, and performance feedback (PF) to positively affect instructors' fidelity to EBPs (e.g., Brock et al., 2017).

Performance Feedback

Many researchers have focused investigations on PF as an essential component of coaching and a means of improving instructor behavior (e.g., Fallon et al., 2015). Researchers have determined PF to be an effective or promising practice for improving interventionist fidelity to an intervention (e.g., Solomon, Klein, & Politylo, 2012). Because PF is a broad category that encompasses a wide range of practices and outcomes, several reviews have examined specific components of PF that contribute to improved interventionist behavior (e.g., Fallon et al., 2015).

To our knowledge, three reviews have examined the immediacy of PF as a component of broader PF for educators (Fallon et al., 2015; Scheeler, Ruhl, & McAfee, 2004; Solomon et al., 2012). Scheeler and colleagues (2004) sought to identify effective attributes of PF through a descriptive literature review. Across 10 studies, they identified the immediacy with which teachers receive PF as the "only attribute that clearly demonstrates efficacy as a characteristic of

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effective feedback" (p. 404). Many researchers have used this rationale for investigating PF delivered with the greatest possible immediacy (i.e., real-time PF).

Fallon and colleagues (2015) conducted a systematic review of single case research on PF and evaluated effects according to What Works Clearinghouse (WWC) single case design standards. In this synthesis, researchers found studies with strong to moderate evidence varied in the immediacy with which PF was provided (Fallon et al., 2015). Solomon and colleagues (2012) used meta-analysis to determine the effect of PF on teachers' treatment integrity and examined immediacy as a moderator of effects. They found studies in which immediate feedback that was delivered had larger effects ($r = .73$) than PF provided later ($r = .65$). This difference was not statistically significant, but the researchers discussed results in the context of the possibility that some teachers may need more support (i.e., more immediate feedback) than others. These studies offer preliminary evidence that the immediacy of PF may have an impact on educator outcomes.

Real-Time Performance Feedback (RPF) via Technology

In this review, RPF is defined as feedback offered to interventionists during instruction and delivered using technology. Rock and colleagues (2009) suggested that the most immediate feedback may be more effective than feedback delayed even slightly, especially for novice or preservice teachers. Others have posited that correcting instructor behavior in the moment may avoid the repeated practice of incorrect techniques (e.g., Scheeler, McKinnon, & Stout, 2012). Researchers have used these rationales to investigate RPF as a way to deliver the timeliest form of feedback in the least obtrusive manner. Educational researchers have used bug-in-ear technology (BIE) to deliver RPF to clinical practitioners since the 1950s (e.g., Korner & Brown, 1951). Technological advances, such as videoconferencing platforms (e.g., Rock et al., 2009), have improved the ease and discretion with which RPF can be delivered.

Randolph and Brady (2017) conducted a review of the published literature on BIE across a wide range of participants (e.g., high school students, bank tellers, medical students). Twelve of the 22 studies they examined targeted teachers' instructional behaviors. The authors reported that studies of BIE "met at least the minimum standards" (p. 296) based on guidance from single case and group design researchers. It was unclear how Randolph and Brady (2017) determined whether each selected study met minimum standards. Summarized standards presented were truly minimal (e.g., researchers required interobserver agreement to be assessed and reported but no minimum level of agreement was established). Effects were not synthesized across studies, making it difficult to draw conclusions about the effects of BIE for specific participant groups.

A second recent review of BIE synthesized published single case literature (Schaefer & Ottley, 2018). Researchers identified 17 single case design studies published since 2002 and used WWC standards to determine BIE met qualifications as an EBP. Both research groups investigating BIE included only published literature in their reviews. Although both reviews classified BIE as an EBP, including only published literature may have positively skewed those findings.

Purpose

Rapid advances in technology and preliminary findings of previous reviews warrant further investigation of RPF as a means of improving interventionists' instructional practices. The purpose of this review was to evaluate the quality of the evidence for RPF to educators teaching students in Grades pre-K–12 as a means of improving instructional practices. This review builds on previous reviews of BIE because it includes gray literature and RPF provided with other technology (e.g., visual PF using an iPad). Following a framework presented in a review of PF to improve teacher praise (Sweigart, Collins, Evanovich, & Cook, 2016), we used the Council for Exceptional Children's (CEC, 2014) *Standards for Evidence-Based Practices in Special Education* to evaluate the quality of research base on teacher-level interventions to answer two research questions:

Research Question 1: Are empirical studies of RPF to improve interventionists' instructional practices methodologically rigorous according to current quality standards in special education research?
Research Question 2: Is existing evidence sufficient to qualify RPF as an EBP?

