Jurnal EVOLUSI

Please cite this article as:
Kamarudin, M. N. A., Mohd Zuri Ghani, Muhammad Amin, Mohd Noor Afiq, Muhammad Amran, Muhammad Fitri Radzuan, … Syaidah Che Danial. (2025). Empowering inclusive learning: The role of technologies, artificial intelligence (AI), and information technology (IT) in special education. *Jurnal Evolusi* , *6*(2), 98–107. https://doi.org/10.61688/jev.v6i2.424

EMPOWERING INCLUSIVE LEARNING: THE ROLE OF TECHNOLOGIES, ARTIFICIAL INTELLIGENCE (AI), AND INFORMATION TECHNOLOGY (IT) IN SPECIAL EDUCATION

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Received 30 September 2025, Revised 20 October 2025, Accepted 31 October 2025, Published 30 November 2025

ABSTRACT

The integration of emerging technologies, particularly Artificial Intelligence (AI) and Information Technology (IT), is reshaping the landscape of special education. As inclusive education becomes a global imperative, these digital innovations offer transformative potential in supporting learners with diverse needs. This paper explores the current applications, challenges, and opportunities presented by AI and IT in special education, with a focus on the Malaysian context. Guided by action research methodology, the study examines how educators, caregivers, and stakeholders perceive and utilise AI-driven tools and IT platforms to enhance teaching and learning. Data collected through interviews, observations, and document analysis revealed that AI tools significantly improve student engagement, especially among learners with autism and learning disabilities. However, barriers such as infrastructure limitations, lack of teacher training, and cultural adaptation of technology persist. This paper concludes by recommending inclusive digital strategies, localised AI solutions, and targeted professional development to bridge gaps in accessibility and equity in special education.

Keywords: *Artificial Intelligence (AI); Information Technology (IT); Special Education; Inclusive Learning; Assistive Technology; Action Research; Educational Innovation; Malaysia*

INTRODUCTION

Inclusive education is a cornerstone of equitable and just societies, affirming every learner's right to access quality education regardless of ability or background. In recent years, the emergence of Artificial Intelligence (AI) and Information Technology (IT) has introduced powerful tools for transforming teaching and learning, particularly in the context of special education. As digital technology becomes more embedded in the global educational ecosystem, there is growing recognition of its potential to empower students with disabilities by overcoming barriers to communication, cognition, and participation (UNESCO, 2020).

In special education, technologies such as speech recognition software, AI-powered learning platforms, and assistive devices have demonstrated tangible benefits in supporting learners with autism spectrum disorder (ASD), attention-deficit/hyperactivity disorder (ADHD), speech impairments, and other developmental conditions. These technologies facilitate differentiated instruction, personalise content delivery, and provide alternative modes of communication (Al-Azawei et al., 2017).

However, while the promise of AI and IT in special education is substantial, their implementation is often uneven—particularly in low- and middle-income countries such as Malaysia. Challenges including digital infrastructure gaps, lack of educator readiness, and cultural mismatch of imported technologies limit their full potential. Moreover, ethical concerns related to bias, data privacy, and over-dependence on automation remain pressing issues that require careful navigation (Holmes et al., 2022).

Malaysia has made significant strides in advancing inclusive education through policy and practice. The Malaysia Education Blueprint 2013–2025 underscores the commitment to ensure equal opportunities for students with special educational needs (SEN). Yet, the integration of advanced educational technologies into mainstream and special education remains inconsistent across regions and school types (Ministry of Education Malaysia, 2022).

This paper investigates how AI and IT technologies are being deployed in Malaysian special education settings, explores the perceptions of key stakeholders, and identifies systemic barriers and enabling factors. Using a qualitative action research approach, this study contributes to a growing body of evidence aimed at promoting inclusive digital transformation in education systems.

Research Objectives and Questions

The advancement of AI and IT has opened new possibilities for improving access and outcomes in special education. However, the success of such technological integration depends heavily on how effectively these tools are selected, adapted, and implemented within diverse learning environments.

To guide this study, the following research objectives (RO) were formulated:

i. RO1: To explore the types and effectiveness of AI and IT technologies currently used in special education settings.
ii. RO2: To investigate the perceptions of educators and caregivers regarding the integration of AI and IT tools in inclusive education.
iii. RO3: To assess the barriers and enabling factors influencing the implementation of AI and IT technologies in special education, especially in resource-constrained environments.

