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Digital Training for Special Education Teachers on Early Literacy Intervention: A Systematic Review

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ABSTRACT

In today's technology-driven world, education is changing rapidly. This is especially important in special education, where we help students with unique needs. One crucial area is teaching students to early literacy. Teaching students with special needs to this skill can be complex, and teachers need specialized training. However, there are many problems when using traditional ways of training, which may not be flexible or adaptable enough for the digital age. Digital training can better prepare special education teachers, making early literacy support more effective and inclusive. In this paper, the PRISMA approach was applied to find the primary data based on a few keywords, such as "digital professional development (PD), special education teacher, and early literacy intervention." Based on advanced searching on SCOPUS and Web of Science (WoS), (n = 12) were discovered. Expert scholars decided to develop three themes, which are (1) the component of digital PD in special education practices, (2) enhancing early literacy intervention by PD, and (3) the effectiveness of technology on early literacy intervention. In summary, digital training serves as a guide for educators, policymakers, and stakeholders in the field of special education, offering insights into the transformative potential of digital training.

1. Introduction

In the ever-evolving landscape of education, special education teachers play a crucial role in supporting students with diverse learning needs, particularly in the area of early literacy intervention [1]. Early literacy intervention is a critical component in the educational journey of students with special needs as it lays the foundation for reading and writing skills [2]. Research has consistently suggested that early intervention can significantly improve reading skills, language development, and overall academic performance in this population [3]. Moreover, the need for specialized training becomes apparent when considering the diverse range of disabilities and learning challenges that special education teachers encounter in their classrooms [4-6]. From

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dyslexia to autism spectrum disorders (ASDs), each disability demands a nuanced approach to literacy intervention [7,8].

However, special education teachers often face challenges [9] in providing effective interventions due to limited training opportunities and resources [10-12]. Furthermore, many special education teachers face challenges accessing relevant and up-to-date training resources due to limited availability, geographical constraints, and time constraints [13]. One area that has garnered significant attention is digital training for special education teachers on early literacy intervention [14].In recent years, technology integration into education has become increasingly prevalent, providing new opportunities for professional development (PD) and training [15].

Digital training, also known as online or distance learning, has gained popularity in recent years as an alternative mode of PD for educators [16]. It offers flexibility in terms of time and location, allowing teachers to access training materials at their own convenience [17]. Additionally, digital training programs often incorporate interactive elements such as videos [18], quizzes, storytelling [19] and discussion forums, facilitating participant engagement and collaboration [20].

This systematic review will comprehensively analyze existing literature on digital training programs for special education teachers engaged in early literacy intervention. The review will focus on examining the effectiveness of digital training programs in improving teachers' knowledge, skills, and confidence in implementing evidence-based strategies for early literacy intervention. In addition, it will explore the impact of digital training on student outcomes, specifically in the areas of reading proficiency, language development, and overall academic achievement.

The findings of this systematic review will not only contribute to the existing body of knowledge on digital training for special education teachers but also provide valuable insights for policymakers, educators, and researchers involved in the field of special education. By understanding the potential benefits and limitations, stakeholders can make informed decisions regarding implementing and integrating digital training programs into PD initiatives for special education teachers. Ultimately, this research aims to promote the use of effective and accessible training methods to improve early literacy intervention practices and enhance educational outcomes for students with special needs.

2. Literature Review

Several studies have also revealed digital training on early literacy intervention for special education teachers. With the rise of technology, there are more options for career advancement through unconventional channels. For teachers and children in early childhood settings, the efficacy of technology-mediated language and literacy PD (Tech PD) programs is in this review. Online technology PD that has been tested in peer-reviewed research with random or quasi-random assignment [21,22]. Regarding this body of research, by [21,22].,two issues were investigated: 1) How technology is employed in the programs, and 2) Is online training successful in assisting teachers in improving their language and literacy instruction and the learning of the students? As a result, 11 studies were discovered after 16 years of published publications (2001–2017) and reviewed. Furthermore, online courses, group courses over satellite or video, online curricula, and remote coaching over live video are the four types of Tech PD [18] that we identify. Findings indicate that these types of Tech PD can have effects on teachers' language and literacy practices and student learning that are comparable to in-person equivalents [21,22].

