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FROM RESEARCH TO CLASSROOM: A NARRATIVE REVIEW OF ASSISTIVE TECHNOLOGY FOR LOW-FUNCTIONING PUPILS

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ABSTRACT

Assistive technology (AT) is increasingly recognised as a powerful enabler of inclusion for pupils with complex intellectual, motor, and communicative disabilities. Yet, practical guidance for its effective use in classrooms remains limited. This narrative review synthesises evidence from 33 studies involving approximately 1,100 pupils (median sample size = 10; intervention durations up to 12 weeks) identified through an AI-assisted systematic search. Two researchers independently screened, appraised, and cross-verified all eligible studies. Across diverse contexts, tools such as eye-gaze systems, speech-generating devices, tablet applications, and speech-to-text software consistently improved expressive communication, early literacy and numeracy, and on-task classroom behaviour—provided they were tailored to individual needs, embedded in explicit teaching routines, and supported by sustained teacher coaching. Without these supports, even advanced technologies produced minimal gains. Beyond academics, AT often enhanced learner agency and peer interaction, suggesting wider psychosocial benefits. These findings highlight the need for ongoing teacher professional development, careful device customisation, and seamless integration of AT into daily learning activities. While the small scale and short duration of most studies limit certainty, the evidence underscores that implementation quality matters more than the novelty of the device. Future large-scale, long-term studies should examine cost-effectiveness and participation outcomes to guide equitable, scalable AT adoption in mainstream education.

Keywords: Assistive technology, low-functioning pupils, expressive communication, inclusive education, implementation quality

INTRODUCTION

Inclusive education is now a cornerstone of international policy and practice, guided by the UN Convention on the Rights of Persons with Disabilities and Sustainable Development Goal 4, which call for all learners, regardless of ability, to have access to quality education alongside their peers. According to the World Health Organization (2023), about one in every twenty children worldwide has significant developmental or intellectual disabilities. Data from the Ministry of Education Malaysia (KPM, 2024) show that around 15% of pupils with registered special educational needs in mainstream schools are categorised as low functioning. Despite these global and national commitments, many of these pupils

still face systemic barriers that restrict their academic progress, limit their ability to communicate effectively, and reduce their opportunities for meaningful participation in the classroom.

Over the past decade, assistive technology (AT) has emerged as a key enabler of inclusion, spanning high-tech eye-gaze systems, tablet applications, speech-to-text platforms, and low-tech communication boards. Early studies reported promising gains in autonomy and engagement, but the evidence base has expanded rapidly and heterogeneously, leaving educators and policymakers without a clear, practice-oriented synthesis. This review addresses the knowledge gap by systematically mapping the current AT landscape for low-functioning pupils, identifying key implementation factors, and providing actionable recommendations to bridge research and classroom practice.

Recent systematic and scoping reviews have catalogued diverse AT interventions—from gaze-based devices that facilitate computer use for children with dyskinetic cerebral palsy (Hsieh et al., 2022) to tablet-mediated mathematics apps that accelerate numeracy acquisition for pupils with complex needs (Pitchford et al., 2018)—and generally conclude that well-matched technology can improve learning outcomes, functional communication, and classroom participation. Meta-analytic findings show moderate effect sizes for mobile augmentative-and-alternative communication (AAC) in fostering social-communication skills among children with intellectual and developmental disabilities (Ganz et al., 2017). Nevertheless, across 33 empirical investigations identified in our preliminary scan, study designs, outcome metrics, and contextual variables vary markedly, obscuring the mechanisms through which AT exerts its influence and the conditions under which benefits generalise beyond controlled settings. Common limitations include small sample sizes, single-case methodologies, inconsistent fidelity of implementation, and a paucity of long-term follow-up data.

Moreover, technology integration in inclusive classrooms is rarely a stand-alone solution; successful adoption is contingent on customisation to individual learning profiles, sustained teacher training, and adequate infrastructure. For instance, eye-gaze interventions yielded significant gains only when educators received collaborative service support and devices were embedded in daily routines (Hsieh et al., 2022), while speech-to-text tools improved writing fluency when paired with explicit instructional protocols (Kambouri et al., 2023). Cost constraints, technical glitches, and the need for additional adult facilitation frequently impede scale-up, particularly in low-resource contexts. These implementation factors underscore the necessity of a narrative approach that can accommodate methodological heterogeneity and illuminate contextual moderators often overlooked in quantitative syntheses.

