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UTILIZING EDUCATIONAL TECHNOLOGY IN EMPOWERING SPECIAL EDUCATION: EXPERIENCES AND CHALLENGES OF STUDENTS AND TEACHERS

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Abstract:

This study explores the integration of educational technology within Malaysia's special education context, focusing on the lived experiences of 47 preservice teachers during their practicum placements. Educational technology offers significant potential for enhancing inclusivity and personalized learning, yet its implementation is often hindered by infrastructural limitations, lack of training, and the absence of localized, customizable tools. Using a qualitative thematic analysis approach, the study employed open-ended digital questionnaires supported by AI-assisted tools (Microsoft Word Macro and ChatGPT) to identify five major themes: enhanced teaching and learning practices, increased student engagement, need for personalized digital solutions, challenges in professional preparation, and the importance of thoughtful, balanced implementation. The findings are interpreted through the lens of Rogers' Diffusion of Innovation Theory, highlighting how adoption dynamics are shaped by contextual challenges within Malaysia's Digital Education Policy (2021–2030). Despite barriers, the study underscores that when technology is implemented thoughtfully and supported by adequate training and resources, it can significantly empower special education practices. The study also demonstrates the methodological innovation of integrating generative AI into qualitative analysis, contributing both theoretically and practically to the field of inclusive educational technology. The implications point to the urgent need for policy intervention, capacity-building efforts, and the development of culturally responsive digital tools to foster equitable digital transformation in special education.

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Keywords:

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Introduction

Special education teachers are increasingly recognizing the significance of integrating technology to provide more accessible and personalized learning opportunities for students with diverse learning requirements (Li et al., 2023; Milad & Fayez, 2024). The use of educational technologies in special education is seen as instrumental in enriching the learning and teaching processes, catering to the specific needs of students with disabilities and enhancing their educational outcomes (Castiblanco Jimenez et al., 2020; Hamutoğlu et al., 2022). It has been acknowledged that educational technology not only facilitates learning but also contributes to increasing the experience of children with special education needs, making learning more manageable and providing individualized education tailored to their unique requirements (Nurseitova et al., 2022).

Rogers (1983) in the Diffusion of Innovation, has been defined as an innovation that is in the form of physical (e.g., smartphones), software (e.g., applications that can be used over the internet), or even practices or ideas. This theory also emphasizes that any form of technology, even though it has been in the mainstream for a while, has never been used or exposed to the teachers, will be considered as 'new' technology. As the world of educational technology has evolved rapidly in this fourth industrial revolution, a significant effect has also influenced the arena of special education (Hamutoğlu et al., 2022; Zafari et al., 2022). Teachers are often faced with challenges in integrating these technologies effectively, leading to a disparity in their confidence and competence in using technology to support diverse learning needs (Anderson & Putman, 2019). This gap can hinder their ability to create inclusive learning environments, ultimately affecting the educational outcomes for students with disabilities.

Therefore, it is essential to examine teachers who have worked in real-life classroom environments to understand how their experience shapes their approach and use of technology. An examination of teachers' real-life experiences with technology integration in special education identifies elements requiring improvement in teacher preparation programs. In addition, as the Malaysian Digital Education Policy continues rolling out its implementation, it not only envisions the use of technology to enhance learning outcomes for general education students but also considers the special demands of students with disabilities with the hope of creating an inclusive learning environment for all learners (MOE, 2023).

While the benefits technology promises to special education is obvious, realizing these benefits is not an easy task and requires careful examination of the barriers to its application (Arı et al., 2022). One of the main barriers is the lack of economic resources (Park et al., 2022), poor infrastructure (N. S. Nordin & Rabi, 2020), and not having appropriate materials specifically designed for special education classrooms (Polat et al., 2019). Without proper resources, it becomes challenging for educators to effectively integrate technology into their teaching practices and provide students with equitable access to these tools. There is a lack of detailed exploration of how these student-teachers perceive and utilize technologies such as artificial

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intelligence (AI) in their preparation and teaching and learning processes. Much of the existing research on technology integration in education overlooks special education contexts. While there is a growing body of work on technology use in mainstream education, studies specifically addressing technology's role in special education are notably scarce.

