


**A Descriptive Review of Professional Development Supporting Special Education Teacher
Technology Integration**

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I have no potential conflict of interest to disclose.

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The central problem addressed in this review is the persistent gap between the widespread availability of mainstream educational technologies (ET) and the limited capacity of special educators to effectively integrate these technologies into daily classroom instruction. We will outline available ET that can enhance learning outcomes for students with disabilities and examine how professional development (PD) is offered as a support. We attempt to find meaningful patterns of success and gap areas to improve future research into effective PD to enhance technology implementation for educators of students with disabilities in the future.

Technology's capacity for delivering improved educational outcomes is a long-recognized concept predating the high-tech advancements of the 21st century. In particular, the needs of students with disabilities (SWD) have legal grounds for educators to consider assistive technology in the form of “any item, piece of equipment, or product system, whether acquired commercially off the shelf, modified, or customized ... to increase, maintain, or improve functional capabilities of a child with a disability” (Individuals with Disabilities Education Act, 1990). The federal definition, particularly its inclusion of commercially available and modified items, means that many tools considered assistive technology also fall under the broader umbrella of Educational Technology (ET; Edyburn, 2013).

Educational Technology

Educational Technology (ET) encompasses physical tools (hardware) and digital resources (software) that enhance learning experiences and performance through intentional, systematic integration with the design, practice, and evaluation of learning (Association for Educational Communications and Technology, 2023; Januszewski & Molenda, 2013; Moreno,

2022). This leaves a near-endless number of applications that may enhance the educational outcomes of SWD through highly individualized and adaptive learning experiences. Increased relevance to individualized needs of SWD is helped by integrating technology into teacher practice (Emerling et al., 2021). However, the innovation of available ET outpaces its integration in practice (Crompton & Sykora, 2021).

Benefits of ET in Teacher Practice

Integrating ET into special education teacher practice increases student engagement and motivation to facilitate the learning experiences for SWD (Anderson & Putman, 2020; Bouck, 2016; Koch, 2017; Smith & Okolo, 2010). Facilitating differentiation, promoting student autonomy, and enabling progress monitoring and data-driven instruction (Fernández-Batanero et al., 2022; Shaheen & Lohnes Watulak, 2019) are also among ET's benefits. The workload burdens of paperwork requirements, data collection, and meeting preparation are lessened by a teacher's ability to implement ET (Starks & Reich, 2023).

Barriers of ET in Teacher Practice

Despite ET's benefits in improving learning for SWD, persistent barriers to teachers have remained for decades (Bausch & Hasselbring, 2004; Jacobsen et al., 2002; McGregor & Pachuski, 1996; Messinger-Willman & Marino, 2010; Schaaf, 2018; Starks & Reich, 2023; Wirth et al., 1982) underscoring the complexities of helping them overcome challenges and bring more of technology's benefits to students (Edyburn, 2013; Starks & Reich, 2023). One framework for examining the barriers to ET implementation is Ertmer's (1999) classification of barriers into orders. Ertmer has updated their framework multiple times since, as further research has tried to understand further and overcome the obstacles of each order (Ertmer, 1999, 2005; Ertmer et al., 2012; Ottenbreit-Leftwich et al., 2010)

First-order barriers refer to obstacles external to teachers, such as insufficient resources, access, time, and support (Ertmer, 1999; Hew & Brush, 2007). Despite infrastructure improvements, special education settings still face these practical constraints. Teachers often report a lack of up-to-date devices, unreliable internet connectivity, and limited technical support, which directly hinder integration of ET (Etscheidt, 2016; Hew & Brush, 2007). Notably, inadequate training and PD are a pervasive first-order barrier. Without ongoing learning opportunities, teachers feel unprepared to use available technology effectively (Alharbi, 2018; Hsu, 2016). Over 75% of special educators described themselves as inadequately prepared to integrate assistive technology into the classroom (Alharbi, 2018; Alkahtani, 2013). Such findings underscore that PD (or the lack thereof) underlies many first-order issues: teachers need time and training to acquire the skills to utilize technology, especially in special education, where devices and software may be specialized (Ault et al., 2013; Bausch et al., 2008; Hsu, 2016). In short, external barriers like resources and training continue to pose challenges to implementation. Ensuring ample PD is often cited as the first step in overcoming these hurdles across classrooms and districts.

Second-order barriers concern internal, teacher-level factors – particularly educators’ beliefs, attitudes, pedagogical philosophies, and confidence regarding technology (Ertmer, 1999; Ertmer et al., 2012). Researchers have long observed that even when external conditions are favorable, integration may falter if teachers are not convinced of technology’s value or feel anxious about its use (Ertmer et al., 2012; Zhao & Cziko, 2001). In special education, these intrinsic barriers can be pronounced: teachers might doubt whether technology will truly benefit students with disabilities or may fear implementing technology without fidelity if they lack confidence in their skills (Ertmer et al., 2012; Etscheidt, 2016). Exemplary technology-using

teachers' perceptions of colleagues being scared or intimidated by technology can be seen as a bigger obstacle than any equipment shortfall, highlighting the significance of mindset and knowledge (Ertmer et al., 2012).

Professional Development as a Means to Overcome Implementation Barriers

Many of these barriers are interwoven, creating complex core belief systems among teachers. PD again appears as a critical, cross-cutting solution. Targeted training and support can increase teachers' knowledge, self-efficacy, and openness to new practices, thereby mitigating second-order barriers (Alharbi, 2018; Ertmer et al., 2012). Researchers show that when special educators receive relevant technology PD, their confidence grows and their instructional use of technology improves, benefiting student outcomes (Alharbi, 2018). To address second-order barriers, PD could build teachers' competencies, grow their confidence, and shift their beliefs to ensure skills and values rooted in authentic learning experiences replace fear and uncertainty (Ertmer et al., 2012).

Current Knowledge

Teacher professional development (PD) has evolved significantly since the start of the 21st century (Darling-Hammond et al., 2017). PD typically took the shape of condensed delivery of effective teacher practices in one-day workshops and in-service at the school, district, or regional level (Hargreaves, 2000). These have been replaced with more persistent, collaborative, and job-embedded forms of PD that engage teachers in reflection and ongoing learning rooted in teacher practice change, resulting in improved student outcomes (Desimone, 2023; El Islami et al., 2022).

The shift to delivery methods such as professional learning communities, coaching/mentoring systems, and other job-embedded PD supports has evidenced the collaborative emphasis on social meaning-making (Darling-Hammond et al., 2017). This social

aspect of adult learning is rooted in neuroscience literature around learning as a science (Darling-Hammond, 2024) that encourages continuous development and reflection over time with peers (El Islami et al., 2022; Vescio et al., 2008). On the individual teacher level, autonomy through micro-credentials and inquiry-based asynchronous PD allows teachers to pursue specific skills and receive recognition for mastery in targeted areas (Hunt et al., 2022).

Innovative delivery through digital platforms has helped to make learning more obtainable through on-demand webinars, virtual coaching, and global teacher networks. These strategies include rural or isolated areas where collaborative participation was much more complicated to access a decade ago (O'Brien et al., 2011). These tools can increase access to quality PD, allowing special educators in remote or resource-poor areas to connect with experts and peers for support.

Current Professional Development

The current generation of best practice in PD is more teacher-centered and tech-enabled, using personalization and innovation to create a continuous learning ecosystem for educators (Darling-Hammond, 2024; Hunt et al., 2022). Effective PD is viewed as an ongoing process integrated into teachers' everyday work in both individual and group settings rather than isolated events (Desimone, 2023).

The PD paradigm shift has picked up pace in the last ten years since the passage of the Every Student Succeeds Act (Every Student Succeeds Act, 2015), which identified common elements in what works in changing teacher practice and tied implementation of those elements to billions of annual federal dollars (Combs & Silverman, 2016). *Table 1* defines those seven elements and provides examples.

If teachers engage in sustained, collaborative learning, they are more likely to implement new strategies and improve student outcomes (Vescio et al., 2008). These trends illustrate an overall move from transmissive to transformative models of PD, which aim to align PD more closely with teachers' real classroom contexts and the need for continual growth (Avalos, 2011; Hargreaves, 2000).

Lastly, there has been a recent push in the literature to work on the macro level of large-scale policy change around the national education system's antiquated factory model so that schools can become more focused on deeper learning that meets the demands of a modern world's post-secondary student careers (Darling-Hammond, 2024; Desimone, 2023).

Gap in Knowledge

As classrooms become more digitally enriched and student populations more diverse, teachers need blended expertise, understanding both how to teach students with varied disabilities and how to leverage technology to do so (CAST, 2024). PD initiatives must aim to help teachers of SWD develop their technological knowledge to improve teacher buy-in and ensure implementation fidelity (Evmenova et al., 2023). The Technological-Pedagogical-Content Knowledge (TPACK) Framework is one model the interaction of a teacher's ability to use technology effectively in the classroom with the rest of the personal experience they bring to the professional setting (Edyburn, 2013). For example, a teacher might learn about a new literacy software and how to adapt it for students with reading disabilities and monitor their progress.

Recent literature underscores the need for this convergence. Emerling et al. (2021) found that special educators had limited experience using assistive technologies to support students with behavioral challenges, in part because they had little training in how to do so. By providing PD that simultaneously builds skills in special education strategies and technology integration,

schools can empower teachers to create more inclusive and equitable learning environments (Chun & Williams, 2021; Emerling et al., 2021). Early evidence shows promising outcomes from such integrated efforts, though at the higher education level, with Chun and Williams (2021) reporting that faculty who participated in inquiry-based PD incorporating assistive tech showed improved competency and more positive mindsets about their students' abilities.

Evidence is building that more cohesion in special educator PD at the intersection of ET improves overall teacher TPACK to better support SWD (Anderson & Putman, 2023; Atanga et al., 2020; Ciampa, 2017; Goldman et al., 2024; Windfont, 2024).

Purpose of the Review

While there is literature about effective ways to change teacher practice, less is known about how these principles apply to special education at the intersection of ET competencies that impact learning for SWD. Special educators often face unique instructional demands, including addressing diverse learner needs, implementing individualized education programs (IEPs), and navigating multiple curricular and behavioral frameworks. This review aims to name patterns, themes, and practices in PD programs that support ET integration by special educators.

Additionally, ET holds promise for supporting SWD, offering tools that personalize instruction, enhance accessibility, and support communication and independence. Yet, special education teachers often report limited access to targeted, relevant PD that supports their ability to integrate such tools effectively. These challenges may require different or more specialized forms of professional learning related to technology.

Thus, this narrative review aims to systematically describe and synthesize existing literature on PD interventions to enhance special education teachers' integration of educational technology in K-12 classrooms. Specifically, we will focus on naming research-backed PD

elements, PD delivery systems, and the types of ET most often targeted in PD for use in special education settings. We build upon the broader PD literature while focusing on the structures, supports, and strategies that foster meaningful, sustainable teacher technology use to support SWD.

Research Questions

Four specific questions guide this review:

- (1) What participant characteristics are reported by authors in studies examining PD about ET for special educators?
- (2) In what setting and delivery contexts is PD about ET delivered to special education teachers?
- (3) What formats and components are used in PD about ET with special education teachers?
- (4) What specific technologies are included in professional development programs?

These research questions are intended to provide a comprehensive synthesis of existing literature, identifying gaps in understanding and opportunities for further study within the PD literature specific to improving in-service special-educator technology integration.

Method

Search Procedure

We conducted an electronic search on October 3, 2024, using the databases: APA PsycINFO (ProQuest), ERIC (ProQuest), and ProQuest Dissertations & Theses. Our systematic search followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA; Page et al., 2021), and we have illustrated the entire process in the PRISMA diagram shown in *Figure 1*.

We constructed search terms using Boolean logic and focused on identifying studies involving in-service special education teachers and PD on technology integration. The search

string was as follows: (*noft("special educat*" OR "special education teacher") AND noft("education* technolog*" OR "assistive technolog*" OR "digital technolog*") AND noft("professional development" OR "coaching" OR "professional learning communit*" OR "instructional coaching" OR "communit* of practice" OR "professional learning")*). We limited our search to records published in English since 1990, which we chose due to its significance in relation to special education law (Individuals with Disabilities Education Improvement Act, 2004). We considered grey literature in this search to minimize publication bias and include valuable research not available in peer-reviewed journals due to the small amount of published work found on this topic. We retrieved a total of 377 records from our database search ($n = 377$).