In 2023, Schladant *et al.,* published a paper on digital training in early literacy intervention. Many children with disabilities do not have access to assistive technology (AT) and do not fully benefit from inclusive preschool education, and even AT is beneficial to them. The current mixed-methods study investigated a multifaceted PD intervention aligned with the early Intervention/Early Childhood Special Education (EI/ECSE) Standards. Furthermore, the intervention was designed to increase the use of AT by general early childhood education (ECE) teachers to encourage young children with disabilities to learn to read and write early. (a) Online modules, (b) coaching, and (c) a classroom kit of AT devices were all part of the 24-week PD intervention. There are 34 special needs students, six lead teachers, ten assistant teachers, and six inclusive classrooms. Moreover, pre-and post-surveys, early literacy assessments, and classroom observations were all quantitative methods. Qualitative analysis examined input and focus group data. The findings demonstrated that (a) knowledge, acceptance, and use of AT by teachers as well as (b) children's use of AT and development of early reading abilities dramatically increased from pre- to post-intervention. Qualitative research produced themes on how PD helped instructors and how AT affected teacher instruction and student learning. Thus, the findings support creative PD techniques to increase practitioners' competence in using adaptive technology as a flexible educational tool in inclusive classrooms [23].

Furthermore, it is consistent with literature from Nic Aindriú *et al*., [24] that digital training for special education providers' design and content is being offered to students in Irish immersion (IM) primary and secondary schools. Data from a mixed-methods study on the requirements of teachers in this field were used to construct the course. The course design methodology is discussed in this article. It lists the five-course modules: assessment, inclusive pedagogies, universal design for learning, bilingualism and second language acquisition, and ICT for the inclusion of all students. Additionally, it contains information from a course assessment form filled out by participating teachers (N = 25) regarding the course's effective and understudied aspects, as well as suggestions for improvement.

3. Material and Methods

3.1 Identification

The systematic review process consists of three basic phases that were used to select many relevant papers for this study. The first phase entails the identification of keywords and the search for associated, related terms using thesaurus, dictionaries, encyclopedias, and prior research. Following the selection of all pertinent terms, search strings on the Scopus and Web of Science databases (see Table 1) have been developed. The current research endeavor effectively retrieves 251 papers from both databases throughout the first stage of the systematic review process.

Table 1
The search string

Scopus	TITLE-ABS-KEY ((digital OR technology OR online) AND (professional AND development) AND (learn* OR education*) AND (special* OR education* teacher) AND (early* OR literacy*or AND intervention*)) AND PUBYEAR > 2018 AND PUBYEAR < 2024 Access Date: 16 September 2023
WOS	(digital OR technology OR online) AND (professional AND development) AND (learn* OR education*) AND (special* OR education*teacher) AND (early* OR literacy*or AND intervention*) (Topic) and Preprint Citation Index (Exclude – Database) and 2023 or 2022 or 2021 or 2020 (Publication Years) Access Date: 16 September 2023

3.2 Screening

Duplicate papers were disqualified during the initial screening. Initially, 177 papers were rejected, and 74 papers were examined in the second stage using the experts' diverse inclusion and exclusion criteria. Literature (research articles) was the first criterion utilized since it is the primary source of useful guidance. Aside from the most recent research, it also includes systematic reviews, reviews, metasynthesis, meta-analyses, books, book series, chapters, and conference proceedings. In addition, the review was restricted to works published in English. Note that the strategy was created for the most recent five-year term (2018-2023). Only studies conducted in special education areas were selected in order to meet the analysis's purpose. A total of 55 publications were disqualified based on specific standards.

3.3 Eligibility

The third level, called eligibility, has a total of 70 items ready. At this point, all article titles and important content were carefully examined to ensure they met the criteria for inclusion and complemented the current study's objectives. Due to the out-of-field, the title not being significant, and the abstract not being related to the purpose of the study based on empirical data, 59 papers were therefore discarded. Ultimately, 11 articles are available for review as of this writing (see Table 2).

