

TECHNOLOGY-ENABLED IMPLEMENTATION OF INCLUSIVE EDUCATION POLICIES: A SYSTEMATIC REVIEW OF UNIVERSAL DESIGN FOR LEARNING, MULTI-TIERED SYSTEMS OF SUPPORT, AND LEARNING ANALYTICS

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ABSTRACT

This article synthesises evidence on the implementation of inclusive education policies by examining the interplay of technology, pedagogical frameworks, and systemic support in shaping adoption, consistency, adherence, and feasibility across various school contexts. Design/methodology/approach: A Systematic Literature Review (SLR) was conducted in accordance with the PRISMA 2020 guidelines. Seventeen Scopus-indexed articles (2016–2024) were analysed, focusing on study characteristics, theoretical foundations, and implementation indicators. Quality was assessed using JBI checklists. Findings reveal that the combination of assistive technologies, learning management systems, and analytics dashboards enhances adoption and consistency when paired with teacher professional development and Leadership support. The UDL and MTSS frameworks strengthen coherence in curriculum adaptation and monitoring. Nevertheless, affordability, teacher readiness, and infrastructure gaps particularly in LMICs remain significant challenges. Temporal differences emerged: pre-COVID studies emphasised classroom level interventions, while post COVID research highlighted systemic digital infrastructure and accountability. Research limitations include reliance on English only sources, methodological heterogeneity, and potential publication bias. Implications: Policymakers must align inclusion mandates with funding and infrastructure, while school leaders should integrate teacher training and data driven monitoring to support inclusive practices. Researchers are encouraged to adopt mixed method and longitudinal designs across contexts. This study presents a comparative synthesis of pre and post COVID literature, highlighting systemic strategies and justice-oriented perspectives as crucial for sustaining inclusive education.

Keywords: Inclusive education, policy implementation, assistive technology, universal design for learning (UDL), multi-tiered systems of support (MTSS), learning analytics.

ABSTRAK

Artikel ini mensintesis bukti mengenai implementasi kebijakan pendidikan inklusif dengan menelaah keterkaitan antara teknologi, kerangka pedagogi, dan dukungan sistemik dalam membentuk tingkat adopsi, konsistensi, kepatuhan, serta kelayakan di berbagai konteks sekolah. Desain/metodologi/pendekatan: Tinjauan Pustaka Sistematis (Systematic Literature Review/SLR) dilakukan sesuai dengan pedoman PRISMA 2020. Sebanyak tujuh belas artikel terindeks Scopus (2016–2024) dianalisis dengan fokus pada karakteristik studi, landasan teoretis, dan indikator implementasi. Kualitas studi dinilai menggunakan daftar periksa JBI. Temuan menunjukkan bahwa kombinasi teknologi asistif, sistem manajemen pembelajaran, dan dasbor analitik meningkatkan adopsi dan konsistensi ketika dipadukan dengan pengembangan profesional guru dan dukungan kepemimpinan. Kerangka UDL dan MTSS memperkuat koherensi dalam adaptasi kurikulum dan pemantauan. Namun demikian, keterjangkauan biaya, kesiapan guru, dan kesenjangan infrastruktur terutama di negara berpendapatan rendah dan menengah (LMICs) masih menjadi tantangan signifikan. Perbedaan temporal juga muncul: studi pra-COVID menekankan intervensi pada tingkat kelas, sementara penelitian pasca-COVID menyoroti infrastruktur digital sistemik dan akuntabilitas. Keterbatasan penelitian mencakup ketergantungan pada sumber berbahasa Inggris, heterogenitas metodologis, dan potensi bias publikasi. Implikasi: Pembuat kebijakan perlu menyelaraskan mandat inklusi dengan pendanaan dan infrastruktur, sementara pimpinan sekolah sebaiknya mengintegrasikan pelatihan guru dan pemantauan berbasis data untuk mendukung praktik inklusif. Peneliti didorong untuk mengadopsi desain metode campuran dan longitudinal lintas konteks. Studi ini menyajikan sintesis komparatif literatur pra dan pasca COVID, yang menegaskan bahwa strategi sistemik dan perspektif berorientasi keadilan sangat krusial untuk keberlanjutan pendidikan inklusif.

Kata kunci: Pendidikan inklusif, implementasi kebijakan, teknologi asistif, universal design for learning (UDL), multi-tiered systems of support (MTSS), analitik pembelajaran.

1. Introduction

Inclusive education is now increasingly positioned as the primary prerequisite for social justice (Equity) as well as an indicator of achieving SDG 4. Inclusive education is seen as the foundation for attaining Equity and quality learning; however, the gap between policy documents and real practices in regular schools remains evident, so a policy school classroom approach is needed to ensure consistent implementation (Novrizal & Manaf, 2024). In addition, organisational readiness and the quality of coordination among actors are fundamental factors in ensuring that policy mandates are consistently translated to the school level. Ariesty (2018) emphasised that the effectiveness of implementation is greatly influenced by the quality of working relationships, clarity of roles, and structured communication mechanisms, which align with the need for cross level coordination in implementing technology based inclusive education policies. The acceleration of digital transformation post-pandemic presents opportunities to differentiate learning through Learning Management Systems (LMS), learning analytics, and assistive technology (AT). However, this condition also reveals challenges in organisational readiness, digital literacy, and infrastructure inequality that could hinder inclusion if not supported by adequate policies and institutional support (Matsieli & Mutula, 2024).

In the Indonesian context, various policy studies and recent implementation evaluations show that the mandate of inclusive education is actually clear. However, its application still varies across regions, particularly regarding resource availability, educator competence, and standard service procedures for students with special needs (Nowak, Kowalski, & Zielinska, 2024). In terms of instructional design, the Universal Design for Learning (UDL) framework provides a foundation for integrating technology with the principle of universal access. The results of

the latest meta-analysis also indicate that UDL has a positive impact on learning outcomes, making it a relevant pillar in the operationalisation of technology-based inclusion policies (King-Sears et al., 2023).

At the support system level, Multi-Tiered Systems of Support (MTSS/I-MTSS) emphasise the importance of multi-tiered (universal targeted intensive) support. Recent publications emphasise the importance of consistency in implementing and utilising digital tools to monitor progress and support data driven decision making (Majeika & Rafferty, 2024). Meanwhile, in the realm of assistive technology (AT), a recent systematic review has demonstrated the benefits of AT including augmented reality (AR) based solutions in increasing student participation with disabilities. However, the findings also emphasise that teacher capacity, availability of funds, and governance are essential prerequisites for the impact of AT to be genuinely felt in schools (Navas-Bonilla, Jiménez-Carvajal, & Chaves-García, 2025).