In addition to the database search, we conducted a hand search to find additional relevant articles in two special education technology journals: (a) the *Journal of Technology and Teacher Education* (JTATE) and (b) the *Journal of Special Education Technology* (JSET). We screened all records published in JTATE up to October 3, 2024 ($n = 632$). We screened all JSET records published between 1990 and October 3, 2024 ($n = 835$).

Inclusion and Exclusion Criteria

We applied exclusion and inclusion criteria to all records during the screening process in the order listed below. Exclusion criteria were as follows: (a) articles written in non-English languages, (b) published before 1990, (c) literature reviews and meta-analyses, (d) practitioner papers focused solely on using a piece of technology, (e) studies involving pre-service teachers that could not be separated from in-service teacher participants, and (f) studies involving Augmentative and Alternative Communication devices, adaptive input, or switch devices as primary interventions as these technologies were considered beyond the scope of this review.

Inclusion criteria were as follows. First, participants had to be special education teachers who worked in K-12 classrooms, as reported by the study authors. Special education teachers included author-reported teachers or educators who were described as (a) named special education teachers or educators, (b) hold a teaching certification in special education, or (c) report working as a special education teacher/educator with an emergency certification or provisional license in a K-12 school. This definition excluded paraprofessionals, librarians, technology specialists, and school administrators. If studies included participants outside of this definition and others who met the criteria, data for included participants had to be able to be disaggregated from participants who did not meet the criteria to be included.

Second, the primary intervention was professional development, coaching, or training to improve the implementation or use of educational technologies in the participant's delivery of instruction, as reported by study authors. Professional development, coaching, or training were defined as targeted continuing education techniques to improve teacher practice, including collaborative progress monitoring, use of live model(s), use of video model(s), role play, independent practice, self-reflection, performance feedback, written directions, problem-solving discussions, in-service workshops, peer mentoring, or communities of practice.

Educational technologies were defined as (a) hardware and (b) software technologies. Hardware included author report of one or more of: personal computers (i.e., laptops, desktops, or Chromebooks), mobile devices (i.e., iOS or Android phones and tablets), eReaders (i.e., Kindle, Nook, or Kobu), extended/virtual reality (XR/VR) headsets (i.e., Meta Quest, Oculus, HTC Vive, or Apple Vision Pro), Interactive Displays (i.e., SmartBoard, Planer, or BenQ). Software included any author report of one or more of: generative Artificial Intelligence (AI; i.e., ChatGPT, Gemini, Perplexity, Claude, or Llama), Applications (i.e., Dragon, ToDoist,

Notability, Grammarly, or Forest,), Websites (i.e., ReadWriteThink, ReadTheory, LearningAtoZ, or Code.org), Learning Management Systems (i.e., Google Classroom, Canvas, Schoology, or Moodle), Content Delivery or Learning Platforms (i.e., Khan Academy, IXL, NewsELA, Nearpod, or BrainPop).

Screening Procedures

We first screened all records retrieved from the database search for duplicates ($n = 30$). We could not retrieve a sampling of records ($n = 23$) from the database search output, despite asking the university librarian for help, so we excluded them.

We conducted the screening process in two phases: Title and Abstract Screening (TAS) and Full-Text Screening (FTS) following PRISMA guidelines (Page et al., 2021). During the TAS phase, we reviewed articles to decide whether they met all the inclusion and no exclusion criteria. We conducted the TAS process with caution, prioritizing the inclusion of potentially relevant articles and excluding only those that definitively fell outside the criteria. Articles that passed the TAS phase underwent FTS, during which we examined each article in detail to confirm eligibility, relevance, and inclusion in this review. We followed the same process for the hand search screening, except that records passing the TAS phase were at once screened in full, with data combined across both phases. Our database screening resulted in the inclusion of ten articles. From the hand-searched journals, the screening of JTATE added no other records, and JSET added one. Thus, 11 articles are included in this review. Our complete screening procedure is illustrated in the PRISMA diagram in *Figure 1*.

Coder Descriptions

The author, a first-year doctoral student in a doctoral program in special education emphasizing Instructional Design, Technology, and Innovation, conducted the descriptive coding

process. Preparation for coding included detailed coursework on systematic reviews under the supervision of an experienced researcher and professor. Secondary coding is planned before this piece is submitted for publication.

Descriptive Coding

The purpose of the coding process was to systematically categorize and interpret key aspects of the studies included in this review to enable meaningful synthesis and analysis. We used a detailed self-developed coding manual to systematically extract data on variables from each included study related to the categories: (1) research design, (2) participants, (3) school setting, (4) intervention agents, and (5) PD intervention components.

We developed a comprehensive coding manual and reviewed it to guide consistent coding decisions, ensuring methodological rigor. We created the coding manual using a Google spreadsheet. The manual provided specific definitions, examples, non-examples, and categorical options for each variable of interest. We expected coders to use general and specific coding instructions to guide their decisions, ensuring consistency across all articles.

Individual categorical variables that could require specific knowledge or vocabulary related to special education and ET had added definitions provided to aid in coding accuracy. When met with ambiguous data, coders were instructed to thoroughly consult definitions and examples in the coding manual, use their best judgment, err on the side of conservatism by selecting “not reported,” and to consult review authors for clarification if necessary. All categories across all variables could be coded as “not reported” if data from the study authors were absent or too ambiguous to determine a suitable code.

The full descriptive coding manual, including a complete list of procedures, general, variable, and category-specific directions, all descriptive variables measured in this review, and

all of their operational definitions, examples, and non-examples, is available in supplemental materials found on Open Science Framework (OSF): <https://justman.fyi/PDonETinSPED-Review>.

Unit of Analysis

We examined articles in which authors used group design methodologies (e.g., randomized controlled trials or quasi-experimental) as well as ones that employed participant-level qualitative case-study methodologies. In the former, we used the entire article as the unit of analysis. In these articles, variables and their categorical or dichotomous data were coded to the mean (\bar{x}) across author-reported data using the formula $(\sum X_i) / n$. For articles employing case-study designs, the unit of analysis for study design was the entire article. Individual participants served as the unit of analysis for all remaining descriptive variables. This approach allowed for a detailed examination of participant-level data across studies.

Research Design

We narratively coded the research design in each article as reported by the study authors. Examples include a mixture of group and case-study designs and methods in order to better determine the unit of analysis in each article. We narratively coded the research methodologies used in each study (i.e., interviews, surveys, and observations).

Participants

Demographics. In single-case designs, we coded individual variables to gain insight into demographics, roles, and PD/ET backgrounds of each participant. In group designs, we coded participant variables to the mean, as reported by the study authors. We coded participant characteristic variables by selecting from a drop-down menu of values, which could be entered as a narrative description to allow for a complete representation of participant identities as

reported by the study authors. Variables included age (ordinal), gender (nominal, narrative possibility), race (nominal, multiple response, and narrative option), sexual orientation (nominal, narrative option), years of experience (ordinal), and highest formal education reached (ordinal).

Role and ET Background. The role of participants was categorically coded across the grade levels of students the participants taught (nominal, multiple response) and the teaching certifications they possessed (nominal, multiple response with narrative option), as reported by study authors. Participants' self-reported ET training before PD intervention was coded categorically (nominal, multiple response with narrative option) as Informal or Formal Training, as reported by the study authors. We defined Informal ET training as self-teaching or peer-teacher support. Formal ET training was defined as previous participation in targeted continuing education techniques to improve teacher practice, including collaborative progress monitoring, use of live model(s), use of video model(s), role play, independent practice, self-reflection, performance feedback, written directions, problem-solving discussions, in-service workshops, peer mentoring, or communities of practice. We also reported ET use in participant practice before intervention categorically (ordinal) as a range with options including never, rarely (less than monthly), occasionally (monthly), often (weekly), or always (daily). Detailed definitions and examples of amounts for each potential choice in the range are included in the supplemental OSF materials at <https://justman.fyi/PDonETinSPED-Review>.

Setting

In case study designs, we coded the setting data for each participant. In group designs, we coded setting data as a percentage, as reported by the study authors. To understand the educational context, we categorically coded variables from a dropdown menu of choices for the participant's school type, school locale, school socio-economic status, and the participant's

placement in the school. We also coded categorically for the technology resources available to the participant at their school. School Types included public, private, or charter. School locale included urban, suburban, or rural. School socio-economic status was coded as either Low, Medium, or High SES as defined by the study authors.

Participant placement was coded, allowing for multiple responses, including “Inclusive,” “Specialized School,” “Resource Room,” or “Self-Contained.” Participant student grade levels taught were coded, allowing for multiple responses, including “Elementary School (K-5),” “Middle School (6-8),” “High School (9-12),” or “Other” for narrative input of any grade level or age group not captured by the other options.

Technology resources available at the participant’s school were coded nominally (multiple response) to allow for more information on the level and type of technology resources made available to the participant for instructional purposes by their school, as reported by the study authors. Coding options for this variable included “No Technology Provided,” “1:1 Devices, Shared Devices,” “Assistive Technology Devices (Excluding AAC/Switch Devices),” “Classroom Interactive Technology,” “Specialized Instructional Technology,” “Software Licenses and Online Tools,” and “Bring Your Own Device (BYOD) Policy.”

Definitions, examples, and non-examples of each of these options are included in the coding manual in the supplemental materials at <https://justman.fyi/PDonETinSPED-Review>.

Intervention Agents

The intervention agents responsible for implementing PD on ET to improve teacher practice were coded. In single-case designs, intervention agent data were coded for each participant. In group designs, intervention agent data were coded as a percentage, as reported by the study authors. Data on the implementor’s roles related to the participant were coded

categorically, allowing for multiple response selection and narrative descriptions. Roles considered were “researcher,” “teacher,” “administrator,” “technology specialist,” and “technology coach.” The implementer’s training, years of experience, and delivery format, as reported by the study author, were coded dichotomously. Definitions, examples, and non-examples of each variable are included in the coding manual in the supplemental materials at <https://justman.fyi/PDonETinSPED-Review>.

Intervention

Professional Development Characteristics. Practices and techniques used in PD provided to teachers were coded as a categorical, multiple-response variable. “Collaborative Progress Monitoring” refers to educators jointly reviewing student data to inform instruction. “Live Models” and “Video Models” were coded as direct demonstrations of practices by facilitators, either in-person or via recorded media, respectively. “Role-Play” involved participants simulating instructional interactions. “Independent Practice” included opportunities for teachers to rehearse new strategies outside of live feedback contexts. “Self-Reflection” captured instances where participants were prompted to analyze their instructional decision-making. “Performance Feedback” was defined as verbal or written information provided on implementation quality. “Written Directions” were operationalized as instructional protocols, handouts, or guides. “Problem-Solving Discussions” included structured opportunities for collaborative analysis of instructional challenges. “In-Service” referred to formal, often school-sponsored PD events. “Peer Mentoring” meant ongoing support between educators, while “Community of Practice” encompassed recurring group-based collaboration grounded in shared goals or interests.

Framework Elements. Each included study was also coded for the presence or absence of the seven effective professional development (PD) elements identified by Darling-Hammond et al. (2017). These elements are: (a) *Content Focus*, (b) *Active Learning*, (c) *Collaboration*, (d) *Use of Models and Modeling*, (e) *Coaching/Expert Support*, (f) *Feedback and Reflection*, and (g) *Sustained Duration*. Definitions and examples for each PD element were clearly operationalized based on Darling-Hammond and colleagues' descriptions and examples (see *Table 1*).

We also coded ordinal data for the variables hours participants spent on PD in hours, the number of weeks the PD intervention spanned, and the total number of sessions. The author's report of any follow-up or ongoing support provided to participants after the planned intervention was coded dichotomously. All variable names, definitions, examples, and non-examples are provided in *Table 2*.

Educational Technology. The type of ET used in the intervention, as reported by study authors, was coded categorically as (a) hardware and (b) software. Categories of hardware and software, definitions, examples, and non-examples are provided in *Table 3*.

Reliability Estimations

This section will discuss reliability measures, which will be added once appropriate certification and review information becomes available. A secondary coder will examine 33% of the articles for all descriptive coding variables (participants, setting, implementers). The primary and secondary coders should meet or exceed 90% agreement of coded variables.

Reliability data for the search and screening process, as well as the coding process, will be collected and assessed for 33% of records.

