Special and Disability Education Studies (2026) 09-16

Contents lists available at Indonesian Scholar Society

Special and Disability Education Studies

Journal homepage: https://journal.solusiriset.com/index.php/sdes

Technopedagogical competencies of special school teachers in integrating assistive technology: An integrative literature review

Maisuhetni[a,*], Ratna Tri Utami[b], Ummiy Fauziyah Laili[c]

[a] Prodi Pendidikan Luar Biasa, Universitas Muhammadiyah Lampung, Bandar Lampung, Lampung 35132, Indonesia
[b] Prodi Pendidikan Luar Biasa, Universitas Muhammadiyah Lampung, Bandar Lampung, Lampung 35132, Indonesia
[c] Prodi Tadris IPA, Universitas Islam Negeri Syekh Wasil Kediri, Kediri, East Java 64127, Indonesia

ARTICLE INFO

Keywords:
Assistive technology,
Inclusive education,
Special education,
Special school teachers,
Technopedagogical competence.

ABSTRACT

The integration of assistive technology in special education has become an essential strategy for improving accessibility, participation, and learning quality among students with special needs. However, the effective use of assistive technology in special schools depends not only on the availability of devices, but also on teachers' technopedagogical competencies in selecting, adapting, and integrating technology into meaningful learning activities. This study aims to synthesize the core technopedagogical competencies required by special school teachers in integrating assistive technology for students with special needs. An integrative literature review was employed by examining relevant scholarly articles, books, and policy documents published between 2015 and 2025. The reviewed literature was analyzed using thematic content analysis to identify major patterns related to teacher competencies, types of assistive technology, implementation barriers, and professional development strategies. The findings indicate that special school teachers require five interrelated competency domains: disability-specific pedagogical competence, assistive technology knowledge, instructional design competence, implementation and facilitation competence, and collaborative competence. Assistive technologies such as hearing aids, cochlear implants, screen readers, text-to-speech tools, braille devices, sign language applications, and interactive learning software can enhance students' access to learning when they are integrated through appropriate pedagogical strategies. However, limited teacher training, inadequate infrastructure, lack of technical support, and weak institutional policies remain major barriers to effective implementation. This study contributes to the development of a conceptual understanding of technopedagogical competence in special education and highlights the need for continuous teacher professional development, school-based support systems, and inclusive education policies that promote sustainable assistive technology integration.

1. Introduction

The rapid development of digital technology has transformed educational practices across different levels and contexts, including special education. For students with special needs, technology is not only a supporting tool for instruction but also an essential means of accessibility, communication, participation, and independence. Assistive technology, such as hearing aids, cochlear implants, screen readers, text-to-speech tools, braille devices, sign language applications, augmentative and alternative communication systems, and interactive learning software, provides opportunities for students with disabilities to access learning materials and participate more actively in classroom activities. In special schools, known in Indonesia as Sekolah Luar Biasa (SLB), the integration of assistive technology is increasingly important because students often experience barriers related to hearing, vision, cognition, communication, mobility, or social interaction [1, 2].

Assistive technology has the potential to reduce learning barriers and create more inclusive learning environments. For students with hearing impairments, technologies such as hearing aids, cochlear implants, FM systems, captioning tools, and sign language applications may support communication and access to auditory or visual information. For students with visual impairments, screen readers, braille displays, text-to-speech tools, and audio-based learning resources can improve access to digital texts and learning materials. For students with intellectual disabilities, autism spectrum disorder, or communication difficulties, visual schedules, interactive applications, simplified digital media, and augmentative communication tools can support understanding, engagement, and self-expression [3–5].

* Corresponding author.
E-mail address: maisuhetniramdani@gmail.com (Maisuhetni).

https://doi.org/10.55749/sdes.v1i1.194
Received 1 January 2026; Received in revised form 2 February 2026; Accepted 11 March 2026
Available online 30 June 2026
XXXX-XXXX/Published by Indonesian Scholar Society.

However, the availability of assistive technology does not automatically guarantee effective learning. The success of assistive technology integration depends strongly on teachers' competencies in understanding students' needs, selecting appropriate tools, adapting instructional materials, designing accessible learning activities, and facilitating technology use during classroom instruction. In this context, special school teachers need more than general digital literacy. They require technopedagogical competence, which refers to the ability to integrate technological knowledge, pedagogical strategies, content knowledge, and disability-specific understanding to create accessible and meaningful learning experiences for students with special needs [6, 7].

The concept of technopedagogical competence is closely related to the Technological Pedagogical Content Knowledge framework. TPACK emphasizes the interaction among technological knowledge, pedagogical knowledge, and content knowledge in designing effective technology-supported learning. In the context of special education, however, TPACK needs to be interpreted more specifically. Teachers must not only understand how to use technology, but also how assistive technology corresponds to the functional needs of students with different disabilities. For example, a screen reader is not simply a digital tool; it becomes pedagogically meaningful only when the teacher can adapt learning materials into accessible formats, provide appropriate guidance, and evaluate whether the tool improves student participation and learning outcomes. Therefore, technopedagogical competence in SLB contexts should include disability-specific pedagogy, assistive technology knowledge, instructional design competence, implementation competence, and collaboration with other stakeholders [8–10].

Despite the growing importance of assistive technology, its implementation in special schools still faces many challenges. Previous literature has reported several barriers, including limited teacher training, inadequate infrastructure, lack of technical support, insufficient institutional policy, limited access to appropriate devices, and low teacher confidence in using assistive technology. In many cases, assistive devices are available but not used optimally because teachers have not received systematic professional development. Some teachers may be able to operate digital tools but still struggle to integrate them into lesson planning, classroom interaction, assessment, and individualized learning support. This gap indicates that the issue is not only technological but also pedagogical, institutional, and professional [3, 11].