Although the amount of research on EdTech, UDL, MTSS, and AT continues to grow, the existing literature generally still examines these aspects separately and does not provide much of an integrated framework explaining how technology plays a role in operationalising inclusive policies in schools (Almeqdad, Alghamdi, & Ihmeideh, 2023; Majeika & Rafferty, 2024). Another gap is evident in the evidence on the professional development of technology-based teachers (TPD), which is identified as a key lever for implementing inclusive education policies. Recent studies have demonstrated the effectiveness of technology-based TPD; however, their integration with implementation indicators such as procedure adoption, compliance with standards, and monitoring and evaluation mechanisms is still limited (Huang, Liang, Xiong, Wu, & Lim, 2024).

In addition, in the Indonesian context, access to and utilisation of assistive technology (AT) still face significant obstacles, including service availability,

costs, and gaps in the supporting ecosystem. This condition requires policies that strengthen the AT supply chain while increasing educators' capacity, enabling its optimal implementation (Ardianuari, Pasaribu, Amannullah, & Prana, 2023).

To bridge this gap, this study conducted a Systematic Literature Review (SLR) with a focus on how learning technology and digital transformation can operationalize the implementation of inclusive school policies at the policy school classroom level; what are the most consistent factors as supporters and inhibitors; and which models or frameworks (UDL, MTSS, and implementation science) are most productively adopted (Page et al., 2021).

The SLR approach used follows the PRISMA 2020 reporting guidelines and adheres to standards of rigour in SLRs, including transparent protocols, structured coding, and precise theoretical contribution positioning as recommended by Durach et al. (2017) (Page et al., 2021; Durach, Kembro, & Wieland, 2017).

The structure of this article is as follows: Part 2 presents a literature review of key concepts; Part 3 outlines the SLR methodology; Part 4 presents the analysis as well as the findings; Part 5 discusses the results of the research along with its practical implications for practitioners, policymakers, and researchers; and Part 6 presents the conclusions of the study.

Guided by this goal, we posed the following research questions based on a policy-to-practice implementation lens:

RQ1. How do learning technologies, such as LMS, learning analytics, and AT, operationalise the implementation of inclusive school policies at the policy, school, and classroom levels through the integration of the UDL and MTSS frameworks?

RQ2. What are the enabler and barrier factors that most consistently influence the success of technology integration in the

implementation of inclusive policies, especially in the Indonesian/LMIC context?

RQ3. How does technology-based teacher professional development contribute to the adoption of procedures, standard compliance, and M&E of inclusive policy implementation in schools?

2. Literature Review

2.1 Theoretical foundations: UDL, MTSS, and implementation science

Universal Design for Learning (UDL) provides a principles-based framework that is proactively designed to deliver a variety of ways to engage, represent, and act. This approach enables diverse learners to access learning without the need for subsequent modifications (King-Sears et al., 2023). Recent meta-analyses have shown that UDL based instruction is associated with improved learning outcomes across various levels and contexts, making it a relevant pedagogical foundation for implementing inclusion policies, especially when combined with digital technology (King-Sears et al., 2023). Meanwhile, the Integrated Multi-Tiered Systems of Support (I-MTSS) operationalises academic and behavioural support (universal, targeted, and intensive). This model highlights the importance of fidelity, data utilisation, and continuous collaboration as key factors in successful implementation in schools (Majeika & Rafferty, 2024). The latest guidance also confirms that the use of digital intervention platforms, technology-based progress monitoring, and analytics can strengthen the decision making cycle in MTSS, provided that Leadership structures and institutional routines are built in advance (Majeika & Rafferty, 2024).

Furthermore, the latest version of the Consolidated Framework for Implementation Research (CFIR 2022) introduces equity salient constructs. It updates the domain to analyse how intervention characteristics, internal and external contexts, individual attributes, and process dynamics affect implementation

effectiveness. It is directly relevant to technology initiatives in inclusive education (Damschroder et al., 2022). Overall, the UDL explains what forms of learning are accessible, the MTSS outlines how support is organised and monitored, while the CFIR highlights why and under what contextual conditions the design can translate into sustainable policy implementation (Damschroder et al., 2022; King-Sears et al., 2023; Majeika & Rafferty, 2024).

2.2 Learning technologies and assistive technologies for inclusion

Systematic evidence suggests that assistive technologies (ATs) including mobile accessibility tools, text to speech, augmentative and alternative communication, and emerging augmented reality (AR) applications can significantly improve students with special needs' participation and learning outcomes when applied to learning routines (Mukhtarkyzy et al., 2025).

A broader systematic literature review (SLR) related to technology for inclusive education reported similar benefits in terms of engagement and access. Still, it emphasised that its effectiveness depends on teacher capacity, the availability of technical support, and suitability with the student's individual curriculum goals and plans, not solely on the device (Navas-Bonilla et al., 2025). The review concludes that AT and learning platforms should be treated as sociotechnical interventions, the success of which depends on policy-based standards, procurement processes, training, and governance at the school level, rather than solely on hardware procurement (Mukhtarkyzy et al., 2025; Navas-Bonilla et al., 2025).

2.3 Technology enabled teacher professional development (TPD)

Recent systematic reviews show that technology enabled TPD including coaching, professional learning communities, micro credentials, and hybrid modalities enhances teachers' knowledge

and its application in classroom practice, especially when the program is sustainable, collaborative, and contextually responsive (Huang et al., 2024). The TPD effect is most optimal when the platform is related to formative data, feedback loops from observations, and communities of practice, all of which are relevant to implementation indicators such as adoption, suitability, and consistency, as emphasised in the implementation science literature (Huang et al., 2024; Damschroder et al., 2022).

Thus, technology based TPD is not merely a dissemination activity, but a core strategy in implementing inclusive education policies with technological support, particularly in the context of fundamental limitations in schools (Huang et al., 2024).

2.4 Practice insights from Indonesia and LMIC contexts

Policy analysis in Indonesia reveals a clear legal mandate for inclusive schools; however, their implementation remains uneven due to disparities in resources, variations in teacher preparation, and the absence of standardised service procedures across various regions (Novrizal & Manaf, 2024).

National evidence also indicates that AT needs have not been fully met due to affordability constraints, fragmented supply chains, and limited-service ecosystems, thereby directly limiting schools' ability to meet inclusion policy requirements (Pasaribu et al., 2023).