Table 2
The selection criterion in searching

Criterion	Inclusion	Exclusion
Language	English	Non-English
Timeline	2018-2023	< 2018
Literature type	Journal (Article)	Conference, Book, Review
Publication Stage	Final	In Press

3.4 Data Abstraction and Analysis

In this study, a range of research designs (quantitative, qualitative, and mixed techniques) were examined and synthesized using an integrative analysis as one of the assessment strategies. The competent study's objective was to determine pertinent subjects and subtopics. Data collection was the initial phase of the theme's development. Figure 1 demonstrates how the authors painstakingly examined a collection of 74 articles for claims or content pertinent to the subjects of the current investigation.

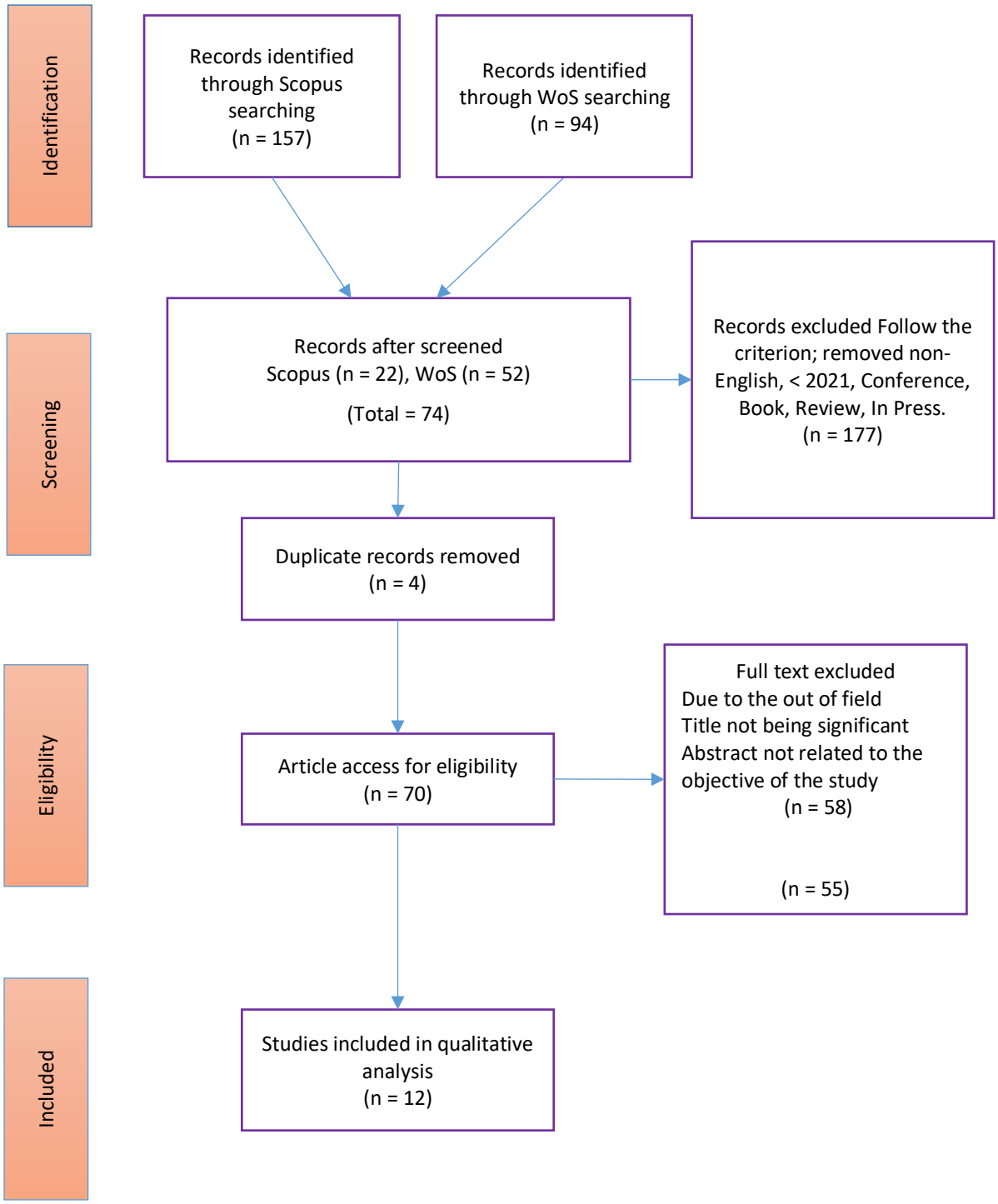

Fig. 1. Flow diagram of the proposed search study [25]

The authors then assessed recent significant online special education teacher certification training studies. Investigations are being conducted into both the research findings and methods employed in all studies. The author then worked with additional co-authors to create themes based on the data in the context of this investigation. Throughout the data analysis process, a log was kept to note any analyses, opinions, puzzles, or other ideas that might be pertinent to the data interpretation. In addition, the writers then compared the findings to look for any discrepancies in the theme design procedure. It is important to note that the writers discuss any differences in the concepts among themselves, if any. Afterwards, final adjustments were made to the themes created

to guarantee uniformity. Two experts, one in special education (Madhayazagan A/L Ganesan — expert in special education) and one in educational management (Ahmad Zabidi Abdul Razak — expert in educational management, planning, and policy), conducted the analysis selection to ascertain the validity of the issues. The phase of expert assessment guarantees clarity by defining the domain, and the expert review phase ensures the precision, significance, and applicability of each subtheme.

4. Result and Finding

For special education teachers to gain more in teaching and learning knowledge and self-efficacy, PD is crucial. This study's major goal is to identify digital training components that can benefit teachers and their teaching and learning. As a result, academics have developed several methods to fix the problems with the categorization method that was first offered. On the basis of the sophisticated search, a total of 12 articles were extracted and processed for this study as tabulated in Table 3.