Method

Literature Search and Article Screening

The first author completed a full-text search of PsycINFO and ERIC, as well an abstract search of Proquest Dissertations and Theses Global in June 2017. Not restricted by publication date, the search consisted of the following terms: (*bug in ear, telecoach, mechanical third ear, telesupervision, ecoach, real time feedback, telementor, technology mediated instruction, video conferenc*, teletrain, performance feedback, virtual coach*, remote coach*, remote supervis**, and *virtual supervis**) AND (*teacher, educator, interventionist, paraprofessional*, and *paraeducator*). The initial search yielded 1,049 relevant titles (see Figure 1 for screening results).

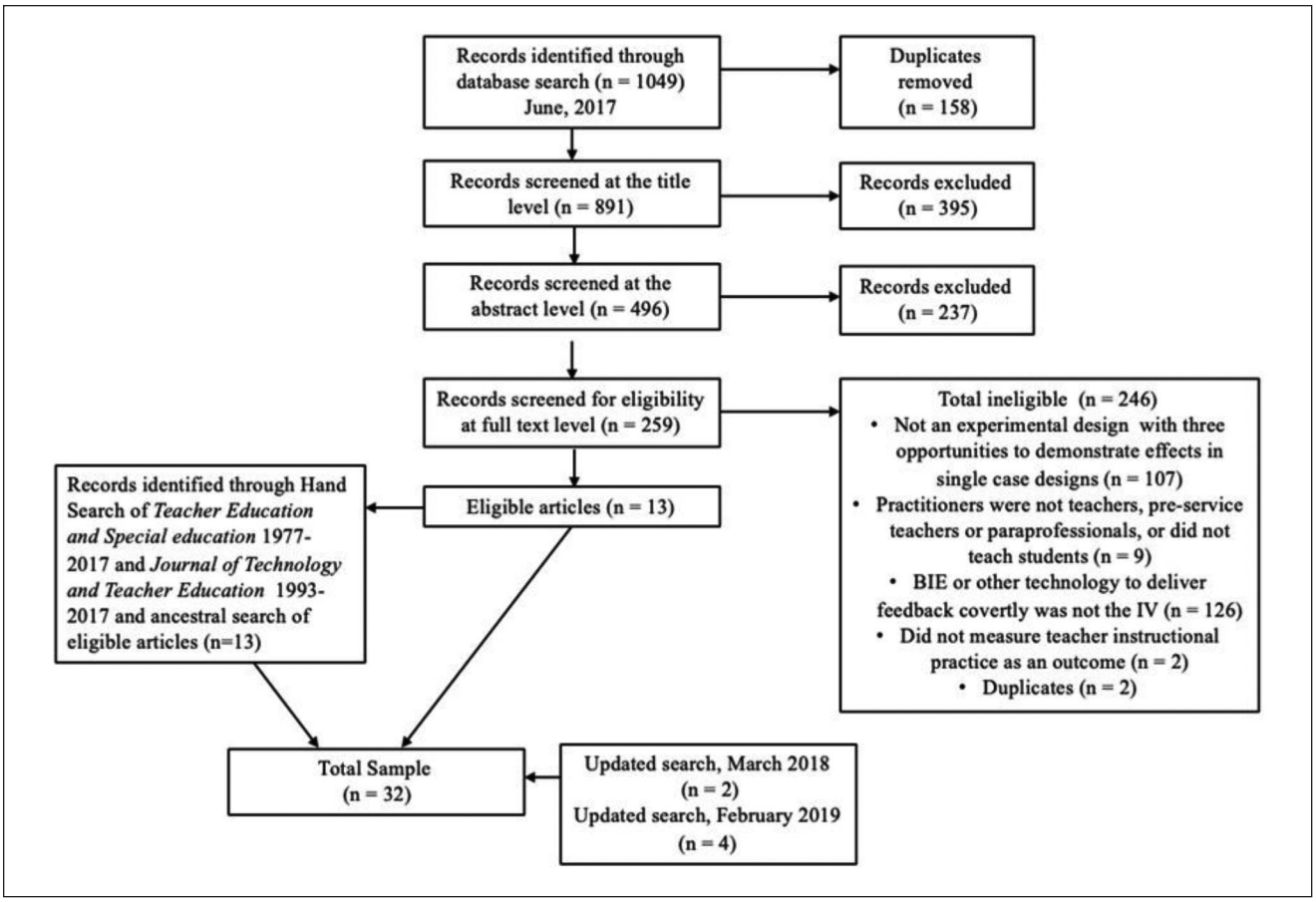

Figure 1. Study search procedures diagram.
Note. BIE = bug-in-ear technology.