Additionally, in the context of Malaysia, special education settings are structured to accommodate students with various learning disabilities across different school levels, including primary and secondary education, with various settings (e.g., special schools, mainstream schools with integration programs) (National Digital Department, 2024). However, there is a notable absence of specific clustering for students with similar disabilities within these settings. The Special Education Integration Programme (PPKI), designed to provide inclusive education for students with special needs within mainstream schools, has been implemented in 1,768 schools across Malaysia. Henceforth, in one setting, teachers need to cater to various students with disabilities. In Malaysia, the Ministry of Education (MOE) has initiated several policies to enhance digital learning, notably the Digital Education Policy (DEP) 2021–2030, which aims to produce digitally fluent students and educators by emphasizing digital competencies and infrastructure development. Despite these initiatives, challenges persist in the implementation of technology within special education settings.

The main objective of this research initiative is to examine educators' outlook on integrating technology, along with their personal experiences of using these technological innovations in designing curricula and pedagogical practices, and to analyse their effectiveness in special education environments.

This research aims to achieve the following research objectives:
1. To explore educators' experiences with the current integration of technology in their special education classrooms.

Literature Review

The Integration of Technological Advances in Special Education.

Technology is rapidly changing the landscape of education and offers a wide range of opportunities to enhance teaching and learning experiences for all students, particularly those with disabilities (Polat et al., 2019; Shyr et al., 2024). It has immense potential to create more inclusive and individualized learning environments, encompassing the diverse needs of students with disabilities. To improve the quality of special education for students with disabilities, it is essential to explore developmental strategies that align with new educational methodologies and technological advancements (Arı et al., 2022; Hamutoğlu et al., 2022; Xia et al., 2023). This includes leveraging technology to support diverse learning needs and enhancing collaboration among educational stakeholders to create an inclusive and supportive learning environment. In the Diffusion of Innovation by Rogers (1983), the adoption of technology can be classified into several adopters, one of which is the early adopters. The study by Zhu (2022) on their 10 years of research on technology integration found that, particularly the use of the internet in education, was a significant factor for early adoption. In taking these findings and putting them into the context of the adoption of technology by special education teachers, it can be suggested that supporting early adopters can significantly affect the wider adoption of technology.

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The successful integration of technology in designing instructional sessions, especially concerning lesson planning and instructional materials, has much potential in enhancing students' educational experience with disabilities. The learning process requires much preparation before its implementation in the classroom learning environment. One of the main challenges faced by special education teachers is the need for multifaceted methodologies and materials to allow them to meet the specific needs of their students (Tomczyszyn et al., 2022). Since students can have differing demands depending on their disabilities, it is critical to apply specific modifications in designing lesson plans and instructional materials.

Generative Artificial Intelligence (genAI), as reflected in software such as ChatGPT, Gemini, and CoPilot, has radically changed lesson planning for teachers through its ability to examine complex details and generate a wide range of innovative content types, hence enabling high-quality learning resources for all. A study by Nordin et al. (2023) found that the use of presentation software, for example, PowerPoint, language games on platforms such as Google Play and the App Store, and interactive boards has motivated teachers to create more interactive learning experiences. This factor is significant as it supports the differentiation of instruction designed to address the various learning demands of students (Boyle & Kennedy, 2019; Polat et al., 2019).

GenAI has the potential to augment learning processes through the support of presentation generation, quizzes, interactive activities, student-centric differentiated resources, and new formats of content (Harry, 2023). GenAI allows teachers to elicit and correct existing learning resources easily or create new resources to match specific learning objectives. In addition, Nordin et al. (2023) highlighted the fact that the integration of technology in the form of video apps, devices, and software can empower teachers with new and efficient pedagogical strategies. However, Surajudeen et al. (2022) highlight the need for analysing teachers' levels of readiness, self-efficacy, and technological skills before harnessing technology as an educational tool. The evidence indicates that integrating technology, particularly generative AI, in lesson planning requires inclusive professional development activities to properly prepare teachers with the required skills for successful implementation. The activities should focus on both technical aspects of using genAI software as well as pedagogical methodologies for fine-tuning and using AI-produced materials to ensure coherence as well as accuracy to curriculum standards.