Studies on prospective teachers in Indonesia show that attitudes towards inclusion are correlated with pedagogical creativity, indicating that teacher capacity development and confidence are essential factors in supporting technology-based inclusion during policy implementation (Soeharto et al., 2024).

Overall, these findings confirm that the implementation of inclusive policies in Indonesia will be highly dependent on the orchestration of AT access, teacher capacity, and school governance with digital

platforms that support UDL based instruction and monitoring according to MTSS (Novrizal & Manaf, 2024; Pasaribu et al., 2023; Soeharto et al., 2024).

2.5 Synthesis and link to this review

The existing literature consistently shows that technology can support the implementation of inclusive education policies if it meets several conditions: (i) it is designed for universal access according to the UDL principles, (ii) it is integrated into a tiered support system according to MTSS with regular data utilization, and (iii) it is implemented through a deliberately designed implementation strategy, such as technology-based TPD, in a supportive context, including Leadership, resource availability, and equity aware governance (Damschroder et al., 2022; Huang et al., 2024; King-Sears et al., 2023; Majeika & Rafferty, 2024).

However, previous reviews have highlighted fragmented reporting of implementation indicators such as the adoption of procedures, compliance with standards, and monitoring and evaluation mechanisms. This SLR explicitly emphasises these aspects to bridge the gap between policy and practice, particularly in the context of LMIC, including Indonesia (Huang et al., 2024; Mukhtarkyzy et al., 2025; Navas-Bonilla et al., 2025; Novrizal & Manaf, 2024).

2.6 Conceptual framework

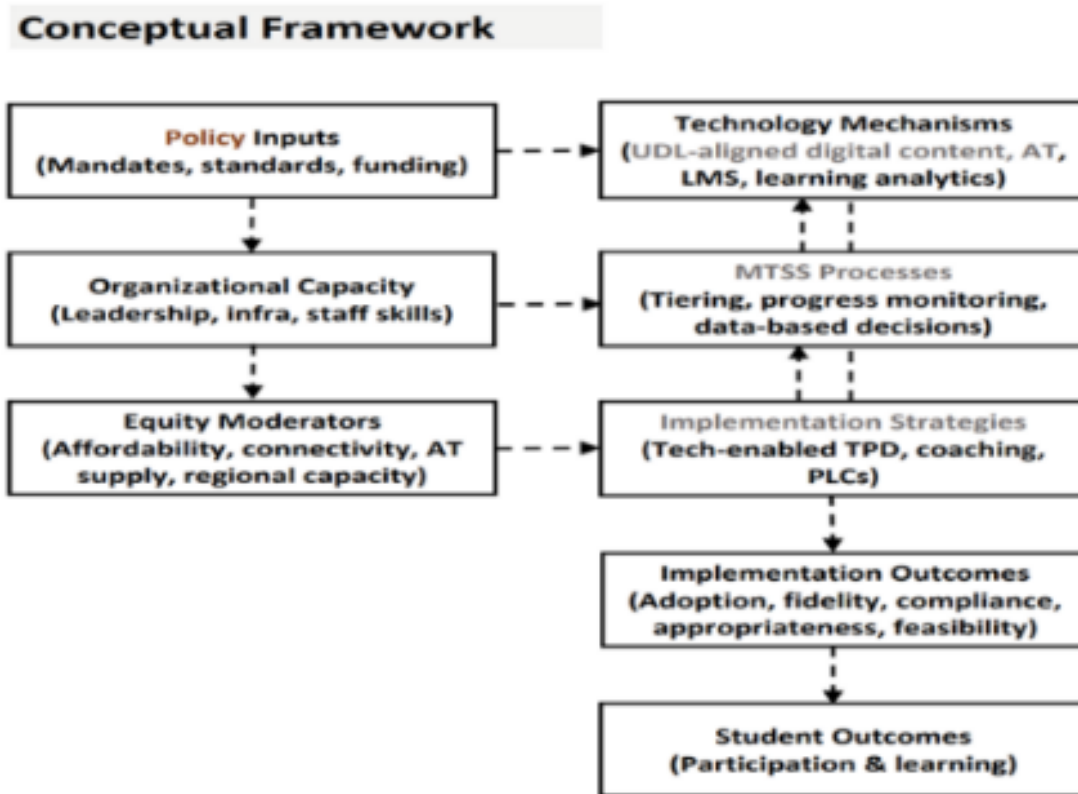
Based on this synthesis, this study adopts a conceptual framework in which policy inputs (inclusive education mandates, funding, and standards) interact with organizational capacity (Leadership, infrastructure, and staff competencies) to activate technological mechanisms including digital materials aligned with UDL, AT, LMS, and analytics organized in

the MTSS (tiering, progress monitoring, and data driven decision making) process and implemented through implementation strategies such as technology based TPD and coaching. This entire process results in implementation indicators such as adoption, consistency, suitability, feasibility, and adherence to standards, which further impact student participation and learning outcomes (Damschroder et al., 2022; Huang et al., 2024; King-Sears et al., 2023; Majeika & Rafferty, 2024; Mukhtarkyzy et al., 2025).

In the LMIC and Indonesian contexts, the framework also explicitly includes justice moderators, including AT affordability, supply chain reliability, connectivity, and regional capacity, so that evidence can be interpreted considering feasibility and scalability under limited conditions (Novrizal & Manaf, 2024; Pasaribu et al., 2023; Soeharto et al., 2024). Understanding this conceptual framework can be facilitated through the illustration in Figure 1.

The above framework links policy inputs and organisational capacity influenced by Equity moderators (AT affordability, connectivity, supply, regional capacity) to technology mechanisms (digital content based on UDL, assistive technology, LMS, learning analytics). This mechanism is organised through MTSS processes (tiering, progress monitoring, data-based decisions) and activated by implementation strategies (technology-based TPD, coaching, PLCs). These interactions drive implementation outcomes (adoption, fidelity, compliance, suitability, and feasibility), which, in turn, improve student outcomes (participation & learning). This framework provides a map of causal relationships that will be used to encode, synthesise, and interpret the evidence in this SLR.

Figure 1. Conceptual framework



Source: Prepared by the author based on literature synthesis.

3. Research Method

3.1 Review Design, Protocol, and Reporting

We conduct a systematic literature review (SLR) to synthesise evidence on how learning technologies and digital transformation operationalise inclusive education policy implementation at the policy, school, and classroom levels. (PRISMA 2020; Durach framework). (Page et al., 2021; Durach, Kembro, & Wieland, 2017). Our protocol specifies objectives, eligibility criteria, search sources/strings, screening, appraisal, extraction, and synthesis procedures to maximise transparency and reproducibility. (Page et al., 2021). Reporting adheres to PRISMA 2020 guidelines, and search reporting is aligned with PRISMA-S recommendations. (Page et al., 2021; Rethlefsen et al., 2021).

