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The role of technology in performance feedback on teacher practice: A systematic review

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ABSTRACT

Evidence-based practices (EBPs) are proven effective in increasing student achievement in the classroom; however, teachers' use of EBPs is far below the recommended rate. Performance feedback offers a potential solution to increase teachers' use of EBPs, and advancements in technology allow performance feedback to be delivered in innovative ways. In this systematic review, we examine 24 experimental studies in which performance feedback is delivered to teachers through various technologies. Overall, the review discovered that technology was primarily used during the training phase of intervention, and real-time feedback was the most common method for delivering feedback. Additionally, generalization and maintenance measures were limited, and there were inconsistencies in the length of intervention. We discuss why the current uses of technology with performance feedback may be limited or outdated and provide recommendations for researchers, teachers, and teacher educators to expand the use of technology within performance feedback.

Keywords: performance feedback, educational technology, instructional technology, coaching, evidence-based practices

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INTRODUCTION

Evidence-based practices (EBPs) are effective teacher strategies that have demonstrated the ability to achieve desired student outcomes through rigorous scientific research and empirical evidence (Criss et al., 2024a; Cook & Odom, 2013). The importance of teacher educators implementing academic and behavioral EBPs is outlined within current federal legislation (Every Student Succeeds Act, 2015; Individuals with Disabilities Education Act, 20 U.S.C. § 1400, 2004). EBPs are taught to educators in educator preparation programs and ensured through accrediting institutions that regularly monitor these programs. Despite evidence of their value and checks for understanding within pre-service teacher programs, a gap remains between the research documenting their validity and in-service teachers' implementing EBPs within their classrooms (Criss et al., 2024a; Cook & Odom, 2013; Sinclair et al., 2020). This lack of teachers' use of EBPs ultimately negatively impacts overall student outcomes (Sweigart et al., 2015).

Several potential reasons exist for a gap between the research and application of EBPs in the K-12 classroom, including teachers' opposition to making changes to their current practices, personal philosophical challenges in implementing EBPs, the preconceived notion that researched strategies are ineffective, and a lack of access to educational materials or training (Kretlow & Bartholomew, 2010; Sweigart et al., 2015). Horn et al. (2021) found that additional challenges educators report include a lack of support from administrators and difficulty addressing the needs of all students within the classroom. This collective list of obstacles highlights the need for teacher education, resources, and support to overcome the challenges surrounding the use of EBPs by classroom educators. By addressing these needs, schools can better empower teachers to weave research-based strategies into their teaching methods.

In recognition of the need to provide teachers with the necessary support to implement EBPs with fidelity, school systems often provide professional development training focused on targeted teacher practices (Criss et al., 2024a; Horn et al., 2021). Traditionally, this training is provided through single professional development sessions. Afterward, teachers are encouraged to apply the covered content in their classrooms with little to no time to practice (Horn et al., 2021; Kretlow & Bartholomew, 2010). Over time, research has determined that stand-alone professional development sessions do not result in long-term changes in teacher behavior or impact student achievement (Horn et al., 2021; Kretlow & Bartholomew, 2010). Instead, evidence indicates that pairing professional development with embedded coaching improves teachers' use of EBPs (Gürgür, 2016; Kretlow & Bartholomew, 2010). Conversely, coaching typically includes various degrees of ongoing support after initial professional development training has ended (Gürgür, 2016; Kretlow & Bartholomew, 2010;

Sinclair et al., 2020). Coaching involves a teacher implementing a newly learned EBP in their classroom under the observation of a person whose role is that of an instructional coach (Kretlow & Bartholomew, 2010; Sinclair et al., 2020). Following the observation session, the coach provides performance feedback to the classroom teacher that addresses both the strengths and areas of improvement observed (Kretlow & Bartholomew, 2010; Sinclair et al., 2020).

Performance Feedback and Coaching

Performance feedback is an EBP in which teachers are provided specific information regarding their classroom performance related to predetermined expectations (Cavanaugh, 2013; Fallon et al., 2015; Sinclair et al., 2020). The use of performance feedback has been widely researched on teacher's use of EBPs, including learning a new instructional strategy and management strategies such as behavior-specific praise (BSP) (Ennis et al., 2020; Royer et al., 2019; Sweigart et al., 2015), student engagement (Cavanaugh, 2013), and with pre-service teachers (Cornelius & Nagro, 2014; Schles & Robertson, 2019). Several researchers have evaluated the use of performance feedback in schools and found performance feedback to be effective in changing teacher behavior (Cavanaugh, 2013; Fallon et al., 2015; Sweigart et al., 2016).

Since performance feedback is a broad term that includes several elements, researchers need to understand better what components of performance feedback contribute to improved outcomes for teachers and students. One component of performance feedback known to enhance teacher outcomes is the medium in which feedback is delivered. This feedback can be delivered orally, handwritten, recorded, or typed. In a review of 50 years of research on the use of BSP, Ennis et al. (2020) found that most studies included coaching both individually and in person and also utilized some technology. While the medium of technology varied across studies, email was the most used method for delivering feedback.

Performance feedback via email has proven to be an efficient and effective method to promote change in teacher behavior (Criss et al., 2024a; Gorton et al., 2022). Email performance feedback provides a written record that classroom teachers can refer back to when needed and allows consistent reinforcement. In this process, a coach observes the teacher, takes notes on specific classroom performance, and then crafts and emails with observation notes and suggestions for improvement. This process affords flexibility, as teachers can read and process feedback in their own time, reducing the pressure of immediate responses during a face-to-face feedback session.

While performance feedback has demonstrated effectiveness as an EBP strategy, it has drawbacks. One limitation of performance feedback lies within its research methodology. Studies on performance feedback require a comprehensive evaluation of an educator over an extended period, which can be time-consuming, mainly when best practice includes consideration of maintenance and generalization (Sinclair et al., 2020). Due to the extensive time needed for an effective intervention and observed changes, these two crucial stages are often limited or omitted. This omission can result in a lack of understanding of how performance feedback strategies are maintained over time and to what extent they are applied to different learning contexts over time (Cavanaugh, 2013; Sinclair et al., 2020).