Discrepancies in primary and secondary coding will be resolved through discussion with the second coder or the lead reviewer.

Results

The overall findings are organized as follows: First, we detail the results of our search and screening procedure. Second, we present participant demographics. Next, we describe the participants' school settings. Then, we detail the agents responsible for intervention. Finally, we discuss the specific PD formats used and examine the hardware and software tools taught during PD.

Search and Screening Procedure

The search and screening process followed the PRISMA process (Page et al., 2021) for a total of 1,844 records found through database and hand searches. Of these, 377 records were retrieved from database searches, and 1,467 records were later retrieved for hand search from relevant special education technology journals: (1) the *Journal of Technology and Teacher Education* (JTATE) and (2) the *Journal of Special Education Technology* (JSET).

After removing duplicates ($n = 30$), 347 database records remained. After exclusions from the TAS screening ($n = 245$) and inaccessible records ($n = 23$), the authors examined the full text of 49 database records against exclusion and inclusion criteria for eligibility. Initially, 12 database records made it through this screening stage to be included in the review. All hand-searched journal records were sought and retrieved from official journal websites and assessed for eligibility in one stage. Initially, eight records passed screening to be included in this review. As primary descriptive coding began, an added screening round was conducted to ensure no studies were erroneously included in the review. More records ($n = 9$) were excluded in this final round of screening. This left 11 articles to be reviewed, from database search ($n = 10$) and hand search ($n = 1$). The PRISMA diagram in *Figure 1* provides a detailed overview of the identification, screening, and inclusion process for database and hand searches. Full coded

results data is available in the supplemental resources found on Open Science Framework (OSF): <https://justman.fyi/PDonETinSPED-Review>.

Descriptive Coding

Study Designs

Seven articles in this review used case study designs (Cain, 2018; Ciampa, 2017; Courduff, 2011; Du & Lyublinskaya, 2022; Gersten & Kelly, 1992; Hollins, 2017; So et al., 2021). These studies used various standard methods to gather data, including interviews, observations, and document analysis. The remaining four articles used group designs (Byrd-Jones, 2011; Du, 2022; Schmidt et al., 2017; Weiss et al., 2016). Two studies used survey designs (Byrd-Jones, 2011; Schmidt et al., 2017), and one used quasi-experimental designs (Weiss et al., 2016) to collect and analyze data from larger groups of teachers. The final group design used a mixed method design which highlighted the experiences of one participant (Du, 2022). The case study participant's data is coded within its other group design participants.

Participants

Seven articles used case-study designs and were examined with each participant as the unit of analysis ($n = 28$) for all descriptive variables (Cain, 2018, $n = 1$; Ciampa, 2017, $n = 3$; Courduff, 2011, $n = 10$; Du & Lyublinskaya, 2022, $n = 3$; Gersten & Kelly, 1992, $n = 4$; Hollins, 2017, $n = 3$; So et al., 2021, $n = 4$). The remaining four articles used group designs with vastly different sample sizes (Byrd-Jones, 2011, $n = 322$; Du, 2022, $n = 20$; Schmidt et al., 2017, $n = 219$; Weiss et al., 2016, $n = 37$).

Age. Only one case study (Du & Lyublinskaya, 2022) reported its participant's ages. Two were in the 40 – 44 range, and one was in the 35 – 39 range. Age data were not reported for all other case studies (Cain, 2018; Ciampa, 2017; Courduff, 2011; Gersten & Kelly, 1992; Hollins,

2017; So et al., 2021; total $n = 25$). Only Schmidt et al. (2017) reported age in group design records. Participants' ($n = 219$) ages were reported as 20 – 29 (16%), 30 – 49 years (47%), and over 50 years 35%.

Gender. Genders were reported for all case study participants (Cain, 2018; Ciampa, 2017; Courduff, 2011; Du & Lyublinskaya, 2022; Gersten & Kelly, 1992; Hollins, 2017; So et al., 2021). Females included 86% of the participants ($n = 24$), while males made up 14% ($n = 4$). In group designs, genders were not reported in two studies (Byrd-Jones, 2011; Du, 2022) and was averaged to 82% Female ($n = 209$) and 18% Male ($n = 45$) across the other two studies (Schmidt et al., 2017; Weiss et al., 2016). Sexual orientations were not reported in any record.

Race. Participant racial identity was not reported by authors in five case study designs (Cain, 2018; Ciampa, 2017; Courduff, 2011; Gersten & Kelly, 1992; So et al., 2021; total $n = 22$). Across the other two records (Du & Lyublinskaya 1992; Hollins 2017), one participant was identified as Asian, one as Black or African American, two as White (Hispanic or Latino or Spanish Origin), and two as White (Not Hispanic or Latino or Spanish Origin). Race was not reported in any group design records (Byrd-Jones, 2011; Du, 2022; Schmidt et al., 2017; Weiss et al., 2016).

Experience. Authors reported on years of teaching experience in all case studies except for those from one record (Courduff, 2011). Authors reported a range of years of experience with students among their participants, the majority ($n = 9$) with 6 – 10 followed by 3 – 5 ($n = 5$) and 11 – 15 ($n = 3$). One participant reported less than 1 year of teaching experience ($n = 1$). A breakdown of years of teaching experience reported for case studies in all records can be found in *Table 3*. In group designs, Byrd-Jones reported an average of 13.9 years of experience (2011). Schmidt et al. (2017) reported that 33% of participants had less than 5 years, 26% had 6

to 10 years, and 40% had over 10 years of experience. Weiss et al. (2016) reported an average of 2 years of experience across all participants. The last study did not report on experience (Du, 2022).

All participants in case studies and group designs were reported as having state licensure as special education teachers, except one, who worked in a private school under a special certification (Du & Lyublinskaya, 2022).

The highest formal education reached by participants was overwhelmingly not reported by authors across the records examined. One case study anecdotally mentioned a participant who has a master's degree (Hollins, 2015). Weiss et al. (2016) reported that all teachers in their group design study had bachelor's degrees. All other records did not report on this variable (Byrd-Jones, 2011; Cain, 2018; Ciampa, 2017; Courduff, 2011; Du, 2022; Du & Lyublinskaya, 2022; Gersten & Kelly, 1992; Schmidt et al., 2017; So et al., 2021).

Grade Level Taught. The grade level of participants' teaching was reported 64% of case studies ($n = 18$). Of these participants, the majority worked with second-grade students (66.7%), followed by fourth and fifth graders (61.1% each). Approximately 50.0% taught first grade, while 38.9% were responsible for teaching kindergarten and third grade. Few participants reported teaching middle or high school grades, with only 11.1% responsible for Grades 9–12 and 5.6% for middle school students (grades 6-8). In one study (Gersten & Kelly, 1992), participants were reported as teaching high school, but the specific grade level was not discussed. See *Table 4* for the grade levels taught per participant in each case study record. In group design records, Byrd-Jones (2011) had the most comprehensive data reported on participants ($n = 322$), with multiple grade levels taught by each participant, described as PK (13.3%), K (27.1%), 1 (32.9%), 2 (32.0%), 3 (36.3%), 4 (37.5%), 5 (36.9%), 6 (25.1%), 7 (22.2%), 8

(22.5%), 9 (28.0%), 10 (29.1%), 11 (29.4%), and 12 (26.2%). Weiss et. al. (2016) reported participants as teaching 40.5% at the elementary level, 16.2% at middle schools, 32.4% at high schools, and 10.8% at combined secondary schools.

Pre Intervention Technology Training. Four case studies (Cain, 2018; Ciampa, 2017) reported on teacher technology training prior to the PD intervention. Three reported having informal training (Cain, 2018; Ciampa, 2017; $n = 3$), and one reported having no training (Ciampa, 2017; $n = 1$). This variable was not reported across all other case studies (Courduff, 2011; Du & Lyublinskaya, Gersten & Kelly, 1992; Hollins, 2017; So et al., 2021). Only Byrd-Jones (2011) reported on this variable in group designs, with 34% of participants reporting informal training and 25% reporting formal training. The other 41% were not reported, and the reviewers assumed the ambiguity meant no training. Du, 2022; Schmidt et al., 2017; Weiss et al., 2016 did not report on this variable.

Technology Use in Practice. According to record authors, no participants reported “always” or “never” using technology in their practice. Data appears skewed to the mean, with half of participants ($n = 14$) reporting occasionally, two reporting rarely, and one reporting often using technology in their practice. The remaining record authors did not report on teacher pre-intervention technology use in their case studies (Gersten & Kelly, 1992; Hollins, 2017; So et al., 2021; total $n = 11$). A Complete breakdown of each participant is in *Table 4*. Two group design records reported teacher technology use before intervention (Byrd-Jones, 2011; Schmidt, 2017) but were ambiguous to our coded variable. The former reported participants described their technology use in practice as Never (2.35%), Rarely (7.06%), Sometimes (30%), and Often (57.65%). Schmidt reported 55% of participants considered themselves at an

intermediate/advanced level, and 45% were self-described at a novice level. Study authors did not define these categories.

Setting

School Locale and Context. The case study and group design research in this review was set primarily in public schools. School locale for case studies was 46% urban ($n = 13$), 36% suburban ($n = 10$), and not reported in the remaining 18% ($n = 5$). No case studies were reported in rural schools. A complete breakdown of school types and locales for each case study participant and record can be found in *Table 4*. Public school teachers all provided Group design data (Byrd-Jones, 2011; Du, 2022; Schmidt et al., 2017; Weiss et al., 2016). In group design records, the school locale was reported as rural in one (Byrd-Jones, 2011), urban in another (Du, 2022) and not reported in the remaining two records (Schmidt et al., 2017; Weiss et al., 2016). School socioeconomic status was not reported in 68% of case studies (Cain, 2018; Courduff, 2011; Du & Lyublinskaya, 2022; Gersten & Kelly, 1992; So et al., 2021; total $n = 19$), was reported as low in 25% (Ciampa, 2017; Gersten & Kelly, 1992; Hollins, 2017; total $n = 7$), and medium in 7% (Gersten & Kelly, 1992; $n = 2$). School socioeconomic status was not reported in any group design records.

Student Educational Placement. The type of educational setting in which the participant teachers worked was reported in all case studies. Most work was not done in inclusive settings, with only 11% of case studies (Cain, 2018; $n = 3$) taking place in classrooms with non-disabled peers. Of the remaining case study placements, 61% took place in resource rooms (Ciampa, 2017; Courduff, 2011; Gersten & Kelly, 1992; total $n = 17$), and 14% each were set in self-contained classrooms (Du & Lyublinskaya, 2022; Hollins, 2017; total $n = 4$) and specialized schools (So et al., 2021; $n = 4$). A breakdown of the student's educational placement

for each teacher participant can be found in *Table 4*. In group design records, inclusive placements were also in the minority. Byrd-Jones's (2011) study was the only one with various placements. Self-contained classrooms were reported 46.3% of the time, resource rooms 39.9%, and inclusive environments in 13.8%. Two records were exclusively about teachers in self-contained environments (Du, 2022; Weiss et al., 2016). The remaining study did not report placement data (Schmidt et al., 2017).

School Grade Levels. The grade level of the school setting where the teacher participants worked was not reported in 14% (So et al., 2021; $n = 4$) of case studies. Of the remaining case studies, 68% were set in elementary schools (grades K-5; Cain, 2018; Ciampa, 2017; Courduff, 2011; Du & Lyublinskaya, 2022; Hollins, 2017; total $n = 19$), 46% in middle schools (grades 6-8; Ciampa, 2017; Courduff, 2011; total $n = 13$), and 21% in high schools (Du & Lyublinskaya, 2022; Gersten & Kelly, 1992; total $n = 6$). A breakdown of the school grade levels for each teacher participant can be found in *Table 4*. Most group designs did not report on the grade levels served at the school level (Byrd-Jones, 2011; Du, 2022; Schmidt et al., 2017). Only Weiss described this variable, with 41% of participants teaching at elementary schools, 16% at middle schools, 32% at high schools, and 11% at mixed middle and high secondary schools. Specific technology resources available to teachers in their practice were not reported in 64% (Cain, 2018; Ciampa, 2017; Du & Lyublinskaya, 2022; Gersten & Kelly, 1992; Hollins, 2017; So et al., 2021; total $n = 18$) of case studies. The remaining 36% (Courduff, 2011; $n = 10$) were all described as shared devices, namely, desktop computers in the classroom. Of group designs, only Byrd-Jones (2011) reported on technology resources available to special educators in their practice. They reported an average of three shared computers in the classroom and another seven shared devices that could be brought into the classroom if needed.

