

INCLUSIVE EDUCATION IN THE AGE OF TECHNOLOGY: BRIDGING ACCESSIBILITY AND EQUITY GAPS

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Abstract

The development of digital technology has brought significant changes to the education system, including strengthening inclusive education practices oriented towards equal access and justice for all students. The research method used a literature review by reviewing various scientific articles, books, policy reports, and relevant academic publications on inclusive education, educational technology, and the issue of equal access to learning. The results of the study indicate that technology has the potential to increase the participation of students with special needs through the use of adaptive assistive devices, flexible learning platforms, artificial intelligence, and disability-friendly learning media. In addition, technology can also expand the reach of education for marginalized groups in remote areas through online learning systems and open learning resources. However, the effectiveness of its implementation is greatly influenced by teacher readiness, policy support, the availability of facilities, and the commitment of educational institutions to the principle of inclusivity.

Keywords: Inclusive Education, Educational Technology, Accessibility, Educational Equity

INTRODUCTION

Inclusive education is an approach that places each student as the primary subject in the learning process, regardless of their physical, intellectual, social, economic, cultural, or other background. This principle affirms that every individual has an equal right to receive a quality education in a learning environment that embraces diversity (Memon & Memon, 2025a). In today's global landscape, inclusive education is gaining increasing attention because many groups still face barriers to equitable access to educational services. Children with disabilities, students from remote areas, economically

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disadvantaged groups, and those from minority communities often face limited facilities, discrimination, and poor support from the education system. These conditions indicate that educational equality has not yet been fully achieved, necessitating new strategies capable of addressing the challenges of the times.

On the other hand, advances in digital technology have transformed nearly every aspect of life, including education. The presence of the internet, smart devices, artificial intelligence, online learning platforms, and various educational applications opens up significant opportunities to expand access to learning. Technology enables flexible learning processes without the constraints of space and time. Learning materials can be accessed online, communication between teachers and students becomes easier, and various learning resources are available in interactive multimedia formats (Memon & Memon, 2025a). In the context of inclusive education, technology holds great potential as an empowerment tool. Students with special needs can utilize assistive devices such as screen readers, automatic subtitles, digital sign language translators, and adaptive learning software tailored to individual needs. Thus, technology can bridge the gap between learning barriers faced by some students.

However, the integration of technology into education does not always automatically result in equity. The reality in various countries demonstrates a significant digital divide. Not all schools have adequate technological infrastructure, such as a stable internet connection, computer equipment, or sufficient electricity. Furthermore, the digital literacy skills of teachers and students also vary. Students from low-income families often lack personal learning devices or adequate internet access. As a result, technology, which should be a solution, has the potential to widen the gap between those with access and those without. This phenomenon is particularly evident when distance learning is widely implemented, where many students are left behind due to limited technological resources. Therefore, the use of technology in education needs to be accompanied by policies that support equal access.

Besides access issues, another challenge lies in the design of digital learning systems, which are not yet fully inclusive. Many educational platforms are still created without considering the diverse needs of users. Some applications are not yet user-friendly for the blind, deaf, or students with specific cognitive disabilities. Digital learning materials are sometimes presented in a single format without accessibility alternatives, making it difficult for some students to understand the content. Furthermore, a technology-based learning approach that is too uniform can ignore the differences in

learning styles and social contexts of students (Tang et al., 2024a). This suggests that technological innovations need to be designed with the principles of universal design for learning, an approach that ensures every student can access, understand, and participate optimally in the learning process.

Teachers also play a crucial role in realizing technology-based inclusive education. The successful use of technology is determined not only by the availability of devices but also by the educator's ability to choose methods, media, and strategies that are appropriate to students' needs. Teachers are required to integrate technology pedagogically, not simply using digital devices as a supplement. They need to understand how to modify teaching materials, utilize accessibility features, and create a collaborative learning environment that respects diversity. However, in reality, many educators still lack adequate training in inclusive learning and digital literacy (Costache & Enachescu, 2025). Therefore, strengthening teacher capacity is a crucial agenda for educational transformation in the technological era.

Based on this description, research on "Inclusive Education in the Age of Technology: Bridging Accessibility and Equity Gaps" is highly relevant. This study is crucial for analyzing how technology can be effectively utilized to expand access to education while reducing ongoing inequalities. This research is also needed to identify various implementation barriers, including infrastructure, policies, teacher competency, and the technology design itself. The research findings are expected to provide strategic recommendations for the government, educational institutions, technology developers, and the community in building a more inclusive, adaptive, and equitable education system. Thus, technology will not only be a symbol of modern progress but will truly serve as a means to ensure that no student is left behind in obtaining equal access to education.