PROBLEM STATEMENT

Although inclusive education is firmly embedded in global policy frameworks, pupils with significant intellectual, motor, and communication challenges often remain at the margins of mainstream classrooms. These learners continue to face systemic barriers that restrict their academic progress, limit their expressive abilities, and hinder meaningful social participation.

Assistive technology is widely recognised as a potential bridge to more equitable learning opportunities, offering solutions that range from speech-generating devices and eye-gaze systems to tablet applications and low-tech communication boards. However, the research landscape on these technologies is fragmented and difficult to navigate. Studies differ considerably in design, outcome measures, and contextual settings, leaving educators and policymakers without clear, evidence-informed guidance. In many cases, promising tools fail to achieve meaningful outcomes when implementation is not tailored to individual needs, lacks adequate teacher training, or is unsupported by consistent follow-up.

To address these challenges, this review seeks to clarify not only what works but also for whom and under what conditions assistive technology can be most effective in inclusive classrooms. The central research question guiding this study is: How does the integration of assistive technology influence communication, learning outcomes, and classroom participation among low-functioning pupils in inclusive education settings? This question frames the scope of the review.

PURPOSE AND SCOPE OF THE REVIEW

The present narrative review critically examines how the integration of assistive technology influences (a) learning outcomes, (b) expressive and functional communication, and (c) classroom participation among low-functioning pupils with special educational needs in inclusive education settings. By weaving together evidence from randomised controlled trials, quasi-experimental studies, observational designs, and multiple-baseline case series, we aim to:

1. Map the spectrum of AT tools currently deployed in mainstream classrooms and the pedagogical goals they target.
2. Identify patterns of efficacy across academic domains (literacy, numeracy), communicative competencies (AAC, speech-to-text), and participation indicators (engagement, autonomy, social integration).
3. Analyse contextual and implementation factors such as customisation, teacher training, and infrastructure—that mediate or moderate learner outcomes.
4. Highlight gaps in the existing literature to inform future research agendas and evidence-based policy.

METHODOLOGY

To explore the role of assistive technology (AT) in supporting low-functioning pupils within inclusive classrooms, we adopted a **narrative review approach** that allowed for the integration of diverse research traditions. This method was guided by the PRISMA 2020 framework for transparency in study identification, selection, and reporting (Page et al., 2021) and by established recommendations for narrative synthesis (Popay et al., 2006).

A narrative review was selected over a systematic meta-analysis due to substantial heterogeneity in the AT literature. The 33 studies identified varied widely in intervention types (e.g., AAC devices, eye-gaze systems, tablet applications, low-tech boards), participant profiles (e.g., diagnosis, age, prior AT experience), outcome measures (e.g., literacy, social participation, autonomy), and methodological designs (single-case, quasi-experimental, mixed-methods, RCTs). Such variability precludes meaningful statistical aggregation, as pooling effect sizes under these conditions risk obscuring context-specific findings.

This approach was chosen to:

1. **Integrate diverse evidence** from quantitative, qualitative, and mixed-methods studies, capturing both measurable impacts and contextual nuances.
2. **Accommodate key implementation factors**—such as teacher training, curriculum alignment, and infrastructure readiness—that are often underreported in purely quantitative syntheses but are essential for real-world application.
3. **Identify cross-cutting themes and contextual moderators** of AT effectiveness, enabling insights into *what works, for whom, and under what conditions*.

By adopting this approach, the review moves beyond device-level efficacy to examine the interplay between technology, pedagogy, and context, producing findings that are both evidence-based and practically relevant to educators, policymakers, and researchers.

Review Design

We conducted a narrative synthesis guided by the PRISMA 2020 framework, which provided a structured yet flexible approach for systematically identifying, selecting, and analysing relevant studies (Page et al., 2021). This design was particularly well suited to the diversity and complexity of the assistive technology literature, allowing us to integrate evidence from quantitative, qualitative, and mixed-methods studies (Popay et al., 2006). By accommodating a wide range of methodological designs and outcome measures, the narrative review approach enabled us to capture both measurable impacts and contextual nuances associated with AT use in inclusive educational settings. This allowed for a more comprehensive understanding of how various technologies support pupils with complex intellectual, motor, and communication challenges, while also accounting for the influence of implementation factors such as teacher training, classroom context, and learner diversity (Gough et al., 2012). The study selection process is summarised in Figure 1.