In addition, the integration of advanced technological equipment and techniques improves educators' ability to create inclusive and engaging learning environments suited to meet the diverse needs of students with disabilities. Boyle and Kennedy's (2019) research illustrates how technology-enhanced graphical organizers designed specifically for students with writing problems, as well as emotional and behavioural disorders, can greatly improve their performance in writing. That finding also illustrates the vital role of visual support utilized by special education teachers in facilitating cognitive processes for such students to enable them to express their thoughts as well as enhance their ability in terms of writing. Essentially, technology is used as an auxiliary tool for educators to allow their students to visually organize their ideas to overcome writing barriers (Ahmed, 2018). In addition, technology can facilitate both communication and social interaction, which is essential for socially challenging students. Zaharudin et al. (2024) have also illustrated how apps using presently augmented and alternative methods of communication can successfully help students with learning disabilities develop routines of self-management and communication. The step-by-step approach that has

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been highlighted in the SmartAPP has been beneficial in exposing the student to procedural activities. These studies demonstrate that technology not only enhances academic development, such as writing, but also contributes to enhancing life skills, thereby fostering a well-rounded educational experience for students with disabilities.

However, the successful implementation of technology in special education requires extensive teacher training and support (Polat et al., 2019). As the educational landscape evolves, educators, policymakers, and stakeholders must collaborate on harnessing the full potential of technology. This approach will ensure that all students, regardless of their abilities, have access to high-quality, personalized education that will prepare them for the future and independence. There are necessities for teachers in this field to have adequate training and support, particularly when technology in education is something undeniable that happens, and it will be unfair if, due to students' disabilities, teachers deny their chances to experience it and deny teachers' chances to professionally develop their literacy skills (Anderson & Putman, 2019). Special education teachers need to be equipped with the necessary knowledge and skills to implement individualized instruction, utilize assistive technology effectively, and promote social-emotional development among students with disabilities (Paico Campos & Andrade–Arenas, 2022).

Training programs and courses focusing on special education technology are essential for teachers to enhance their proficiency in using technology in the classroom and catering to the diverse needs of students with disabilities (Campos & Andrade-Arenas, 2022). Teachers need to acquire comprehensive training programs that equip them with the knowledge and skills to effectively utilize technology in their classrooms. This includes understanding how to select the most suitable technology tools for their students' specific needs and how to effectively incorporate technology into their lesson plans and teaching strategies. Besides, teachers would need to be exposed to the use of technology itself, but also to evaluate and adapt it to ensure it can assist them in managing their class session, aligned with curriculum standards and pedagogically sound. At the same time, it is necessary to use technology to include schools where students with special needs can go further; thus, they have a motivational learning environment that complements their educational experiences (Xu et al., 2024).

In Malaysia, the employment of technology in special education is influenced by steps such as the Special Education Integration Programme (PPKI) and the Digital Education Policy (DEP) 2021-2030. The DEP envisions "an inclusive digital education ecosystem," yet only 38% of special education schools currently report having functional ICT facilities (National Digital Department, 2024). Moreover, many teachers under the PPKI program face infrastructural challenges and limited access to specialized software designed for diverse disabilities (Zaharudin et al., 2024). A study by Nordin et al. (2023) revealed that while PPKI teachers expressed a positive attitude towards using apps like Canva, Google Slides, and interactive whiteboards, they often lacked the confidence and training to integrate them meaningfully into individualized learning plans. Another study by Zulkifli and Yusof (2022) found that 71% of special education teachers in Selangor relied heavily on non-digital methods due to the absence of adequate assistive technologies and concerns about students' screen dependency. In addition, SIP+ (School Improvement Specialist Coaches Plus), a mentoring initiative by MOE, has yet to extend structured digital competency training to special education personnel. This leads to a situation where student-teachers entering the field may have theoretical awareness of educational technology but face major barriers during their practicum when expected to

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implement it in heterogeneous classrooms with minimal support. The Ministry of Education, through the Digital Education Policy (DEP), acknowledges that not all schools have equal access to technology, as referred to in international benchmarking studies that have been conducted by them, which can create disparities in the ability to prepare and deliver lessons effectively (MOE, 2023). Henceforth, based on this scenario, it can be assumed that ensuring that technology is accessible to all students, which in this study's context, can be challenging.