Intervention Agents

The intervention agents responsible for delivering the PD and training in the records of this review were primarily researchers (Cain, 2018; Ciampa, 2017; Courduff, 2011; Du & Lyublinskaya, 2022; Gersten & Kelly, 1992; Hollins, 2017; total $n = 24$; 85%). One case study did not report on implementor data (So et al., 2021; 14%). One researcher described herself as a technology coach with 6-10 years of experience in that role before conducting her case studies (Courduff, 2011, 35%). Group design studies also considered the researcher the implementor in all records except one (Byrd-Jones, 2011), which did not report who was responsible for implementing the PD. Training and qualification of the researchers were either not reported (Byrd-Jones, 2011; Cain, 2018; Hollins, 2017; 29%) or were reported simply as being associated with a professional background or career in higher education related to technology implementation and special education in the remaining case studies and group design research (Ciampa, 2017; Du, 2022; Du & Lyublinskaya, 2022; Gersten & Kelly, 1992; Schmidt et al., 2017; Weiss et al., 2016; 71%). Only Courduff's case studies mentioned years of relevant experience implementing technology-related PD for special educators. Implementors in case studies delivered PD in person 50% of the time ($n = 14$) and through a hybrid in-person/online format 36% of the time ($n = 10$). The delivery format was not reported for 14% of case studies ($n = 4$). For group design research, an in-person format was used by two studies (Schmidt et al., 2017; Weiss et al., 2016), a hybrid format by one study (Du, 2022) and not reported for one study (Byrd-Jones, 2011).

Intervention

The delivery formats used in PD for improved implementation of ET by special educators are shown for each study design in *Table 5*. All case studies mixed multiple PD types in their

intervention efforts. The most utilized PD types among case studies were peer mentoring and community of practice (Cain, 2018; Ciampa, 2017; Courduff, 2011; Du & Lyublinskaya, 2022; Hollins, 2017; So et al., 2021; total $n = 24$, 86%). Independent practice was used next most frequently (Cain, 2018; Ciampa, 2017; Courduff, 2011; Du & Lyublinskaya, 2022; Gersten & Kelly, 1992; Hollins, 2017; total $n = 21$, 75%), followed by problem-solving discussions (Courduff, 2011; Du & Lyublinskaya, 2022; So et al., 2022; total $n = 17$, 61%), written directions for teacher use in practice (Ciampa, 2017; Courduff, 2011; Du & Lyublinskaya, 2022; total $n = 16$, 57%), live modeling (Cain, 2018; Ciampa, 2017; Du & Lyublinskaya, 2022; Gersten & Kelly, 1992; So et al., 2021; total $n = 15$, 53%) self-reflection (Ciampa, 2017; Du & Lyublinskaya, 2022; Hollins, 2017; So et al., 2021; total $n = 13$, 46%), in-service workshops (Ciampa, 2017; Gersten & Kelly, 1992; So et al., 2021; total $n = 11$, 39%), collaborative progress monitoring (Courduff, 2011; $n = 10$, 35%), and performance feedback (Cain, 2018; Gersten & Kelly, 1992; total $n = 5$, 18%). Both quasi-experimental group designs (Du, 2022; Weiss et al., 2016) used a combination of Live Model, Independent Practice, Self Reflection, and Performance Feedback with their participants. In-service workshops were used in both survey designs (Byrd-Jones, 2011; Schmidt et al., 2017). Schmidt discussed the use of problem-solving discussions in those in-service sessions as well.

In 14% of the case studies (Cain, 2018; Hollins, 2017; total $n = 4$), the total weeks of PD were not specified. Another 14% (So et al., 2021; $n = 4$) only covered a single week. The typical duration of PD, in 46% of case studies was 5-6 weeks (Ciampa, 2017; Courduff, 2011; total $n = 13$). Additionally, three case studies (Du & Lyublinskaya, 2022) extended over 15 weeks. The breakdown of the number of PD sessions offered was varied between the methods of study authors. Du & Lyublinskaya (2022) offered the most sessions in their 11% of case studies

($n = 3$) with 15. 15% of case studies lasted 10 or 11 sessions (Gersten & Kelly, 1992; $n = 4$). The most frequent number of sessions was 5 – 6 (46%; Ciampa, 2017; Courduff, 2011; total $n = 13$). 18% of studies included 2 – 3 sessions (Cain, 2018; So et al., 2021; total $n = 5$). The number of PD sessions offered was not detailed in the one article's case studies (Hollins, 2017; $n = 3$).

Length of time spent on PD tasks was detailed in hours by session, though not reported in 14% of studies (Cain, 2018; Hollins, 2017; total $n = 4$). Most other case studies (61%; Ciampa, 2017; Courduff, 2011; Gersten & Kelly, 1992; total $n = 17$) had approximately one hour per session, while Du & Lyublinskaya (2022) saw each case study's PD session length reported by study authors as 1.5 hours ($n = 3$). The final case studies sessions were full 8-hour days (So et al., 2021; $n = 4$).

In group designs, Du (2022) also had a 15-week duration with an equal number of 90-minute sessions for PD. One study was a single eight-hour session (Schmidt et al., 2017), and another was a single three-hour session (Weiss et al., 2016). Byrd-Jones (2011) reported an average PD time of 8 hours in their survey. From group designs, only one provided follow-up (Weiss et al., 2016) by giving feedback on a produced audio podcast the teachers created using computer software after the PD.

The analysis of Darling-Hammond et al.'s (2017) seven PD elements across all included studies revealed clear patterns of inclusion in case study designs. For the participants ($n = 28$), all experienced PD that included Content Focus, Active Learning, and Coaching/Expert Support (Cain, 2018; Ciampa, 2017; Courduff, 2011; Du & Lyublinskaya, 2022; Gersten & Kelly, 1992; Hollins, 2017; So et al., 2021). Collaboration and the Use of Models and Modeling were reported in approximately 86% of case study participants (Cain, 2018; Ciampa, 2017; Courduff, 2011; Du

& Lyublinskaya, 2022; Hollins, 2017; So et al., 2021). Feedback and Reflection, along with Sustained Duration, were universally present across these studies (Cain, 2018; Ciampa, 2017; Courduff, 2011; Du & Lyublinskaya, 2022; Gersten & Kelly, 1992; Hollins, 2017; So et al., 2021).

In contrast, group-design studies showed more variability. Content Focus and Active Learning were widely present, each reported in 75% of group studies (Du, 2022; Schmidt et al., 2017; Weiss et al., 2016). Collaboration and Modeling were less common, appearing in only half of the group-design studies reviewed (Du, 2022; Schmidt et al., 2017; Weiss et al., 2016). Coaching/Expert Support and Sustained Duration were the least often reported elements, clear in only 25% of group studies (Du, 2022). Feedback and Reflection were noted in 75% of group studies, although often lacked detailed reporting of what it was defined as (Du, 2022; Schmidt et al., 2017; Weiss et al., 2016). These findings, including specific examples and detailed coding justifications for each PD element, is provided in supplementary materials available at <https://justman.fyi/PDonETinSPED-Review>.

The type of ET used in all case studies is presented in *Figure 2*. The most common hardware topics discussed were tablets (71%; Cain, 2018; Courduff, 2011; Du & Lyublinskaya, 2022; Hollins, 2017; total $n = 20$), each of mobile phones and interactive displays was represented in 61% of case studies (Cain, 2018; Ciampa, 2017; Courduff, 2011; Du & Lyublinskaya, 2022; Hollins, 2017; total $n = 17$), extended / virtual reality headsets in 57% (Courduff, 2011; Du & Lyublinskaya, 2022; So et al., 2021; total $n = 16$), laptop computers (Courduff, 2011; Du & Lyublinskaya, 2022; Hollins, 2017; total $n = 16$), desktop computers (Courduff, 2011; Du & Lyublinskaya, 2022; total $n = 13$), maker technologies (i.e., 3D printers and MakeyMakeys; Du & Lyublinskaya, So et al., 2021; total $n = 7$), Video Discs (Gersten &

Kelly, 1992; $n = 4$), Chromebooks and Wearables were each represented in 11% of case studies (Du & Lyublinskaya, 2022; $n = 3$). The most common type of software discussed were websites in 86% of case studies (Cain, 2018; Ciampa, 2017; Courduff, 2011; Du & Lyublinskaya, 2022; Hollins, 2017; So et al., 2021; total $n = 24$), followed by computer applications in 75% of case studies (Cain, 2018; Ciampa, 2017; Courduff, 2011; Du & Lyublinskaya, 2022; Hollins, 2017; and So et al., 2021; total $n = 21$), mobile apps were utilized in 68% of case studies (Cain, 2018; Ciampa, 2017; Courduff, 2011; Du & Lyublinskaya, 2022; Hollins, 2017; total $n = 19$), learning management systems (Cain, 2018; Du & Lyublinskaya, 2022; total $n = 4$), and natural language processors (Ciampa, 2018; Courduff, 2011; $n = 2$). Audiobooks, videos, and word prediction tools were all mentioned once each.

In group designs, all studies mentioned laptop computers (Byrd-Jones, 2011; Du, 2022; Schmidt et al., 2017; Weiss et al., 2016). Tablets were used in all studies except one (Byrd-Jones, 2011; Schmidt et al., 2017; Weiss et al., 2016). Interactive displays were discussed in all studies except one (Byrd-Jones, 2011; Du, 2022; Weiss et al., 2016). One study also mentioned Extended / Virtual Reality Headsets, Mobile Phones (Du, 2022).

Reliability Estimations

The average agreement for descriptive coding (participants, setting, implementers) will be reported here after secondary coding has been completed.

Discussion

This descriptive review aimed to synthesize existing research examining professional development (PD) programs designed to support special education teachers in integrating educational technology (ET). The review was guided by four research questions addressing

participant characteristics, PD settings, PD components, and the description of the types of technologies guiding teacher trainings.

On participant characteristics (RQ1), study authors commonly reported special educators' roles and general teaching responsibilities. However, fewer studies detailed specific demographic characteristics such as teacher experience, years of practice, training backgrounds, or other variables that may influence their practice.

In the PD (RQ2), school setting variability was seen across case studies and group designs. PD interventions were often situated within elementary (K-5) and middle (6-8) public school settings, spanning mostly urban contexts with a smaller number in high school (9-12) settings.

The results show consistent emphasis across studies on the two core elements of effective PD of content focus and active learning as described by Darling-Hammond et al. (2017). Most studies, irrespective of design, integrated these elements clearly into their PD activities. This aligns with prior literature highlighting the necessity of connecting PD directly to instructional practices and ensuring active participation by teachers (Darling-Hammond et al., 2017; Kennedy et al., 2014).

Our findings also revealed variability in the inclusion and depth of critical PD elements, such as modeling, collaboration, coaching, or expert support. Studies employing single-session or short-term workshop designs often omitted or superficially addressed these components, while case studies featuring sustained and embedded PD tended to integrate them more (Courduff, 2011; Du & Lyublinskaya, 2022; Hollins, 2017). Additionally, structured opportunities for feedback and reflection were inconsistently implemented, pointing to a notable gap in the literature about reflective practice as part of teacher learning in ET integration contexts for

special educators. Finally, the review highlighted that studies often described various educational technologies (RQ4) used in PD.

Our discussion is organized around the four research questions guiding this review. For each research question, key findings are summarized, and implications for future research and practical application are articulated. Limitations of this review are then discussed, and the section concludes with an integrative summary of key contributions to the existing literature.

RQ1: Participant Characteristics

The characteristics of participating special education teachers were reported with varying degrees of detail and consistency. Most studies provided basic demographic information, focusing on teachers' professional roles (e.g., special education teachers, resource specialists, inclusion teachers) and the disability categories they served. Teachers mostly worked with students experiencing high-incidence disabilities such as learning disabilities, autism spectrum disorder, or emotional and behavioral disorders (Courduff, 2011; Du & Lyublinskaya, 2022; Weiss et al., 2016). From the records reviewed, this leaves a gap in the literature among students with low-incidence disabilities.