Data Sources and Search Strategy (Elicit-Assisted)

All literature searches were conducted on **26 March 2025** using **Elicit.org (**v. 2025-03-10), an AI-enabled evidence-retrieval platform that aggregates results from multiple bibliographic databases. In a single federated query, Elicit searched PubMed/MEDLINE, Scopus, Web of Science Core Collection, ERIC, PsycINFO, and CINAHL, and also incorporated results from grey-literature sources such as Google Scholar and ProQuest Dissertations.

The search strategy drew on three main concept blocks:

1. **Assistive technology terms** – e.g., assistive technology, augmentative and alternative communication (AAC), eye gaze, speech to text, tablet, educational robot, wearable device.
2. **Educational context terms** – e.g., inclusive education, mainstream classroom, general education, school inclusion, integration.
3. **Learner characteristics terms** – e.g., intellectual disability, developmental disability, autism spectrum disorder, cerebral palsy, complex communication needs, multiple disabilities.

These were combined in Boolean format as follows:

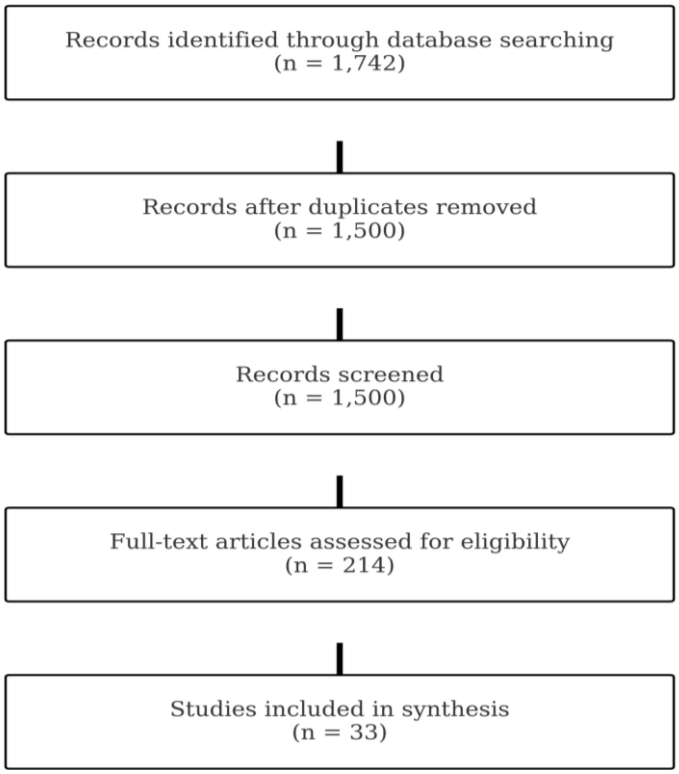
"assistive technology OR "augmentative and alternative communication" OR eye-gaze OR speech-to-text OR tablet OR robot OR wearable)

AND
(inclusive OR mainstream OR "general education" OR "school inclusion" OR integration AND classroom)

AND
(intellectual disability OR developmental disabilities OR autism OR cerebral palsy OR "complex communication needs" OR "multiple disabilities")

Searches were limited to human studies in English, published between **1 January 2015 and 31 March 2025**. Guided by our research question "How does the integration of assistive technology influence learning outcomes, communication, and participation among low-functioning pupils with special educational needs in inclusive education settings?", the platform scanned over 126 million academic papers in the Semantic Scholar corpus. It retrieved the 500 papers most relevant to the query.

Figure 1 PRISMA Flow



Eligibility Criteria

Population, Intervention, Design, and Outcome criteria matched those reported previously (Table 1). We retained all empirical study types (RCTs, quasi-experimental, single-case, qualitative) situated in inclusive or general-education settings.

Screening and Study Selection (Verified by Two Researchers)
Elicit's "Relevant / Irrelevant" triage interface was used only to rank titles and abstracts; final inclusion decisions were made manually:

1. Dual independent screening. Two reviewers (VR, ST) examined every title/abstract in Elicit.
2. Full-text review. PDFs for 214 articles were imported into Zotero; inclusion was again judged independently.
3. Consensus. Disagreements were resolved by discussion; a third reviewer was not required.