To be included, studies had to (a) be written in English; (b) describe an empirical study examining the effect of an intervention; (c) include teachers, paraprofessionals, or pre-service teachers serving students in Grades pre-K–12 as the interventionists; (d) involve delivery of RPF; and (e) include at least one outcome measure of interventionists' use of instructional practices. Studies examining side-by-side coaching without technology were not included in this review because of the unique contribution technology makes to the feasibility, discretion, and distance with which RPF can be provided.

The first author served as primary screener and trained the second and third authors as secondary screeners. All screeners were doctoral students in a special education program. A random number generator was used to select 25% of titles and 27% of abstracts for double screening. Interresearcher agreement (IRA) was calculated as the number of agreements divided by the number of agreements plus disagreements × 100, with overall IRA of 85.6% at the title level and 81.2% at the abstract level. All disagreements at these levels were included in the next level of screening. Although agreement was relatively low at the title and abstract levels, at the full-text level, coders independently agreed on exclusion of 100% of discrepancies identified at the two previous levels, indicating an abundance of caution at earlier levels of screening. All 259 potentially relevant full-text articles were double-screened and discrepancies were resolved by consensus. Overall agreement was 95.96%. A total of 13 full-text articles met criteria from the initial database search.

We conducted an archival search by examining references and forward citations of all included articles using Google Scholar. The archival search and a hand search of two journals based on relevant aims, *Teacher Education and Special Education* and *Journal of Technology and Teacher Education*, yielded an additional 13 articles that met inclusion criteria. An expert in RPF was consulted and agreed the list of identified studies was comprehensive. This expert was selected because she was the first author of the largest number of included studies identified by the database search for this review. Updated searches using the same procedures identified two additional studies in March

2018 and four additional studies in February 2019, yielding a total of 32 studies for analysis.

Article Coding

Articles were coded for descriptive information, including participant and setting characteristics, independent and dependent variables, and verified by a second, trained doctoral student coder. Next, articles were coded for methodological quality. Following the model provided by Sweigart and colleagues (2016), we used all eight CEC quality indicators (QIs) for the evaluation of quality in single case and group design studies (Cook et al., 2015; CEC, 2014). Cook and colleagues (2015) provided guidance outlining specific criteria for interpreting CEC standards. Both documents informed the development of a codebook available upon request.

We adapted the CEC standards in the following two ways. First, QI 6.5 requires that "the design provides at least three demonstrations of experimental effects at three different times" (p. 4). We interpreted this to mean the design provides three *potential* demonstrations of effect, because it is not a methodological flaw to show noneffects. We evaluated studies' effects separately, after determining methodological quality. Second, the only CEC QI omitted was QI 2.2, participants' disability status, because participants in the current review were teachers, preservice teachers, and paraeducators without disabilities. All studies were coded independently by the first author and two trained secondary coders. IRA was calculated on 100% of included studies by dividing the number of agreements by the number of agreements plus disagreements × 100 across QIs. Overall agreement was 95.25% (range = 75% [QI 6.7, design controls for common threats to internal validity] – 100%). Discrepancies were resolved via consensus.

Effects in single case design studies that met all QIs were examined further according to CEC guidelines that require demonstration of a functional relation and therapeutic change in at least three fourths of cases to establish the presence of positive effects (CEC, 2014). In addition, at least five studies with high confidence of positive treatment effects across at least 20 total participants are required to classify a practice as evidence based (CEC, 2014). Two coders independently used visual analysis to examine the level, trend, variability, overlap, and immediacy of change of data points presented in each study (Ledford & Gast, 2018). Both coders had taken two graduate-level courses in single case design research including instruction on using visual analysis to interpret results. Coders counted the number of potential and demonstrated experimental effects. IRA was calculated with point by point agreement. Total IRA across studies' potential demonstrations was 100% and across actual demonstrations was 92.93%. Discrepancies were resolved via consensus.