Anderson and Putman (2019) believe that teachers may feel hesitant to embrace technology because they fear it will disrupt their classroom routines or feel unsafe about their technology skills. Teachers may be more critical of the value of technological integration in schools than their students. Besides, teachers might question the impact of technology on student outcomes. As it is well known, managing the daily affairs of students with special needs requires tons of energy and commitment by teachers, and the fact that integrating technology effectively normally requires significant time and effort, hence the synergy of these two situations can be overwhelming to the teachers.

Methodology

Sample

The sample comprised 47 student-teachers (also referred to as preservice teachers) who had completed a six-month practicum placement in either primary or secondary special education settings under the Ministry of Education's PPKI program. The sample included 25 student-teachers from primary school settings and 22 from secondary schools. This sample size is consistent with Creswell (2013) and Braun & Clarke (2019), who suggest that 15–50 participants are adequate for thematic analysis in qualitative studies, particularly when the goal is to capture a range of perspectives rather than statistical generalizability. In this study, data saturation was reached by the 41st response, where no new themes or codes emerged, affirming the adequacy of the sample size for robust thematic interpretation. Participants were selected using purposive sampling based on their recent practicum experience in special education classrooms and their exposure to digital teaching tools during that time. Table 1 provides a detailed breakdown of the teachers' distribution across these educational settings. The study seeks to uncover forward-looking ideas and potential trends in technology integration, especially in the field of special education, by collecting first-hand accounts of these budding educators.

Table 1: The Number of Teachers Corresponds to the Education Settings

Type of education settings	Number of teachers
Primary school	25
Secondary school	22

Source: Authors' own work

Research Instruments

The investigation was conducted by a digital questionnaire that was operated by human power. The data was collected from prior related research by using questions that were adapted from previous studies. There were two sections of the instruments, which were Section A: Demographic and Section B: Technology Integration in Special Education. In Section A, four items are related to education settings, the type of special needs students encounter, preference

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in using technology for teaching and learning, and preference to use technology to prepare for teaching and learning. Section B then comprises six open-ended items that focus on eliciting teachers' experience with the current use of technology in their special education.

Six items that belong to elicit teachers' experiences were adapted from Anderson and Putman (2019), Nordin et al. (2023), and Polat et al. (2019). Before being distributed, the items underwent language and content validity checks by experts. The revised instrument was tested by 5 preservice special education teachers who were not part of the main study. Based on the remarks of the test, the language clarity, question structure, and technical terminology have remarkably progressed. Furthermore, minor adjustments had to be made to the questions. Not only to guarantee that the items were culturally acceptable, but that they were understandable for non-native speakers of the English language as well.

Data Collection

For data collection, Google Forms were used. The instructors were separated among three coordinators. In turn, every coordinator was given a survey link that was unique, and they shared it with their subordinates through the WhatsApp messaging platform. The coordinators played the roles of data collection administrators; the only thing they did was to help in distributing the survey without direct participation in the response process. Thus, this way allowed for efficient survey distribution but kept a gap between the coordinators and the data collection process. The original writers of the website designed the survey as a non-mandatory one, with responses being kept anonymous. Permission for conducting the research in the respective university campus was gathered from the university's moral and ethical research approval board, and consent statements were included at the very beginning of the form as well.