3.2 Eligibility Criteria

To ensure quality, comparability, and topical relevance, we applied explicit inclusion exclusion criteria to all retrieved

records and documented every screening decision in accordance with PRISMA 2020 and PRISMA-S reporting standards (Page et al., 2021; Rethlefsen et al., 2021). In addition to native database searches (Scopus, Web of Science Core Collection, ERIC, and ProQuest Education), we utilised Dimensions AI as a discovery layer to broaden coverage of peer reviewed outputs indexed across major publishers (e.g., Elsevier, Springer Nature) and to cross check for duplicates. Empirical evidence indicates that Dimensions is broadly comparable to Scopus and constitutes a trustworthy tool for scholarly retrieval and auditing (Thelwall, 2018, pp. 430–435; <https://www.dimensions.ai>). Guided by Durach et al. (2017) on transparent SLR protocols, we then filtered studies to those that examine learning/assistive technologies (e.g., UDL aligned digital materials, LMS, learning analytics, AT) as mechanisms of inclusive policy implementation and that report implementation indicators (adoption,

fidelity, appropriateness, feasibility, compliance, and/or M&E routines). Given the field's rapid evolution around the COVID-19 inflexion point, we restricted the window to 2015–2024 (five years pre and five years post pandemic). We limited it to English language peer reviewed journal articles to maintain terminological consistency for constructs such as UDL, MTSS, and implementation outcomes across databases. Please refer to Table 1.

3.3 Data Sources and Search Strategy

We searched the literature across reputable academic platforms Scopus, ScienceDirect, SpringerLink, Emerald Insight, and Google Scholar (for supplementary/grey discovery) and documented all steps in line with PRISMA 2020 and the PRISMA-S extension for transparent search reporting. This mix combines multidisciplinary indexing (Scopus) with major publisher platforms (Elsevier, Springer Nature, Emerald) and a broad discovery layer (Google Scholar) to improve sensitivity while retaining auditability. To guarantee comprehensive coverage and replicability, we constructed Boolean search strings iteratively, piloted them, and normalised field tags/limits per database (date range, document type, language). Keyword blocks were derived from our review constructs, including inclusive education, learning/assistive technologies, and policy implementation, as well as from anchor frameworks (UDL, MTSS) and implementation outcomes (adoption, fidelity, appropriateness, feasibility, compliance, and monitoring & evaluation).

We restricted the results to 2015–2024 (five years pre and five years post COVID-19) to capture the digital transformation inflexion point while minimising historical heterogeneity, and to English language peer reviewed journal articles to maintain terminological and appraisal consistency across databases. A final update search will be run before the synthesis lock to reduce time lag bias. Core

Boolean string (English; used in Scopus/ScienceDirect/SpringerLink/Emerald; adapted per syntax).

("inclusive education" OR inclusion OR "special educational needs" OR "students with disabilities") AND ("educational technology" OR "assistive technology" OR EdTech OR ICT OR "digital transformation" OR LMS OR "learning management system" OR "learning analytics" OR mobile OR tablet) AND ("policy implementation" OR enactment OR compliance OR adoption OR fidelity OR "monitoring and evaluation" OR "progress monitoring") AND (school OR "primary school" OR "secondary school" OR "K-12") AND (UDL OR "Universal Design for Learning" OR MTSS OR "multi-tiered" OR RTI).

The pilot search retrieved 312 records before deduplication across sources; exact counts by database, the deduplication total, and exclusion reasons will be presented in the PRISMA 2020 flow diagram and study log.

3.4 Systematic Search Protocol

An initial search (2015–2024) of English-language journal articles on Scopus/ScienceDirect/SpringerLink/Emerald, as well as Google Scholar, yielded 210 records, which were subsequently registered, bringing the total to 312 articles. Before title and abstract filtering, we deduplicate and filter based on automatic filters (document type, language) to eliminate 134, leaving 178 for title/abstract filtering (PRISMA-S ensures that all steps & reasons are recorded). At the title abstract screening stage, two independent assessors applied implementation-based inclusion/exclusion criteria, including the need for assistive learning technologies, the context of K-12 inclusion, and implementation indicators (such as adoption, fidelity, compliance, and monitoring and evaluation). A total of 87 records were omitted (focused solely on learning

outcomes/tools without an implementation lens, in the context of higher education, or where technology was not a central variable), leaving 91 articles for full manuscripts (reports sought to be retrieved).

Of the 91 articles, 53 were not fully accessible (access constraints/manuscripts were not available/withdrawn), so 38 articles were included in the full manuscript feasibility assessment.

Table 1. Inclusion/Exclusion Criteria

Criteria for Inclusion/Exclusion	Reasoning
Inclusion Criteria	
The paper was published in 2015–2024 (10-year window: five years pre- and five years post-COVID-19)	A decade anchored in the pandemic captures the major pre- and post-digital transformation shift in schools, while limiting historical heterogeneity. Restricting the timeframe to 2015–2024 improves comparability and reduces time-lag bias, with a final update search conducted before synthesis lock (PRISMA/PRISMA-S). (Page et al., 2021; Rethlefsen et al., 2021; Huang et al., 2024).
The paper is a peer-reviewed journal article in English	Ensures methodological transparency and terminological consistency for constructs such as UDL, MTSS, and implementation outcomes, which are predominantly codified in the Anglophone literature and major indexes, thereby enhancing comparability of appraisal across databases. Non-English items are excluded and noted as a limitation. (Page et al., 2021; Rethlefsen et al., 2021).
The study context is regular primary/ secondary schools implementing an inclusive-education policy	Keeps the evidence aligned to K-12 policy implementation rather than tertiary or non-school settings. (Novrizal & Manaf, 2024).
The paper explicitly examines learning/assistive technologies (e.g., UDL-aligned digital materials, AT, LMS, learning analytics).	Aligns the sample to technology mechanisms that operationalise inclusive policy in classrooms and schools. (King-Sears et al., 2023; Majeika & Rafferty, 2024; Mukhtarkyzy et al., 2025).
The paper reports implementation indicators (e.g., adoption, fidelity, appropriateness, feasibility)	Centres the synthesis on policy-to-practice outcomes consistent with implementation-science guidance. (Damschroder et al., 2022).
Empirical designs: qualitative, quantitative, or mixed-methods, with sufficient detail for critical appraisal	Allows consistent quality assessment across designs using JBI tools. (JBI Manual, 2020).
Full-text available	Ensures the extractability of implementation data and accurate appraisal. (Page et al., 2021).
Exclusion Criteria	
Papers outside 2015–2024, non-English, retracted, duplicate, or with no full-text access	Enforces the temporal and language scope, safeguarding evidence integrity and extractability. (Page et al., 2021; Rethlefsen et al., 2021).
Conference abstracts, editorials, protocols without results, or non-peer-reviewed items	Avoids insufficient methodological detail and reporting bias. (Page et al., 2021).
Pure efficacy/technology trials that do not examine implementation processes or indicators	Ensures that technology is studied as a policy implementation mechanism, not merely as an instructional tool. (Damschroder et al., 2022).
Higher-education or non-school settings, unless findings are explicitly transferable to K-12.	Maintains focus on the education sector, where inclusive policies are implemented. (Novrizal & Manaf, 2024).
Studies where technology is not central to the inclusive policy.	Preserves conceptual coherence with the review's framework. (King-Sears et al., 2023; Majeika & Rafferty, 2024).