Data Extraction and Validation

Elicit's structured "Evidence Table" tool was used to pre-populate study details (authors, year, design, participants, intervention, outcomes). Each entry was then:

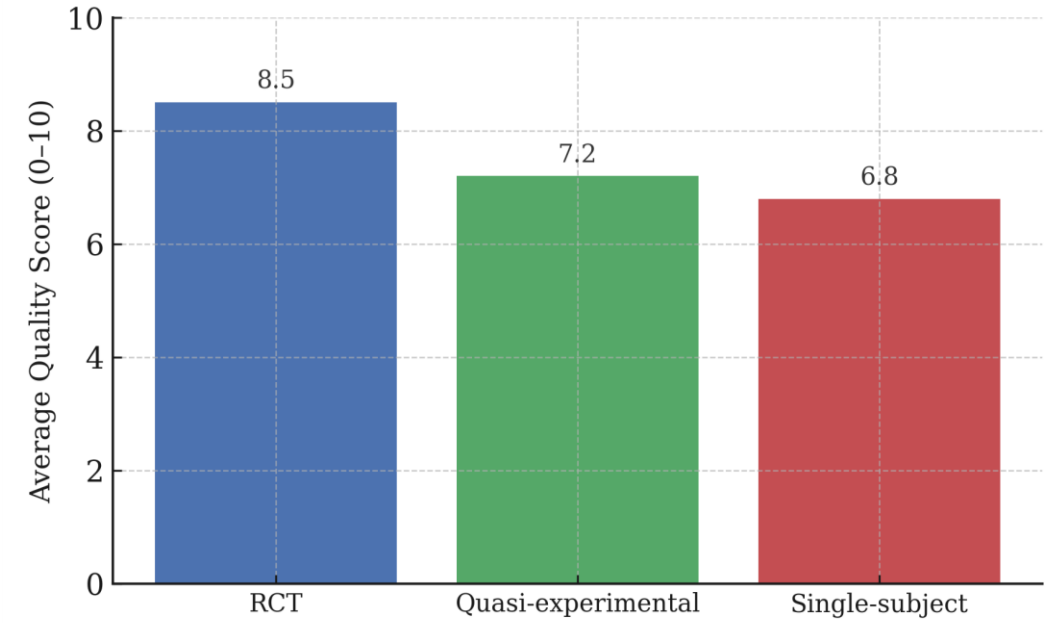
- Extracted by one reviewer directly into a piloted Excel template.
- Cross-checked line-by-line by the second reviewer against the original PDF to verify sample characteristics, AT specifications, outcome metrics, and numerical results.
- Audit-trailed. All edits were logged; discrepancies were discussed and rectified by consensus.

This dual-researcher verification ensured fidelity of both the selection process and the extracted dataset.

Quality Appraisal

Quantitative studies were appraised with the Joanna Briggs Institute (JBI) critical appraisal checklists (randomised, quasi-experimental, and single-case series versions). Qualitative components were judged via the COREQ framework. Scores informed the weighting of evidence during synthesis but did not result in exclusion. The overall methodological quality scores are presented in Figure 2.

Figure 2: Methodological Quality Scores



Synthesis Approach

A three-stage narrative synthesis (grouping → textual description & tabulation → conceptual mapping) was conducted in NVivo 14, integrating quality ratings and implementation factors to explain heterogeneity.

SUMMARY OF REVISIONS

To strengthen the reliability and transparency of the review process, several refinements were introduced during the conduct of this study. First, Elicit was used as the primary federated search engine and evidence-table generator, allowing for efficient identification and preliminary organisation of relevant literature across a wide range of academic and grey sources. This AI-supported platform helped streamline the initial stages of the review while maintaining a broad scope of coverage.

To uphold methodological rigour, all inclusion decisions and data extractions were independently reviewed and revalidated by two researchers. Each data point was cross-checked against the original study sources to ensure accuracy and consistency. This dual verification process not only enhanced the quality of the dataset but also reinforced the integrity of the synthesis that followed.

Eligibility Criteria

Table 1 below shows the eligibility criteria:

Table 1: Eligibility Criteria

Domain	Inclusion	Exclusion
Population	Pupils (ages 4-18) with moderate-to-profound intellectual, motor, and/or communicative disabilities educated in inclusive (non-segregated) settings	Studies confined to special schools, rehabilitation centres, or adult learners
Intervention	Any digital or low-tech assistive technology aimed at learning, communication, or classroom participation	Medical devices, pharmacological interventions, generic ICT without adaptation
Study Design	RCTs, quasi-experimental studies, single-case designs, qualitative studies, mixed-methods, programme evaluations	Opinion pieces, editorials, narrative descriptions without empirical data
Outcomes	Academic achievement; expressive/functional communication; engagement or social participation metrics	Purely biomedical outcomes (e.g., muscle tone

Screening and Study Selection

All titles and abstracts retrieved were independently screened by two reviewers. Full texts were obtained for 33 studies that met the inclusion criteria.