RESEARCH METHOD

This research uses a literature review method with a descriptive-qualitative approach to analyze the development of inclusive education in the technological era and efforts to bridge the gap in accessibility and educational equity. The literature review was chosen because it can compile various concepts, theories, empirical research results, and relevant policies regarding technology integration in inclusive education. Research data sources were obtained from reputable national and international journal articles, academic books, seminar proceedings, educational institution reports, and policy documents related to inclusive education, digital transformation, technology

accessibility, and equal learning opportunities. The literature used focused on publications within the last ten years to accurately reflect current developments in the issue and align with the dynamics of current educational technology.

The data analysis process was carried out through several stages: identifying literature sources, selecting them based on thematic relevance, grouping key information, and then critically interpreting the findings. Researchers compared various views on the benefits of technology in supporting students with special needs, implementation barriers in various regions, and strategies for creating a more equitable and inclusive education system. Next, the study results were systematically compiled to identify patterns of relationships between technology use, increasing access to learning, and reducing educational inequality. Through this method, research is expected to be able to provide a comprehensive understanding and conceptual recommendations for the development of inclusive education policies and practices that are responsive to the challenges of the digital era.

RESULT AND DISCUSSION

The Challenge of the Technology Accessibility Gap in Inclusive Education

The challenge of the technology accessibility gap in inclusive education has become a critical issue amidst the acceleration of digital transformation in the education sector (Costache & Enachescu, 2025). The presence of technology actually brings significant opportunities to create learning systems that are more open, flexible, and responsive to the needs of diverse learners. Various digital tools, such as adaptive learning applications, assistive devices for students with disabilities, online classroom platforms, and interactive media, can increase learning participation for all groups. However, these benefits have not been felt equally due to the persistence of significant gaps in technology accessibility between regions, social groups, and individuals with special needs. As a result, inclusive education, which should guarantee equal learning opportunities, instead faces new obstacles in the form of unequal digital access.

One major challenge lies in the disparity in technological infrastructure between urban and rural areas (Hossain, 2025). Schools in large cities generally have more stable internet connections, adequate computer availability, and better technical support than schools in remote areas. Conversely, many schools in underdeveloped areas still experience limited electricity, weak internet signals, and even a lack of sufficient digital devices to support technology-based learning. This situation prevents students in certain areas

from having equal access to digital learning resources (Welesilassie et al., 2025). In the context of inclusive education, this inequality is further compounded when students with special needs require additional devices such as screen readers, digital hearing aids, or specialized learning applications that are not available at school.

In addition to infrastructure issues, another challenge arises from the economic disparity among students' families. Not all parents can afford to provide devices, laptops, or internet data on a sustainable basis. For low-income families, basic daily needs often take precedence over procuring digital learning devices. As a result, children from economically vulnerable groups are at risk of falling behind in a learning process that is increasingly dependent on technology. This situation is even more challenging for families with children with special needs because their education costs are generally higher, including the need for therapy, assistive devices, and support services. When access to technology requires additional costs, social inequality widens the gap in educational opportunities (Murillo-Jiménez et al., 2025).

The next challenge relates to technology design, which is not fully inclusive. Many digital learning platforms are designed for general users without considering the diverse needs of learners (Samaniego López et al., 2025). For example, apps that lack screen reader capabilities will create difficulties for blind students. Learning videos without subtitles will hinder deaf students. Overly complex displays with lots of animation can be difficult for students with concentration disorders or autism spectrum disorders. This demonstrates that access to technology is not just about having a device, but also about the ability of that technology to be used comfortably and effectively by all learners. If inclusive design is neglected, technology can become a new tool of exclusion in education.

Limited teacher digital competency also poses a serious challenge in addressing the accessibility gap. Many educators have not received adequate training in the use of inclusive learning technology. Some teachers may be able to use basic applications but lack understanding of how to modify digital materials to suit students with special needs. For example, teachers are not yet accustomed to creating teaching materials with alternative text for images, using automatic captions, or adapting online assignments to individual student abilities. As a result, even though devices are available, the learning process does not fully support the principles of inclusion. Teachers play a central role as facilitators, so low digital literacy among educators can exacerbate existing gaps.