Another limitation is the amount of time necessary to implement this strategy effectively, regardless of maintenance and generalization. Teachers, coaches, and administrators must dedicate time to conduct detailed observations, engage in constructive feedback sessions, and ensure the subsequent application of feedback recommendations, which can be challenging, given the many responsibilities educators already possess (Cavanaugh, 2013). Additionally, the process of providing performance feedback can be cumbersome. A coach must provide feedback that is aligned with predetermined goals and objectives, ensure specific and actionable feedback, and monitor feedback application. The time involved in the performance feedback process can dissuade consistent participation and implementation by both participating parties (Cavanaugh, 2013). Delivering feedback through technology could offer a potential solution to the time constraints that limit schools from providing meaningful feedback. Further, researchers have recommended that technological advances in schools could improve the efficiency of performance feedback with teachers (Cavanaugh, 2013; Ennis et al., 2020; Sleiman et al., 2020).

Technology and Performance Feedback

Fortunately, the availability of technology for classroom usage has also improved how performance feedback can be implemented. Combining current classroom technology and performance feedback can reduce the time involved in the traditional performance feedback process and increase the overall efficiency of the process. One such use of technology is performance feedback with video self-reflection (McLeod, 2019). In this study, researchers analyzed pre-service teachers' ability to review their teaching practices captured via video and reflect upon their ability to implement an EBP taught during class (constant time delay). By viewing their performance via self-reflection, these pre-service teachers better understood their teaching practices and how they aligned with predetermined expectations (McLeod, 2019). Video-based reflection may present one medium that can improve the barriers to effective coaching.

Another component of performance feedback is the immediacy of feedback. Real-time feedback, specifically bug-in-ear (BIE) technology, allows a coach to provide instant teacher feedback during instruction (Horn et al., 2021; Schaefer & Ottley, 2018; Sinclair et al., 2020). Often, the teacher wears headphones or an earpiece, allowing the observer the ability to communicate while the teacher provides instruction. During the observation, the observer can offer real-time feedback to the teacher. The immediacy of this feedback makes it highly actionable and allows teachers to make immediate adjustments to their instruction. This guidance can reinforce effective instruction and address potential issues as they occur. In a recent review of immediate feedback using BIE technology, Schaefer and Ottley (2018) found that immediate feedback using BIE technology has a strong evidence base for changing teacher behavior.

Similarly, Sinclair et al. (2020) conducted a comprehensive review of various types of real-time performance feedback, including BIE technology, and confirmed its status as an effective EBP. However, neither review delved into the specifics of technological implementation nor investigated the aspects of maintenance and generalization. Furthermore, their research was unable to identify a consistent medium for real-time performance feedback, making generalization to different schools difficult (Sinclair et al., 2020).

Purpose

The literature on performance feedback underlies its effectiveness as an EBP in education. However, traditional modes of performance feedback often come with barriers to effective implementation.

Fortunately, technological advancements have overcome these barriers and allowed further facilitation of performance feedback implementation, making it more accessible, manageable, and rewarding. Research indicates that technology can effectively improve teacher performance (Sinclair et al., 2020). Teachers are becoming increasingly receptive and comfortable using these technology tools (Hartman et al., 2019), thus opening new avenues for performance feedback delivery. Current reviews highlight specific technology. However, there has yet to be a literature review to date that broadly explores the use of technology with performance feedback. This understanding will further the field by identifying the mediums of delivering performance feedback to improve teacher performance. Therefore, the purpose of this comprehensive review of the literature is to understand the current research base of technology-enhanced performance feedback as a tool for improving instructional practices among in-service K-12 educators beyond the scope of only real-time feedback. The research questions that guide this review include:

1. What types of technology are used, and during which intervention phases is technology utilized when providing performance feedback to teachers?
2. Are researchers measuring the long-term effects of using performance feedback and technology with teachers?
3. What teacher behaviors are measured in these studies, and are researchers measuring maintenance and generalization of skills?
4. How is student performance measured in studies that use performance feedback with technology on teacher performance?

METHODS

Search Procedures

A systematic search was conducted using the PRISMA-P protocol and traditional approaches to identify all current and relevant articles (Gersten et al., 2005; Horner et al., 2005). The following databases were selected for analysis: Academic Search Complete, Education Resources Information Center (ERIC), Psychology and Behavioral Sciences Collection, SocINDEX with Full Text, and Teacher Reference Center. All searches were conducted in September of 2022 and did not limit time or date to ensure a thorough search. The target independent variable was searched in combination (i.e., and, or) with individual terms relating to coaching, technology, study design, and location (i.e., coaching and technology and single case design and classroom). The exact terms and phrases were used in all four database searches. Search terms related to the independent variable included feedback, performance feedback, coaching, technology, real-time feedback, virtual coach, etc.

The Boolean search operator of an asterisk was utilized to find all forms of the word (i.e., inclusion, inclusive, included). All searches were filtered by language (English) and limited to peer-reviewed sources. Thesis, dissertation, conference, workshop, and lecture proceedings were included for review if they underwent peer review. We expanded the search to find all articles in and out of academic databases. Peer review was deemed necessary to ensure a level of scientific rigor. The initial search across all databases conducted by the first author returned 4,608 articles.