In Indonesia, the role of SLB teachers is particularly important because special schools serve students with diverse needs and require highly adaptive instructional practices. Teachers are expected to understand the characteristics of students with hearing impairments, visual impairments, intellectual disabilities, autism spectrum disorder, physical disabilities, and multiple disabilities. At the same time, they are expected to use technology to support accessibility and learning. However, teacher preparation, school infrastructure, and professional training are not always equally distributed across regions. This condition creates a need for a clearer understanding of the competencies required by SLB teachers to integrate assistive technology effectively and sustainably [12, 13].

Previous studies have discussed assistive technology in special education, teacher competence, inclusive education, and the TPACK framework. However, many studies tend to focus separately on the benefits of assistive technology or on teacher digital competence in general education. Limited attention has been given to the synthesis of technopedagogical competencies specifically required by SLB teachers in integrating assistive technology. Furthermore, the relationship between disability-specific pedagogy, assistive technology knowledge, instructional design, classroom facilitation, and professional collaboration remains underdeveloped in the literature. Therefore, an integrative literature review is needed to synthesize existing knowledge and formulate a conceptual understanding of the competencies required for assistive technology integration in special school contexts (Table 1) [6, 14, 15].

Table 1
Research gap and contribution of the study

Research Area	Focus of Previous Studies	Identified Gap	Contribution of This Study
Assistive technology in special education	Many studies discuss the benefits of assistive technology for accessibility, communication, and learning participation.	Limited synthesis on the teacher competencies needed to integrate assistive technology effectively in special schools.	This study identifies core competency domains required by SLB teachers for assistive technology integration.
Teacher digital competence	Existing literature often focuses on general digital literacy or educational technology use.	General digital competence does not fully address disability-specific learning needs and accessibility barriers.	This study emphasizes technopedagogical competence that combines technology, pedagogy, content, and disability-specific understanding.
TPACK framework	TPACK is widely used to analyze technology integration in general education.	The application of TPACK in special education and assistive technology contexts remains limited.	This study contextualizes TPACK for SLB teachers by linking it with assistive technology and special education practices.
Professional development	Some studies highlight the importance of teacher training and infrastructure.	There is limited discussion of systematic professional development strategies for sustainable assistive technology use.	This study proposes the need for continuous training, school-based support, and collaborative implementation.
Indonesian SLB context	Research has discussed special education and inclusive practices in Indonesia.	The specific competency framework for SLB teachers in integrating assistive technology is not yet well established.	This study contributes a conceptual basis for strengthening teacher competence and assistive technology implementation in Indonesian special schools.

Based on these gaps, this study aims to synthesize the core technopedagogical competencies required by special school teachers in integrating assistive technology for students with special needs. Specifically, this study seeks to answer the following research questions:

1. What competency domains are required by SLB teachers to integrate assistive technology into learning activities?
2. What types of assistive technology are commonly used to support students with different disabilities?
3. What barriers affect the implementation of assistive technology in special schools?
4. What professional development and institutional support strategies are needed to strengthen teachers' technopedagogical competencies?

The novelty of this study lies in its attempt to conceptualize technopedagogical competence in the context of special schools and assistive technology integration. Rather than viewing assistive technology merely as a set of devices, this study positions it as part of a broader instructional system that requires teacher competence, adaptive pedagogy, accessible learning design, and institutional support. By synthesizing literature on special education, assistive technology, TPACK, and teacher professional

development, this study provides a conceptual foundation for improving assistive technology integration in SLB and other inclusive education settings.

This study is expected to contribute theoretically and practically. Theoretically, it expands the discussion of TPACK and teacher competence by situating them within the context of special education and assistive technology. Practically, it provides insights for SLB teachers, school leaders, teacher education institutions, and policymakers in designing professional development programs, providing appropriate infrastructure, and developing sustainable support systems for assistive technology integration. Ultimately, strengthening teachers' technopedagogical competencies can improve accessibility, participation, independence, and learning quality among students with special needs.

2. Materials and Methods

2.1. Research design

This study employed an integrative literature review approach to synthesize existing knowledge on the technopedagogical competencies required by special school teachers in integrating assistive technology. An integrative literature review was selected because it allows the researcher to examine theoretical, empirical, and policy-related sources in order to develop a comprehensive understanding of a specific educational issue. This approach is appropriate for studies that aim to identify conceptual patterns, research gaps, competency domains, implementation barriers, and professional development strategies.

The review focused on literature related to special education, assistive technology, teacher competence, technopedagogical competence, TPACK, inclusive education, and professional development for teachers in special school contexts. The purpose was not only to summarize previous studies, but also to synthesize them into a conceptual understanding of how special school teachers can effectively integrate assistive technology into learning activities for students with special needs [4, 16].

2.2. Data sources and search strategy

The literature search was conducted using academic databases and search engines that provide access to national and international sources. The main sources included Google Scholar, DOAJ, Garuda, ScienceDirect, ERIC, and SINTA-indexed journals. These databases were selected because they contain relevant publications on special education, assistive technology, inclusive education, educational technology, and teacher professional competence.

The literature search focused on publications from 2015 to 2025. This time range was chosen to capture recent developments in assistive technology, digital learning, inclusive education, and teacher competency frameworks. Older sources were included only when they provided foundational theoretical frameworks, such as the TPACK model or key concepts in assistive technology and inclusive education.

The search was conducted using English and Indonesian keywords. The English keywords included "assistive technology," "special education," "special school teachers," "teacher competence," "technopedagogical competence," "TPACK," "inclusive education," "students with special needs," "teacher professional development," and "accessibility in education." The Indonesian keywords included "teknologi asistif," "guru SLB," "Sekolah Luar Biasa," "pendidikan khusus," "pendidikan inklusif," "kompetensi guru," "kompetensi teknopedagogik," and "anak berkebutuhan khusus."

2.3. Inclusion and exclusion criteria

The selection of literature was guided by inclusion and exclusion criteria to ensure relevance (Table 2), academic credibility, and alignment with the research objectives [17, 18].