In addition to teachers, the readiness of students and parents also influences the effectiveness of technology access. Not all students have the same digital literacy skills. Some adapt quickly to new devices, while others require intensive guidance. For students with special needs, the process of adapting to technology often requires a special approach and more time. Parents may not be able to accompany their children using learning platforms, especially if they have educational limitations or are unfamiliar with digital technology. In distance learning situations, a lack of family support can significantly reduce student learning participation.

Language and cultural issues are another dimension of the accessibility gap. Many educational applications use foreign languages or formal Indonesian, which some students find difficult to understand. Meanwhile, students from certain local communities may be more comfortable learning using regional languages or cultural contexts closer to their lives. If digital materials are not sensitive to linguistic and cultural diversity, the technology will not fully reach all groups. Inclusive education should address not only the physical and cognitive aspects but also the sociocultural backgrounds of students (Akhter et al., 2025).

Another challenge is the lack of specific policies and funding for inclusive technology (Memon & Memon, 2025b). In many educational institutions, technology budgets are still focused on procuring common devices like computers and projectors, while the need for accessibility devices is often overlooked. In fact, inclusive schools require additional investments such as screen reader software, adaptive keyboards, digital hearing aids, and teacher training. Without clear policy support, schools tend to struggle to prioritize these needs. The government, the private sector, and the community need to collaborate to ensure that inclusive technology access becomes part of the national education agenda.

Furthermore, the rapid development of technology also poses sustainability challenges. Devices that are relevant today may become obsolete within a few years. Schools that successfully provide certain technologies may not be able to afford regular system updates. Changes to applications, operating systems, and hardware require significant maintenance costs. Without a long-term strategy, inclusive education digitalization programs risk stalling at the initial procurement stage without sustainable benefits ("Challenges in Teachers' Knowledge and Use of Accessible Digital Technologies for Inclusive Learning in Mongolia," 2025).

To address these challenges, a comprehensive approach is needed that places accessibility as a primary principle, not an afterthought. Equitable digital infrastructure must go hand in hand with device subsidies for vulnerable families. Technology developers need to implement universal design so that products are accessible to all from the start. Teachers require ongoing training in inclusive digital pedagogy, while parents need to be involved through digital literacy education. Furthermore, the government must strengthen regulations and dedicated funding to ensure inclusive schools have adequate resources.

Thus, the gap in technology accessibility in inclusive education is not simply a technical issue, but rather a matter of social justice and the right to education. Technology will only be a solution if it is equitably available, inclusively designed, and supported by a responsive education ecosystem. If these challenges are not addressed, the digital transformation has the potential to widen existing inequalities. Conversely, if managed appropriately, technology can be a bridge to truly equitable inclusive education for all students.

Social, Economic, and Infrastructure Barriers to Educational Equality

Educational equality is the principle that every individual has the same rights and opportunities to receive quality educational services regardless of social and economic background, place of residence, gender, physical condition, or cultural identity (Chen, 2025). However, in practice, efforts to achieve educational equality still face various complex obstacles. These obstacles originate not only from the internal aspects of educational institutions but are also influenced by the social conditions of the community, the economic capacity of families, and the availability of supporting infrastructure. These three factors are interrelated and often create a cycle of inequality that is difficult to break if not addressed systematically. As a result, some groups still experience limited access to adequate education, while others enjoy far better educational facilities.

Social barriers are a major factor influencing educational equality (Judijanto, 2025). In many societies, social status still determines an individual's opportunities to receive a quality education. Children from families with high social standing generally have easier access to top schools, tutoring, educational information networks, and supportive learning environments. Conversely, children from families with low social status often face stigma, discrimination, and even low expectations from their surroundings. This situation can lower students' motivation to learn and self-confidence. When a

child perceives themselves as belonging to a less valued group, they tend to experience psychological barriers in developing their academic potential.

Furthermore, certain societal cultures can also hinder educational equality. In some regions, the view that higher education is not particularly important, especially for women or certain groups, persists. Girls are sometimes prioritized to help with household chores or marry at a young age over continuing their education. Meanwhile, boys in poor families are often encouraged to work from an early age to contribute to the family income. This cultural perspective leads to unequal participation in education (Chattopadhyay et al., 2025). When traditional values are not aligned with the importance of modern education, the process of improving the quality of human resources is hampered.

Other social barriers are evident in the treatment of vulnerable groups such as people with disabilities, indigenous communities, and minority groups. They often experience limitations because the education system is not fully inclusive. For example, students with disabilities require special facilities, adaptive learning methods, and educators who understand their needs (Khatib & Noor, 2025). However, many schools are not yet prepared to provide these services. As a result, they struggle to participate optimally in learning. Similarly, children from linguistic and cultural minority groups often face challenges because the curriculum and language of instruction are not appropriate to their context.