Potential and demonstrated experimental effects were compiled as success estimates to determine the presence or absence of positive effects according to CEC guidelines. Success estimates, first suggested by Reichow and Volkmar (2010) and replicated in additional reviews (e.g., Schaefer & Ottley, 2018) are estimated using visual analysis and provide "a ratio of successful implementations of the independent variable to the total number of implementations attempted" (p. 152). Rather than an effect size, this ratio represents the consistency of the replication of experimental effects within and across studies. Researchers have yet to come to consensus on the appropriateness of a statistic for estimating effect sizes for single case designs (Shadish, 2014) and have suggested that visual analysis should be the primary means of interpreting single case data (Ledford & Gast, 2018).

Results

Participants and Contexts

Thirty-two experimental studies of RPF to preservice teachers (n = 77), practicing teachers (n = 115), or paraprofessionals (n = 6) met inclusion criteria for this review (see Table 1). The majority of studies were published in the last 5 years (2012–2018, n = 24, 75%) and employed single case designs (n = 26, 81.25%). Six studies employed group designs (18.75%).

Reporting of specific details regarding study context and participant demographics varied across studies. Studies took place in HeadStart (n = 5), preschool (n = 7), elementary (n = 14), middle (n = 7), and high school (n = 3) settings; one vocational school; and two self-contained schools for SWD (see Table 1). Interventionists served a wide range of students with and without disabilities in pre-K–12 general and special education classrooms. Ten studies did not report information about the presence or absence of SWDs in participating classrooms. Information regarding reported student disability status at the classroom or individual student level is provided in Table 1. More detailed information regarding students' disability status is available from the first author upon request.

Academic Dependent Variables

Seven studies (21.88%) measured the percentage of three-term contingencies (TTC), also referred to as "learn units" or "embedded learning opportunities" (see Table 1 for categorization by dependent variable). TTC is an academic instructional strategy that consists of a teacher antecedent (i.e., opportunity to respond directed at students), followed by a student response, then teacher-delivered corrective feedback or praise (Albers & Greer, 1991). Eight studies (25%) examined teacher use of communication strategies including combinations of the following specific strategies: contingent

Table 1. Descriptive Characteristics of Included Studies.

Study	Design	Participants	Primary outcome measure	Disability status reported
Bowles and Nelson (1976)	Q	19 U	C	N
Cheek (2016) (D)	MB-P	3 SPED	MC	Y
[a]Coogle, Ottley, Storie, Rahn, and Burt (2017)	MP-P	1 E-SPED	CS	Y
[a]Coogle, Ottley, Storie, Rahn, and Burt (2018)	MP-P	3 E-SPED	CS	Y
[a]Coogle, Rahn, and Ottley (2015)	MP-P	3 E-PST-S	CS	Y
[a]Coogle, Rahn, Ottley, and Storie (2016)	MP-B	2 E-SPED	CS	Y
[a]Coogle Ottley, Rahn, and Storie (2018)	MP-P	4 E-SPED	CS	Y
Eichelberger (2015) (D)	MB-B	2 TA	C	Y
[a]Garland (2013) (D)	MB-P	3 GE	TTC	Y
Giebelhaus (1994)	Q	22 PST-G	TCB	N
[a]Goodman, Brady, Duffy, Scott, and Pollard (2008)	MB-P	3 SPED	TTC	Y
[a]Holden (2016) (D)	MP-B	1 PST-G	MC	Y
Hollett, Brock, and Hinton (2017)	Q	16 PST-G	C	N
Jackson-Lee (2013) (D)	Q	12 U	MC	N
[a]LaBrot, Pasqua, Dufrene, Brewer, and Goff (2016)	MB-P	4 E	BSP	N
Lindell (2001) (D)	Q	19 PST-G, 2 PST-S	TCB	N
Lown (2017) (M)	ABAB	3 E	BSP	N
[a]Nguyen (2015) (D)	MB-P	4 GE	BSP	N
[a]Ottley, Coogle, Rahn and Spear (2017)	MB-P	4 E	CS	Y
[a]Ottley and Hanline (2014)	MB-P	8 E	CS	N
[a]Ottley, Piasta, Coogle, Spear, and Rahn (2018)	RCT	21 E	CS	Y
[a]Savio-Wolf (2016)	MB-P	3 GE	C	Y
Scheeler and Lee (2002)	MB-P	3 PST-S	TTC	Y
[a]Scheeler, Bruno, Grubb, and Seavey (2009)	MB-P	3 PST-S[b]	TTC	Y
[a]Scheeler, Congdon, and Stansberry (2010)	MB-P	3 GE, 3 SPED	TTC	Y
[a]Scheeler, McAfee, Ruhl, and Lee (2006)	MB-P	5 PST-S	TTC	N
[a]Scheeler, McKinnon, and Stout (2012)	MB-P	3 PST-S[b]	TTC	Y
[a]Scheeler, Morano, and Lee (2018)	MB-P	4 TA	BSP	Y
[a]Sweigart, Landrum, and Pennington (2015)	ABAB	1 SPED	BSP	Y
[a]Taber (2015) (D)	MB-P	4 GE	BSP	Y
[a]White (2018) (M)	ABAB	3 E	BSP	N
[a]Wimberly (2016) (D)	MB-P	4 E	MC	N