Table 2
Inclusion and exclusion criteria

Criteria	Inclusion	Exclusion
Publication period	Sources published between 2015 and 2025, with older sources included only for foundational theories	Sources published before 2015 without strong theoretical relevance
Topic relevance	Studies discussing assistive technology, special education, teacher competence, TPACK, inclusive education, or professional development	Studies unrelated to assistive technology, special education, or teacher competence
Educational context	Studies related to special schools, inclusive schools, students with special needs, or disability-based learning support	Studies focusing only on general education without relevance to disability or accessibility
Type of source	Peer-reviewed journal articles, academic books, conference papers, and official policy documents	Blogs, opinion articles, non-academic websites, and sources without clear academic credibility
Language	Sources written in English or Indonesian	Sources in other languages that could not be adequately interpreted
Accessibility	Sources with accessible abstracts, full texts, or sufficient bibliographic information	Sources with incomplete information or inaccessible content
Analytical relevance	Sources that provide evidence, models, concepts, or findings related to teacher competence and assistive technology integration	Sources that only mention technology without discussing pedagogical or disability-related aspects

2.4. Literature selection procedure

The literature selection process was conducted in several stages. First, potentially relevant sources were identified through database searching using the selected keywords and search strings. Second, duplicate records were removed. Third, the titles and abstracts were screened to determine their relevance to the study focus. Fourth, the full texts of potentially relevant sources were examined based on the inclusion and exclusion criteria. Finally, the selected sources were included in the thematic synthesis [3, 6, 16]. The literature selection process can be presented in a flow diagram (Fig. 1). The number of records in each stage should be completed based on the actual literature search and screening process.

2.5. Data extraction

Data from the selected sources were extracted using a structured matrix. The extraction process focused on identifying the main information relevant to the research questions, including author and year, research focus, type of assistive technology, educational context, type of student needs, teacher competency domain, implementation barriers, and professional development implications (Table 3) [19–21]. This matrix helped organize the reviewed literature and identify recurring patterns across studies.

2.6. Data Analysis

The selected literature was analyzed using thematic content analysis. The analysis was conducted in four stages. First, all selected sources were read carefully to understand their relevance to assistive technology integration and teacher competencies. Second, important concepts and findings were coded based on the research questions. Third, similar codes were grouped into broader themes. Fourth, the themes were synthesized to construct a conceptual understanding of technopedagogical competencies among special school teachers.

The thematic analysis produced five major competency domains:

1. Disability-specific pedagogical competence, referring to teachers' ability to understand students' characteristics, learning barriers, and individual needs.
2. Assistive technology knowledge, referring to teachers' understanding of the functions, benefits, limitations, and suitability of assistive tools.
3. Instructional design competence, referring to teachers' ability to design accessible and adaptive learning activities using assistive technology.
4. Implementation and facilitation competence, referring to teachers' ability to guide students in using assistive technology during classroom learning.
5. Collaborative competence, referring to teachers' ability to work with parents, school leaders, therapists, technology providers, and policymakers to support sustainable implementation.

These themes were then interpreted using the Technological Pedagogical Content Knowledge framework and inclusive education principles. The analysis emphasized how technology, pedagogy, content, and disability-specific understanding interact in the process of assistive technology integration [3, 6, 16].

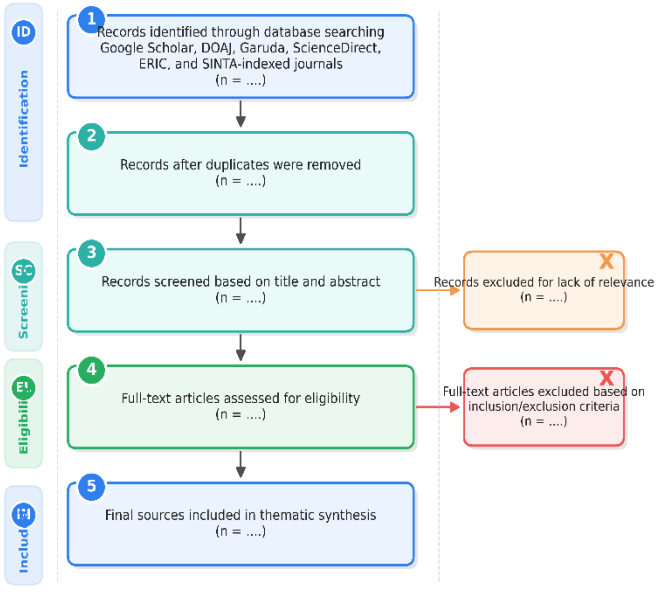

Fig. 1. Literature selection flow. The figure illustrates the process of identifying, screening, assessing, and selecting literature for the integrative review on technopedagogical competencies of special school teachers in integrating assistive technology. The number of records in each stage should be completed based on the actual literature search and screening process.

2.7. *Trustworthiness of the review*

Several strategies were used to strengthen the trustworthiness of this review. First, multiple databases and search engines were used to obtain broader coverage of national and international literature. Second, explicit inclusion and exclusion criteria were applied to ensure that the selected sources were relevant and credible. Third, data extraction was conducted using a structured matrix to maintain consistency during analysis. Fourth, the findings were synthesized thematically rather than based on isolated statements from individual sources [7].

The use of thematic content analysis allowed the study to identify recurring patterns across different types of literature. However, because this study is literature-based, its conclusions depend on the quality and availability of the reviewed sources. Therefore, the findings should be understood as a conceptual synthesis that requires further empirical validation [6, 14, 15].

2.8. *Ethical considerations*

This study did not involve human participants, field observations, interviews, or personal data collection. All data were obtained from published academic literature, books, and policy documents. Ethical considerations were addressed by accurately representing the ideas of previous authors, avoiding plagiarism, and ensuring that all sources used in the review were properly cited.