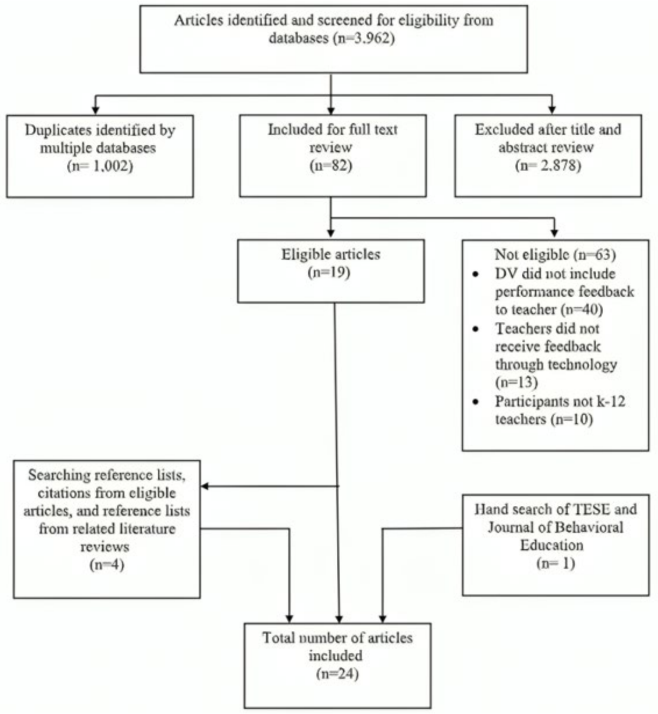

Figure 1. Performance feedback and technology review systematic search diagram (Source: Authors)

To establish search reliability, a graduate research assistant replicated the search strands across the databases and found a near-identical number of articles. The first author found 4,608 articles, whereas the graduate research assistant found 4,690 articles five days later. This minimal discrepancy may be due to articles being indexed or published over the five days. The authors then eliminated 1,648 duplicate articles, resulting in a total of 2,960. These 2,960 articles were downloaded and aggregated into a single database (Google Sheets) for screening. Overall, a total of 2,960 articles were identified for screening.

Screening Procedures and Inclusion Criteria

The initial 2,960 articles were screened for inclusion by all authors (see **Figure 1**). Title and abstract were carefully screened for the following inclusion criteria:

(a) articles included in-service teacher as the main participant,

(b) articles included performance feedback with technology (defined as any resource that uses a form of power) as the independent variable,

(c) articles within an educational setting in which participants were in kindergarten through twelfth-grade, and

(d) articles that were peer-reviewed and empirically based using single-subject, experimental, or mixed methods.

We retained articles when the title and abstracts provided insufficient or missing information for exclusion. Following a group discussion, consensus was reached by the first three authors to eliminate 2,640 articles and include 320 articles after the initial screening. The resulting 320 were downloaded and read thoroughly for inclusion. Articles were excluded if they

(a) included only early childhood or only higher education teachers,

(b) only included student outcomes,

(c) only included pre-service teachers or were conducted in a non-educational setting, and

(d) did not utilize technology for the independent variable.

Using these parameters, an additional 301 articles were excluded, resulting in 19 articles for inclusion. In addition, an ancestral review of two of the most recent seminal coaching literature reviews in teacher professional development with feedback (i.e., Schaefer & Ottley, 2018; Sinclair et al., 2020) resulted in four additional articles for screening. The hand search resulted in one additional article being identified. Finally, a comprehensive hand search of three journals was chosen for their reputation for publishing teacher coaching manuscripts (*Journal of Special Education Technology, Teacher Education & Special Education, Journal of Behavioral Education*). A second ancestral review of the retained articles was conducted, resulting in no additional articles being added. The agreement of inclusion and exclusion by the authors was 91% for the ancestral reviews. A total of 24 articles were combined into a single database for coding.

Coding and Interrater Reliability

The first three authors served as the primary coders, and the fourth author completed the inter-observer agreement. All coders were trained by

(a) providing a detailed coding manual,

(b) reviewing the coding manual through oral instructions for clarity,

(c) assigning practice studies to code, and

(d) collaborating on detailed feedback during practice studies.

Coders did not begin coding until meeting 90% accuracy on practice studies between the first three authors. We calculated point-by-point agreement during the entire article coding phase on ten randomly selected studies. The average agreement across all variables was 92% (range 85-97%). Disagreements were resolved by having the two coders review the coding manual and come to a consensus. When consensus could not be reached, coders consulted the first author.

Teacher Characteristics

We coded specific characteristics of the teacher participants in each study. First, we coded the level of teacher experience as TE 1-5 (i.e., teachers in first 1-5 years of teaching), TE 6-15 (i.e., teachers with 6-15 years of experience), and TE 15+ (i.e., teachers with 15+ years of experience). Then, we recorded whether teachers were special education, general education (GE) teachers, or teachers of English language learners (ELLs). Next, the grade level the teacher participants taught was coded for elementary (i.e., grades K-5), middle school (i.e., grades 6-8), and high school (i.e., grades 9-12). Finally, the type of classroom in which the intervention took place was also coded: GE (which included a classroom in which special education services were not provided and primarily consisted of students without disabilities), inclusion classroom (which included students with and without disabilities), co-taught classroom (classrooms taught explicitly by both a GE teacher and includes students with and without disabilities), self-contained (SC) special education classroom (classroom for students with disabilities in which the students with disabilities remain in the classroom for over 60% of their school day), resource room (RR) (i.e., classroom for students with disabilities in which students spend > 21% up to > 59% of their day in this room for specific services), and other (i.e., any classroom description that did not fit into the previously described classroom such as a virtual classroom or classroom for ELLs).

Independent Variables

We coded the type of technology used during each intervention to evaluate the independent variables. For the purposes of this review, we identified and coded technology if the technology described had two distinct characteristics, which included the device using power (i.e., battery, plugged in) and was interactive in some way. This vague technology definition allowed us to find and code more articles for inclusion. If studies used more than one form of technology, each individual use case was coded.