Note. D = dissertation; M = master's thesis; Q = quasi-experimental; ABAB = single case reversal design; U = unspecified certification; C = combined dependent variables; N = no; MB-P = multiple baseline (participants); SPED = special educator; MC = fidelity to multicomponent intervention; Y = yes; MP-P = multiple probe (participants); E-SPED = early childhood educator (preschool, HeadStart, Early HeadStart, or HeadStart Aftercare); CS = communication strategies; E-PST-S = early childhood educator preservice; MP-B = multiple probe (behaviors); MB-B = multiple baseline (behaviors); TA = paraprofessional or teaching assistant; MB-P = multiple baseline (participants); GE = general educator; TTC = three-term contingencies; PST-G = preservice GE; TCB = teacher clarity behaviors; BSP = behavior-specific praise or positive feedback; PST-S = preservice SPED; RCT = randomized control trial.
[a]Met all quality indicators. [b]Studies had five participants, but only three were included in an experimental design.

imitation, expanding language, modeling language, offering choices, providing wait time, reinforcement, asking questions, mands, and descriptive talk. Two studies (6.25%) measured "teacher clarity behaviors." Researchers stated that the teacher clarity behaviors they selected came from the academic literature on observable teacher behaviors. Some examples included "repeats things that are important, writes important things on the board, repeats things students do not seem to understand, allows time for students to ask questions, examines student work" (Giebelhaus, 1994, p. 366).

Behavioral and Combined Dependent Variables

Seven studies (21.88%) measured teacher use of positive feedback or behavior-specific praise (BSP). Four studies (12.5%) measured a combination of academic and/or

behavioral instructional practices. For example, Bowles and Nelson (1976) measured teacher prompts, contingency statements, praise, and appropriate and inappropriate teacher verbalizations. Eichelberger (2015) measured precorrection, active supervision, and BSP. Four studies (12.5%) measured treatment fidelity to a multicomponent academic or behavioral intervention. These multicomponent interventions included reading comprehension interventions (Cheek, 2016), a peer-mediated learning intervention (Jackson-Lee, 2013), a behavioral intervention (Wimberly, 2016), and a self-regulated learning strategies intervention (Holden, 2016).

Student Dependent Variables

Although the primary dependent variable in all studies captured teacher instructional practice, less than half of studies collected student outcome variables (n = 15, 46.88%). Student-level dependent variables included student engagement (Cheek, 2016; Holden, 2016; Lown, 2017; Sweigart, Landrum, & Pennington, 2015; White, 2018), disruptive behavior (Lown, 2017; Nguyen, 2015; Sweigart et al., 2015; Taber, 2015; White, 2018), percentage of correct responses (Cheek, 2016; Garland, 2013; Scheeler, McAfee, Ruhl, & Lee, 2006), expressive communication (Coogle, Ottley, Rahn, & Storie, 2018; Coogle, Ottley, Storie, Rahn, & Burt, 2017; Coogle, Ottley, Storie, Rahn, & Burt, 2018; Ottley & Hanline, 2014; Ottley, Piasta, Coogle, Spear, & Rahn, 2018), use of self-regulated learning strategies (Holden, 2016), and "initiation compliance," or following directions (Wimberly, 2016).

Independent Variables

All but two studies used BIE to deliver RPF to teachers (n = 30, 93.75%). The teacher in these cases wore an earbud to hear comments from a supervisor. The two remaining studies used visual RPF by sharing a graph of teacher behavior with the participating teacher via iPad (Sweigart et al., 2016) or Smartwatch (White, 2018). Most studies employed researchers or university supervisors as the interventionist (n = 25). One study used either a peer preservice teacher or researcher as the interventionist, depending on group assignment (Hollett, Brock, & Hinton, 2017). One study used community coaches from a nonprofit professional development organization (Ottley et al., 2018). The remaining five studies employed mentor teachers, coteachers, or other school staff as the interventionist (Giebelhaus, 1994; Lindell, 2001; Ottley, Coogle, Rahn, & Spear, 2017; Savio-Wolf, 2016; Scheeler, Congdon, & Stansberry, 2010).