3. Results and discussion

3.1. *Overview of thematic findings*

The integrative literature review shows that the successful integration of assistive technology in special schools is closely related to teachers' technopedagogical competencies. Assistive technology has considerable potential to improve accessibility, participation, communication, independence, and learning quality among students with special needs. However, the findings indicate that technology alone is not sufficient. Its effectiveness depends on how teachers understand students' needs, select appropriate technologies, adapt instructional materials, facilitate technology use, and collaborate with school stakeholders [19–21].

Table 3
Thematic synthesis of assistive technology integration in special schools

Main Theme	Sub-theme	Description	Educational Implication
Teacher competence	Disability-specific pedagogy	Teachers need to understand the characteristics, barriers, and learning needs of students with different disabilities.	Learning activities can be adapted to students' sensory, cognitive, communication, and behavioral needs.
Teacher competence	Assistive technology knowledge	Teachers need to understand the functions, benefits, limitations, and suitability of assistive technologies.	Teachers can select appropriate tools rather than using technology randomly.
Instructional practice	Accessible learning design	Teachers need to design learning materials and activities that can be accessed through assistive tools.	Students gain better access to learning content and classroom participation.
Instructional practice	Classroom facilitation	Teachers need to guide students in using assistive technology during learning.	Technology becomes part of meaningful learning, not merely a classroom device.
Institutional support	Training and infrastructure	Schools need to provide continuous training, technical assistance, and adequate facilities.	Assistive technology implementation becomes more sustainable.
Collaboration	School-family-stakeholder partnership	Teachers need to collaborate with parents, school leaders, therapists, and technology providers.	Assistive technology use can continue across school and home environments.

The thematic analysis produced five major competency domains required by special school teachers: disability-specific pedagogical competence, assistive technology knowledge, instructional design competence, implementation and facilitation competence, and collaborative competence. These competencies are interconnected and should not be understood separately. A teacher may know how to operate a device, but the device will not be pedagogically meaningful unless it is integrated into accessible learning activities that match students' disability characteristics, learning goals, and classroom conditions [14, 22, 23].

The findings also show that assistive technology integration in special schools is shaped by several supporting and inhibiting factors. Supporting factors include teacher readiness, school infrastructure, adaptive learning resources, institutional policy, and professional development (Table 3). In contrast, inhibiting factors include limited teacher training, inadequate technical support, limited access to appropriate devices, unequal infrastructure across regions, and the absence of systematic integration into curriculum and lesson planning.

3.2. Core technopedagogical competencies of special school teachers

The first major finding concerns the competency domains required by special school teachers in integrating assistive technology (Table 4). The literature indicates that technopedagogical competence in special education should be understood as a multidimensional competence. It is not limited to the ability to operate digital devices, but also includes the ability to design adaptive instruction, understand disability-specific needs, and use technology to support meaningful learning [24].

The first domain is disability-specific pedagogical competence. Special school teachers must understand the learning characteristics of students with hearing impairments, visual impairments, intellectual disabilities, autism spectrum disorder, physical disabilities, and communication difficulties. Each group of students requires different instructional adaptations. For example, students with hearing impairments may need visual support, captioning, sign language applications, or speech-to-text tools. Students with visual impairments may require screen readers, braille devices, audio learning materials, and accessible document formats. Students with intellectual disabilities may benefit from simplified visual media, repeated instructions, and structured digital activities [20, 21, 25].

Table 4
Proposed competency domains for assistive technology integration

Competency Domain	Description	Example of Teacher Practice
Disability-specific pedagogical competence	Ability to understand students' disability characteristics, learning barriers, and individual needs	Adapting instruction for deaf, blind, autistic, or intellectually disabled students
Assistive technology knowledge	Ability to understand the functions, limitations, and suitability of assistive tools	Selecting screen readers, hearing aids, TTS, braille devices, or sign language applications based on student needs
Instructional design competence	Ability to design accessible and adaptive learning activities using assistive technology	Preparing captioned videos, accessible documents, visual schedules, or interactive learning materials
Implementation and facilitation competence	Ability to guide students in using assistive technology during learning	Demonstrating how to use a screen reader or supporting students in using communication applications
Collaborative competence	Ability to work with parents, school leaders, therapists, and technology providers	Coordinating technology use between school and home and seeking technical or institutional support

The second domain is assistive technology knowledge. Teachers need to understand the functions, limitations, and suitability of assistive technologies. This includes knowledge of hardware, software, mobile applications, adaptive devices, and digital accessibility tools. Teachers should be able to determine whether a specific tool is appropriate for a particular student's needs and learning objectives. Without this knowledge, assistive technology may be used superficially or may not address the actual barriers experienced by students [16, 26, 27].

The third domain is instructional design competence. Teachers must be able to integrate assistive technology into lesson plans, learning activities, materials, and assessments. Assistive technology should not be treated as an additional tool used separately from instruction. Instead, it should become part of the instructional design process. For example, when preparing digital materials for students with visual impairments, teachers must ensure that documents are compatible with screen readers. When teaching students with hearing impairments, teachers may need to combine visual media, written instructions, captioned videos, and sign language support.

The fourth domain is implementation and facilitation competence. Teachers must be able to guide students in using assistive technology during classroom learning. This includes introducing the tool, modeling its use, providing practice opportunities, monitoring student difficulties, and adjusting support when needed. Some students may require repeated guidance before they can use assistive technology independently. Therefore, teacher facilitation remains important even when technology is available [14, 22, 23].

The fifth domain is collaborative competence. Assistive technology integration requires collaboration among teachers, parents, school leaders, therapists, technology providers, and policymakers. Teachers need to communicate with parents to ensure continuity of technology use at home, work with school leaders to obtain resources, and collaborate with specialists to determine appropriate tools for students. This collaborative dimension is essential because assistive technology use often extends beyond the classroom.

3.3. Types and functions of assistive technology in special schools

The second major finding concerns the types and functions of assistive technology used in special education. The reviewed literature indicates that assistive technology varies according to the type of disability and learning barrier experienced by students (Table 5). Therefore, teachers must be able to match the technology with the specific needs of each learner [28, 29].