Based on these objectives, the study is framed by the following research questions (RQ):

i. RQ1: What types of AI and IT technologies are currently in use within Malaysian special education, and how effective are they in addressing students' learning needs?

ii. RQ2: How do educators and caregivers perceive the role of AI and IT in supporting inclusive education for learners with special needs?
iii. RQ3: What are the primary challenges and opportunities related to the adoption and use of AI and IT technologies in special education settings?

These questions were designed to facilitate a holistic understanding of both the technical and human dimensions involved in using technology to support inclusive learning. They also serve to inform strategic recommendations for policy, practice, and future innovation.

LITERATURE REVIEW

Technologies in Special Education: A Global Perspective

Globally, the application of digital technologies and AI in special education has evolved significantly over the past decade. Assistive technologies—such as screen readers, alternative keyboards, and AAC (Augmentative and Alternative Communication) systems—have long been used to support learners with physical and communication disabilities (Alper & Raharinirina, 2006). However, the emergence of AI has introduced tools that offer real-time adaptive learning, emotional recognition, and predictive diagnostics tailored to individual needs (Holmes et al., 2022).

AI-enabled applications now assist in early screening for learning disorders (e.g. dyslexia, ADHD), personalise instructional content, and enable multimodal learning through gamified environments (Luckin et al., 2016). These tools can significantly enhance accessibility and student engagement, particularly for children with autism spectrum disorder (ASD) and other neurodevelopmental conditions (Pillai & Subramanian, 2021).

Despite these advances, global disparities remain in the implementation and scaling of such tools. Barriers include high costs, lack of culturally sensitive designs, limited teacher training, and ethical concerns regarding data privacy and algorithmic bias (UNESCO, 2021).

Malaysian Context: Current Practices and Gaps

Malaysia has taken meaningful steps to promote inclusive education through policy and infrastructure, such as the Malaysia Education Blueprint 2013–2025, which emphasises equal access to quality education for students with special educational needs (Ministry of Education Malaysia, 2022). The implementation of Inclusive Education Programs (IEPs) in mainstream schools, and the integration of ICT in teaching, has created a foundation for further innovation.

Several pilot initiatives have explored the use of digital and AI-based solutions. For instance, mobile applications such as "iSINA" (for sign language), and locally developed speech therapy tools, are being introduced in selected government schools. However, these initiatives often remain isolated and face sustainability challenges due to resource constraints and lack of inter-agency coordination (Ismail et al., 2020).

Studies by Alwi et al. (2019) and Wahab et al. (2021) highlight that while educators in Malaysian special schools are generally positive about technology use, many express concerns about the lack of training, limited access to modern devices, and the absence of standardised guidelines for AI integration.

The Role of Educators and Caregivers

Educators and caregivers play a critical role in the successful deployment of technology in special education. According to Ghalebandi et al. (2019), the perception and readiness of teachers determine the extent to which AI tools are adopted and adapted for individual learners.

In Malaysia, teacher competency in ICT is variable. While some schools benefit from proactive leadership and dedicated ICT support, others—especially in rural areas—struggle with connectivity issues and outdated infrastructure (Noor et al., 2022). Caregivers, on the other hand, have expressed appreciation for technologies that promote autonomy and communication among their children but often lack digital literacy themselves.

Gaps in Literature

The following gaps are evident in current literature:

1. Lack of longitudinal studies evaluating the sustained impact of AI-based tools in special education contexts.
2. Limited research on localised, culturally adapted AI applications for learners with disabilities in Southeast Asia.
3. Insufficient engagement with caregivers in the design and evaluation of educational technologies.
4. Few action research-based frameworks that incorporate continuous stakeholder feedback in AI and IT implementation for special needs education.

This study seeks to address these gaps by employing an action research methodology involving teachers, administrators, and caregivers, while focusing on real-world applications and challenges of AI and IT in Malaysian special education environments.

METHODOLOGY

This study employed a qualitative action research approach to examine the implementation of AI and IT tools in special education settings in Malaysia. Action research was selected due to its participatory and iterative nature, allowing for real-time observation, stakeholder engagement, and context-sensitive reflection (Kemmis & McTaggart, 2005).

Research Design

The action research framework followed a four-phase cycle:

1. Planning – Identifying the technological practices, research objectives, and study locations.
2. Action – Supporting the ongoing use or introduction of AI/IT tools in selected special education environments.
3. Observation – Documenting interactions, challenges, and behavioural outcomes among stakeholders.
4. Reflection – Analysing data and discussing findings collaboratively with participants for further action and policy recommendations.