Technology Components

We coded the specific use of technology during each treatment package. The categories included whether technology was used to collect data (i.e., classroom observations were recorded during baseline and intervention), deliver feedback (i.e., real-time feedback, BIE feedback, email feedback, and video conferencing), document feedback (i.e., communication logs), and train teachers to use a new skill (i.e., video modeling, videos used during training, online modules). We also recorded which phase in the study technology was used (i.e., training or during intervention).

Dependent Variables

We coded the type of teacher and student outcomes measured in each study. The types of outcomes included statements or directives provided by the teacher (i.e., prompts, questions, and teacher academic talk), BSP, opportunities to respond [OTRs], teacher implementation of intervention fidelity, completed trials of the three-term contingency (TTC), instructional strategies (i.e., models used, accommodations, modifications, and redirections). We coded if teacher needs and beliefs were measured and if a dependent variable included a student measure. The types of student measures included academic achievement (i.e., curriculum-based measures [CBMs], performance on classroom assessments), student behavior such as aggressive, disruptive, or maladaptive behavior, and student engagement (i.e., on-task behavior, initiation and completion of directive, and communication skills).

Maintenance, Generalization, and Length

Researchers coded if maintenance and generalization measures were reported in each study. There are often multiple definitions of maintenance and generalization in research. For the purposes of this study, maintenance refers to the continued use of the EBP over time after the conclusion of the intervention, and generalization refers to the application of EBPs in different contexts and situations (Cooper et al., 2020). Additionally, we coded the total length of the intervention. We recorded the total length of intervention, the frequency of the feedback or observations, and the total number of sessions. We also noted if the authors reported the length of time each feedback or observation.

RESULTS

The overall findings associated with current performance feedback and technology literature are chronicled below and can be found in **Table 1**. All studies were experimental in design, and most studies used a single-case research design (n = 16, 66.7%).

Table 1. Overview of performance feedback with technology

Study	Classroom setting & grade level	Dependent variables	Length of study and frequency	Length of observations/ coaching sessions	Generalization and Maintenance	Student outcomes
Amendum et al. (2018)	GE; ES	Student academic performance	6-10 weeks, 3-4 times weekly	15 min. observations	G-R; M-NR	Reading measures
Bradshaw et al. (2021)	GE; HS	Teacher implementation PBIS supports	3 years	NR	G-NR; M-NR	NR
Brown et al. (2014)	SC; HS	Teacher prompts	NR	15-20 min. coaching sessions	G-NR; M-R	NR
Cheek at al. (2019)	SC; ES	OTR, teacher questioning	26-30 sessions	15 min. e-coaching sessions	G-R; M-R	Listening comprehension, engagement
Chen at al. (2020)	NR; MS	APT (teacher academic productive talk)	1 year, 5 sessions every 1-2 months	2 hours training sessions	G-NR; M-NR	Math achievement scores
Coogle et al. (2016)	1 Inc, 1 SC; ES	Teacher talk	4 months, 18-27 sessions	6 min. coaching	G-R; M-R	NR
Cuticelli et al. (2016)	GE; ES	OTR	12-18 sessions	30 min. observations, feedback 5-10 minutes	G-NR; M-NR	NR
Fallon et al. (2018)	GE; MS	Academic engagement & student disruptions	3 months, 36 sessions, 3 times a week	40 min. observations	G-NR; M-NR	Academic engagement & disruptions
Fawley et al. (2019)	GE; ES	Yelling, destructive behavior, aggressive behavior	5 months, 72 sessions	5 min. observations, 10 min. coaching, 305 min. feedback	G-NR; M-R	Yelling, destructive behavior, & aggressive behavior
Gage et al. (2018)	GE; ES	BSP	22-27 sessions, 3 times weekly	15 min. observations	G-NR; M-R	NR
Garland et al. (2016)	VC; MS	Teacher fidelity	10-12 sessions	10-15 min. lessons	G-NR; M-R	NR
Garland and Dieker (2019)	GE; 2 MS, 1 HS	Completed TTC trials, rate of correct student responses, ratio of praise to error correction	6 weeks, 20-24 sessions per teacher	15 min. observations	G-NR; M-R	NR
Ginns and Begeny (2019)	SC; 2 MS, 2 HS	Student engagement and disruptive behavior	8-10 sessions	39.4-43.8 min. observations, 8.25-15 min. coaching,	G-NR; M-NR	Student engagement & disruptive behavior
Goodman et al. (2008)	SC; 2 ES, 1 MS	Teacher implementation of learning units, student responses, consequences	24-27 sessions, 3-5 times weekly	20 min. sessions	G-NR; M-R	Correct & incorrect responses
Gregory et al. (2013)	NR; 53 MS, 34 HS	CLASS-S measures	One school year, 6 sessions	40-60 min. observations	G-NR; M-NR	NR
Kennedy et al. (2017)	GE; HS	OTR, BSP, pre-correction, student engagement	3 weeks, 4 sessions	20 min. observations	G-NR; M-NR	Engagement
O'Handley et al. (2021)	1 GE, 2 SC; ES	Effective instruction delivery	4 weeks, 9-15 sessions, 3 times a week	5-10 min. observations	G-NR; M-R	Initiation & completion of directive
Ploessl and Rock (2014)	Coteach; ES	Models used, accommodations, modifications, redirections, and praise	8 planning meetings, 8 teaching observations	30 min. co-planning sessions, 30 min. observations	G-NR; M-NR	NR
Randolph et al. (2020)	SC; 2 ES, 2 MS	OTR, student responses, CBMs	16-17 sessions	5-15 min. observations	G-NR; M-R	Response behavior & CBMs
Scheeler et al. (2010)	Coteach; 2 ES, 2 MS	TTC trials	4 months, 11-15 sessions, 2-3 times a week	40 min. observations	G-R; M-R	NR
Tang et al. (2020)	GE; ES	Teacher implementation of intervention	4 years, 3 sessions per school year	45 min. observations	G-NR; M-NR	NR
Vernon-Feagans et al. (2012)	GE; ES	LWI, CTOPP	1 school year, 4 sessions weekly	15 min. lessons	G-NR; M-NR	Academic measures
Verschuur et al. (2021)	SC; ES	CPRT components, communication skills, maladaptive behavior	20-28 sessions	10-15 min. observations, 30 min. coaching	G-NR; M-R	Communication skills, maladaptive behavior
Weiser et al. (2019)	17 Inc, 4 SC, 36 RR; NR	Teachers' needs and beliefs	8 months	NR	G-NR; M-NR	Academic achievement