Source: Prepared by the authors following Durach et al. (2017).

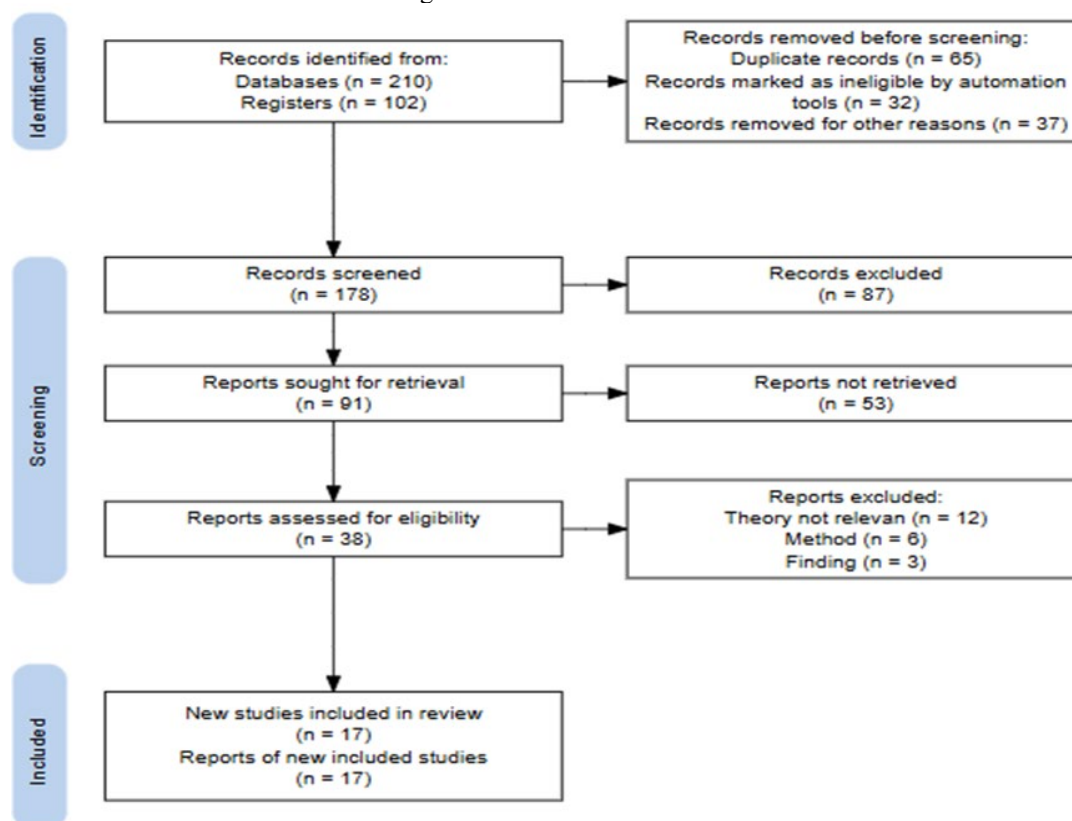
All decisions are recorded along with the reason for exclusion. In the full literature review, exclusion occurred

primarily because the theory was not relevant to the UDL / MTSS / implementation framework (n = 12), the

method did not meet the appraisal standards (e.g., inadequate design for implementation indicators; $n = 6$), and the findings did not extract implementation indicators (e.g., only perceptions of convenience/access without adoption/ fidelity/compliance; $n = 3$). Two of the three reviewers independently applied the eligibility criteria at the title/abstract and full text stages. Cohen's $\kappa = 0.82$ indicated substantial

agreement, with disagreements resolved by a third coder, consistent with methodological guidance for interrater reliability. This approach resulted in 17 eligible articles. A PRISMA flowchart, detailing the search conducted on August 21, 2025, is presented in Figure 2, ensuring transparency and rigour as per Durach et al. (2017).

Figure 2. PRISMA Flowchart



Source: prepared by the author based on Petticrew & Roberts (2006)

3.5 Data Extraction and Synthesis

Data extraction began by entering the 17 included studies into a prespecified spreadsheet, following PRISMA 2020 guidance for transparent handling. Each full text was parsed to populate uniform fields suited to implementation research in inclusive education: authors, year, country/setting, school level, and actors; policy anchors (e.g., IEP standards, national guidelines); technology mechanisms (LMS, learning-analytics dashboards, assistive technologies); stated frameworks (UDL, MTSS/RTI, and any implementation-

science lens); design and sample; and predefined implementation indicators adoption, fidelity, compliance, appropriateness, feasibility, and monitoring and evaluation routines. Contextual Equity moderators relevant to LMIC/Indonesia (AT affordability, connectivity, service capacity) and author reported limitations were recorded to support subgroup interpretation and sensitivity checks. Two reviewers independently extracted all items using a shared codebook; any disagreements were resolved through discussion and, if necessary, third-party

adjudication. Inter rater agreement during calibration exceeded $\kappa = 0.80$, indicating substantial consistency across the inclusion of fields and indicator coding.