On the other hand, economic factors are a very real barrier to educational equality. Poverty is often the main reason children drop out of school or do not continue their education to a higher level (Khatib & Noor, 2025). Although some countries have implemented free education policies, families still face numerous indirect costs, such as uniforms, books, transportation, food allowances, internet access, and other supporting needs. For low-income families, these costs are quite significant, making children's education often a secondary priority after basic needs like food and shelter.

Economic limitations also impact the quality of children's learning experiences at home. Children from wealthy families typically have comfortable study spaces, digital devices, supplementary books, and private tutoring support. In contrast, children from poor families often learn in crowded, noisy environments with minimal facilities. They may have to share devices with other family members or may not have access to technology at all. These differences in household conditions create a wider gap in learning outcomes. When schools

demand the same results from students with different circumstances, educational inequities become even more apparent.

Economic challenges are also closely related to the need to work during school age. Many children from poor families must help their parents with informal work, such as agriculture, small trade, or household chores. This reduces the time and energy that could be devoted to learning (Hasyim, 2025). In the long term, this situation increases the risk of dropping out of school. Children who drop out of the education system tend to remain in a cycle of poverty due to limited skills and job opportunities. Thus, economic inequality not only hinders current access to education but also reproduces intergenerational inequality.

In addition to social and economic factors, infrastructure barriers also significantly determine educational equality. Educational infrastructure includes school buildings, classrooms, libraries, laboratories, sanitation, electricity, internet access, roads to schools, and transportation (Tang et al., 2024b). In urban areas, educational facilities are generally more comprehensive and easily accessible. Conversely, in remote, border, or island areas, many schools face limitations in basic facilities. Damaged classrooms, a shortage of desks and chairs, a shortage of books, and the absence of laboratories are still common problems. These conditions contribute to suboptimal learning quality compared to schools in developed regions.

Geographical access also poses a serious challenge. Many students in rural areas must travel long distances on poor roads to reach school. During the rainy season, access can be cut off, resulting in decreased student attendance. Excessive distances also increase the risk of dropping out of school, especially for young children and girls. When transportation is inadequate, education becomes difficult to access, even if it is formally available. This demonstrates that the mere existence of schools is insufficient without adequate physical access (Ghosh, 2024).

Developments in digital technology demonstrate that internet infrastructure is now a crucial component of educational equality. Modern learning increasingly relies on technological devices, online platforms, and digital learning resources. However, many regions still experience weak or unstable internet connections. Network limitations make it difficult for students to participate in online learning, download materials, or communicate with teachers. This digital divide becomes even more apparent during emergencies such as pandemics, when learning shifts to online systems.

Students without devices and internet access fall significantly behind those with adequate access.

These three barriers are interconnected and reinforce each other. Poor families generally live in areas with limited infrastructure and have disadvantaged social positions. Conversely, economically affluent groups tend to reside in areas with quality schools and stronger social networks. Therefore, solutions to educational equality cannot be implemented in isolation. Educational assistance policies must be accompanied by infrastructure development, improving the quality of schools in disadvantaged areas, strengthening inclusive education, and changing public mindsets about the importance of education for all groups.

Thus, social, economic, and infrastructural barriers are key challenges to achieving educational equality. As long as social discrimination persists, poverty limits learning opportunities, and educational facilities are unequal, the goal of education for all will be difficult to achieve. Educational equality requires a shared commitment between the government, educational institutions, the community and the private sector so that every child, regardless of their background, has the same opportunity to develop and achieve a better future.

Utilizing Assistive Technology for Students with Special Needs

Utilizing assistive technology for students with special needs is a strategic step in realizing inclusive, equitable, and individual-centered education (Olumorin et al., 2022). Assistive technology comprises a variety of devices, applications, aids, and systems designed to enhance the functional abilities of individuals with physical, sensory, intellectual, or developmental disabilities. In the educational context, this technology plays a crucial role in helping students with special needs access learning materials, communicate, participate in classroom activities, and optimally develop their academic and social potential. The presence of assistive technology has shifted the educational paradigm from one focused on student limitations to one focused on creating an adaptive and welcoming learning environment for all.