Notes: TE 1-5: teaching experience 1-5 years; TE 6-15: teaching experience 6-15 years; TE 15+: teaching experience 15+ years; GE: general education; SC: self-contained; RR: resource room; Inc: inclusion; Coteach: cotaught; NR: not reported; ES: elementary school; MS: middle school; HS: high school; OTR: opportunities to respond; BSP: behavior specific praise; TTC: three-term contingency; CLASS-S: classroom assessment acoring system – secondary; LWI: letter-word identification; CTOPP: comprehensive test of phonological processing; G: generalization; M: maintenance; R: reported.

Table 2. Teacher characteristics and setting across studies

Characteristic	Total *n* across studies reporting	% of *n* across studies reporting
Licensure		
General education	193	43.3
Special education	77	17.3
Bilingual teachers	75	16.8
Early childhood education	2	0.4
Not reported[a]	101	22.6
Experience[b]		
Early career	23	5.1
Mid-career	19	4.2
Experienced	33	7.3
School setting[c]		
Elementary school	198	44.2
Middle school	123	27.5
High school	78	17.8
Classroom setting		
General education (non-specific)	362	81
Inclusion	18	4
Co-taught	12	2.6
Self-contained special education	32	7.1
Resource classroom	36	8

Notes: Early career: 1-5 years of experience; Mid-career: 6-15 years of experience; Experienced: 15+ years of experience; General education (non-specific): a classroom in which special education services were not provided and primarily consisted of students without disabilities; Inclusion: a classroom in which included students with and without disabilities; Co-taught: classrooms taught explicitly by both a general education teacher and includes students with and without disabilities; Self-contained special education: classroom for students with disabilities in which the students with disabilities remain in the classroom for over 60% of their school day; Resource classroom: classroom for students with disabilities in which students spend >21% up to >59% of their day in this room for specific services.

[a] Two studies did not report teacher licensure

[b] Most studies did not report teacher experience

[c] One study did not report school setting.

Of the 16 single-case research designs identified, ten studies used a multiple-baseline design (41.7%), five studies used a multiple-probe design (20.8%), and one study used a withdrawal design (4.2%). Further, there were seven randomized-controlled trials (RCTs) (29.2%), and one study used a quasi-experimental design (4.2%).

Teacher Characteristics

A total of 446 teachers across 24 studies were included. Seven randomized control trials accounted for 326 (or 74%) of the teachers (see **Table 2**). Most of the teachers included in these seven studies were GE teachers (n = 193, 43.3%), 77 were special educators (17.3%), 75 were bilingual teachers (16.8%), and two teachers had early childhood credentials (0.4%). Two studies did not explicitly state the type of licensure for their participants, which accounted for 22.6% of participants (n = 101). For most studies, the researcher did not report teacher experience. For the studies that did report teacher experience, 23 (5.1%) of the teachers were early career (i.e., 1-5 years of experience), 19 (4.2%) were mid-career (i.e., 6-15 years of experience), and 33 (7.3%) were experienced teachers with more than 15 years' experience. Only one study did not report the grade level of teachers (Weiser et al., 2019). Of the studies that reported teacher grade level, 198 (44.2%) teachers were elementary teachers, 123 (27.5%) were middle school, and 78 (17.8%) were high school teachers. Teacher participants taught in different classroom settings, including non-specific GE teachers (n = 362, 81%), inclusion (18 teachers, 4%), co-taught (12 teachers, 2.6%), SC special education (32 teachers, 7.1%), and resource classrooms (36 teachers, 8%).

Dependent Variables

Researchers coded the type of dependent variable measured in each study. Teacher directives such as teacher prompts, questioning, and academic conversations were measured in 10 studies (41.6%). Student behavior was measured in seven studies (29.1%), BSP in six studies (25%), teacher implementation of the intervention in six studies (25%), and OTR in four studies (16.6%). Active student engagement was measured in five studies (20.8%), academic skills in two studies (8.3%), CLASS–S (classroom assessment scoring system–secondary) dimensions in one study (4.2%), and teacher beliefs in one study (4.2%). Several studies (n = 11, 45%) evaluated more than one dependent variable in the study. For example, in Kennedy et al. (2017), researchers collected data on teachers' use of OTRs, BSP, pre-correction, and student engagement. Studies such as Gregory et al. (2013) used CLASS-S that evaluated several dimensions of classroom management, such as emotional support and classroom organization.

Technology Components and Independent Variables

The type of technology used with performance feedback was coded, including when technology was used, and in 12 studies (50%), technology was used during the training (see **Table 3**). However, how technology was utilized during training varied across studies. Specifically, five studies used videos to teach a new skill to teachers during baseline. Three studies used a type of online module to teach a new skill, and two studies used a video-based professional development system. Brown et al. (2014) had teachers watch a video lecture to learn the new skill, and Kennedy et al. (2017) created videos using CAP-TV with teachers from the participating school district to introduce the new skill.