Study authors less often provided comprehensive information on demographic or added professional details that might influence teachers' experiences of and responses to PD. Variables such as years of teaching experience, prior training in technology integration, cultural and linguistic backgrounds, and educational attainment were rarely reported. Teacher personal and professional identities may play a critical role in understanding how PD is experienced, implemented, and sustained (Lovett, 2023; Noonan, 2019).

Implications for Research

Future research should prioritize detailed reporting of participant demographics beyond fundamental professional roles and student populations. Specifically, research should systematically document variables including teacher experience levels, certification areas, prior PD exposure, and demographic backgrounds such as race and ethnicity. Such detailed reporting will enable more nuanced analyses of how teacher characteristics influence responsiveness to PD and continued classroom implementation (Imants & Van Der Wal, 2020). Researchers might also further explore interactions between teacher demographics and PD outcomes, examining whether specific subgroups benefit more or feel as if they have more agency than others within PD designs or elements. Further research may also be needed in utilizing PD to improve special educator implementation of ET with students with low incidence disabilities, consistent with the findings in a recent review of the literature on current uses of technology among special education (Olahanmi et al., 2020).

Implications for Practice

PD providers and school leaders should consider the potential benefits of tailoring PD offerings based on the needs of different teacher demographics and characteristics. (Hayes et al., 2024; Imants & Van Der Wal, 2020). Recognizing teacher experience, expertise, and prior training variations can help to confirm participants and inform differentiated PD models. For instance, novice special educators or those less experienced with technology may require more intensive, structured support, while experienced educators might benefit more from advanced, collaborative formats (Van Driel et al., 2001).

Prior experience with educational technology among educators was rarely reported, though available data showed teachers often had at least minimal technology familiarity. This gap in reporting is significant for practice, as understanding educators' baseline technology skills

is crucial to designing PD programs in line with their needs. Without clear documentation of prior experience, PD effectiveness may vary substantially.

RQ2: PD Settings and Delivery Contexts

Across reviewed studies, the settings and contexts of professional development (PD) delivery for special education teachers showed notable variability. Most PD interventions took place within public elementary (K–5) and middle school (6–8) settings, with a smaller representation of studies situated in high school (9–12) contexts. Among case studies, 46% were situated in urban and 36% in suburban settings, with no case studies occurring in rural schools. Only one group design study explicitly reported on rural participation (Byrd-Jones, 2011), suggesting an underrepresentation of rural schools in this literature. Given that special education teachers in rural areas may face additional barriers, such as access to technology, fewer in-person training opportunities, and limited school budgets, this gap is noteworthy. Prior research has noted that rural educators may experience higher levels of professional isolation and fewer district-level supports for technology integration (Rooks-Ellis et al., 2025). The underrepresentation of these settings may limit an understanding of the unique challenges and related solutions pertinent to a portion of special educators.

Socioeconomic status (SES) of the school setting was another area of limited reporting, with 68% of case studies and all group design studies not reporting school level SES data. Among those that did, low-income settings were the most common, which may add to a documented digital divide among K-12 students (Dolan, 2016). The widespread omission of socioeconomic status (SES) reporting in studies limits understanding of how economic disparities among schools might affect the availability and effective implementation of educational technology. Given that technology integration typically depends upon adequate

funding for devices, teacher training, and digital infrastructure, neglecting SES as a variable constrains researchers' and practitioners' abilities to tailor professional development effectively for resource-limited educational contexts (Cheng & Parker, 2023).

Implications for Research

Future research could explore PD across different school contexts and delivery formats, comparing effectiveness in urban versus rural settings or examining PD models across grade banded contexts. Doing so could contribute important insights into overcoming context-specific needs of a remote setting (Sundeen & Kalos, 2022). The overall lack of SES reporting restricts the ability to understand how economic disparities across schools may influence the accessibility to and implementation of ET once the researcher has left and the teacher is left to implement their technology learning in practice (Cheng & Parker, 2023; Dolan, 2016).

Additionally, further longitudinal study examining sustained PD that is embedded in teacher's daily practice might help to understand how delivery context impact the authenticity of technology integration by special education teachers and help to reduce abandonment of ET (Lamond & Cunningham, 2020).

Implications for Practice

Practitioners and school administrators should carefully consider the suitability of PD delivery formats to their specific school contexts and teacher needs. Embedded and sustained models (i.e., coaching, peer collaboration, and communities of practice) appear to offer greater potential for meaningful integration and lasting instructional change than short-term workshops. Schools should be encouraged to implement these longer-term more individualized PD formats, particularly where ongoing support and collaboration are possible.

RQ3: PD Components and Formats

The reviewed studies consistently incorporated components of PD aligned with best-practice criteria described by Darling-Hammond et al. (2017). Most often clear were content focus and active learning, with most studies explicitly highlighting PD designed to engage teachers in tasks relevant to their instructional practices and curriculum areas (Du, 2022; Du & Lyublinskaya, 2022; Gersten & Kelly, 1992). This robust inclusion aligns closely with contemporary PD literature emphasizing the centrality of instructional relevance and active participation in achieving meaningful teacher change (Kennedy et al., 2014).

However, we observed variability in other critical PD elements, including modeling, collaboration, coaching/expert support, and structured opportunities for feedback and reflection. Studies employ embedded or sustained delivery formats more often and robustly integrate these elements (Courduff, 2011; Hollins, 2017). Conversely, studies using short-duration, workshop-based approaches offered fewer opportunities for meaningful modeling, collaborative activities, structured coaching, and reflective practices (Schmidt et al., 2017; Weiss et al., 2016). The depth and fidelity of these components varied or were often not described by study authors.

Implications for Research

Future studies could investigate how specific combinations and sequences of PD components contribute to improved technology integration outcomes. Specifically, research could examine the differential impacts of modeling, collaboration, coaching, and reflective feedback when integrated into PD designs. Greater attention should also be paid to fidelity measures, documenting how consistently and effectively each PD component is implemented. Exploring these dimensions will offer more nuanced insights into which PD components are most critical and under what conditions they yield sustained instructional changes among special

education teachers. The impact of long-term and follow-up procedures to reinforce learning could also be helpful to examine further.

Implications for Practice

PD developers and school leaders should consider PD components' critical presence, quality, and integration into their professional learning offerings. While content-focused and active learning experiences are foundational, integrating sustained coaching, modeling of effective practice, structured collaboration, and reflective activities is likely essential for teachers to make meaning from their learning and help them better generalize how they may use the educational technologies meaningfully with their students. In order to better contextualize PD, schools should ensure it is delivered in a setting that an authentic time and space to how teachers work with SWD.

An additional gap in this literature is the lack of evidence on how PD programs function independently of research teams, highlighting the need for studies exploring real-world implementation by districts or schools alone.

RQ4: Technology Types

The reviewed studies featured a wide range of educational technologies, including common classroom devices (e.g., tablets, interactive whiteboards), specialized intervention tools (e.g., Content Acquisition Podcasts, structured mobile apps), and advanced technologies (e.g., virtual reality, 3D printing). However, most studies provided limited detail on how these technologies were consistently integrated into routine instructional practices, restricting the field's understanding of effective, sustained technology integration.

Implications for Research

Future research could document and examine how specific ETs introduced in PD programs are implemented in classroom contexts over time following the PD. Emphasis could be placed on reporting not just the type of technology, but the pedagogical strategies teachers use to integrate these tools meaningfully into instruction. Investigations that track longitudinal implementation, teacher adaptations, and student responses to various technologies enhance understanding of how and why particular tools may be effective in special education settings.

Implications for Practice

For practitioners and PD facilitators, selecting and introducing technologies should extend beyond mere tool exposure to explicitly modeling effective instructional integration strategies. Special educators will receive help from PD showing how technology can be seamlessly embedded into daily instructional routines and differentiated to meet diverse student needs. Furthermore, schools could consider ongoing follow-up and coaching support to help teachers sustain and iterate on their technology integration practices, moving beyond initial training toward continuous instructional improvement.

Limitations

There are several methodological and conceptual limitations when interpreting the findings of this descriptive review. First, we had an intentionally focused scope of the review on studies and grey literature published within a defined range of years and limited to U.S.-based contexts, potentially omitting relevant research conducted in international contexts. This inclusion criteria might limit the generalizability of findings or overlook perspectives from broader geographic or educational contexts. This limitation in scope is also limited by the number of databases included in our search, as more records may have been found through the addition of other databases.

Second, due to the descriptive and narrative nature of the synthesis, no quantitative meta-analysis was conducted. Thus, findings are limited to descriptive trends, without the ability to examine effect sizes or comparative effectiveness among different PD elements or technologies.

Third, substantial variability was clear in the level of detail reported across studies on our chosen coded variables of PD implementation fidelity, teacher characteristics, and technology integration strategies. Studies lacked detailed reporting on the duration, depth, and consistency of implementation, hindering comprehensive synthesis and limiting the ability to draw robust conclusions on effectiveness without examining additional data points.

Lastly, inherent publication bias may influence the results, as studies reporting positive outcomes or comprehensive PD designs might be more likely to reach publication than studies with inconclusive or negative findings. This bias could contribute to an overly optimistic portrayal of PD effectiveness in integrating ET.

These limitations suggest that the findings presented should be interpreted with caution, underscoring the importance of ongoing research with more rigorous and comprehensive documentation of PD processes and outcomes.

Conclusion

This narrative descriptive review synthesized existing research on PD aimed at enhancing special education teachers' integration of ET. The review highlighted important gaps, notably the inconsistent reporting of participant demographics, limited detail on the sustained implementation of PD components, and varied documentation of ongoing coaching of specific ET integration strategies.

The findings emphasize the necessity for future research to focus on systematic, detailed documentation of PD implementation fidelity, teacher demographics, and longitudinal

integration strategies for educational technologies. The mere inclusion of Darling-Hammond et al.'s (2017) PD elements does not inherently foster meaningful teacher change or measurable impacts on student outcomes. In these studies, the presence of “coaching” varied, from single-session consultations to ongoing, structured coaching relationships. Thus, even PD programs dichotomously aligned with recommended framework elements may not necessarily produce substantial, lasting instructional improvement.

For practitioners and PD developers, these results emphasize the importance of designing and providing meaningful and authentic PD experiences that integrate multiple evidence-based elements to foster equally meaningful and authentic instructional changes. Addressing these gaps will support the use of PD programs that effectively prepare special educators to use ET on an ongoing basis, thus enhancing learning outcomes for SWD.

Table 1*Seven Foundational Elements of Successful Teacher Professional Development (PD)*

Element of Effective PD	Summary of Description from (Darling-Hammond et al., 2017)	Example of Potential Special Education Technology Context
Content Focus	Focuses on teaching strategies associated with specific curriculum content within teachers' classroom contexts.	A PD series helps special educators use screen readers and speech-to-text tools to support reading comprehension for students with dyslexia.
Active Learning	Engages teachers in designing and practicing new strategies, mirroring the student learning they will lead.	Teachers engage directly with Augmentative and Alternative Communication (AAC) devices, developing lesson plans that incorporate voice output tools.
Collaboration	Promotes teacher interaction and shared learning in job-embedded, often schoolwide or districtwide contexts.	Special education teams meet weekly to co-plan lessons using digital visual schedules and share implementation strategies across classrooms.
Use of Models and Modeling	Provides examples of effective practice, including lesson plans, student work, or videos.	Facilitators model how to use iPad apps for behavior tracking and task analysis, followed by peer discussion of modeled strategies.
Coaching / Expert Support	Ongoing guidance from mentors or coaches tailored to teacher needs.	An instructional coach with expertise in assistive technology provides weekly feedback on teachers' integration of tools like ChatGPT or Project iKnow.
Feedback and Reflection	Includes structured opportunities for self-assessment and feedback from peers or mentors.	Teacher's video-record lessons using text-to-speech tools, reflect on student engagement, and receive peer feedback in departmental learning group meetings.
Sustained Duration	Occurs over an extended time to allow for implementation, feedback, and iteration.	A yearlong PD initiative supports teachers in using Microsoft Immersive Reader across subject areas, with monthly check-ins and mid-year refreshers.

Note. Summary of seven widely shared features of effective professional development, as named in the seminal Darling-Hammond et al. (2017) review of 35 studies around professional development. Each feature is illustrated with an author created potential PD example focused specifically on the integration of educational technology in special education settings.