For students with hearing impairments, assistive technology includes hearing aids, cochlear implants, FM systems, captioning tools, visual learning media, speech-to-text applications, and sign language applications. These technologies can support communication, access to instruction, and classroom participation. However, their effectiveness depends on teachers' ability to combine technological tools with appropriate communication strategies. For students with visual impairments, assistive technology includes screen readers, text-to-speech tools, braille displays, audio books, tactile graphics, and accessible digital documents. These tools help students access written materials, digital content, and learning resources. However, teachers must understand accessibility principles, such as preparing readable document formats, using alternative text for images, and ensuring compatibility with screen reader software.

For students with intellectual disabilities, assistive technology may include simplified interactive software, visual schedules, step-by-step digital instructions, audio-visual materials, and structured learning applications. These technologies support understanding, memory, and task completion. However, teachers need to simplify content, repeat instructions, and provide concrete examples. For students with autism spectrum disorder or communication difficulties, assistive technology includes visual communication tools, social stories, augmentative and alternative communication devices, structured digital routines, and visual behavior support systems. These tools can support communication, predictability, self-regulation, and social interaction.

For students with physical disabilities, assistive technology may include adaptive keyboards, switches, alternative input devices, eye-tracking systems, and accessible learning platforms. These technologies allow students to interact with digital learning materials despite motor limitations [14, 22, 23].

Table 5
Types of assistive technology based on student needs

Type of Student Need	Common Learning Barriers	Relevant Assistive Technology	Pedagogical Function
Hearing impairment	Limited access to auditory instruction and spoken communication	Hearing aids, cochlear implants, FM systems, captioning tools, sign language applications	Supports communication, auditory access, and visual learning
Visual impairment	Limited access to printed and visual materials	Screen readers, text-to-speech tools, braille devices, audio books, tactile graphics	Supports access to text, digital content, and independent learning
Intellectual disability	Difficulty understanding abstract concepts and complex instructions	Visual schedules, simplified interactive media, step-by-step applications	Supports comprehension, repetition, and structured learning
Autism spectrum disorder	Communication barriers, need for routine, difficulty with social interaction	Visual communication tools, social stories, AAC devices, structured digital routines	Supports communication, predictability, and self-regulation
Physical disability	Limited motor access to learning tools and digital devices	Adaptive keyboards, switches, eye-tracking systems, alternative input devices	Supports access, participation, and independent interaction

This differentiation is important because assistive technology should not be implemented as a one-size-fits-all solution. Teachers must evaluate the suitability of each tool based on students' functional needs, learning objectives, classroom context, and available support [24].

3.4. Impact of assistive technology on accessibility and learning participation

The reviewed literature suggests that assistive technology can improve accessibility and learning participation when integrated appropriately. For students with visual impairments, screen readers and text-to-speech tools can increase access to digital learning materials and reduce dependence on printed texts. For students with hearing impairments, captioning, visual media, and sign language applications can support communication and comprehension. For students with cognitive or communication difficulties, interactive applications and visual supports can help organize learning tasks and increase engagement. Assistive technology also supports student independence. When students are trained to use assistive tools effectively, they can access materials, complete tasks, communicate ideas, and participate in classroom activities with greater autonomy. This is especially important in special education because the goal of learning is not only academic achievement, but also functional independence, confidence, and participation in social life [19–21].

In addition, assistive technology can enhance motivation and engagement. Interactive software, audio-visual media, and adaptive digital tools can make learning more attractive and accessible. However, motivation does not come from technology itself. It emerges when technology is used in meaningful, supportive, and student-centered learning activities. Therefore, teacher competence remains central to ensuring that assistive technology contributes to learning rather than becoming a passive or unused device. The findings also indicate that assistive technology can support inclusive learning environments. By providing alternative ways to access information and express understanding, assistive technology allows students with disabilities to participate more equally in learning activities. This aligns with inclusive education principles, which emphasize accessibility, participation, and the removal of barriers.

3.5. Barriers to assistive technology integration

Despite its potential benefits, the implementation of assistive technology in special schools still faces several barriers. The first barrier is limited teacher training. Many teachers may have positive attitudes toward technology but lack sufficient training to select, operate, and integrate assistive tools into instruction. One-time workshops are often insufficient because assistive technology use requires continuous practice, mentoring, and classroom-based support [19–21].

Table 6
Barriers and recommended strategies for assistive technology implementation

Barrier	Explanation	Recommended Strategy
Limited teacher training	Teachers may lack knowledge of how to use and integrate assistive technology	Provide continuous professional development, mentoring, and classroom-based coaching
Inadequate infrastructure	Schools may lack devices, internet access, maintenance systems, or accessible materials	Strengthen school facilities and prioritize assistive technology in school planning
Limited technical support	Teachers may struggle with installation, troubleshooting, and maintenance	Establish technical support teams or partnerships with technology providers
Weak curriculum integration	Assistive technology may not be connected to lesson plans and assessment	Integrate assistive technology into instructional design and curriculum planning
Limited policy and funding	Implementation may not be sustainable without institutional support	Develop policies for procurement, maintenance, teacher training, and evaluation
Unequal access across regions	Rural schools may have fewer resources than urban schools	Provide targeted support for under-resourced SLB and inclusive schools

The second barrier is inadequate infrastructure. Some schools may lack stable internet access, sufficient devices, maintenance support, or accessible digital resources. This barrier is especially significant in rural and under-resourced areas. When infrastructure is limited, teachers may find it difficult to integrate assistive technology consistently

The third barrier is limited technical support. Assistive technologies often require installation, maintenance, troubleshooting, and updates. Without technical support, teachers may stop using devices when technical problems occur. This indicates that assistive technology integration should be supported by school-level systems, not only by individual teacher initiative. The fourth barrier is weak curriculum integration. In many cases, assistive technology is introduced as an additional tool rather than being embedded in lesson planning, learning objectives, classroom activities, and assessment. As a result, the technology may be available but not used meaningfully. Teachers need guidance on how to integrate assistive tools into curriculum implementation.