Table 3
The research article's findings based on the proposed search criterion

Theme 1: Component in Digital Professional Development in Special Education Practices

Authors	Title	Year	Source Title	Methodology	Finding
Amendum S. J.; Bratsch-Hines M.; Vernon-Feagans L [1]	Investigating the Efficacy of a Web-Based Early Reading and Professional Development Intervention for Young English Learners	2018	Reading Research Quarterly	This study aimed to assess the effectiveness of the Targeted Reading Intervention (TRI), a PD and early reading program delivered using webcam technology. This study involved 108 students from 47 different classrooms, and these participants were part of a larger three-year randomized controlled trial and one-on-one session. Weekly, and later biweekly, webcam coaching sessions between a TRI coach and each classroom teacher allowed the coach to interact with both the teacher and students in real-time and allowed classroom teachers to receive real-time feedback from the coach.	According to the results of two-level hierarchical linear models, students who were having a difficult time learning to read fared significantly better than their peers in control classrooms on early reading tests at the word level, with effect sizes of .43 and .45. However, not on measures at the text level. Additionally, the findings indicated that Els with difficulty learning to read were making the same progress as their classmates who were not having trouble; however, they could not catch up during the study year.
Schladant M.; Ocasio-Stoutenburg L.; Nunez C.; Dowling M.; Shearer R.; Bailey J.; Garilli A.; Natale R. [23]	Promoting a culture of inclusion: impact of professional development on teachers' assistive technology practices to support early literacy	2023	Journal of Early Childhood Teacher Education	In this study, despite the efficacy of AT, many children with disabilities do not have access to AT and are not fully benefiting from inclusive preschool education. The current mixed-methods study examined a multifaceted PD intervention aligned with the EI/ECSE Standards to increase general ECE teachers' use of AT to promote early literacy in young children with disabilities. The 24-week PD intervention included (a) online modules, (b) coaching, and (c) a classroom kit of AT devices.	Results revealed (1) teacher's AT knowledge, positive beliefs and use, and (2) children's use of AT and early literacy skills significantly increased pre to post-intervention.