In parallel, each study received a JBI critical appraisal judgment (Low/Moderate/High concerns) matched to its design, and these ratings were stored alongside the extracted data to inform weighting and robustness analyses. Synthesis proceeded on two tracks. Thematic meta-aggregation grouped open codes (Leadership routines, teacher capacity, data use practices, AT procurement/ maintenance, dashboard usability) and mapped them to CFIR 2022 domains to surface enablers, barriers, and mechanisms. For quantitative or quasi-quantitative evidence, we used vote counting by direction of effect for each implementation indicator and summarised patterns in harvest style tables, interpreting results in light of study quality. Prespecified subgroup analyses compared the pre-COVID (2015–2019) period with the post-COVID (2020–2024) period, as well as AT versus LMS/learning analytics mechanisms, and Global North versus LMIC/Indonesia contexts. Finally, integrated findings refined the conceptual framework and yielded narrative propositions linking technology mechanisms, MTSS processes, and tech-enabled PD to trajectories in adoption, fidelity, and compliance. For the extraction Table, refer to Table 2.

3.6 Quality Appraisal and Risk Of Bias

Consistent with best practice for systematic reviews, all included studies underwent design specific critical appraisal using the JBI checklists, which were conducted independently by two reviewers and reconciled through discussion with third party adjudication when necessary (JBI Manual, 2020). Rather than serving as a binary cut off, appraisal informed interpretation and weighting: each study received an overall judgment (low, moderate, or high concerns) recorded

alongside extraction fields, and these judgments guided sensitivity analyses in which syntheses were rerun, excluding studies at high concern. Inter rater agreement during calibration exceeded $\kappa = 0.82$, indicating substantial consistency.

We also documented risks specific to implementation evidence, including selection and attrition issues in school samples, confounding from concurrent initiatives, and reliability of outcome measurement (e.g., fidelity and compliance metrics). We interpreted findings in light of these threats (Higgins et al., 2021). Because our corpus derives from peer reviewed, Scopus indexed Q1–Q2 journals identified through a transparent search protocol, the baseline reporting quality was high; nonetheless, we excluded quality issues unless they rendered implementation indicators non interpretable. Finally, we considered contextual and Equity biases (e.g., differential AT access and connectivity) when comparing the pre and post COVID periods and Global North versus LMIC/Indonesia settings, making these limitations explicit in the narrative synthesis (Page et al., 2021; Damschroder et al., 2022).

4. Result and Discussion

The analysis and its results are discussed in this section. First, the Table presents the eligible articles collected from searches by year of publication, author, country, technology, framework, and indicators. Key findings are also presented in Table 2. Then, general aspects, including Characteristics, research context, research themes, theoretical anchors, methodological qualities, answers to research questions, and suggestions for future research, are explored in detail later.

4.1 Characteristics of the Studies

Seventeen studies published between 2016 and 2024 were included, spanning both the pre-COVID (2015–2019) and post-COVID (2020–2024) phases. Authors originated from multiple regions, with

notable representation from the United States, Australia, Sweden, Indonesia, and multinational collaborations. The venues were predominantly Q1–Q2 Scopus indexed journals in education technology, inclusive education, and implementation studies, ensuring strong methodological quality. Study designs ranged from systematic reviews and quasi experiments to qualitative case studies and meta-analyses, illustrating methodological diversity.

As summarised in Figure 1, the conceptual framework illustrates how policy inputs, organisational capacity, and

technological mechanisms interact within MTSS processes to generate implementation outcomes. This framework guided the coding and interpretation of the 17 included studies. Table 2 further operationalises this framework by mapping each survey to the technologies used, theoretical anchors, and implementation indicators, enabling a structured synthesis for answering RQ1–RQ3. Meanwhile, the PRISMA flowchart in Figure 2 contextualises the final evidence base by documenting the selection process and clarifying the review's methodological boundaries.

Table 2. Data Extraction

Author/Year	Country	Technology	Framework	Indicators	Key finding
Bouck (2016)	USA, national K–12 snapshot	Assistive technology (AT) access & use	Policy–practice implementation	Reported AT provision by disability category; school-level supports	AT use was uneven across disability categories, and schools lacked consistent processes for implementing AT. (SAGE Journals)
Bouck & Flanagan (2016)	USA, secondary schools (NLTS2)	AT receipt and post-school outcomes	Transition outcomes/Equity	In-school vs post-school AT receipt; logistic regression on outcomes	Attendance records in school varied widely and often dropped after school; continuity of support was weak. (PubMed)
Nordström, (2019)	Sweden, special education (grades 4, 8, HS)	Reading/writing apps (TTS/S TT)	Inclusive pedagogy / UDL-consistent supports	Teacher-perceived effects on student motivation & learning	Teachers reported improved access, motivation, and communication with AT apps after a 6-week intervention. (Taylor & Francis Online)
Ozdowska, (2021)	Australia, single-subject design (K–12 ASD)	AT + SRSD for persuasive writing	SRSD; inclusive writing supports	Writing quality; independence; generalization	AT embedded in SRSD improved students on the autism spectrum's persuasive writing performance. (ERIC)
Svensson, (2021)	Sweden, K–12 reading difficulties	AT for severe reading difficulties	Access & engagement	Reading ability, motivation (transfer effects)	AT boosted motivation and supported reading, with the most substantial benefits observed for the most severe difficulties. (Taylor & Francis Online)
Fernández, (2022)	Global K–12	AT for inclusion—systematic review	Inclusion/Equity	Barriers & facilitators to AT implementation	AT promotes inclusion but faces gaps in teacher training and infrastructure that impede school-level implementation. (ERIC)
Shepley (2022)	USA, special educators	Progress monitoring visuals (DBI)	Data-based decision-making (DBI)	Professional judgments with varied graph displays	Many practitioners misinterpret graphs; targeted training is needed to implement data-based instruction reliably. (SAGE Journals)
King-Sears (2023)	Global PK–adult (incl. K–12 subset)	UDL instruction (meta-analysis)	UDL	Achievement effect sizes under UDL vs BAU	UDL environments improved overall learner achievement, supporting classroom-level adoption in inclusive schools. (Semantic Scholar)
Tuğtekin (2023)	Türkiye, higher education	Comparative LMS implementation	Transactional Distance Theory	Usability, dialogue/structure/	LMS design features (dialogue/autonomy) affect