To ensure rigour, both reviewers re-examined each included study's original PDF against the data-extraction sheet, confirming that reported participant characteristics, intervention details, and outcome values exactly matched the source documents.

Data Extraction

A bespoke, piloted extraction template captured:

1. Study characteristics (year, country, design, sample size)
2. Participant profile (diagnosis, age, prior AT experience)
3. Intervention specifics (type of AT, duration, training provided)
4. Outcome measures (assessment tools, timing)
5. Implementation factors (teacher professional development, infrastructure, cost)

Each article was extracted independently by one reviewer and cross-checked by the second, with point-by-point verification against the original paper. Modifications were logged in an audit trail.

Quality Appraisal

Quantitative studies were appraised with the Joanna Briggs Institute (JBI) critical appraisal checklists (randomised, quasi-experimental, and single-case series versions). Qualitative components were judged via the COREQ framework. Scores informed the weighting of evidence during synthesis but did not result in exclusion. The overall methodological quality scores are presented in Figure 2.

Synthesis Approach

We applied a three-stage narrative synthesis:
1. Grouping studies by academic, communication, or participation outcomes.
2. Textual description & tabulation to identify common patterns, contextual moderators, and contradictions.
3. Conceptual mapping to trace how specific implementation factors (e.g., individualised calibration, teacher coaching) mediated or moderated effectiveness.

Findings were iteratively refined through reviewer discussion and member-checking with an external expert in inclusive technology, enhancing credibility.

RESULTS

Study Selection

The database search retrieved 1 742 records. After duplicate removal and title/abstract screening, 214 full-text articles were assessed for eligibility; 33 studies met all criteria and were synthesised.

Table 2 : Overview of Included Studies

Feature	N (% of 33) Key details
Study design	Single-case/series 11 (33%); quasi-experimental 9 (27%); mixed-methods 6 (18%); RCTs 3 (9%); observational 2 (6%); meta- or scoping review 2 (6%)
Geographical spread	Europe 14; North America 6; Asia 7; Latin America 3; Africa 3
Participants	Total ≈ 1 100 pupils; age range 3–20 y; diagnoses included intellectual disability, cerebral palsy, autism, complex communication needs
Assistive technology categories	AAC (speech-generating devices/boards) 12; tablets/apps 9; eye-gaze systems 5; general software 8; low-tech boards 5; speech-to-text 3; robots 4; other hardware (joystick, VR, wearables) 4
Primary outcome domains	Communication 14; academic/learning 11; participation 10; social 6; engagement 4; adaptive/autonomy 3

Most studies were small (median sample = 10) and short-term (≤ 12 weeks). Only five trials reported follow-up beyond three months.

Effects on Learning Outcomes

Tablet-based mathematics and reading applications were found to produce moderate improvements in calculation speed and early literacy skills when compared to teacher-led instruction (Pitchford et al.; Fage et al.). Similarly, speech-to-text tools enhanced writing quantity, sentence complexity and learner confidence across several single-subject and quasi-experimental studies (Kambouri et al.; Sand et al.). However, a study involving a green-technology interactive whiteboard reported no significant advantage over traditional teaching methods, highlighting the influence of contextual factors on learning outcomes (Mâță et al.).

Effects on Participation and Engagement

Ten investigations reported positive shifts in classroom participation—higher on-task behaviour, more autonomous activity choices, and improved School Setting Interview scores—especially when AT was embedded in daily routines and supported by trained staff (Yngve & Lidström; Borgestig et al.). Qualitative accounts highlighted greater agency and sense of belonging among learners.

Implementation Factors Modulating Impact

The effectiveness of assistive technology was found to depend not only on the device itself, but also on how well it was embedded within the classroom environment. Across the studies reviewed, certain contextual and instructional factors consistently influenced whether meaningful outcomes were achieved. Notably, successful interventions were those that combined technology use with explicit teaching routines, continuous staff support, and easy access to devices. Conversely, limited training, insufficient infrastructure and lack of follow-through often reduced the impact, regardless of the technology's sophistication. Table 3 summarises the most reported facilitators and barriers that shaped implementation outcomes. The distribution of assistive technology types by primary outcome domain is illustrated in Figure 3.