Data Analysis

The study utilized an inductive thematic analysis approach (Braun & Clarke, 2014), which addressed the focus of the research and enabled the analysis to dictate the creation of new patterns and insights directly from the data and appendix. The analytic process began with data extraction, with data collection through Google Forms, and wholly exporting the responses to a comma-separated (CSV) file, which was then transported into Microsoft Word, before analysis. Each researcher working in isolation reads the responses and then hand-codes each response, using the Comment function in Microsoft Word applicable to the content of each response (Adbehkodaie et al., 2018).

To ensure the reliability of open coding, three researchers collaborated as a team to brainstorm and engage with the text by establishing initial codes. To further enhance the reliability of the analysis, researchers checked for inter-rater reliability across multiple coding and comparison cycles. Once the coding was done, the Macro function in Microsoft Word was used to extract all comments to begin the identification of final themes. Afterwards, axial coding was implemented to group codes into related subthemes, which were extracted into themes. Additionally, following Şen et al. (2023), the research team integrated ChatGPT in the advanced analysis of the data using ChatGPT as open coding. This began with the uploading of the data collected into ChatGPT. ChatGPT was first tasked with organizing the initial codes into subthemes.

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This involved identifying common concepts, grouping similar and associated ideas. Then the researchers examined each of the AI-generated subthemes, determining whether they are still valid for the context and admissible from the data. If there were any discrepancies between the suggestions from ChatGPT and the data, adjustments were made, and the research team made minor adjustments to better represent the study goals. Next, the researchers asked ChatGPT to combine subthemes into broader themes. The purpose was to create overall categories that encapsulated the main ideas from emerging themes in the data. The research team also reviewed these themes again and made changes as required to ensure that the final thematic structure was true to the study context while representing the original data. This process, while using grounded theory methodology, allowed for a similar and systematic exploration of the data so that researcher bias could be minimized. This approach permitted a systematic and in-depth analysis of the data, while ensuring that the study findings were a true representation of the participants' responses and lent to answering the research objectives. In the final section of the results chapter, a diagram was constructed to provide a sense of the flow of data analysis. (Figure 1)

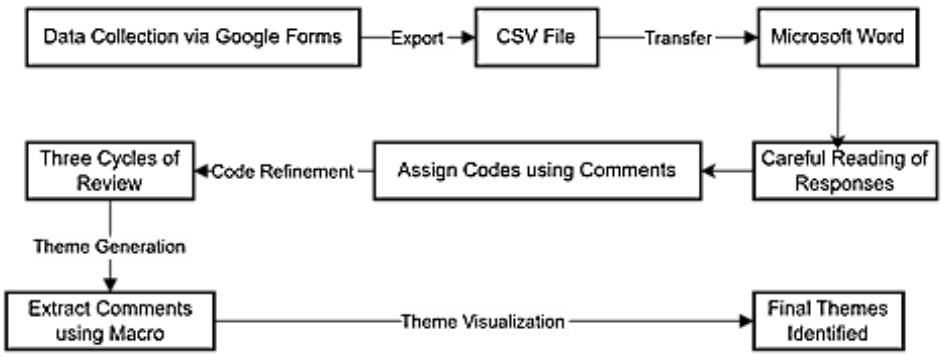

Figure 1. Data Analysis Flowchart

Source: (Author's work)

Results

This section develops findings from the thoughts of the 47 student-teachers about their use of technology in practice while student-teaching in special education settings. Through inductive thematic analysis supported by AI and manual coding, five major themes emerged, each comprising several sub-themes. Each theme is discussed in detail, supported by participant quotations to illustrate the nuances of their experiences. It was also found in this research that teachers are facing challenges and limitations in their special education classrooms. Five main challenges have been found, which comprise, i. limited resources (n=6), ii. Technical issues and training (n=7), iii. customized tools (n=5), IV. moderation (n=6), v. thoughtful implementation (n=8) (Table 1).

Theme 1: Limited Resources (n=6; 12.8%)

A predominant theme emerging from the data is the lack of sufficient technological resources in special education classrooms. This includes an inadequate number of devices, poor internet connectivity, and a lack of assistive technologies tailored to students with diverse disabilities.

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Sub-Theme 1.1: Insufficient Devices (N=4).