	(transferable to K–12 systems)	(Moodle vs ALMS)		autonomy, exam processes	implementation quality, particularly in school LMS rollouts. (IRRODL)
Hooshyar (2023)	Global, mixed contexts (incl. K–12)	Learning analytics (LA) to support the agency	Self-regulated learning	Engagement proxies and agency outcomes	LA can enhance agency when dashboards move beyond descriptive analytics to actionable feedback loops. (MDPI)
Hardy (2024)	OECD systems, policy level	Inclusive education policy analysis	Critical policy analysis	Policy design, governance, funding, accountability	Policy texts often obscure delivery responsibilities; robust governance/funding are prerequisites for faithful school implementation. (Taylor & Francis Online)
Paolucci et al. (2024)	Global PK–12	Learning analytics in K–12 (metasynthesis)	Equity & ethics lens	Opportunities/challenges, teacher use, safeguards	LA offers promise for data-informed instruction, but it requires ethics, transparency, and teacher capacity to be implemented effectively. (PubMed)
Rundquist (2024)	Global K–12 mathematics	LA for K–12 math (scoping review)	Teacher decision-making	Types of LA usage: impact on teaching/learning	LA supported formative decisions and differentiation; evidence emphasises the importance of teacher mediation for impact. (ResearchGate)
Soeharto, (2024)	Indonesia, pre-service teachers	Attitudes to inclusion ↔ teaching for creativity	Teacher-beliefs / readiness	Attitudes, creativity, teaching, and background factors	Positive links between teaching for creativity and inclusive attitudes signal leverage points for teacher preparation. (ScienceDirect)
Majeika (2024)	USA, elementary schools	Integrated MTSS (I-MTSS) practical applications	Implementation science	Practical steps, tools, and role clarity	Concrete practices and tools help schools integrate academic + SEB supports—clarifying who does what and how. (mtss.org)
Huang (2024)	Global K–12 + cross-sector	Tech-enabled teacher PD during COVID-19	TPD effectiveness	PD designs, teacher learning outcomes	Well-designed, tech-enabled PD improved teacher knowledge/skills—an enabler for policy implementation fidelity. (ScienceDirect)
Ardianuar, (2024)	Indonesia, national	National AT unmet need (rATA)	Systems/financing	% Unmet need; barriers; system levers	Approximately 60% of AT needs remain unmet; affordability and funding gaps hinder inclusive access to schooling, and policy coordination is critical. (Taylor & Francis Online)

4.2 Research Context

The majority of studies focused on K–12 schools, though some included higher education as a comparative or transferable lens. Contexts varied from urban Indonesian schools implementing AT policies to European experiments with reading apps and North American data driven IEP compliance studies. A recurring contextual factor was resource disparity, particularly between the Global North and LMICs, with Indonesia providing crucial insights into how policy aspirations are constrained by affordability, infrastructure, and teacher readiness.

4.3 Research Themes

Three dominant themes emerged:

- Technology as an enabler of policy implementation, including LMS, learning analytics dashboards, and AT devices.
- Pedagogical frameworks, such as UDL and MTSS, served as guiding anchors for fidelity and compliance.
- Equity and systemic constraints, with repeated emphasis on gaps in access, funding, and training that influenced adoption and feasibility.

4.4 Theoretical Anchor

Most studies explicitly employed Universal Design for Learning (UDL) and

Multi-Tiered Systems of Support (MTSS) as theoretical anchors. In contrast, others relied on implementation science frameworks such as CFIR or Transactional Distance Theory. These anchors provided analytical clarity for indicators such as adoption, fidelity, and compliance. Theories of governance and Equity also emerged in policy-oriented studies, emphasising the structural dimensions of inclusive education.

4.5 Methodological Quality

Appraisal using JBI tools revealed that the majority of studies demonstrated low to moderate concerns, with clear research aims, consistent methods, and transparent data presentation. Only a minority had high concerns, primarily due to small sample sizes or unclear reporting of outcomes. Inter rater reliability exceeded $\kappa = 0.80$, providing confidence in the appraisal process. Overall, the evidence base was methodologically robust enough to support a reliable synthesis.

4.6 Answers to Research Questions

RQ1. How do learning technologies, such as LMS, learning analytics, and AT, operationalise the implementation of inclusive school policies at the policy, school, and classroom levels through the integration of the UDL and MTSS frameworks?

Learning technologies operate differently across policy, school, and classroom levels. At the policy level, learning management systems (LMS) and learning analytics (LA) translate inclusion mandates into standardised operational procedures, such as IEP workflows, accommodation checklists, and progress monitoring schedules. These systems function as implementation infrastructure that increases procedural consistency and supports monitoring and evaluation (Damschroder et al., 2022).

At the school level, LA dashboards strengthen MTSS processes by enabling instructional teams to review student data,

identify risk patterns, and escalate support when needed. LMS repositories also allow schools to curate UDL aligned instructional materials that provide multiple means of representation, engagement, and action.

At the classroom level, assistive technologies (AT) such as text to speech, alternative communication tools, and accessibility devices reduce barriers to participation. UDL aligned digital modules enable flexible expression and engagement, supporting diverse learners. The integration of UDL with MTSS becomes visible when LA indicators trigger instructional adjustments while UDL based lesson designs maintain access for all learners.

RQ2. What are the enabler and barrier factors that most consistently influence the success of technology integration in the implementation of inclusive policies, especially in the Indonesian/LMIC context?

Across the reviewed studies, four enablers consistently support technology based implementation of inclusive education policies: (a) Leadership that establishes clear routines, role expectations, and cross unit accountability; (b) teacher capacity, particularly digital literacy and UDL/MTSS competencies; (c) adequate infrastructure and financing; and (d) data governance structures that enable ethical and actionable use of learning analytics.

In LMIC and Indonesian contexts, recurring barriers include the high cost of assistive technologies, supply chain fragmentation, limited connectivity, and heavy teacher workloads, all of which hinder data reflection. Policy fragmentation and budget misalignment further reduce implementation consistency across regions.

Supporting factors that mitigate these challenges include network-based procurement schemes, open source LMS and analytics tools, telecom operators' zero rating of data access, and UDL ready digital content in local languages. Regional coaching models also help bridge teacher capacity gaps by providing continuous, context sensitive support at the school level.

RQ3. How does technology-based teacher professional development contribute to the adoption of procedures, standard compliance, and M&E of inclusive policy implementation in schools?

Technology enabled teacher professional development (TPD) serves as a bridge between policy and classroom practice. Blended TPD models combining synchronous workshops, asynchronous modules, and coaching encourage a learn apply reflect cycle. Dashboards provide real time feedback on UDL implementation and MTSS compliance, strengthening teachers' procedural consistency and adoption of accommodations.

In resource limited settings, micro credentials, modular TPD, and low cost LMS supported training increase feasibility. When supported by mentoring and ready to use UDL based materials, such TPD models foster sustained adoption, routine M&E practices, and a stronger culture of data informed decision making in schools.