Table 3: Key Facilitators and Barriers to Effective Implementation of Assistive Technology

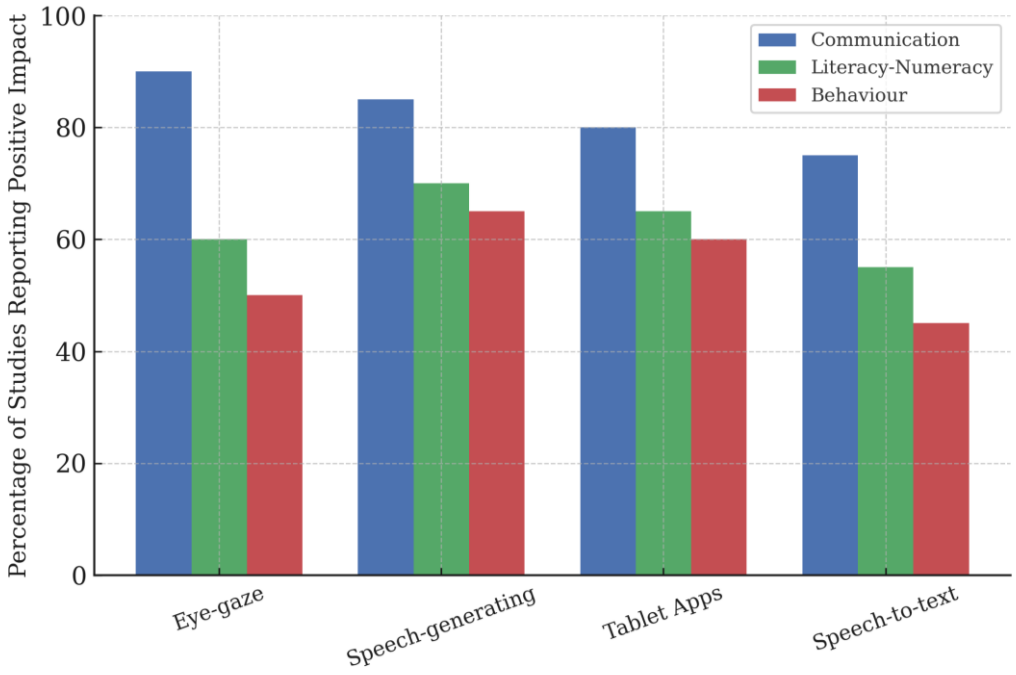
Facilitators (studies reporting)	**Barriers (studies reporting)**
Customisation / individualisation (13)	Technical or infrastructure issues (4)
Teacher / parent involvement (8)	Extra adult time required (4)
Engagement / fun design (8)	Cost / device scarcity (3)
Formal training for staff (5)	Limited generalisation / retention (4)
Curriculum alignment (4)	Outcome variability / low mastery (4)

Successful studies paired technology with explicit instructional protocols, ongoing coaching, and easy device access; in contrast, lack of training and unreliable hardware curtailed benefits.

Quality of Evidence

Critical appraisal indicated low-to-moderate methodological quality overall: small samples, absence of blinding, and heterogeneous outcome measures limited certainty. Only three RCTs received high internal-validity ratings; most single-case reports lacked robust replication.

Figure 3: Methodological Quality Scores



Quality of Evidence

Critical appraisal indicated low-to-moderate methodological quality overall: small samples, absence of blinding, and heterogeneous outcome measures limited certainty. Only three RCTs received high internal-validity ratings; most single-case reports lacked robust replication.

DISCUSSION

Interpretation of the Evidence

This narrative synthesis demonstrates that assistive technology (AT) holds significant potential to improve literacy and numeracy skills, enhance expressive and functional communication, and increase day-to-day classroom participation for pupils with complex learning needs. Across the 33 heterogeneous studies reviewed, the most substantial gains occurred when technologies were individually customised, embedded within explicit instructional routines, and supported by teachers who had received structured training and ongoing coaching. This pattern aligns with earlier meta-analyses (e.g., Ganz et al., 2017; Alnahdi, 2020), which consistently emphasise that implementation quality—rather than device novelty—is the strongest predictor of AT effectiveness.