Real-time feedback was used in 12 studies (50%). BIE technology was described in nine of those studies (37.5%), but four studies did not specifically state that BIE technology was used during the real-time feedback. The type of BIE technology varied across studies. Three studies did not specify what type of BIE technology was used in their study. Goodman et al. (2018) and Scheeler et al. (2010) used two-way radios (Motorola and Personal FM system, respectively), whereas Cheek et al. (2019) used a Plantronics VoIP headset. Garland and Dieker (2019) used Adobe Connection and Bluetooth, and two studies used Bluetooth and Skype through Call Recorder with Mac. Finally, Randolph et al. (2020) used Bluetooth technology with Facetimeduring real-time feedback. We also coded where BIE feedback was delivered. For example, in four studies, the researcher delivering the feedback was in the classroom. Feedback was delivered from outside of the study in four studies, and in one study the description does not state where the feedback was delivered. In most studies that utilized BIE technology, the researcher or coach provided feedback; however, in Ploessl and Rock (2014), the BIE feedback was delivered by co-teachers within the same classroom.

In addition to real-time feedback, researchers used video conferencing for feedback in five studies (20.1%), the use of graphic feedback was used in four studies (16.7%), email feedback in four studies (16.7%), and video modeling was utilized in one study (4.2%). A simulated classroom was used in one study (4.2%), and online logs to track coaching were implemented in one study (4.2%).

Table 3. Types of technology with performance feedback across studies

Study	TUDT	ORDBI	RT	BIE	VC	GF	EF	VM	SC	OL
Amendum et al. (2018)	√	√	√		√					
Bradshaw et al. (2021)										√
Brown et al (2014)	√	√								
Cheek at al. (2019)	√	√	√	√						
Chen at al. (2020)	√	√					√			
Coogle et al. (2016)			√	√						
Cuticelli et al. (2016)	√	√				√				
Fallon et al. (2018)	√					√	√			
Fawley et al. (2019)	√	√	√	√						
Gage et al. (2018)						√	√			
Garland et al. (2016)									√	
Garland and Dieker (2019)	√	√	√	√						
Ginns and Begeny (2019)	√					√				
Goodman et al. (2008)			√	√						
Gregory et al. (2013)					√					
Kennedy et al. (2017)	√	√						√		
O'Handley et al. (2021)			√	√						
Ploessl and Rock (2014)			√		√					
Randolph et al. (2020)		√	√	√			√			
Scheeler et al. (2010)			√	√						
Tang et al. (2020)	√	√	√		√					
Vernon-Feagans et al. (2012)			√							
Verschuur et al. (2021)	√	√								
Weiser et al. (2019)	√	√			√					
Total	**13**	**12**	**12**	**8**	**5**	**4**	**4**	**1**	**1**	**1**
Percentage (%)	**54.2**	**50.0**	**50.0**	**33.3**	**20.8**	**16.7**	**16.7**	**4.2**	**4.2**	**4.2**

Notes: TUDT: Technology used during training; ORDBI: Observations recorded during baseline or intervention; RT: Real-time; BIE: Bug-in-ear; VC: Video conferencing; GF: Graphic feedback; EF: Email feedback; VM: Video modeling; SC: Simulated classroom; OL: Online log.

Video recordings of classroom teachers occurred in 12 studies (50%). Of the 12 studies that video recorded, three studies used live-feed recording through a webcam or Skype. One study had teachers mail video recordings of their classroom observations for review (Gregory et al., 2013), and one study specified that a Cannon video camera and Rode microphones were used. Seven studies did not specify the type of technology used to video record the lessons.

Overall, most studies used at least two different types of technology (n = 12, 50%). For coding, we combined real-time feedback with BIE because, due to the nature of BIE technology, all BIE studies used real-time feedback. Ten studies only used one form of technology (i.e., simulated classroom, online log for training, BIE/real-time feedback, and videos during training). Two studies used three different types of technology; Amendum et al. (2018) used videos during training, real-time feedback, and video modeling, and Randolph et al. (2020) used videos during training, real-time feedback/BIE, and email feedback. Researchers used videos during training most frequently with other types of technology across studies (n = 10, 41.6%).

Student Measures, Generalization, Maintenance, and Length of Intervention

We coded if maintenance and generalization measures were reported in the included studies. Generalization data were collected in four studies (16.7%), and maintenance data were collected in 12 studies (50%). We also coded whether student impact measures were collected in each study and in 13 studies (54.1%), student measures were collected.

Finally, we coded the reported length of the intervention, frequency of observations, and coaching sessions. Of the included studies, 14 (58%) reported the total length of the intervention. While the length varied across studies, the mean length of the interventions was 10.73 months (range = 3 weeks to 4 years). Five RCT studies reported the length of intervention as one year or longer. The remaining single-case studies reported a range of length from three weeks to eight months (mean [M] = 3.91 months). Only nine studies (37.5%) reported the frequency of feedback or observations, and most of those studies reported observations occurring multiple times a week during the length of the intervention. For example, Fallon et al. (2018), Gage et al. (2018), and O'Handley et al. (2021) reported observations three times a week during intervention. Further, Ploessl and Rock (2014) reported the number of planning meetings and observations of teachers but did not report the total length of the intervention. Six studies only reported the number of sessions across the study. We also coded the length of observations and coaching sessions. Eighteen studies (75%) reported the specific length of teacher observations (M = 23.6 min., range = 5-60 min.), and nine studies (37.5%) reported the length of the coaching or feedback sessions (M = 28.6 min., 2 min-2 hours).

DISCUSSION

Performance feedback is an EBP (Fallon et al., 2015) that is widely researched in teacher education (Criss et al., 2024b; Cavanaugh, 2016; Ennis et al., 2020; Sweigart et al., 2015). The literature reviews by Sinclair et al. (2020) and Schaefer et al. (2018) identify studies that exclusively used real-time feedback and BIE technology. However, little is known or aggregated about other uses of all technology with performance feedback to improve teacher practice. In this systematic review of research, we identified 24 articles that evaluated the use of performance feedback with technology on teacher performance. The purpose of this study was to identify how technology is used in combination with performance feedback to improve teacher performance. We identified that the use of technology varies widely across intervention phases (training, intervention, and post-intervention). Additionally, we found that the length of intervention and frequency of observations varied greatly across studies and were difficult to compare.