The fifth barrier is limited institutional policy and funding. Sustainable implementation requires procurement policies, maintenance budgets, teacher training programs, and monitoring systems. Without institutional commitment, assistive technology use may depend on temporary projects or individual teacher motivation challenges. Positive family involvement can reduce anxiety and increase the child's willingness to participate in religious activities.

3.6. Professional development for technopedagogical competence

The findings indicate that teacher professional development is a key strategy for improving assistive technology integration. Professional development should not focus only on technical skills. It should also address pedagogical design, disability-specific adaptation, classroom facilitation, evaluation, and collaboration [19–21]. An effective professional development model should include several components. First, teachers need foundational training on different types of assistive technology and their relevance to various disability categories. Second, teachers need practical workshops that allow them to design accessible learning materials and lesson plans. Third, teachers need classroom-based mentoring to apply the technology in real teaching contexts. Fourth, schools should establish teacher learning communities where teachers can share experiences, challenges, and solutions. Fifth, professional development should include evaluation of whether assistive technology improves student access, participation, and learning outcomes.

The professional development process should also be aligned with the TPACK framework. Teachers should be supported in integrating technological knowledge, pedagogical knowledge, and content knowledge. In special education, this integration must be expanded to include disability-specific understanding. Therefore, a TPACK-based professional development program for SLB teachers should not only teach teachers how to use technology, but also how to adapt technology to students' functional needs and learning barriers [30].

3.7. Conceptual framework of technopedagogical competence for assistive technology integration

Based on the thematic synthesis, this study proposes a conceptual framework for technopedagogical competence in assistive technology integration. The framework consists of five competency domains supported by institutional and collaborative factors. At the center of the framework is the teacher's ability to design accessible learning experiences. This ability is shaped by disability-specific pedagogical competence, assistive technology knowledge, instructional design competence, implementation and facilitation competence, and collaborative competence. These domains interact with school infrastructure, professional development, policy support, and technical assistance.

This framework shows that effective assistive technology integration requires more than device availability. It requires competent teachers, adaptive instructional design, collaborative support, and institutional commitment. In this sense, assistive technology should be understood as part of a broader inclusive education system.

The results of this review emphasize that technopedagogical competence is central to the effective use of assistive technology in special schools. The findings support the argument that special school teachers need competencies that combine technological ability, pedagogical understanding, content knowledge, and disability-specific sensitivity. General digital competence is not enough because assistive technology is closely connected to students' functional needs and accessibility barriers.

The review also indicates that assistive technology integration should be based on student-centered and disability-responsive pedagogy. Different students require different tools, strategies, and levels of support. Therefore, teachers must be able to assess students' learning barriers and select appropriate technologies accordingly. This finding challenges the assumption that providing devices alone will automatically improve learning. Instead, technology becomes effective only when it is used through appropriate instructional planning and teacher facilitation.

Table 7
Conceptual framework for technopedagogical competence in assistive technology integration

Framework Component	Main Focus	Practical Application	Expected Outcome
Disability-specific pedagogy	Understanding students' learning characteristics and barriers	Identifying appropriate instructional adaptations for each student	More responsive and individualized learning
Assistive technology knowledge	Understanding tools, devices, software, and accessibility features	Selecting technologies based on student needs and learning goals	Better access to learning materials
Instructional design	Designing accessible and adaptive learning activities	Creating captioned videos, accessible documents, visual supports, or interactive activities	Meaningful integration of technology into learning
Classroom facilitation	Supporting students during technology use	Modeling, guiding, monitoring, and adjusting technology use	Improved participation and independence
Collaboration	Building support among teachers, parents, school leaders, and specialists	Coordinating technology use, training, maintenance, and evaluation	Sustainable assistive technology implementation
Institutional support	Providing infrastructure, policy, and technical assistance	Funding devices, maintaining tools, and organizing professional development	Long-term improvement in accessibility and learning quality

Another important point is that assistive technology should be integrated into the curriculum rather than used as a separate support tool. Teachers need to connect assistive technology with learning objectives, teaching strategies, classroom activities, and assessment. This requires a shift from technology as a device to technology as an instructional system. Such a shift can be achieved through continuous professional development and school-based support.

The findings also highlight the importance of institutional responsibility. If assistive technology implementation depends only on individual teachers, it may not be sustainable. Schools need to provide infrastructure, technical support, training programs, and policies that encourage the use of assistive technology. Government and educational authorities also need to support special schools, especially those in rural or under-resourced areas [31].

Overall, this study suggests that the integration of assistive technology in special schools should be viewed as a multidimensional process involving teacher competence, student needs, pedagogical design, technology suitability, collaboration, and institutional support. Strengthening technopedagogical competencies among special school teachers is therefore essential for improving accessibility, participation, independence, and learning quality among students with special needs. [3, 11].

4. Conclusion

This study synthesized the technopedagogical competencies required by special school teachers in integrating assistive technology to support students with special needs. The findings indicate that the effective use of assistive technology in special schools does not depend solely on the availability of devices or digital applications. Instead, it requires teachers' ability to understand students' disability-specific needs, select appropriate assistive tools, design accessible learning activities, facilitate technology use in the classroom, and collaborate with relevant stakeholders.

The review identified five interrelated competency domains that are essential for assistive technology integration: disability-specific pedagogical competence, assistive technology knowledge, instructional design competence, implementation and facilitation competence, and collaborative competence. These competencies enable teachers to use assistive technology not merely as a technical aid, but as an integral part of adaptive and inclusive learning. Technologies such as hearing aids, cochlear implants, screen readers, text-to-speech tools, braille devices, sign language applications, visual communication tools, and interactive software can enhance accessibility, participation, independence, and learning quality when they are aligned with students' needs and learning objectives.