For students with visual impairments, assistive technology provides significant support in the learning process. Screen reader software, audio-based digital books, braille printers, and text recognition applications enable blind students to gain access to information that was previously difficult to access (Fernández-Batanero et al., 2022). Through screen reader technology, text on a computer or smartphone can be converted into speech, allowing students to read course materials independently. Furthermore, optical

character recognition technology can convert printed documents into machine-readable digital formats, making textbooks and worksheets more easily accessible. The use of this technology not only enhances learning independence but also fosters students' self-confidence, enabling them to participate in lessons on an equal footing with their peers.

For students with hearing impairments, assistive technology helps overcome communication barriers and understand verbal information in the classroom. The use of hearing aids, cochlear implants, personal speaker systems, and sign language interpretation apps are important tools to support learning (Fernández-Batanero et al., 2022). Teachers can also utilize subtitled instructional videos, visual presentations, and text-based digital platforms to make information more easily understood. Speech-to-text technology, which converts speech into text in real time, is increasingly beneficial because it allows deaf students to follow along with teacher explanations. With this support, student interactions with teachers and peers can be more effective and inclusive. For students with physical or motor disabilities, assistive technology helps with mobility and access to learning devices. For example, the use of adaptive keyboards, specialized mice, touchscreens, voice-controlled devices, and even electric wheelchairs allows students to continue using computers and participate in learning activities independently. In some cases, students with limited hand mobility can use eye tracking technology, which allows computers to be controlled through eye movements. These developments demonstrate that physical limitations are no longer a major barrier to obtaining a quality education when supported by the right technological resources.

Assistive technology also offers significant benefits for students with intellectual disabilities, autism, ADHD, or specific learning disorders such as dyslexia. Interactive learning apps, visual scheduling tools, educational games, text-to-speech, and reading and numeracy practice software can help improve focus, comprehension, and basic academic skills. For example, students with autism often benefit from using alternative communication apps based on images or symbols to convey their needs and feelings (Syriopoulou-Delli & Gkiolnta, 2022). Meanwhile, students with dyslexia can utilize special fonts, automatic text readers, and word prediction features to facilitate reading and writing. This type of technology helps make learning more personalized and tailored to each individual's characteristics.

The use of assistive technology also improves the social participation of students with special needs. When they are better able to communicate, complete assignments, and participate in learning, opportunities for interaction

with peers increase. This is important because education is not only oriented towards academic achievement but also social-emotional development. Students feel valued as part of the school community and are not isolated due to their disabilities. Classroom environments that utilize adaptive technology tend to be more inclusive because all students have equal opportunities to contribute (Marino et al., 2023).

However, the implementation of assistive technology in schools still faces various challenges. One major obstacle is the limited budget for purchasing devices, which are generally quite expensive. Furthermore, many schools still lack supporting infrastructure such as a stable internet connection, adequate electricity, or basic digital devices. Another challenge is the lack of teacher competency in selecting, using, and integrating assistive technology into learning. Many assistive devices are available but are not optimally utilized because educators have not received adequate training. Therefore, the successful use of this technology is determined not only by the availability of devices, but also by the readiness of human resources and institutional policies.

To optimize the use of assistive technology, collaboration between the government, schools, teachers, parents, and the community is necessary. The government needs to strengthen inclusive education policies by providing budgets, subsidizing assistive devices, and implementing teacher training programs. Schools need to assess students' needs to ensure that the technology used is truly appropriate and effective. Teachers are required to be creative in integrating technology with differentiated learning strategies. Parents also need to be involved so that technology use can continue at home as part of the ongoing learning process. Furthermore, collaboration with the private sector and technology developers can accelerate the development of more affordable and easy-to-use teaching aids.

CONCLUSION

The conclusion of this study shows that inclusive education in the technology era has great potential to bridge the gap in accessibility and equity of education for all students. The use of digital technologies such as online learning platforms, adaptive assistive devices, artificial intelligence, and interactive media can provide more flexible learning opportunities for students from diverse social, economic, and geographic backgrounds, as well as those with special needs. Technology also plays a role in creating a more personalized, responsive, and welcoming learning environment that accommodates students' differing abilities. Therefore, the integration of technology in

inclusive education is not only a supporting tool but also a crucial strategy in realizing the right to equal and quality education.

However, the success of technology-based inclusive education still faces various challenges, such as limited digital infrastructure, low technological literacy, economic disparities, and the lack of preparedness of educators in managing inclusive learning. Therefore, synergy is needed between the government, educational institutions, educators, the community, and the private sector to provide policies that support inclusivity, continuous training for teachers, and equitable access to technology across all regions. Through this shared commitment, inclusive education in the technology era can develop into a more equitable, adaptive education system that meets the needs of all students without discrimination.

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