Training Phase

Technology has evolved rapidly, providing an avenue for improving teacher use of evidence-based performance feedback. Technology-delivered teacher performance interventions can reduce time spent on in-person traditional performance feedback interventions while increasing their impact (Sinclair et al., 2020). However, our review found that current research on technology and current performance feedback was most commonly used during the training phase of studies. Specifically, most studies used technology during training to teach teachers a new skill. This is not surprising given that most studies that used performance feedback as the intervention are teaching a new skill to teachers (Fallon et al., 2015; Sweigart et al., 2015) and that video instruction for new skills is a common professional development practice (Kennedy et al., 2018). Often, teachers watched a video that modeled the dependent variable (e.g., task) or completed an online module that included audio, video, and text parts. As stated above, this skill was mostly used during training, negating current research on professional development. Lee et al. (2023) recommend that schools provide technology-facilitated opportunities for professional learning and coaching, suggesting a longer-term technology solution.

As technology continues to permeate the school environment and alter the practices of all stakeholders, particularly teachers, it is important to utilize the aspects that are effective for performance feedback and professional development, including expert support, feedback, reflection, and sustained duration (Darling-Hammond et al., 2017). However, not all studies use the recommended technology practices beyond the training phase. This is not surprising as principals, instructional coaches, and peer teachers are limited in the amount of time and innovative practices they can use to train and coach teachers to use EBPs in the classroom (Sweigart et al., 2016) and training with technology is an easier solution than one-to-one meetings. The lack of time also suggests that alternative mediums besides introducing skills in training may be an effective way to teach a new skill and conquer typical barriers of a school day like time.

Intervention Phase

The use of technology is widely accepted and adopted as an instructional tool in the classroom (U.S. Department of Education, 2017); it is essential that we utilize advancements in technology to improve teacher practice in the classroom. Additionally, Scheeler et al. (2006) found that teaching the delivery of feedback in vivo is more effective than immediately following the lesson, leading researchers to attempt often to deliver feedback as quickly as possible after an observation. Consistent with this finding, real-time feedback was the most popular method for providing feedback to teachers with technology outside of the training phase. Most studies specifically reported that BIE technology was used to provide real-time feedback; however, some studies did not specify how the feedback was delivered. While not specifically mentioned, it was assumed that the feedback delivered in the teacher's ear was accurate. Further, the delivery of real-time feedback varied across studies. For example, some studies included the observer in the classroom providing feedback, whereas some studies had an observer delivering feedback from a remote location. This variation in the delivery of the EBP may limit the effectiveness of performance feedback coaching. This also suggests the need for transparent and consistent feedback to understand the impact of real-time feedback.

Despite Schaefer and Ottley (2018) finding BIE as an EBP, providing real-time feedback can often be time-consuming for the professional delivering the feedback. Real-time feedback requires an observer to be either present or observing from a remote location and provide timely, specific, and applicable feedback to the teacher. An in-class observer may be distracting to the students and teachers, ultimately impacting the observation's authenticity. Further, an observer observing the teacher remotely may miss specific details or behaviors from the lesson that the camera cannot capture, and the teacher receiving the feedback can be very distracted by the interruption while delivering instruction. This suggests that the type of feedback that can be delivered may be limited to not be too overwhelming for the teachers or to be distracting to all classroom participants. With the limiting factors, technology may offer a solution to provide observation or remote capabilities. Nevertheless, most studies reported the use of a person doing in-time observations and delivering the intervention in some way with real-time feedback. Several technologies, such as video conferencing, high-resolution cameras, and 360-degree cameras, could be leveraged to capture teaching in a less intrusive manner. These technologies can record, create transcripts, and accurately depict the observations in the infinite. This review found that four of the articles utilized video conferencing (Gregory et al., 2013; Ploessl & Rock, 2014; Tang et al., 2020; Weiser et al., 2019), and only half of them were utilized for real-time feedback.

Post-Intervention Phase

Teachers show greater improvement in performance when they receive feedback immediately before the next opportunity to teach (Aljadeff-Abergel et al., 2017; Criss, in press). Several studies utilized technology to provide feedback to teachers post-intervention, such as through email or a graphic display of results. Teachers were able to read and implement feedback prior to their next session in hopes of improving their performance in the classroom.

As with all phases noted, there are limitations associated with post-intervention feedback. There is often a lack of dialogue between the observer and the teacher about the specific feedback. Our review found that video conferencing with coaching was utilized more frequently than just written email feedback without dialogue, suggesting that alternative forms of these interventions are needed. Technology can offer educators a more efficient method for coaching teachers when time is limited. Additionally, the feedback can be delayed as teachers do not often have the opportunity to read the feedback immediately after the observation. For example, in Fallon et al. (2018), the teacher with the highest performance while receiving email feedback read their feedback immediately before the next teaching opportunity. This extends the research from Aljadeff-Abergel et al. (2017) and Criss (in press) that teachers may perform better when the feedback serves as an antecedent to change behavior. While it is not always feasible for coaches (e.g., administrators, coaches, and other teachers) to meet with teachers immediately after observations, when considering how to structure the feedback cycle, teacher educators and instructional coaches should examine the most effective time to provide performance feedback and how to utilize technology to improve time and efforts needed for effective professional development.

A major measure of teacher success in the classroom is student performance. A plethora of research exists on attempting to improve teacher performance (Cavanaugh, 2013; Sinclair et al., 2020; Sweigart et al., 2016). However, consistent with other reviews of performance feedback with teachers, there is limited evidence of its effectiveness on student performance (Ennis et al., 2020; Fallon et al., 2015). Only 29% of the studies included a student measure, whereas nearly half of the studies only measured teacher directives such as prompts, BSP, and OTRs. This is problematic, as the lack of focus on student performance in performance feedback research may lead to the emphasis on teacher practices that have little to no impact on student achievement. Without student data, we cannot truly measure effectiveness. While we recognize that performance feedback is primarily a teacher initiative, the ultimate goal is to effect positive classroom change, which includes positive student outcomes. Therefore, student outcomes need to be included and measured during more teacher-initiative research studies.