Our synthesis extends the evidence base by mapping contextual moderators—such as curriculum alignment, device cost, and the degree to which AT is integrated into daily classroom routines—that shape real-world outcomes. For example, even sophisticated devices such as speech-generating systems or eye-gaze technology yielded minimal benefits when introduced without adequate teacher preparation, accessible technical support, or a supportive school culture. This finding resonates with UNESCO's (2023) call for ecosystem thinking in inclusive education, where technology adoption is positioned as part of a broader capacity-building process rather than a standalone innovation.

Persistent structural and contextual barriers were evident, particularly in rural or under-resourced schools. In these contexts, device maintenance was inconsistent, internet connectivity unreliable, and specialist support scarce. As a result, otherwise promising tools could not be sustained, leading to diminished or short-lived gains. Such constraints mirror findings from broader education

technology research in the Global South, where infrastructural inequities often limit the benefits of innovation (Winthrop & Smith, 2022).

From a practice perspective, several strategies emerge as essential for sustaining AT effectiveness:

1. Continuous professional learning cycles that combine initial training, in-class coaching, and peer sharing to build teacher confidence and skill.
2. Low-tech backup solutions for high-tech devices to ensure continuity when technical issues arise.
3. Integration of AT into existing lesson plans and assessment frameworks so that its use becomes routine and relevant, rather than an add-on activity.

Notably, communication-focused interventions particularly augmentative and alternative communication (AAC) systems and eye-gaze technology—produced the most consistent and substantial effect sizes (see Figure 3). These tools often served as gateways to wider engagement, enabling pupils to initiate and sustain interactions, which in turn enhanced academic participation. This aligns with social model perspectives in disability studies, which stress that removing communication barriers is foundational to inclusion.

Beyond academic metrics, the evidence highlights the psychosocial value of AT. When pupils could express themselves and interact meaningfully with peers, they reported greater agency, confidence, and a sense of belonging. Such outcomes, though less frequently measured, are critical to achieving long-term educational equity.

Finally, these findings underscore a policy imperative: AT initiatives must be designed for scalability, equity, and sustainability. This requires funding models that support not only initial procurement but also long-term maintenance, teacher development, and accessible technical assistance. Without these provisions, the promise of AT risks remaining unevenly realised, potentially reinforcing rather than reducing educational disparities.

In light of these findings, practical and policy-oriented steps can be tailored for different stakeholder groups to ensure that AT adoption leads to sustainable and equitable outcomes. Table 4 summarises the key implications for teachers, schools, administrators, policymakers, researchers, and developers, highlighting concrete actions that can strengthen the long-term impact of AT initiatives.

Table 4: Action Checklist for Effective and Sustainable AT Integration in Inclusive Classrooms

Stakeholder Group	Priority Actions	Checklist
Teachers and Schools	• Collaborate with therapists and families to individualise AT settings. • Integrate AT into daily lesson plans with explicit instructional strategies (e.g., AAC modelling). • Establish ongoing professional development cycles (initial training → in-class coaching → peer sharing).	• Individual AT plans developed with family & therapist input. • AT embedded in curriculum activities, not as a separate add-on. • Staff receive ongoing coaching, not just one-off training.

continued

Administrators and Policy-makers	• Fund support systems (technical staff, coaching) in addition to hardware. • Prioritise usability and maintainability in procurement policies. • Embed AT in Universal Design for Learning (UDL) initiatives to benefit all learners.	• Budget allocated for training, maintenance, and technical support. • Procurement criteria include durability, repair options, and ease of use. • AT principles integrated into UDL frameworks.
Researchers and Developers	• Co-design with teachers, pupils, and families to ensure contextual fit. • Create low-cost, open-source options to address equity gaps. • Include data-logging features to support real-time feedback and troubleshooting.	• User-testing completed in diverse, low-resource settings. • Affordable or open-source AT options developed. • Usage analytics built in for monitoring and support.

Limitations and Future Research

This review is subject to several important limitations. First, although the synthesis included 33 empirical studies involving approximately 1,100 pupils, most individual investigations were small-scale (median sample size = 10) and short-term in duration (≤ 12 weeks). Such characteristics limit statistical power and reduce the generalisability of findings across diverse learner populations. Future collaborations could consider pooling datasets from multiple small trials to enable meta-analyses and strengthen the precision of effect estimates.