Cheyney-Collante K.; Gonsalves V.; Giuliani S. [26].	Online Dyslexia Professional Development for Diverse Practitioners: A Multiple-Case Study	2022	Teacher Education and Special Education	Five courses make up the online Dyslexia PD program. The first four courses are intended to build a foundational understanding of assessment, reading interventions, and dyslexia. The fifth course is a capstone practicum in which participants put the evaluation and intervention techniques they have learned into practice under the guidance of an instructor. Students have two alternatives for fulfilling the practicum requirement. The face-to-face option is conducted in person at the university's laboratory school, while the online option uses video-based coaching and supervision.	In addition to identifying common supports acquired as participants increased their internal capacity through their online learning experiences, the analysis identified common contextual barriers to practice across various locations.
Schladant, Michelle; Ocasio-Stoutenburg, Lydia; Nunez, Christina; Dowling, Monica; Shearer, Rebecca; Bailey, Jhonelle; Garilli, Austin; Natale, Ruby [23]	Promoting a culture of inclusion: impact of professional development on teachers' assistive technology practices to support early literacy	2023	JOURNAL OF EARLY CHILDHOOD TEACHER EDUCATION	In order to increase the use of AT by general ECE and support early literacy in young children with disabilities, the current mixed-methods study examined a multifaceted PD intervention that was in accordance with the CEC's EI/ECSE Standards. The 24-week PD intervention included coaching, online classes, an AT device classroom package, and coaching. The participant group included ten teaching assistants, six lead teachers, and 34 students from six inclusive classrooms split across two preschools.	The results demonstrated that from pre- to post-intervention, teachers' understanding, acceptance, and use of AT, as well as children's use of AT and the development of their early reading skills, significantly increased.
Van der Linden, S; Papadopoulos, PM; Nieveen, N; Mckenney, S [27]	ReflAct: Formative assessment for teacher reflection in video-coaching settings	2023	COMPUTERS & EDUCATION	video coaching seems like a promising strategy for instructors' professional growth, although it is not usually effective. As far as we are aware, no methods are available to assist coaches in formally evaluating the calibre of reflective discourse. To enable coaches to fully utilize reflective video coaching conversations, such a tool is required. An online study included 17 individuals who had knowledge	Overall, this study illustrates how digital technology can facilitate the operationalization of ambiguous processes like reflective talk and highlights the importance of attending to the implementation early on.

				of teachers' reflective practices. Think-aloud techniques, interviews, surveys, and use logs were employed to collect the data.	

Theme 2: Enhancing Early Literacy Intervention by Professional Development

Authors	Article Title	Publication Year	Source Title	Methodology	Finding
Beamish, Wendi; Taylor, Annalise; Macdonald, Libby; Hay, Stephen; Tucker, Madonna; Paynter, Jessica [28]	Field testing an Australian model of practice for teaching young school-age students on the autism spectrum	2021	RESEARCH IN DEVELOPMENTAL DISABILITIES	In this study, the researcher investigated the perspectives and experiences of Australian mainstream teachers who put a validated Model of Practice to the test in the classroom to assist their daily work with early school-aged autistic pupils. This new online resource included 29 practices guided by the latest research, each with a two-page practical summary.	These findings have broader ramifications for how PD might be tailored to encourage teaching practices informed by research.
Mahajan, Rajneesh; Sagar, Rajesh [29]	Adequate Management of Autism Spectrum Disorder in Children in India	2023	INDIAN JOURNAL OF PEDIATRICS	Despite the significant suffering caused by neurodevelopmental disorders like ASD in India, there are still unmet needs at every stage of the healthcare system. This contains methods for analyzing and successfully managing ASD, as well as reliable and valid instruments for doing so. All professionals in linked fields, medical professionals, paraprofessionals, special education teachers, and others, lack the necessary knowledge and training. Lack of public awareness and cultural variables cause delays in early recognition and interventions.	A strategy is provided to address these unmet criteria at various stages in order to effectively care for these ASD young children. These include using audiovisual technology, collaborating with foreign specialists, and a) emphasizing the training of medical professionals, paraprofessionals, and educators; b) building infrastructure at the local, regional, and state levels with adequate funding.
Alatifi, Nouf M.; Gray, Kylie M.; Hastings, Richard P. [30]	Knowledge and reported use of evidence-based practices by early intervention	2023	RESEARCH IN AUTISM SPECTRUM DISORDERS	An online survey was completed by 173 early intervention professionals who work directly with autistic children (under the age of six) in early intervention programs in public and private daycare centers in all of Saudi Arabia's provinces.	By establishing the experts' acquaintance with and reported use of these procedures, our findings add to the scant Saudi literature on early intervention