Generalization, Maintenance, and Length of Interventions

According to our review, researchers of performance feedback are not primarily focused on the generalized effects across different settings and over time. These results on generalization are consistent with other literature reviews that focus on performance feedback with teachers (Ennis et al., 2020; Fallon et al., 2015). The lack of generalization and maintenance measures is problematic because how can researchers, teacher educators, and educators understand how teacher behavior and success are maintained over time once the feedback condition is removed? To truly impart teacher performance change, their success needs to be measured not only in the short term but also in the long term.

While there is not a consensus on the amount of time needed for effective PD, research shows that short, pointed, technological professional development can be effective without intensive meetings (Kennedy et al., 2018). However, research has suggested that combining ongoing feedback and coaching with training can be more effective at increasing discrete teacher behaviors such as BSP (Samudre et al., 2023). With regard to feasibility, extended coaching and feedback cycles may cause issues with cost and time, and researchers may consider practices such as a multi-tiered approach that vary the intensity of the intervention (e.g., Gage et al., 2017). Our results indicate that there is high variability in the length of time, from a short 5-minute session to a longer 45 minutes, needed to demonstrate change in teacher behavior, which often coincides with lengthy meetings in person or via video conference software. The length of intervention also varied significantly across studies, specifically from three weeks to four years. While most of the longer interventions were RCTs, a large range still exists. Unfortunately, there were also a number of studies that did not indicate the length of intervention at all. Overall, this lack of consistency makes replication of methodology and impact challenging.

Despite variation in the length of observations, coaching sessions across studies were typically 5-30 minutes long, with one training increasing the mean to 29 minutes. These results, paired with current research in PD (Kennedy et al., 2018), indicate that fairly short intervention and coaching sessions can create positive change in teacher performance through technology. This suggests there is an interest in further understanding the impact of short and sustainable coaching on changing teacher behavior via technology.

Limitations

As with any research study, our literature review is not without limitations. First, the inclusion criteria allowed only peer-reviewed studies that focused on technology-enhanced performance feedback for in-service teachers. Additional studies may have been available but were not peer-reviewed, did not involve technology to enhance performance feedback, were not implemented in a K-12 setting, or an experimental design was not conducted. A second limitation was our broad inclusionary criteria surrounding the technology used in the included studies. Our intent was to find as many articles as possible to support our understanding of how technology, as a whole, was used to enhance performance feedback. Past reviews have included more stringent search strands and were only able to make limited determinations of the current field.

A third limitation was that this review is limited to specific researcher coding definitions of technology and performance feedback. We controlled definitions through coding agreement amongst all authors; technology, outcomes, and performance feedback may be defined, coded, and evaluated differently across researchers. A final limitation of this study was that we did not code for the effectiveness of the performance feedback intervention. The scope of the review was to understand how technology was utilized and not its effectiveness. Therefore, no determinations of the effect of the technology were made.

Implications for Practice

The findings from this literature shed light on a crucial aspect of educational practice–the integration of technology to deliver performance feedback, an EBP that has the potential to improve teacher performance and student achievement. While technology used to deliver EBPs such as performance feedback is prevalent, current use of technology is often basic or outdated which highlights the need for schools to create more effective and innovative technology toolkits. The technology available to educators is rapidly evolving, and even more importantly, can improve the quality of performance feedback by providing it immediately, thus more actionable and impactful. Further research is needed to fully understand the impact of updated types of technology capable of providing performance feedback and other EBPs. This includes which device, what the device can be used for, and the effect the technology can have on successful teacher and student outcomes. In this time of technological advancement, the use of technology to provide performance feedback can and should go beyond emails, graphic organizers, or simple two-way radios. Current technology is available and should be explored by current practitioners to alter and improve their practice.

Second, our review identified the prevalent trend of relying on technology solely during the initial training phase. This limits the potential of technological interventions and highlights the need to explore the ways technology can benefit the entire cycle of professional development. Only studies that used BIE technology offered feedback beyond the initial learning phase. However, as highlighted above, this can be time-consuming, difficult to implement, and often intrusive for the participating teachers. Therefore, further research is needed to understand how current and future technology can be used to facilitate more effective teacher training beyond the training phase, including generalization and maintenance of learned skills.

Finally, all included articles contained a wide variation of intervention length while maintaining similar observations of teacher lengths. While research does not specifically mention the perfect amount of time needed to achieve teaching skills, this variation in time makes determining the most effective length of intervention difficult. Additionally, our review indicates that future research is not implementing generalization and maintenance phases to check if skills are maintained long-term or generalized to other settings.

Future Research

The majority of current research centers on performance feedback using conventional technological tools. Future studies should evaluate the capabilities of emerging technology. This would allow researchers to analyze the potential of these tools to enhance the efficacy of performance feedback. A gap in the current literature is the lack of focus on long-term sustainability and generalizability of skills acquired through performance feedback. Future research should investigate how skills persist over time and how they translate to different settings. This insight could inform the future design of feedback interventions. With a wide variation of intervention durations, it is difficult to identify an optimal length that predicts meaningful outcomes. Future studies should explore this to provide concrete evidence to teachers and administrators when planning and maximizing teacher and student outcomes.

CONCLUSION

The importance of this research lies in its potential to change a fundamental aspect of instruction - how teachers receive feedback. By improving and modernizing feedback delivery, we can provide educators with a way to apply EBPs in their classrooms more effectively. Ultimately, this will encourage meaningful and sustainable improvements in student achievement. This review serves as both a call to action and a roadmap, urging stakeholders to rethink and revitalize performance feedback through technology.

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