Many participants reported that classrooms lacked adequate numbers of devices (e.g., tablets, computers, interactive whiteboards), limiting their ability to ensure equal access for all students. In several cases, student-teachers had to rotate the use of a single device among multiple students, interrupting the flow of activities and reducing instructional time. This was particularly challenging in classrooms with students who required one-on-one support or assistive interfaces. “Lack of devices made it difficult to engage all students equally. "I had to rotate tablet use; it broke the flow of the lessons." (Participant 12)

Sub-Theme 1.2: Poor Connectivity And Infrastructure (N=2)

In rural and semi-urban school environments, poor internet connection was commonly cited as a barrier. This barrier impeded streaming video, online games, or synchronous interactions completely. Without stable infrastructure, even rudimentary educational apps were rendered inaccessible. “Students responded positively to interactive tools, but we did not have internet access in some classrooms.” (Participant 5)

Recognizing these barriers illustrates issues of equity in digital access across school systems, resulting in inequity in the delivery of inclusive education overall. This theme represents the complexity of the challenges and limitations teachers are experiencing when attempting to use technology in their special education classrooms. While there were several resources, many apparent obstacles stand out as the biggest challenges, lack of access to resources. This factor is essential as the lack of resources in schools limits teachers' opportunities to access and integrate technology into their teaching and learning approaches. One of the teachers pointed out that while students responded positively to interactive tools, many schools simply did not have enough resources to allow for access. One of the respondents’ notes, *“Lack of devices made it difficult to engage all students equally.”*

Theme 2: Technical issues and training (n=7; 14.9%)

Student-teachers frequently reported difficulties in using educational technologies due to technical malfunctions and limited training.

Sub-Theme 2.1: Disruptive Technical Issues (N=4)

Even in schools with adequate devices, frequent technical issues such as malfunctioning projectors, software crashes, and unresponsive screens disrupted lesson delivery. Student-teachers often lacked on-site technical support, leading to delays and frustration during instructional time. “Technical problems disrupted some of my lessons. The projector wouldn’t work, and I didn’t have enough time to troubleshoot.” (Participant 19)

Sub-Theme 2.2: Lack Of Professional Development (N=3)

Participants highlighted the absence of practical training on the integration of technology for students with disabilities. While they had some exposure to tools like PowerPoint or Canva, many lacked strategies for adapting these tools to students with ADHD, autism, or learning disabilities. This gap left them unprepared to use technology confidently and effectively during practicum. “I had basic training on PowerPoint but not on how to use apps or games for students with autism or ADHD.” (Participant 33)

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This theme emphasizes the need for structured digital literacy and technical troubleshooting support within teacher education programs. It was then followed by the factor of technical issues and training that emphasized these difficulties hinder effective technology integration. Teachers reported that, *"While technology improved learning, there were challenges such as technical issues and lack of training".* This has been supported by other respondents who say, *"Technical problems disrupted some of my lessons".*

Theme 3: Customized tools (n=5; 10.6%)

Student-teachers stressed the importance of technology tools tailored to special education needs, which were largely unavailable or not localized to the Malaysian curriculum.

Sub-Theme 3.1: Lack Of Customizable Apps (N=3)

Student-teachers struggled to find tools that allowed for customization based on each student's learning level or cognitive ability. Many applications used were one-size-fits-all, making it difficult to address individual needs, especially in mixed-ability classrooms typical of the PPKI program. "It's hard to find apps that allow me to adjust levels based on each student's needs. Most tools are generic." (Participant 8)

Sub-Theme 3.2: Limited Local Language Support (N=2)

Another significant challenge was the lack of tools that supported Bahasa Melayu or incorporated Malaysian curriculum standards. Participants reported difficulty in adapting English-based platforms for students who required local language instruction or culturally relevant content. "Some of the AI tools I tried didn't support Bahasa Melayu, which is essential for my students." (Participant 20)

The findings point to a significant gap between the general-purpose educational tools and the specific requirements of Malaysia's special education environment. Additionally, teachers also highlight the need for customized technological tools that are specifically designed for special education settings. Some of the teachers reported that it is quite challenging for them to find tools that can meet the needs of special needs students. One of the teachers mentioned that "*There's a need for more customized tools for special education,"* and this is supported by other respondents, *"Customizing tools for different students was a challenge due to limited options"*.