This cyclical design ensured that insights were co-generated with educators and caregivers, leading to practical improvements and local relevance.

Research Sites and Participants

The research was conducted in five educational settings:

i. Three government special education schools (Peninsular Malaysia and East Malaysia)
ii. Two inclusive mainstream schools with dedicated SEN (Special Educational Needs) units

Participants were selected using purposive sampling and included:

i. 10 Special education teachers
ii. 5 School administrators
iii. 5 Parents or caregivers of children with disabilities
iv. 3 Educational IT officers or specialists

All participants had experience in or were currently involved with the use of technology in special education.

Data Collection Methods

Multiple qualitative techniques were used to ensure data triangulation:

1. Semi-structured Interviews
    i. Conducted with teachers, caregivers, and IT staff
    ii. Focused on perceptions, practices, and challenges with AI/IT use
    iii. Each interview lasted approximately 45–60 minutes
2. Participant Observations
    i. Researchers observed AI/IT-assisted classes over an 8-week period
    ii. Attention was paid to student engagement, communication behaviours, and teacher facilitation techniques
3. Document Analysis
    i. Reviewed lesson plans, IEPs (Individualised Education Plans), and school ICT policies
    ii. Examined existing evaluation reports of tech-based interventions
4. Focus Group Discussions
    i. Conducted with educators at the end of the cycle to validate findings and gather collaborative recommendations

All data collection was conducted in compliance with ethical research procedures, including informed consent and anonymity of participants.

Data Analysis

Data were analysed using thematic analysis (Braun & Clarke, 2006). Transcribed interviews and observation notes were uploaded into NVivo for coding. Key themes were generated inductively based on recurring patterns aligned with the three research questions.

Initial codes (e.g. “increased student participation”, “infrastructure limitations”, “teacher digital confidence”) were grouped under broader categories, such as:

i. Technological impact
ii. Stakeholder perception
iii. Implementation barriers

Reflexive memos were maintained throughout to ensure positionality and minimise researcher bias.

Trustworthiness and Rigour

To ensure credibility and reliability:

i. Member checks were conducted with participants to validate the interpretation
ii. Data triangulation was applied using multiple data sources
iii. Peer debriefing was used to review coding categories and emergent themes
iv. Audit trails were maintained throughout the research process

FINDINGS AND DISCUSSION

RQ1: What types of AI and IT technologies are currently in use within Malaysian special education, and how effective are they in addressing students' learning needs?

Table 1*:*
Findings and Discussion for RQ1

Themes	Findings	Interpretation
Types of Technologies Used	- TTS and speech-to-text tools - AAC apps (e.g., Proloquo2Go) - AI gamified apps (e.g., Otsimo) - Robotics kits	Consistent with global adoption of AI for adaptive learning; mostly pilot-based in Malaysia
Student Engagement	- Improved focus among ASD learners - Increased comprehension via multimodal inputs - Active participation in group work	Supports the claim that AI enhances engagement and inclusivity in SEN settings
Limitations in Adoption	- Tech use concentrated in urban areas or pilot programs	Reflects infrastructure disparity and digital divide

RQ2: How do educators and caregivers perceive the role of AI and IT in supporting inclusive education for learners with special needs?

Table 2:
Findings and Discussion for RQ2

Themes	Findings	Interpretation
Teacher Perceptions	- 8/10 teachers: AI improves autonomy and lesson efficiency - Some feel unprepared and undertrained	Reflects both optimism and lack of digital readiness in Malaysian special education
Caregiver Feedback	- Caregivers value communication apps - Need for simpler interfaces and training	Positive family-level impact but highlights the need for inclusive UX and community digital literacy
Shared Concerns	- Digital fatigue - Mismatch of foreign content - Lack of standard guidelines	Underscores ethical, pedagogical, and cultural considerations in adopting imported AI tools

RQ3: What are the primary challenges and opportunities related to the adoption and use of AI and IT technologies in special education settings?

Table 3:
Findings and Discussion for RQ3

Themes	Findings	Interpretation
Challenges	- Infrastructure gaps (internet, outdated devices) - Limited teacher training - Data privacy concerns	Barriers are systemic and require national-level investment and upskilling
Opportunities	- Strong willingness among younger teachers - Growing local edtech ecosystem - National digital education policies	Malaysia is well-positioned for expansion of AI/IT in SEN if policies are inclusive and targeted

Table 4:
Synthesis of Key Findings Across Research Questions

Research Question	Key Insight
RQ1	AI and IT tools significantly improve student engagement and learning outcomes for SEN students.
RQ2	Teachers and caregivers see benefits but face skill gaps and technology mismatch.
RQ3	Structural barriers exist, but Malaysia's digital transformation offers major opportunities.