Independent variables were classified into two main categories (see Table 2). In RPF alone, researchers isolated RPF as the only independent variable introduced during intervention. If these researchers included additional training components, they were completed prebaseline, so that only the effects of RPF were evaluated. In the second, enhanced RPF, researchers introduced additional professional development components during intervention. Sometimes, enhancement to RPF was minor (e.g., an explanation of why BSP is important to effective teaching lasting less than 5 min; Taber, 2015). In other cases, the enhancement was extensive (e.g., professional development including modeling and guided practice before implementation of RPF; Ottley & Hanline, 2014). Participants in enhanced RPF studies were exposed to multiple forms of training during treatment phase, making it impossible to isolate effect of RPF from the effect of other professional development components offered during intervention.

Methodological Quality

Group design studies. Of the six group design studies identified for this review, only one met all QIs (Ottley et al., 2018). The researchers in this study employed a randomized control trial with a small sample size (n = 21). In this study, early childhood teachers in public and private preschool settings were randomly assigned to either didactic training alone or didactic training plus BIE coaching from a trained coach, to improve educators' use of communication strategies. Researchers found educators in the BIE group used significantly more mand models than educators in the control group (d = 1.16). However, no significant differences were found between groups for the other five communication strategies that were taught and measured across participants.

The remaining five group design studies were quasi-experimental designs with small sample sizes (range n = 12–22). None of the five studies evaluated coaches' treatment fidelity (QI 5.1). Three studies that employed nonresearcher implementers of the intervention did not adequately describe interventionist training or qualifications necessary to deliver the intervention (QI 3.2; Giebelhaus, 1994; Hollett et al., 2017; Lindell, 2001). Only two of the six studies adequately described intervention steps with replicable precision (QI 4.1; Lindell, 2001; Ottley et al., 2018).

Single case design studies. Nearly all single case design studies in this review used multiple probe or multiple baseline designs to evaluate research questions (n = 23, 88.46%). Two studies were A-B-A-B reversal designs (Sweigart et al., 2015; White, 2018) and one was an A-B-C-B-C design (Lown, 2017). Four studies did not meet met all CEC QIs and were not evaluated for evidence of effects (Cheek, 2016; Eichelberger, 2015; Lown, 2017; Scheeler & Lee, 2002).

Studies that met all QIs. Twenty-two single case design studies met all QIs and were categorized into two intervention categories: RPF alone and enhanced RPF (see Table 2). Across

Table 2. Success Estimates of Studies That Met All Quality Indicators.

Independent variable	Study	Success estimate	Positive effects	Number of participants
RPF in isolation	Coogle, Rahn, Ottley, and Storie (2016)	5 of 6	Yes	2
	LaBrot, Pasqua, Dufrene, Brewer, and Goff (2016)	4 of 4	Yes	4
	Scheeler, Bruno, Grubb, and Seavey (2009)	3 of 3	Yes	3
	Scheeler, McAfee, Ruhl, and Lee (2006)	5 of 5	Yes	5
	Scheeler, McKinnon, and Stout (2012)	3 of 3	Yes	3
	Wimberly (2016)	4 of 4	Yes	4
Enhanced RPF	Coogle, Rahn, and Ottley (2015)	3 of 3	Yes	3
	Coogle, Ottley, Storie, Rahn, and Burt (2017)	2 of 3	No	1
	Coogle, Ottley, Storie, Rahn, and Burt (2018)	2 of 3	No	3
	Coogle, Ottley, Rahn, and Storie (2018)	4 of 4	Yes	4
	Garland (2013) (D)	3 of 3	Yes	3
	Goodman, Brady, Duffy, Scott, and Pollard (2008)	3 of 3	Yes	3
	Holden (2016) (D)	3 of 3	Yes	1
	Ottley and Hanline (2014)	10 of 12	Yes	4
	Ottley, Coogle, Rahn, and Spear (2017)	2 of 4	No	8 (4 dyads)
	Nguyen (2015) (D)	4 of 4	Yes	4
	Savio-Wolf (2016) (D)	7 of 9	Yes	3
	Scheeler, Congdon, and Stansberry (2010)	3 of 3	Yes	6 (3 dyads)
	Scheeler, Morano, and Lee (2018)	4 of 4	Yes	4
	Sweigart, Landrum, and Pennington (2015)	2 of 3	No	1
	Taber (2015) (D)	4 of 4	Yes	4
	White (2018) (M)	9 of 9	Yes	3
Total		89 of 99	18 of 22	76