	professionals working with autistic children in Saudi Arabia				methods for autism. The implications of these findings for promoting knowledge translation into practice are examined.
Ndou, Nettie N.; Omidire, Margaret F. [31]	Systemic support for learners with developmental language disorders in Zimbabwe and South Africa	2022	SOUTH AFRICAN JOURNAL OF COMMUNICATION DISORDERS	Multiple cases involving Zimbabwe and South Africa were studied. Participants were chosen using a purposeful sampling technique. Fifty-six people took part in the study: 47 students, 2 Speech Language Therapists (SLT), a learning support therapist, five teachers, and an educational psychologist. Data were gathered utilizing interviews, focus group discussions, and classroom observations as part of a qualitative research approach. The information was sorted and thematically evaluated.	Teachers employ remedial instruction and promote a culture of leisure reading as two strategies for supporting student language and storytelling development. SLTs and learning support therapists use speech-language programming and assistive technologies**.**
Alyami, Hamad S.; Naser, Abdallah Y.; Alyami, Mohammad H.; Alharethi, Salem H.; Alyami, Abdullah M. [32]	Knowledge and Attitudes toward Autism Spectrum Disorder in Saudi Arabia	2022	INTERNATIONAL JOURNAL OF ENVIRONMENTAL RESEARCH AND PUBLIC HEALTH	This cross-sectional study, which had 769 participants, was carried out in Saudi Arabia between November 2021 and February 2022, utilizing an online survey tool to examine the general population's understanding of typical child development and ASD. In order to determine the variables influencing participants' understanding of autism, a binary logistic regression analysis was utilized.	The study participants had little understanding of autism. The average score of the study participants was 5.9 (SD: 3.1), or 34.7% of the total possible score, indicating a generally low degree of awareness regarding autism. Participants who fall into the middle-income bracket of 5,000–7,500 SR are less likely than other participants to have an awareness of autism (OR: 0.60; 95% CI: 0.39–0.92; *p*-value = 0.020).

Theme 3: Effectiveness of technology on early literacy intervention

Author	Article Title	Year	Source Title	Methodology	Finding
Sood M.R.; Toornstra A.; Sereno M.I.; Boland M.; Filaretti D.; Sood A. [33]	A digital app to aid detection, monitoring, and management of dyslexia in young children (DIMMAND): Protocol for a digital health and education solution	2018	JMIR Research Protocols	The proposed solution will be designed and developed in phases. In the initial phase, the full functional specification of the games that constitute the app will be designed, together with the overall architecture of the solution. Prototype proof-of-concept implementation for a few games and commercialization strategies will also be developed. The follow-on phases will see the design implemented into a validated solution.	During the initial stages, the researcher worked closely with dyslexia specialists, adult dyslexics, special education teachers, parents of children with dyslexia, and senior dyslexia representatives from significant organizations. These connections provided details on the various linguistic difficulties dyslexics face, the tools used by professionals and educators, and the sector as a whole.
Falth, Linda; Selenius, Heidi [34]	Primary school teachers' use and perception of digital technology in early reading and writing education in inclusive settings	2022	DISABILITY AND REHABILITATION-ASSISTIVE TECHNOLOGY	Primary school teachers in Sweden (N = 289) were invited to respond to a survey about the use of digital technology in reading and writing instruction for this study. Both statistical analysis and summative content analysis were used to analyze the data.	According to the research, 82% of teachers were enthusiastic about teaching young children to read and write using digital technology. More than 50% of the instructors used technology every week to aid students in learning vocabulary, spelling, phonological awareness, decoding skills, or text editing.