Table 2*Intervention Variables: Educational Technology*

Variable	Definition	Example(s)	Non-Example(s)	Specific Direction
Hardware	Physical educational and assistive technology devices that are the focus of the professional development being conducted.	Personal computers (i.e., laptops, desktops, or Chromebooks) Mobile devices (i.e., iOS or Android phones and tablets) eReaders (i.e., Kindle, Nook, or Kobu) Extended/virtual reality headsets (i.e., Meta Quest, Oculus, HTC Vive, or Apple Vision Pro) Interactive Displays (i.e., SmartBoard, Planer, or BenQ).	Augmentative and Alternative Communication (AAC) Devices Artificial Intelligence (i.e., ChatGPT, Gemini, Perplexity, or Llama) Applications (i.e., Dragon, ToDoist, Notability, Grammarly, or Forest), Websites (i.e., ReadWriteThink, ReadTheory, LearningAtoZ, or Code.org) Learning Management Systems (i.e., Google Classroom, Canvas, Schoology, or Moodle) Content Delivery or Learning Platforms (i.e., Khan Academy, IXL, NewsELA, Nearpod, or BrainPop)	Using the dropdown menu, select all categorical examples of technology examined. Select the proper unit of analysis (i.e., group design: included article or single case design: individual participant)
Software	Educational and assistive technology programs ran on hardware that are the focus of the professional development being conducted.	Artificial Intelligence (i.e., ChatGPT, Gemini, Perplexity, or Llama) Applications (i.e., Dragon, ToDoist, Notability, Grammarly, or Forest) Websites (i.e., ReadWriteThink, ReadTheory, LearningAtoZ, or Code.org) Learning Management Systems (i.e., Google Classroom, Canvas, Schoology, or Moodle) Content Delivery or Learning Platforms (i.e., Khan Academy, IXL, NewsELA, Nearpod, or BrainPop)	Hardware Personal computers (i.e., laptops, desktops, or Chromebooks) Mobile devices (i.e., iOS or Android phones and tablets) eReaders (i.e., Kindle, Nook, or Kobu) Extended/virtual reality (XR/VR) headsets (i.e., Meta Quest, Oculus, HTC Vive, or Apple Vision Pro) Interactive Displays (i.e., SmartBoard, Planer, or BenQ).	Using the dropdown menu, select all categorical examples of technology examined. Select the proper unit of analysis (i.e., group design: included article or single-case design: individual participant)

Note. Further information on all coded educational technology items is provided to coders to ensure all terminology is understood. See the full coding manual via the supplemental materials available on Open Science Framework (OSF): <https://justman.fyi/PDonETinSPED-Review>.

Table 3*Professional Development (PD) Intervention Variables*

Variable	Definition	Example(s)	Non-example(s)	Specific direction
Practices / Techniques ¹	Specifies the type of format used for PD activities that participants received, as reported by study authors	John Doe took part in a workshop about integrating educational technology. Jane Smith received one-on-one coaching on classroom technology integration.	John attended a PD event. (Needs more details about the format.) Jane joined a meeting. (Does not specify that it was related to PD.)	Categorize based on format type. Include all techniques described as being used in the study.
Total Time Spent (Hours) ²	The total number of hours that participants spent in PD related to technology integration. This includes formal instruction time, practice sessions, and reflection activities.	Teachers completed 12 hours of training, over three weeks. A total of 20 hours of PD were reported for the school year.	The teachers attended a series of PD sessions. (Lacks specific information about the total number of hours.) The PD lasted for a while. (Too vague—no time specified.)	Coders should use the exact number of hours when provided. If hours are given in ranges, use the midpoint (e.g., 5-10 = 7.5 hours). If only days are reported: Assume 6 per day, 3 per half day, etc.
Total Weeks ²	The number of weeks over which the PD activities were spread.	The PD was spread out over 4 weeks, every Friday. Participants attended PD activities for 8 weeks.	The PD lasted several months. (Needs a specific number of weeks.) Participants attended PD sessions over time. (Too vague—no clear duration.)	Use the exact number of weeks. If only months are provided, assume 4 weeks per month. Code the total number of weeks for multiple phases combined.
Total Sessions ²	The total number of individual sessions or meetings that were part of PD. This includes both live and online meetings.	Teachers attended 10 sessions, each lasting 90 minutes. The PD included 5 group sessions and 3 follow-up coaching meetings.	The PD had multiple sessions. (Needs an exact number.) Sessions were conducted on an ongoing basis. (Too vague without specific session counts.)	Include all formal sessions, whether group-based, individual, or follow-up meetings. If Sessions Are Given in Ranges: Use the midpoint (e.g., 4-6 sessions = 5 sessions).
Follow Up or Ongoing Support Provided ³	Indicates whether participants received support or follow-up after the initial PD sessions. (i.e., coaching, feedback, online resources, or mentoring).	Teachers received monthly coaching sessions as follow-up support after the initial PD. Participants had access to an online community where they could ask questions for three months following the training.	The PD was delivered, but follow-up was not made. (No support was explicitly stated.) The teachers were left to implement the learning on their own. (No ongoing support provided.)	If explicit follow-up support is mentioned (e.g., regular coaching, resources), "Yes." If explicit follow-up support is listed as not being provided, "No."

Note. Options for each variable are included: ¹Collaborative Progress Monitoring, Live Model, Video Model, Role Play, Independent Practice, Self Reflection, Performance Feedback, Written Directions, Problem-Solving Discussions, In-Service, Peer Mentoring, Community of Practice ²1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, etc. ³Yes, No.

Table 4
Highlighted Case Study Participants and Setting Variables

Record	Participant				Setting				
	Participant ID	Years of Experience	Grade Levels Taught	Self-Reported Technology Use in Teaching Practice	School Type	School Locale	School SES	Special Education Placement ^a	School Level ^b
Cain (2018)	1	6-10	-	Often	Public	-	-	I	E
Ciampa (2017)	2	3-5	5	Occasionally	Public	Urban	Low	R	E, M
	3	6-10	8	Occasionally	Public	Urban	Low	R	E, M
	4	11-15	7	Rarely	Public	Urban	Low	R	E, M
Courduff (2011)	5	-	K, 1, 2, 3, 4, 5	Occasionally	Public	Suburban	-	R	E, M
	6	-	K, 1, 2, 3, 4, 5	Occasionally	Public	Suburban	-	R	E, M
	7	-	K, 1, 2, 3, 4, 5	Occasionally	Public	Suburban	-	R	E, M
	8	-	4, 5	Occasionally	Public	Suburban	-	R	E, M
	9	-	K, 1, 2, 3, 4, 5	Occasionally	Public	Suburban	-	R	E, M
	10	-	K, 1, 2, 3, 4, 5	Occasionally	Public	Suburban	-	R	E, M
	11	-	2, 4, 5	Occasionally	Public	Suburban	-	R	E, M
	12	-	K, 1, 2, 3, 4, 5	Occasionally	Public	Suburban	-	R	E, M
	13	-	K, 2, 4	Occasionally	Public	Suburban	-	R	E, M
	14	-	2, 3, 4, 5	Occasionally	Public	Suburban	-	R	E, M
Du & Lyublinskaya (2022)	15	6-10	5	Occasionally	Private	Urban	-	C	E
	16	11-15	9, 10, 11, 12	Occasionally	Private	Urban	-	C	H
	17	11-15	9, 10, 11, 12	Rarely	Private	Urban	-	C	H
Gersten & Kelly (1992)	18	6-10	-	-	Public	Urban	Low	R	H
	19	6-10	-	-	Public	Urban	-	R	E, H
	20	6-10	-	-	Public	Urban	Medium	R	H
	21	6-10	-	-	Public	Urban	Medium	R	H
Hollins (2017)	22	6-10	4	-	Public	Urban	Low	I	E
	23	0	-	-	Public	Urban	Low	I	E
	24	3-5	1, 2,	-	Public	Urban	Low	C	E
So et al. (2021)	25	3-5	-	-	-	-	-	S	-
	26	6-10	-	-	-	-	-	S	-
	27	3-5	-	-	-	-	-	S	-
	28	3-5	-	-	-	-	-	S	-

Note. Total case studies ($n = 28$). A dash (-) means the variable was not reported by the study's authors. ^a Special Education Placement: I = Inclusive, R = Resource Room, C = Self-Contained, S = Specialized School. ^b School Level: E = Elementary (K=5), M = Middle (6-8), H = High School (9-12). All participant and setting variable data available at <https://justman.fyi/PDonETinSPED-Review>.

Table 5

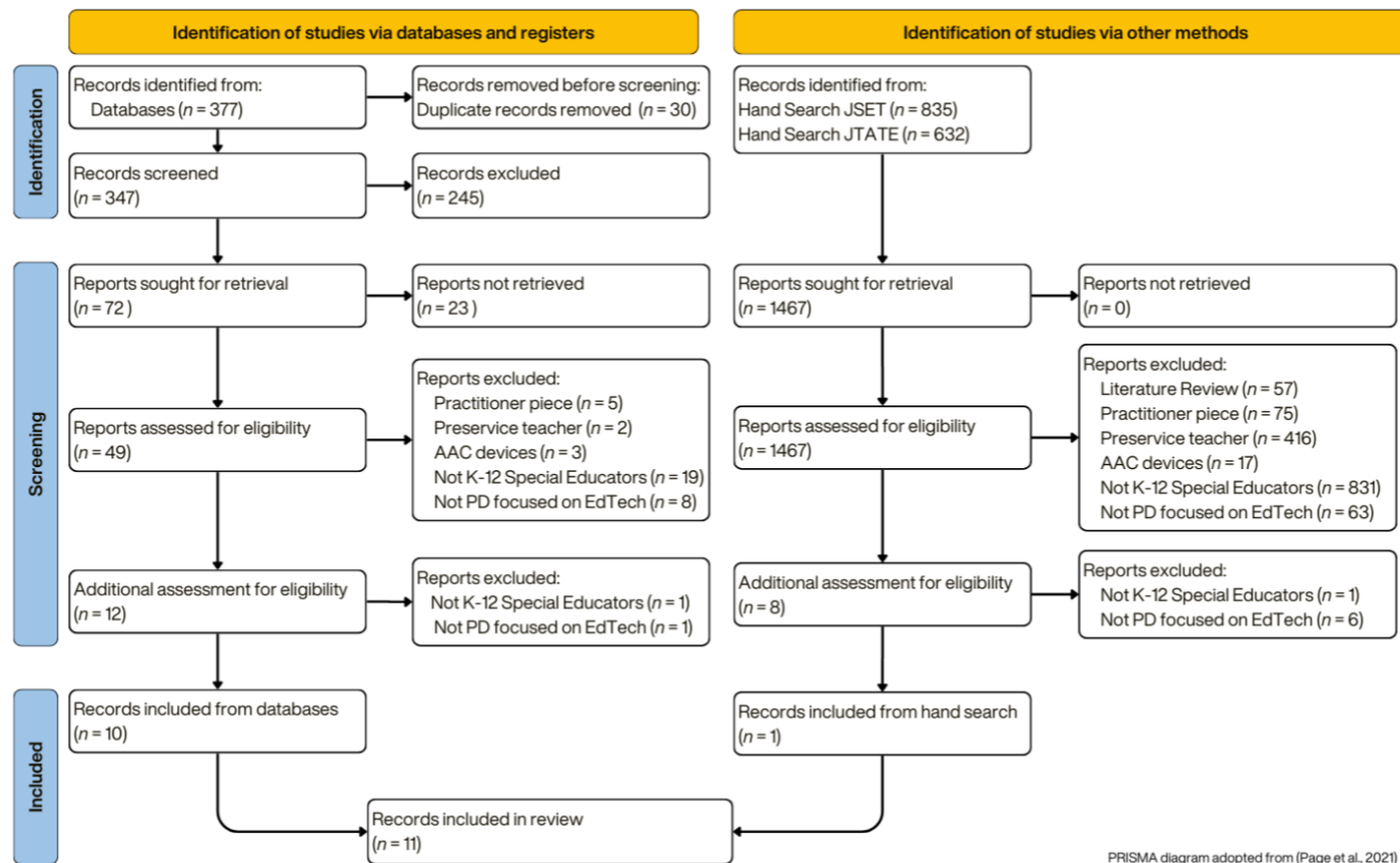
Professional Development Delivery Format Utilized to Improve Implementation of Educational Technology by In-Service Special Educators

Study	Type ^a	Participant Quantity	CPM ^b	LM ^c	IP ^d	SR ^e	PF ^f	WD ^g	PSD ^h	ISW ⁱ	PM ^j	CP ^k
Cain (2018)	C	1	□	■	■	□	■	□	□	□	□	■
Ciampa (2017)	C	3	□	■	■	■	□	■	□	■	■	■
Courduff (2011)	C	10	■	□	■	□	□	■	■	□	■	■
Du & Lyublinskaya (2022)	C	3	□	■	■	■	□	■	■	□	□	■
Gersten & Kelly (1992)	C	4	□	■	■	□	■	□	□	■	■	□
Hollins (2017)	C	3	□	□	□	■	□	□	□	□	■	■
So et al. (2021)	C	4	□	■	□	■	□	□	■	■	■	■
Byrd-Jones (2011)	G	232	□	□	□	□	□	□	□	■	□	□
Du (2022)	G	20	□	■	■	■	■	□	□	□	□	□
Schmidt (2019)	G	219	□	□	□	□	□	□	■	■	□	□
Weiss (2016)	G	37	□	■	■	■	■	□	□	□	□	□

Note: Total case study participants (n = 28). Total group design participants (n=508). ■ = Used; □ = Not Used. ^a C = Case study, G = Group design. ^b CPM = Collaborative Progress Monitoring. ^c LM = Live Model. ^d IP = Independent Practice. ^e SR = Self Reflection. ^f PF = Performance Feedback. ^g WD = Written Directions. ^h PSD = Problem Solving Discussions. ⁱ ISW = In-Service Workshops. ^j PM = Peer Mentoring. ^k CP = Community of Practice.