Note. RPF = real-time performance feedback; D = dissertation; M = master's thesis.

the six studies that isolated RPF, there were 24 demonstrations of experimental effects out of 25 potential demonstrations according to visual analysis. Across the 16 studies that used enhanced RPF as the independent variable, there were 65 demonstrations of experimental effects out of 73 potential demonstrations.

According to CEC guidelines (2014), all studies of RPF alone demonstrated high confidence of treatment effects. These six studies included 21 participants (n = 10 in-service teachers, n = 11 preservice teachers). Twelve of 16 enhanced RPF studies demonstrated positive treatment effects. These 12 studies included 42 participants (n = 31 in-service teachers, n = 7 preservice teachers, n = 4 paraprofessionals). Across both study types (i.e., RPF alone and enhanced), 18 studies demonstrated positive effects across 63 participants (success estimate = 89 of 99). Thus, both kinds of RPF (i.e., alone and enhanced) qualify as EBPs based on CEC indicators applied to the included studies.

Discussion

The purpose of this review was to evaluate the quality of the evidence for RPF to preservice and practicing educators of students in Grades pre-K–12 by answering two research questions: (a) Are empirical studies of RPF to improve interventionists' instructional practices methodologically rigorous according to current quality standards in special education research? (b) Is existing evidence sufficient to qualify RPF as an EBP? To answer these questions, we followed a model presented by Sweigart and colleagues (2016) and applied CEC (2014) Standards to 32 studies of RPF.

Results indicate the majority of recently published single case design studies are of high methodological quality and provide sufficient evidence to classify RPF as an EBP. Most of the studies examined discrete interventionist behaviors (e.g., TTC) and demonstrated positive effects of RPF on interventionist behavior during intervention sessions. Findings support previous research that found immediately delivered teacher feedback had the potential to improve teacher behavior (Scheeler et al., 2004; Solomon et al., 2012). Our findings are similar to others classifying RPF as an EBP (Randolph & Brady, 2017; Schaefer & Ottley, 2018). This review improves upon previous research by rigorously evaluating the methodological quality of included studies and including gray literature. These results should be considered alongside broader implications outlined below for the use of RPF in professional development to

improve implementation of EBPs and, ultimately, student outcomes.

Implications for Practice

University supervisors of preservice teachers, academic coaches, and other professionals who provide feedback to practicing teachers and paraprofessionals may consider RPF an effective means of changing teacher behavior, at least during intervention sessions. This practice can be especially useful for increasing desirable interventionist behaviors that are not currently implemented at an acceptable rate. By training teachers on EBPs and practicing implementation with RPF, it is possible that teachers may eventually incorporate those behaviors into their craft as generalized teaching skills (Scheeler et al., 2012). These findings should be considered with the following caveats.

Context-dependent behavior change. Because feedback was offered to teachers in real time, teacher behavior was measured within a context-dependent system (Yoder, Symons, & Lloyd, 2018). It is unsurprising that most researchers were able to demonstrate teacher behavior change when they gave direct instruction on what to say or do in the moment. In some cases, researchers asked teachers to repeat statements verbatim. Although providing RPF may improve teacher behavior during intervention sessions, these effects do not necessarily facilitate change in generalized teacher skills or student outcomes. The only methodologically sound group design study evaluated in this review employed a small sample size ($n = 21$) and demonstrated positive effects for only one of five communication strategies measured (Ottley et al., 2018). Additional methodologically rigorous group design studies are essential to determining the generalizability of RPF as an effective teacher-level intervention.

The fact that teacher behaviors measured across studies occurred in the context of environmental changes does not negate the value of RPF in supporting teachers as they implement strategies that are relatively new to their teaching repertoire. Although only nine studies employed preservice teachers as participants, all studies investigated interventionist behaviors that were not employed on a regular basis in baseline conditions. Potentially, context-dependent behavior change can be useful to educating and training preservice, novice, and poorly performing interventionists to implement new teaching behaviors that require practice and feedback in hopes of eventually promoting more generalized teaching skills (Yoder et al., 2018).