5. Discussion and Conclusion

This discussion is based from findings and tabulated in Table 4. Digital PD in the realm of special education encompasses a multifaceted approach that empowers educators to better serve students with diverse learning needs. It comprises various key components, including online modules, coaching and mentoring, resource kits, and collaborative networks. These online modules offer educators the flexibility to acquire essential knowledge and skills at their own pace, covering various topics, from understanding learning disabilities to implementing evidence-based intervention strategies. Furthermore, the integral coaching and mentoring element, often facilitated through virtual means, provides invaluable real-time feedback and personalized support, crucial for translating acquired knowledge into effective classroom practices. Moreover, resource kits equipped with AT tools and tailored materials bolster educators' readiness to address the unique needs of students with disabilities. Hence, collaborative opportunities, both local and global, foster the exchange of insights and best practices, enriching educators' professional growth.

Nonetheless, despite the tremendous potential of digital PD, it is not without its limitations. Resource constraints, including time, funding, and necessary infrastructure, can hinder the widespread implementation and accessibility of such programs. Ensuring the sustainability of PD initiatives remains a significant challenge, as educators often grapple with the demands of their daily classroom responsibilities. Furthermore, the one-size-fits-all approach frequently observed in PD may not sufficiently address the personalized needs of educators and their students with learning disabilities.

However, the integration of technology into PD offers a powerful means to overcome these limitations. It enhances accessibility by granting educators access to a wealth of online resources, such as e-learning platforms and webinars, accommodating their diverse schedules and needs. Personalization is facilitated through adaptive technology, tailoring PD content to individual educators' requirements and ensuring they receive pertinent information and support. Real-time feedback mechanisms, as evidenced in the dyslexia intervention study, strengthen the practical application of acquired strategies, enhancing educators' confidence and competence in supporting students with learning disabilities. Moreover, technology fosters global collaboration, enabling educators to connect with experts and peers worldwide, enriching the exchange of best practices and innovative approaches.

Table 4
Structured table summarizing the discussion

Component	Description
Digital PD in Special Education	Empower educators to serve diverse learning needs, comprising online modules, coaching, resource kits, and collaboration networks.
Online Modules	Flexible self-paced learning, covering topics like understanding learning disabilities and evidence-based intervention strategies.
Coaching and mentoring	Real-time feedback and personalized support, often virtual, for effective classroom application of acquired knowledge.
Resource Kits	Equipped with AT tools and tailored materials to enhance readiness in addressing students' unique needs.
Collaborative Networks	Local and global opportunities for sharing insights and best practices, enriching educators' professional growth.
Limitations of Digital PD	Resource constraints, sustainability challenges, and the one-size-fits-all approach may hinder widespread implementation.
Integration of technology	Enhances accessibility, personalization, and real-time feedback. Strengthens global collaboration for educators and experts.
Accessibility	Provides access to a wealth of online resources, accommodating diverse schedules and needs.
Personalization	Tailors PD content to individual educators' requirements, ensuring pertinent information and support.
Real-time feedback	Strengthens practical application of strategies, boosting educators' confidence and competence in supporting students with learning disabilities.
Global collaboration	Enables connections with experts and peers worldwide, enriching the exchange of best practices and innovative approaches.

In summation, digital PD in special education represents a comprehensive and dynamic approach that holds the promise of equipping educators with the knowledge and tools needed to effectively support students with learning disabilities, particularly in the realm of early literacy intervention. While limitations persist, technology's integration emerges as a transformative force, enhancing accessibility, personalization, feedback, and global collaboration in the quest to create more inclusive and effective learning environments for all students.

Conflicts of Interest
The authors declare that they have no conflicts of interest to report regarding the present study.

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