Figure 1

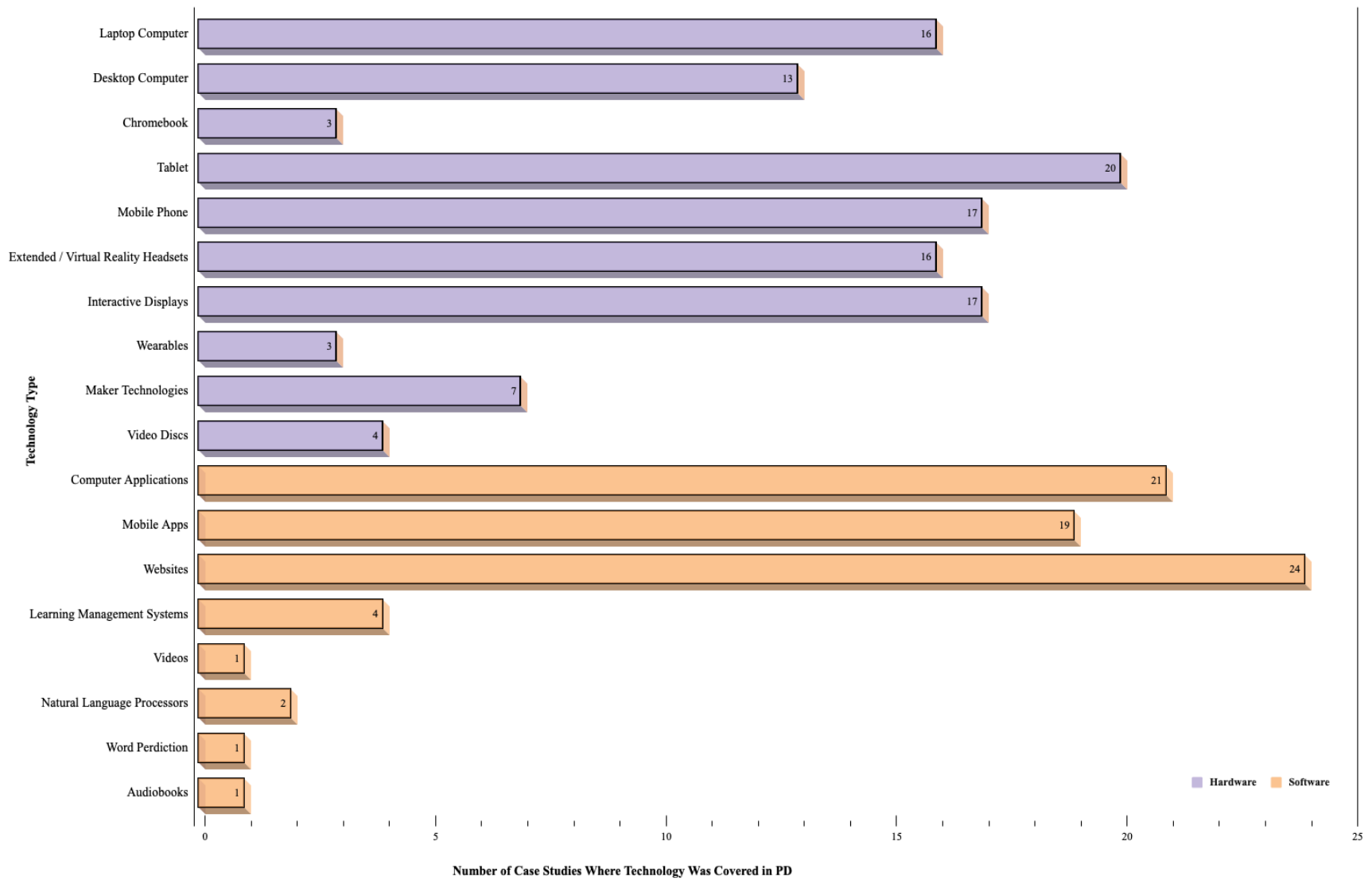
PRISMA Diagram



Note. PRISMA diagram adopted from (Page et al., 2021) and recreated using Canva to show additional assessment. Full diagram available at <https://justman.fyi/techPDprisma>.

Figure 2

Educational Technology Topics Covered by Professional Development for In-Service Special Educators



References

*Denotes a study included in this systematic review.

Alharbi, S. A. (2018). *Special education teachers' knowledge and use of assistive technology for inclusive classrooms in Saudi Arabia* (2108008033; 2018-40525-018) [Ph.D., Saint Louis University]. APA PsycInfo®.

<https://www.proquest.com/docview/2070503070/abstract/5E8E7FC75F7744F1PQ/1>

Alkahtani, K. D. F. (2013). Teachers' knowledge and use of assistive technology for students with special educational needs. *Journal of Studies in Education*, 3(2), 65–86.

<https://doi.org/10.5296/jse.v3i2.3424>

Anderson, S. E., & Putman, R. S. (2020). Special education teachers' experience, confidence, beliefs, and knowledge about integrating technology. *Journal of Special Education Technology*, 35(1), 37–50. <https://doi.org/10.1177/0162643419836409>

Anderson, S. E., & Putman, R. S. (2023). Elementary special education teachers' thinking while planning and implementing technology-integrated lessons. *Education and Information Technologies*, 28(8), 9459–9481. <https://doi.org/10.1007/s10639-022-11358-0>

Association for Educational Communications and Technology. (2023). *AECT definition*. <https://www.aect.org/aect/about/aect-definition>

Atanga, C., Jones, B. A., Krueger, L. E., & Lu, S. (2020). Teachers of students with learning disabilities: Assistive technology knowledge, perceptions, interests, and barriers. *Journal of Special Education Technology*, 35(4), 236–248.

<https://doi.org/10.1177/0162643419864858>

- Ault, M. J., Bausch, M. E., & McLaren, E. M. (2013). Assistive technology service delivery in rural school districts. *Rural Special Education Quarterly*, 32(2), 15–22.
<https://doi.org/10.1177/875687051303200204>
- Avalos, B. (2011). Teacher professional development in teaching and teacher education over ten years. *Teaching and Teacher Education*, 27(1), 10–20.
<https://doi.org/10.1016/j.tate.2010.08.007>
- Bausch, M. E., Ault, M. J., Evmenova, A. S., & Behrmann, M. M. (2008). Going beyond at devices: Are at services being considered? *Journal of Special Education Technology*, 23(2), 1–2. ERIC. <https://doi.org/10.1177/016264340802300201>
- Bausch, M. E., & Hasselbring, T. S. (2004). Assistive technology: Are the necessary skills and knowledge being developed at the pre-service and in-service levels? *Teacher Education and Special Education*, 27(2), 97–104. <https://doi.org/10.1177/088840640402700202>
- Bouck, E. C. (2016). A national snapshot of assistive technology for students with disabilities. *Journal of Special Education Technology*, 31(1), 4–13.
<https://doi.org/10.1177/0162643416633330>
- *Byrd-Jones, S. L. (2011). *The use of educational technology integration by special education teachers in rural schools in South Carolina* (1312419834; ED537286) [Ed.D., University of South Carolina]. ERIC.
<https://www.proquest.com/docview/915123953/abstract/9A0195467D304CE5PQ/1>
- *Cain, T. (2018). *A case study on best practices of technology integration within instruction* (2155995253; ED588600) [Ed.D., Northcentral University]. ERIC.
<https://www.proquest.com/docview/2101642611/abstract/C217C82D1DCE47B5PQ/1>

CAST. (2024). *Universal design for learning guidelines version 3.0*.

<https://udlguidelines.cast.org>

Cheng, S., & Parker, M. (2023). The role of school socioeconomic status in school-wide technology integration in the U.S. *Contemporary Educational Technology, 15*(2), ep422.

<https://doi.org/10.30935/cedtech/13059>

Chun, J., & Williams, T. O. (2021). A community of practice for professional development in technology integrations for accessibility: A case study of a faculty inquiry group. *College Teaching, 69*(3), 126–137. <https://doi.org/10.1080/87567555.2020.1832435>

*Ciampa, K. (2017). Building bridges between technology and content literacy in special education: Lessons learned from special educators' use of integrated technology and perceived benefits for students. *Literacy Research and Instruction, 56*(2), 85–113. ERIC.

<https://doi.org/10.1080/19388071.2017.1280863>

Combs, E., & Silverman, S. (2016). *Bridging the gap: Paving the pathway from current practice to exemplary professional learning*. Frontline Research & Learning Institute.

https://www.frontlineeducation.com/uploads/sites/2/2023/04/Bridging-The-Gap_Paving-the-Pathway-from-Current-Practice-to-Exemplary-Professional-Learning.pdf

*Courduff, J. L. (2011). *Technology integration in the resource specialist environment* (1140139295; ED534877) [Ph.D., Walden University]. ERIC.

<https://www.proquest.com/docview/907104754/abstract/71BEA1EB7D294231PQ/1>

Crompton, H., & Sykora, C. (2021). Developing instructional technology standards for educators: A design-based research study. *Computers and Education Open, 2*, 100044.