]

RECOMMENDATION

[The integration of Artificial Intelligence (AI) and Information Technology (IT) in special education presents a transformative opportunity to enhance accessibility, engagement, and learning outcomes for students with special educational needs (SEN). This study, conducted through an action research framework in selected Malaysian schools, found that while AI and IT tools such as speech-to-text systems, communication apps, and gamified learning platforms show significant promise, their effectiveness is limited by infrastructural disparities, skill gaps, and contextual mismatches.

Educators and caregivers acknowledge the value of technology but express the need for better training, culturally relevant tools, and institutional support. Malaysia's ongoing digital education agenda offers a timely platform to scale inclusive technologies, provided policies explicitly address the needs of SEN learners.

The findings highlight the urgency of strategic investments, stakeholder training, and the development of localised, ethical, and sustainable technology solutions tailored for inclusive education in Malaysia.

Table 5
Recommendations

Recommendation Area	Specific Actions	Justification
Technology Localisation	- Develop or localise AI-based educational apps in Bahasa Malaysia and Malaysian Sign Language (MySL)	Reduces language barriers and ensures cultural relevance
Professional Development	- Implement structured training for teachers on AI tools in inclusive classrooms - Offer CPD (Continuing Professional Development) modules in edtech use	Enhances teacher confidence and competence in tech integration
Infrastructure Support	- Invest in reliable internet and updated hardware, especially in rural and inclusive schools	Addresses the digital divide that limits implementation
Policy Alignment	- Embed SEN-specific digital inclusion strategies within national ICT in education frameworks	Ensures SEN needs are represented in national digital agendas
Parental Involvement	- Provide bilingual user guides and community workshops to train caregivers on how to support tech-based learning at home	Supports continuity of learning and strengthens home-school collaboration
Ethical Safeguards	- Establish data privacy protocols for AI tools in SEN contexts - Conduct impact audits on algorithmic bias	Builds trust and ensures compliance with global digital ethics standards
Collaborative Research	- Foster partnerships between universities, edtech firms, and schools to co-develop inclusive learning tools	Promotes innovation and contextual problem-solving through participatory action research

CONCLUSION

This study set out to explore the integration of Artificial Intelligence (AI) and Information Technology (IT) in special education within selected Malaysian educational settings. Using an action research methodology, the research revealed that while digital technologies significantly enhance learning outcomes particularly in improving communication, engagement, and autonomy among students with special educational needs several challenges persist. These include infrastructural limitations, lack of teacher training, insufficient localised tools, and digital inequalities across school types and regions.

The findings underscore the importance of adopting a whole-system approach that not only introduces innovative technologies but also strengthens the competencies of educators, engages caregivers, and aligns with national education and digital transformation policies. Moving forward, localised AI tools, professional development, inclusive policy frameworks, and cross-sector collaborations will be crucial to ensure that the promise of digital transformation truly includes every learner regardless of ability.

As Malaysia continues to expand its digital education agenda, a deliberate and inclusive focus on special education can transform AI and IT from promising tools into powerful enablers of equitable learning. The study concludes with a call for sustained research, development, and policy commitment to foster a more inclusive and digitally empowered educational landscape.]

ACKNOWLEDGEMENT

The authors would like to express their sincere gratitude to Universiti Poly-Tech Malaysia for providing the resources and support necessary to complete this study. We would also like to thank all participants who contributed their time and

insights to this research. Special appreciation is extended to colleagues and peers who offered valuable feedback during the development of this manuscript.].

CONFLICT OF 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 the paper.

AUTHOR CONTRIBUTION STATEMENT

Author 1 contributed to the conceptualization, research design, and writing of the original draft.
Author 2 was responsible for data collection, analysis, and validation of the results.
Author 3 provided supervision, critical review, and editing of the final manuscript.
All authors have read and approved the final version of the manuscript.

ETHICS STATEMENT

This research was conducted in accordance with the ethical standards of Universiti Poly-Tech Malaysia and adhered to the principles outlined in the Declaration of Helsinki. Ethical approval was obtained from the [**Institutional Ethics Committee/Review Board**] under reference number [**Approval Number, if applicable**]. All participants were informed about the purpose of the study and provided written informed consent prior to participation. Participants' privacy and confidentiality were strictly maintained, and data collected were used solely for academic purposes.

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