The findings also show that several barriers still limit the effective implementation of assistive technology in special schools. These barriers include limited teacher training, inadequate infrastructure, lack of technical support, weak curriculum integration, limited institutional policy, and unequal access to assistive technology across regions. Therefore, strengthening teachers' technopedagogical competencies requires continuous professional development, school-based technical support, adequate infrastructure, collaborative partnerships, and inclusive education policies that support sustainable implementation.

This study contributes to the conceptual development of technopedagogical competence in special education by emphasizing the integration of technology, pedagogy, content knowledge, and disability-specific understanding. The proposed competency framework can serve as a reference for special school teachers, school leaders, teacher education institutions, and policymakers in designing professional development programs and assistive technology implementation strategies.

However, this study is limited by its literature-based approach and does not include direct empirical data from teachers, students, or school settings. Future research is recommended to validate the proposed competency framework through field studies, surveys, interviews, classroom observations, or intervention-based research in special schools. Further studies may also examine the effectiveness of specific assistive technologies for different disability categories and evaluate how teacher training programs influence the sustainable use of assistive technology in inclusive and special education contexts..

CRediT authorship contribution statement

Maisuhetni: Writing – review & editing, Writing – original draft, Supervision, Software, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Ratna Tri Utami:** Conceptualization, Writing – original draft, Supervision, Software, Resources, Methodology, Investigation, Formal analysis. **Ummiy Fauziyah Laili:** Formal analysis, Writing – review & editing, Investigation.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Acknowledgment

The authors would like to express their sincere gratitude to all parties who provided academic support and constructive input during the preparation of this article. The authors also

acknowledge the contributions of previous researchers whose works provided important theoretical and empirical foundations for this integrative literature review on technopedagogical competence, assistive technology, and special education.