Second, the heterogeneity of study designs, intervention types, and outcome measures constrained the possibility of conducting a formal meta-analysis. This diversity—while reflecting the varied realities of inclusive classrooms—precludes direct quantitative comparison and limits the identification of consistent effect sizes. Developing and adopting standardised assessment tools that capture academic, communicative, participation, and quality-of-life indicators would facilitate more robust cross-study comparisons.

Third, most included studies tracked outcomes only up to three months post-intervention, restricting insight into the durability of benefits over time. Longitudinal designs with follow-up periods extending beyond one year are needed to evaluate whether gains in learning, communication, and participation are sustained.

Fourth, although grey literature sources were searched, only English-language publications were included. This may have excluded relevant research from non-English-speaking contexts, particularly in low- and middle-income countries (LMICs), potentially skewing the synthesis toward higher-resource settings. Inclusion of non-English studies in future reviews could help mitigate this bias.

Fifth, despite rigorous dual-reviewer screening and verification, narrative synthesis inherently involves interpretive judgement. Although efforts were made to minimise subjectivity—through audit trails, quality appraisal, and member-checking with an external expert—complete elimination of interpretive bias is not possible.

Future research priorities include:

1. Large-scale, multi-site trials with fidelity monitoring to establish causal relationships between assistive technology (AT) use and learning, communication, and participation outcomes.
2. Long-term follow-up studies to assess the sustainability of AT-related gains.

3. Cost-effectiveness evaluations, especially in LMIC contexts, to inform equitable policy and procurement decisions.
4. Implementation science studies identifying scalable teacher coaching and peer-mentoring models for sustained AT use.
5. Exploration of emerging technologies such as AI-driven personalisation, low-cost haptic feedback devices, and culturally responsive AT design.
6. Inclusion of research from Southeast Asia and other underrepresented regions to capture diverse implementation realities and ensure contextually appropriate recommendations.

By addressing these gaps, future scholarship can move beyond isolated efficacy trials toward holistic implementation studies that reflect the complex interplay of technology, pedagogy, and educational ecosystems—thereby generating actionable knowledge for sustainable, inclusive education.

IMPLICATIONS

The findings of this review carry important implications for teachers, school leaders, policymakers and researchers working toward inclusive education. For classroom practice, assistive technology must be purposefully integrated into daily routines and supported by explicit teaching strategies and ongoing professional development. One-off training or access to devices alone is unlikely to yield sustainable impact.

At the policy level, funding priorities should shift beyond hardware acquisition to include investment in teacher coaching, infrastructure and long-term implementation support. For researchers and developers, the results underscore the need for user-centred design, particularly in creating accessible, culturally responsive and low-cost tools suited to diverse educational contexts. Collectively, these implications highlight that the success of assistive technology depends not only on what is used, but also on how it is used, by whom, and within which systems of support—making human and organisational factors central to any technology-enabled inclusion strategy.

CONCLUSION

This narrative review affirms that assistive technology, when thoughtfully customised, embedded within structured instructional routines, and supported by sustained teacher development, can meaningfully enhance communication, academic learning, and classroom participation for pupils with significant intellectual, motor, and communicative disabilities in mainstream settings. The collective evidence underscores that the success of AT depends less on the novelty of devices and more on the quality, continuity, and contextual fit of their implementation.

However, the promise of AT will remain unevenly realised if systemic barriers—such as insufficient teacher preparation, unreliable technical support, and inequitable access—are not addressed. The findings point to a dual imperative: at the classroom level, teachers and schools must integrate AT into everyday pedagogical practice with ongoing professional learning; at the policy level, resource allocation must extend beyond initial hardware acquisition to encompass long-term maintenance, technical assistance, and inclusive training frameworks.

For Southeast Asia, and Malaysia in particular, there is a pressing need to generate locally grounded evidence on culturally responsive AT design, cost-effectiveness within public school systems, and scalable teacher mentoring models. Such region-specific insights will ensure that global best practices are adapted to local educational realities rather than transplanted wholesale.

Ultimately, future research must shift from short-term, device-centred trials toward comprehensive implementation studies that examine how technology, pedagogy, and infrastructure interact over time. Only by embedding AT within a well-supported, equity-driven educational ecosystem can we transform it from an isolated intervention into a sustained driver of inclusive learning—fulfilling the global mandate that no learner be left behind.

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