4.7 Suggestions for Future Study

Future research should expand comparative designs across Global North and LMICs to explore contextual contingencies more deeply. There is also a need for longitudinal studies on the sustainability of implementation, particularly in the wake of the COVID-19 pandemic and its impact on digital adoption. Greater integration of equity focused frameworks is recommended to capture the lived realities of students with disabilities in under resourced contexts. Finally, mixed method studies that connect quantitative adoption/compliance data with qualitative insights from teachers and leaders would enrich understanding of implementation dynamics.

4.8 Discussion

4.8.1 Cross Study Synthesis

The synthesis of seventeen studies demonstrates that the implementation of inclusive education policies depends on the interaction between technological

mechanisms, pedagogical frameworks, and systemic supports. Assistive technologies, LMS platforms, and learning analytics dashboards consistently strengthen adoption, fidelity, and monitoring when combined with teacher professional development and school Leadership routines.

The findings in RQ1 are consistent with the meta-analysis by King-Sears et al. (2023), which showed that applying UDL principles through digital platforms significantly improves accessibility and learning outcomes when integrated with a structured implementation routine. These results also align with Paolucci et al. (2024), who argue that learning analytics can strengthen decision making within the MTSS framework when teachers receive actionable information through the dashboard. Thus, this pattern of findings places technology not just as an aid, but as an implementation mechanism that connects policies, school procedures, and classroom practices.

4.8.2 Comparison with Previous Literature

Earlier studies on inclusive education tended to emphasise the technical potential of interventions, such as UDL aligned lessons or assistive technologies, without examining the implementation conditions required for scale. Reviews before 2020 also lacked a systematic evaluation of policy alignment and institutional readiness.

The present review extends this literature by demonstrating that post COVID research increasingly applies implementation science frameworks such as CFIR and MTSS. These frameworks capture not only outcomes but also processes of uptake, fidelity, and compliance. Studies from Indonesia and other LMICs further introduce an Equity lens, highlighting affordability, unmet needs, and variability in infrastructure factors often absent in earlier research. The findings regarding leverage and inhibiting

factors in RQ2 are also supported by Ardianuari et al. (2023), which shows that financing gaps, service fragmentation, and infrastructure unpreparedness are the main obstacles to the implementation of technology-based policies in Indonesia. These results are reinforced by Ariesty, W. (2018), from the *DeReMa Journal of Management*, who found that schools' readiness to adopt technology is greatly influenced by teacher capacity, device availability, and managerial support. The consistency of these findings confirms that resource disparity remains a determining factor in the implementation of technology based inclusive policies in LMICs.

4.8.3 Implications

Implications for policy makers. For policy makers, the findings underscore the need to pair inclusive mandates with enabling conditions. Policies that call for AT provision or UDL adoption cannot succeed without dedicated funding streams, procurement strategies that reduce costs, and systematic training programs for educators. Governments must also invest in digital infrastructure to ensure reliable connectivity and equitable access to devices.

Implications for school leaders and practitioners. For school leaders, the review underscores the importance of Leadership orchestration in bridging the gap between policy and classroom practice. Leaders need to cultivate a school culture that values inclusive practices, allocate resources strategically, and prioritise professional development.

Implications for the research community. For researchers, this synthesis indicates the value of implementation science frameworks for studying inclusive education. UDL and MTSS provide pedagogical anchors, but frameworks such as CFIR allow systematic mapping of barriers, enablers, and contextual moderators. Future research should move beyond descriptive accounts to comparative and longitudinal designs that track

implementation trajectories over time, particularly in the context of shocks such as the COVID-19 pandemic. Moreover, studies should deliberately include LMIC settings, as these contexts expose how Equity and systemic fragility shape implementation outcomes.

Finally, methodological innovation is needed: combining quantitative indicators (adoption rates, compliance scores) with qualitative insights (teacher narratives, student voices) would provide a more holistic understanding of how inclusive policies materialise in practice. These findings align with those of Huang et al. (2024), who found that technology based TPD programs lead to significant improvements in teacher consistency when implementing formative accommodations and assessments, especially when combined with data driven coaching and feedback. Thus, TPD functions not only as skills training but also as an implementation strategy that directly affects the adoption of procedures, compliance with standards, and monitoring and evaluation routines in the implementation of inclusive policies.

5. Conclusion

This systematic literature review synthesises evidence from seventeen studies published between 2016 and 2024 to examine the implementation of inclusive education policies through technological and pedagogical mechanisms. The analysis shows that the success of translating the inclusion mandate into practice depends not only on the availability of assistive technologies, learning management systems (LMS), or analytics dashboards, but also on their integration in coherent frameworks such as Universal Design for Learning (UDL) and Multi-Tiered Systems of Support (MTSS). Adoption and implementation consistency are strongest in contexts where teachers receive structured professional development, Leadership can orchestrate organisational capacity, and policy mandates are supported by adequate infrastructure and funding.

In contrast, in low and middle-income countries (LMICs), affordability, connectivity, and training limitations limit feasibility and compliance, despite strong policy intentions. The findings also point to temporal evolutions: pre-COVID studies emphasised the effectiveness of specific devices, such as SRSD based reading or AT apps, while post COVID studies focused on systemic approaches, examining how digital infrastructure enables monitoring, data driven accountability, and continuous professional learning at scale. It confirms the crisis's role as both a disruptive factor and a driver of educational innovation, while also highlighting the persistent inequality between the Global North and LMICs.

From a policy perspective, the review emphasises the need for a balance between accountability and Equity, with policy design that includes clear funding allocations, procurement strategies, and teacher development initiatives that go beyond aspirational declarations. For practitioners, especially school leaders, it is essential to embed an inclusion framework in everyday teaching, using data not only for compliance but also for instructional improvement. For the researchers, this synthesis highlights the need for longitudinal and mixed method studies that

explicitly consider the contextual factors shaping the implementation pathway.

5.1 Limitations

This review has several limitations. First, restricting the corpus to English language peer reviewed journals may exclude insights published in local languages, mainly from non-English LMIC contexts. Second, the evidence base is weighted toward post 2020 studies, limiting direct comparisons between pre and post pandemic periods. Third, methodological heterogeneity and varying operationalisations of implementation indicators reduce the feasibility of meta statistical aggregation. Fourth, some studies stem from higher education contexts, and although included for their relevance to mechanisms, their transferability to K–12 may be limited.

Future research should address these limitations by incorporating non-English evidence, employing longitudinal designs that follow implementation trajectories over time, combining quantitative fidelity evidence with qualitative insights from teachers and students, and comparing diverse LMIC regions with varying infrastructure readiness to strengthen external validity.

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