References

1. American Psychiatric Association. (2022). Diagnostic and Statistical Manual of Mental Disorders, 5th ed., text rev., Washington, DC: American Psychiatric Association. Doi: 10.1176/appi.books.9780890425787
2. Ball, J., and Fazil, Q. (2013). Does Engagement in Meaningful Occupation Reduce Challenging Behavior in People with Intellectual Disabilities? A Systematic Review of the Literature, Journal of Intellectual Disabilities: JOID, Vol. 17, No. 1, pp. 64–77. Doi: 10.1177/1744629512473557
3. Billen, E. (2022). Improving the Understanding of Self-Regulation: Perspectives for Forensic Research and Practice, PhD Dissertation, Tilburg University
4. Bonta, J., and Andrews, D. A. (2023). The Psychology of Criminal Conduct, 7th ed., New York, NY: Routledge
5. Cohen, I. L., and Tsiouris, J. A. (2020). Triggers of Aggressive Behaviors in Intellectually Disabled Adults and Their Association with Autism, Medical Conditions, Psychiatric Disorders, Age and Sex: A Large-Scale Study, Journal of Autism and Developmental Disorders, Vol. 50, No. 10, pp. 3748–3762. Doi: 10.1007/s10803-020-04424-4
6. Craik, C., Bryant, W., Ryan, A., Barclay, S., Brooke, N., Mason, A., and Russell, P. (2010). A Qualitative Study of Service User Experiences of Occupation in Forensic Mental Health, Australian Occupational Therapy Journal, Vol. 57, No. 5, pp. 339–344. Doi: 10.1111/j.1440-1630.2010.00857.x
7. Delforterie, M. J., Hesper, B. L., and Didden, R. (2020). Psychometric Properties of the Dynamic Risk Outcome Scales (DROS) for Individuals with Mild Intellectual Disability or Borderline Intellectual Functioning and Externalising Behaviour Problems, Journal of Applied Research in Intellectual Disabilities: JARID, Vol. 33, No. 4, pp. 662–672. Doi: 10.1111/jar.12546
8. De Vogel, V., and Didden, R. (2022). Victimization History in Female Forensic Psychiatric Patients with Intellectual Disabilities: Results from a Dutch Multicenter Study, Research in Developmental Disabilities, Vol. 122, 104179. Doi: 10.1016/j.ridd.2022.104179
9. Farnworth, L., Nikitin, L., and Fossey, E. (2004). Being in a Secure Forensic Psychiatric Unit: Every Day is the Same, Killing Time or Making the Most of It, British Journal of Occupational Therapy, Vol. 67, No. 10, pp. 430–438. Doi: 10.1177/030802260406701003
10. Frielink, N., Schuengel, C., and Embregts, P. J. C. M. (2018). Autonomy Support, Need Satisfaction, and Motivation for Support among Adults with Intellectual Disability: Testing a Self-Determination Theory Model, American Journal on Intellectual and Developmental Disabilities, Vol. 123, No. 1, pp. 33–49. Doi: 10.1352/1944-7558-123.1.33
11. Guina, J., Hernandez, C., Witherell, J., Cowan, A., Dixon, D., King, I., and Gentile, J. P. (2022). Neurodevelopmental Disorders, Criminality, and Criminal Responsibility, The Journal of the American Academy of Psychiatry and the Law, Vol. 50, No. 3, pp. 358–368. Doi: 10.29158/JAAPL.210103-21
12. Harris, J. C. (2006). Intellectual Disability: Understanding Its Development, Causes, Classification, Evaluation, and Treatment, New York, NY: Oxford University Press.Bai, C., Zhu, Q., and Sarkis, J. (2024). Do Blockchain Capabilities Help Overcome Supply and Operational Risks: Insights from Firm Market Returns during COVID-19, Omega, Vol. 126, 103049. Doi: 10.1016/j.omega.2024.103049
13. Hollomotz, A. (2018). Successful Interviews with People with Intellectual Disability, Qualitative Research, Vol. 18, No. 2, pp. 153–170. Doi: 10.1177/1468794117713810
14. Jahoda, A., Kemp, J., Riddell, S., and Banks, P. (2008). Feelings about Work: A Review of the Socio-Emotional Impact of Supported Employment on People with Intellectual Disabilities, Journal of Applied Research in Intellectual Disabilities, Vol. 21, No. 1, pp. 1–18. Doi: 10.1111/j.1468-3148.2007.00365.x
15. Kaal, H. L., Nijman, H. L. I., and Moonen, X. M. H. (2015). Identifying Offenders with an Intellectual Disability in Detention in The Netherlands, Journal of Intellectual Disabilities and Offending Behaviour, Vol. 6, No. 2, pp. 94–101. Doi: 10.1108/JIDOB-04-2015-0008
16. Kim, M., and Cheon, K. A. (2024). Exploring the Clinical Characteristics and Comorbid Disorders of Borderline Intellectual Functioning, Journal of the Korean Academy of Child and Adolescent Psychiatry, Vol. 35, No. 3, pp. 181–187. Doi: 10.5765/jkacap.240012
17. Littlewood, M., Dagnan, D., and Rodgers, J. (2018). Exploring the Emotion Regulation Strategies Used by Adults with Intellectual Disabilities, International Journal of Developmental Disabilities, Vol. 64, No. 3, pp. 204–211. Doi: 10.1080/20473869.2018.1466510
18. Orío-Aparicio, C., López-Escribano, C., and Bel-Fenellós, C. (2025). Borderline Intellectual Functioning: A Scoping Review, Journal of Intellectual Disability Research: JIDR, Vol. 69, No. 6, pp. 437–456. Doi: 10.1111/jir.13221
19. Quinn, S., Rhynas, S., Gowland, S., Cameron, L., Braid, N., and O'Connor, S. (2022). Risk for Intellectual Disability Populations in Inpatient Forensic Settings in the United Kingdom: A Literature Review, Journal of Applied Research in Intellectual Disabilities: JARID, Vol. 35, No. 6, pp. 1267–1280. Doi: 10.1111/jar.13030
20. Ratti, V., Hassiotis, A., Crabtree, J., Deb, S., Gallagher, P., and Unwin, G. (2016). The Effectiveness of Person-Centred Planning for People with Intellectual Disabilities: A Systematic Review, Research in Developmental Disabilities, Vol. 57, pp. 63–84. Doi: 10.1016/j.ridd.2016.06.015
21. Ritchie, J., and Lewis, J. (2003). Qualitative Research Practice: A Guide for Social Science Students and Researchers, London: SAGE Publications.
22. Ryan, R. M., and Deci, E. L. (2000). Self-Determination Theory and the Facilitation of Intrinsic Motivation, Social Development, and Well-Being, The American Psychologist, Vol. 55, No. 1, pp. 68–78. Doi: 10.1037/0003-066X.55.1.68
23. Sumarni, S., Ramadhani, R., Sazaki, Y., Astika, R. T., Andika, W. D., and Prasetiyo, A. E. (2019). Development of "Child Friendly ICT" Textbooks to Improve Professional Competence of Teacher Candidates: A Case Study of Early Childhood Education Program Students, Journal for the Education of Gifted Young Scientists, Vol. 7, No. 3, pp. 643–658. Doi: 10.17478/jegys.596095
24. Huda, S., Muawanah, M., Munifah, M., Syazali, M., Palupi, E. K., Umam, R., and Tortop, H. S. (2020). Islamic Education in Supply Chain System by Prioritizing Manners as a Success Factor of Millennial Generation on Socializing, International Journal of Supply Chain Management, Vol. 9, No. 2, pp. 853–863. Doi: 10.59160/ijscm.v9i2.4727
25. Munifah, M., Huda, S., Hamida, U. D., Subandi, S., Syazali, M., and Umam, R. (2019). The Use of Management Strategies to Attract the Public's Interest in Pesantren: A New Model for Pesantren Dynamics Study, International Journal of Innovation, Creativity and Change, Vol. 8, pp. 363–383.
26. Sumarni, S., Pertiwi, S. T. Y., Rukiyah, A., Astika, W. D., Abdurrahman, R. T., and Umam, R. (2019). Behavior in Early Childhood (2–3) Years: A Case Study on the Use of Gadgets in Social Environments, International Journal of Innovation, Creativity and Change, Vol. 8, No. 8, pp. 384–404
27. Huda, S., Suherman, Komarudin, Syazali, M., and Umam, R. (2020). The Effectiveness of Al-Qurun Teaching Model (ATM) Viewed from Gender Differences: The Impact on Mathematical Problem-Solving Ability, Journal of Physics: Conference Series, Vol. 1467, 012001. Doi: 10.1088/1742-6596/1467/1/012001
28. Huda, S., Munifah, M., and Umam, R. (2020). Think Talk Write (TTW) Learning Model on Thinking Skills, Creativity, and Problem Solving, Journal of Gifted Education and Creativity, Vol. 7, No. 1, pp. 25–32.
29. Munifah, M., Tsani, I., Yasin, M., Tortop, H. S., Palupi, E. K., and Umam, R. (2019). Management System of Education: Conceptual Similarity (Integration) between Japanese Learning System and Islamic Learning System in Indonesia, Tadris: Jurnal Keguruan dan Ilmu Tarbiyah, Vol. 4, No. 2. Doi: 10.24042/tadris.v4i2.4893
30. Segeren, M. W., Fassaert, T. J. L., Kea, R., de Wit, M. A. S., and Popma, A. (2018). Exploring Differences in Criminogenic Risk Factors and Criminal Behavior between Young Adult Violent Offenders with and without Mild to Borderline Intellectual Disability, International Journal of Offender Therapy and Comparative Criminology, Vol. 62, No. 4, pp. 978–999. Doi: 10.1177/0306624X16674009
31. Tassé, M. J., Schalock, R. L., Balboni, G., Bersani, H., Borthwick-Duffy, S. A., Spreat, S., Thissen, D., Widaman, K. F., and Zhang, D. (2012). The Construct of Adaptive Behavior: Its Conceptualization, Measurement, and Use in the Field of Intellectual Disability, American Journal on Intellectual and Developmental Disabilities, Vol. 117, No. 4, pp. 291–303. Doi: 10.1352/1944-7558-117.4.291