Feasibility. The utility of RPF in changing interventionist behavior is not enough to establish its effectiveness in improving student outcomes in natural settings. It is also important to evaluate the feasibility of RPF in practice. University supervisors are frequently required to observe preservice teachers and offer constructive feedback, so RPF could easily be incorporated into their current practice. Although technology improves the ability of university supervisors to observe and offer RPF from a distance, this form of coaching may not be useful or feasible to other school-level implementers. Without researcher support, it may not be possible for indigenous school-level staff (e.g., mentor teachers, instructional coaches, principals, coteachers) to feasibly implement RPF with fidelity.

In addition, RPF is an extremely intensive intervention. Its use with all teachers is neither feasible nor desirable. Instead, RPF should be applied when other less intensive interventions have proven ineffective. Just as not all students require intensive intervention to make academic gains, not all teachers need intensive interventions to improve their practice. Future researchers may consider evaluating the feasibility of RPF for professionals besides university supervisors of preservice teachers or evaluating RPF as one of a menu of intervention options for teachers with a range of strengths and limitations.

Implications for Future Research

Several research questions pertaining to RPF remain to be investigated. This review established some shared limitations across included studies. Adequate descriptions of RPF interventions, interventionists, interventionist training, and fidelity to those interventions are important components of establishing internal validity and replicability of educational research. Thus, the following components should be considered and clearly described when implementing future research on RPF.

Independent variables. Because interventions and outcome measures varied so widely across studies, it was difficult to uniformly assess the essential components of RPF as a practice. Is it more important to give teachers feedback on a timed schedule, or to give feedback that is directly aligned with teacher behavior, or some combination of both? Researchers used all three in implementing and evaluating interventionist fidelity to RPF. In addition, many studies did not isolate RPF as the only independent variable. Enhanced RPF included a range of additional components that may or may not have been essential to the functional relation between independent and dependent variables. Establishing norms for the implementation and measurement of feedback to interventionists may be helpful to replicating studies of RPF in the future. Future research on RPF should include detailed descriptions of the intervention, report fidelity to the intervention, and isolate intervention components hypothesized to impact results.

Outcome measures. Included studies' dependent variables included any outcome measure related to interventionists'

instructional practice. These outcome measures sometimes represented the implementation of an EBP (e.g., BSP) but often did not (e.g., teacher clarity behaviors). In that vein, only about half of included studies examined student outcomes. If the ultimate goal of teacher training and professional development is to improve student outcomes, the behaviors researchers choose to implement with teachers should be EBPs. A recent report issued by the Institute of Education Sciences found that though content-focused professional development opportunities improved teacher knowledge, they did not translate to improved student outcomes (Garet, Heppen, Walters, Smith, & Yang, 2016). Future studies of RPF should include independent variables directly related to both interventionist implementation of EBPs and related student outcome data.

Generalization and maintenance. Long term generalization and maintenance data are essential to determining whether RPF is effective at improving generalized teaching skills in teachers once the supervisor has left. Few studies evaluated generalization of teacher behavior in other contexts. Although maintenance data were reported in all studies that met all QIs, researchers frequently reported a single data point, or maintenance data were collected in close proximity to the intervention, or intervention levels of desired teacher behavior did not maintain during maintenance conditions. In addition to the incorporation of thorough generalization and maintenance data collected with ample distance from the time of the intervention in single case design studies, future research should evaluate RPF with methodologically rigorous group design research to increase the generalizability of results.

Limitations

The review process employed has several limitations. First, all relevant studies may not have been identified. The initial database search yielded only half of eventually included studies identified through ancestral and hand searches. In addition, though overall IRA on quality coding was 95.25%, when analyzed at the QI level it was lower than ideal in some categories (range = 75%–100%). Discrepancies were resolved via consensus instead of a blind third coder.

Conclusion

Improving educator practice has the potential to improve outcomes for SWDs. This review evaluated the quality of the research base for RPF as a means of improving interventionist implementation of instructional practices. Sufficient quality evidence exists to establish RPF as an EBP for improving teacher instruction during intervention sessions according to guidelines published by the CEC (2014). At the same time, several questions remain unanswered with respect to the place of RPF in the broader context of teacher preparation, training, coaching, and professional development. These questions create opportunities for future research that examines the essential components of RPF for changing educator behavior, the parallel student outcomes associated with RPF, the practitioners and behaviors for which it is most effective and practical, and whether the gains made during RPF sessions are generalizable to other contexts and able to be maintained over time as generalized teacher skills.

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