<https://doi.org/10.1016/j.caeo.2021.100044>

- Darling-Hammond, L. (2024). Reinventing systems for equity. *ECNU Review of Education*, 7(2), 214–229. <https://doi.org/10.1177/20965311241237238>
- Darling-Hammond, L., Hyler, M., & Gardner, M. (2017). *Effective teacher professional development*. Learning Policy Institute. <https://doi.org/10.54300/122.311>
- Desimone, L. M. (2023). Rethinking teacher PD: A focus on how to improve student learning. *Professional Development in Education*, 49(1), 1–3. <https://doi.org/10.1080/19415257.2023.2162746>
- Dolan, J. E. (2016). Splicing the divide: A review of research on the evolving digital divide among K–12 students. *Journal of Research on Technology in Education*, 48(1), 16–37. <https://doi.org/10.1080/15391523.2015.1103147>
- *Du, X. (2022). Professional development for virtual environment: Designing assistive-technology infused inquiry-based learning experience for online teaching. *Journal of Online Learning Research*, 8(3), 425–446. ERIC. <https://eric.ed.gov/?id=EJ1372630>
- *Du, X., & Lyublinskaya, I. (2022). Designing professional development for special education teachers: Effects on assistive technology competency in developing inquiry-based student experiences. *Journal of Digital Learning in Teacher Education*, 38(4), 199–210. ERIC. <https://doi.org/10.1080/21532974.2022.2113938>
- Edyburn, D. L. (2013). Critical issues in advancing the special education technology evidence base. *Exceptional Children*, 80(1), 7–24. <https://doi.org/10.1177/001440291308000107>
- El Islami, R. A. Z., Anantanukulwong, R., & Faikhamta, C. (2022). Trends of teacher professional development strategies: A systematic review. *Shanlax International Journal of Education*, 10(2), 1–8. <https://doi.org/10.34293/education.v10i2.4628>

- Emerling, C. R., Wilkinson, S., & Maggin, D. M. (2021). Educator knowledge and implementation of assistive technology to support challenging behaviors: An exploratory inquiry. *Journal of Special Education Technology, 36*(3), 162–174.
<https://doi.org/10.1177/01626434211034803>
- Ertmer, P. A. (1999). Addressing first- and second-order barriers to change: Strategies for technology integration. *Educational Technology Research and Development, 47*(4), 47–61. <https://doi.org/10.1007/bf02299597>
- Ertmer, P. A. (2005). Teacher pedagogical beliefs: The final frontier in our quest for technology integration? *Educational Technology Research and Development, 53*(4), 25–39.
<https://doi.org/10.1007/bf02504683>
- Ertmer, P. A., Ottenbreit-Leftwich, A. T., Sadik, O., Sendurur, E., & Sendurur, P. (2012). Teacher beliefs and technology integration practices: A critical relationship. *Computers & Education, 59*(2), 423–435. <https://doi.org/10.1016/j.compedu.2012.02.001>
- Etscheidt, S. L. (2016). Assistive technology for students with disabilities: A legal analysis of issues. *Journal of Special Education Technology, 31*(4), 183–194.
<https://doi.org/10.1177/0162643416673912>
- Evmenova, A. S., Regan, K. S., Schladant, M., Hall, T. E., Buzhardt, J., Erickson, K. A., Ai, J., Sudduth, C., & Jackson, T. (2023). Stepping-up technology implementation—How does it happen? *Journal of Special Education Technology, 38*(1), 61–74.
<https://doi.org/10.1177/01626434221074357>
- Fernández-Batanero, J. M., Montenegro-Rueda, M., Fernández-Cerero, J., & García-Martínez, I. (2022). Assistive technology for the inclusion of students with disabilities: A systematic

- review. *Educational Technology Research and Development*, 70(5), 1911–1930.
<https://doi.org/10.1007/s11423-022-10127-7>
- *Gersten, R., & Kelly, B. (1992). Coaching secondary special education teachers in implementation of an innovative videodisc mathematics curriculum. *Remedial and Special Education (RASE)*, 13(4), 40–51. ERIC.
<https://doi.org/10.1177/074193259201300411>
- Goldman, S., Carreon, A., & Smith, S. (2024). Exploring the integration of artificial intelligence into special education teacher preparation through the TPACK framework. *Journal of Special Education Preparation*, 4(2), Article 2. <https://doi.org/10.33043/6zx26bb2>
- Hargreaves, A. (2000). Four ages of professionalism and professional learning. *Teachers and Teaching*, 6(2), 151–182. <https://doi.org/10.1080/713698714>
- Hayes, K. N., Preminger, Linda, & Bae, C. L. (2024). Why does teacher learning vary in professional development? Accounting for organizational conditions. *Professional Development in Education*, 50(1), 108–128.
<https://doi.org/10.1080/19415257.2023.2283433>
- Hew, K. F., & Brush, T. (2007). Integrating technology into K-12 teaching and learning: Current knowledge gaps and recommendations for future research. *Educational Technology Research and Development*, 55(3), 223–252. <https://doi.org/10.1007/s11423-006-9022-5>
- *Hollins, K. G. (2017). *Assistive technology, disability, and access: Transforming thinking and practice through inquiry-based professional development* (1906272624) [Ed.D., Teachers College, Columbia University]. ProQuest Dissertations & Theses Global; Publicly Available Content Database.
<https://www.proquest.com/docview/1906272624/abstract/7EDDF6EEA66F4FAFPQ/1>

- Hsu, P.-S. (2016). Examining current beliefs, practices and barriers about technology integration: A case study. *TechTrends*, 60(1), 30–40. <https://doi.org/10.1007/s11528-015-0014-3>
- Hunt, T., Carter, R., Yang, S., Zhang, L., & Williams, M. (2022). Navigating the use of micro-credentials. *Journal of Special Education Technology*, 37(1), 3–10. ERIC. <https://doi.org/10.1177/0162643420933568>
- Imants, J., & Van Der Wal, M. M. (2020). A model of teacher agency in professional development and school reform. *Journal of Curriculum Studies*, 52(1), 1–14. <https://doi.org/10.1080/00220272.2019.1604809>
- Individuals with Disabilities Education Act (1990).
- Individuals with Disabilities Education Improvement Act of 2004, 20 U.S.C. § 1400 et seq. (2004). <https://www.govinfo.gov/content/pkg/PLAW-108publ446/pdf/PLAW-108publ446.pdf>
- Jacobsen, M., Clifford, P., & Friesen, S. (2002). Preparing teachers for technology integration: Creating a culture of inquiry in the context of use. *Contemporary Issues in Technology and Teacher Education*, 2(3), 363–388. <https://www.learntechlib.org/primary/p/17761/>
- Januszewski, A., & Molenda, M. (2013). *Educational technology: A definition with commentary* (2nd ed). Taylor and Francis.
- Kennedy, M. J., Aronin, S., O’Neal, M., Newton, J. R., & Thomas, C. N. (2014). Creating multimedia-based vignettes with embedded evidence-based practices: A tool for supporting struggling learners. *Journal of Special Education Technology*, 29(4), 15–30. <https://doi.org/10.1177/016264341402900402>

- Koch, K. (2017). Stay in the box! Embedded assistive technology improves access for students with disabilities. *Education Sciences*, 7(4), 82. Publicly Available Content Database. <https://doi.org/10.3390/educsci7040082>
- Lamond, B., & Cunningham, T. (2020). Understanding teacher perceptions of assistive technology. *Journal of Special Education Technology*, 35(2), 97–108. ERIC. <https://doi.org/10.1177/0162643419841550>
- Lovett, M. C. (with Bridges, M. W., DiPietro, M., Ambrose, S. A., & Norman, M. K.). (2023). *How learning works: Eight research-based principles for smart teaching* (2nd ed). John Wiley & Sons, Incorporated.
- McGregor, G., & Pachuski, P. (1996). Assistive technology in schools: Are teachers ready, able, and supported? *Journal of Special Education Technology*, 13(1), 4–15. Nursing & Allied Health Premium. <https://doi.org/10.1177/016264349601300102>
- Messinger-Willman, J., & Marino, M. T. (2010). Universal design for learning and assistive technology: Leadership considerations for promoting inclusive education in today's secondary schools. *National Association of Secondary School Principals. NASSP Bulletin*, 94(1), 5–16. Research Library: Business; Research Library: Health & Medicine; Research Library: History; Research Library: Literature & Language; Research Library: Science & Technology; Research Library: Social Sciences; Research Library: The Arts. <https://proquest.com/scholarly-journals/universal-design-learning-assistive-technology/docview/747526321/se-2>
- Moreno, G. (2022). Expanding definition of technology in special education: Impact of training on the adoption of iPad tablets by special educators. *International Journal of Disability*,

Development and Education, 69(2), 722–738. ERIC.

<https://doi.org/10.1080/1034912X.2020.1731432>

Noonan, J. (2019). An affinity for learning: Teacher identity and powerful professional development. *Journal of Teacher Education*, 70(5), 526–537.

<https://doi.org/10.1177/0022487118788838>

O'Brien, C., Aguinaga, N. J., Hines, R., & Hartshorne, R. (2011). Using contemporary technology tools to improve the effectiveness of teacher educators in special education. *Rural Special Education Quarterly*, 30(3), 33–40.

<https://doi.org/10.1177/875687051103000305>

Olakanmi, O. A., Akcayir, G., Ishola, O. M., & Demmans Epp, C. (2020). Using technology in special education: Current practices and trends. *Educational Technology Research and Development*, 68(4), 1711–1738. <https://doi.org/10.1007/s11423-020-09795-0>

Ottenbreit-Leftwich, A., Glazewski, K., & Newby, T. (2010). Preservice technology integration course revision: A conceptual guide. *Journal of Technology and Teacher Education*, 18(1), 5. Research Library.

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., ... Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *PLOS Medicine*, 18(3), e1003583.

<https://doi.org/10.1371/journal.pmed.1003583>

Rooks-Ellis, D. L., Ryan, J., Floyd, K., & Sundeen, T. (2025). Assistive technology and rural settings: A scoping review of the literature. *Journal of Special Education Technology*, 40(2), 138–151. <https://doi.org/10.1177/01626434241289955>

S.1177 - 114th Congress (2015-2016): Every Student Succeeds Act (2015).

<https://www.govinfo.gov/app/details/COMPS-11851>

Schaaf, D. N. (2018). Assistive technology instruction in teacher professional development.

Journal of Special Education Technology, 33(3), 171–181. ERIC.

<https://doi.org/10.1177/0162643417753561>

*Schmidt, M. M., Lin, M.-F. G., Paek, S., MacSuga-Gage, A., & Gage, N. A. (2017).

Implementing project SIED: Special education teachers' perceptions of a simplified technology decision-making process for app identification and evaluation. *Journal of Special Education Technology*, 32(1), 12–22. ERIC.

<https://doi.org/10.1177/0162643416681160>

Shaheen, N. L., & Lohnes Watulak, S. (2019). Bringing disability into the discussion: Examining technology accessibility as an equity concern in the field of instructional technology.

Journal of Research on Technology in Education, 51(2), 187–201.

<https://doi.org/10.1080/15391523.2019.1566037>

Smith, S. J., & Okolo, C. (2010). Response to intervention and evidence-based practices: Where does technology fit? *Learning Disability Quarterly*, 33(4), 257–272.

<https://doi.org/10.1177/073194871003300404>

*So, W. W. M., He, Q., Cheng, I. N. Y., Lee, T. T. H., & Li, W. C. (2021). Teachers'

professional development with peer coaching to support students with intellectual

disabilities in STEM learning. *Journal of Educational Technology & Society*, 24(4), 86–

98. APA PsycInfo®.

<https://www.proquest.com/docview/2583395670/abstract/54C39E56D7EC4A93PQ/1>

Starks, A. C., & Reich, S. M. (2023). “What about special ed?”: Barriers and enablers for teaching with technology in special education. *Computers & Education, 193*, 104665.

<https://doi.org/10.1016/j.compedu.2022.104665>

Sundeen, T. H., & Kalos, M. (2022). Rural educational leader perceptions of online learning for students with and without disabilities before and during the COVID-19 pandemic. *Theory & Practice in Rural Education, 12*(2), Article 2.

<https://doi.org/10.3776/tpre.2022.v12n2p105-128>

Van Driel, J. H., Beijaard, D., & Verloop, N. (2001). Professional development and reform in science education: The role of teachers’ practical knowledge. *Journal of Research in Science Teaching, 38*(2), 137–158. [https://doi.org/10.1002/1098-](https://doi.org/10.1002/1098-2736(200102)38:2<137::aid-tea1001>3.0.co;2-u)

[2736\(200102\)38:2<137::aid-tea1001>3.0.co;2-u](https://doi.org/10.1002/1098-2736(200102)38:2<137::aid-tea1001>3.0.co;2-u)

Vescio, V., Ross, D., & Adams, A. (2008). A review of research on the impact of professional learning communities on teaching practice and student learning. *Teaching and Teacher Education, 24*(1), 80–91. <https://doi.org/10.1016/j.tate.2007.01.004>

*Weiss, M. P., Evmenova, A. S., Kennedy, M. J., & Duke, J. M. (2016). Creating content acquisition podcasts (caps) for vocabulary: The intersection of content, pedagogy, and technology. *Journal of Special Education Technology, 31*(4), 228–235.

<https://doi.org/10.1177/0162643416673916>

Windfont, C. M. (2024). *Secondary special education teachers’ perception of technology integration and its use in classroom instructions (2922240137)* [Ed.D., Walden University]. ProQuest Dissertations & Theses Global; Publicly Available Content

Database. <https://proquest.com/dissertations-theses/secondary-special-education-teachers-perception/docview/2922240137/se-2>

Wirth, P. A., Stile, S. W., & Cole, J. T. (1982). The need for in-service training in instructional technology for special education personnel in small rural school districts. *Journal of Special Education Technology*, 6(1), 25–29.

<https://doi.org/10.1177/016264348300600104>

Zhao, Y., & Cziko, G. A. (2001). Teacher adoption of technology: A perceptual control theory perspective. *Journal of Technology and Teacher Education*, 9(1), 5–30.

<http://www.learntechlib.org/p/8455>