Theme 4: Moderation (n=6; 12.8%)

While participants acknowledged the benefits of technology, they also expressed concern over overuse and the need for strategic, well-balanced implementation.

Sub-Theme 4.1: Avoiding Overreliance (N=3)

While most participants acknowledged that technology increased student engagement, they also observed that excessive reliance on it could lead to boredom, distraction, or reduced interpersonal interaction. Student-teachers expressed the need to strike a balance between digital tools and hands-on learning experiences. "Technology is great for making lessons interactive, but when overused, students lose interest and become passive." (Participant 27)

Sub-Theme 4.2: Pedagogical Alignment (N=3)

Participants emphasized the need to align technology use with lesson objectives and pedagogical goals. Without proper planning, technology became a superficial add-on rather

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than a meaningful instructional tool. There was a call for intentional integration that supports critical thinking, collaboration, and student autonomy. “We need to think carefully about how technology supports, not replaces, teacher-student interaction.” (Participant 6)

This theme reinforces the call for intentional technology integration, aligned with both pedagogy and learner engagement needs. There are two main concerns found in this research, which are the need for moderation of technology and planned implementation. Teachers noted that while technology is beneficial in their teaching and learning, it should be used in moderation, as they mentioned that *"Technology is good for making lessons more interactive, but it cannot be overused, or it will lose its impact”.* It is also supported by other respondents who highlight, *"Technology was great, but it needs to be used in moderation to avoid student burnout or loss of interest”.*

Theme 5: Thoughtful Implementation (n=8; 17.0%)

Despite these challenges, participants noted that when effectively used, technology enhances inclusivity, student motivation, and personalized learning.

Sub-Theme 5.1: Increased Engagement (N=5)

Despite challenges, many student-teachers reported that digital tools made learning more enjoyable for students with disabilities. Videos, sound effects, and visual animations captured students’ attention and motivated them to participate more actively than during conventional lessons. “My students were more responsive during lessons with videos or interactive slides. They enjoyed participating.” (Participant 16)

Sub-theme 5.2: Support for Differentiated Learning (n=3)

Several participants shared success stories where simple technologies helped students overcome literacy barriers, follow routines, and complete structured tasks. For example, drag-and-drop games or visual task boards were particularly effective for students with dyslexia or autism. “I used simple drag-and-drop activities on a tablet to match words with pictures. It helped my students with dyslexia understand better.” (Participant 31)

Participants emphasized that with adequate training and resources, technology could empower both students and teachers in special education settings. Teachers also mentioned their concern about the need for thoughtful implementation to ensure that technology can enhance teaching and learning practices for special education. One of the teachers responded that, *"I believe technology played a crucial role, but its success depends on thoughtful implementation,”* and another noted that *"It’s important to carefully plan how technology is used to avoid disengaging students”.* This shows that the effectiveness of technology in education is closely tied to how well it is implemented.

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Table 2: Challenges And Limitations Experienced by Teachers

Themes	Number of Occurrences, n	Example of Excerpt
Limited resources	6	1. "Students respond positively to interactive tools, but some schools lack sufficient resources." 2. "Lack of devices made it difficult to engage all students equally."
Technical issues and training	7	1. "While technology improved learning, there were challenges such as technical issues and a lack of training." 2. "Technical problems disrupted some of my lessons."
Customized tools	5	1. "There's a need for more customized tools for special education." 2. "Customizing tools for different students was a challenge due to limited options."
Moderation	6	1. "Technology is good for making lessons more interactive, but it cannot be overused, or it will lose its impact." 2. "Technology was great, but it needs to be used in moderation to avoid student burnout or loss of interest."
Implementation	8	1. "I believe technology played a crucial role, but its success depends on thoughtful implementation." 2. "It's important to carefully plan how technology is used to avoid disengaging students."

Source: (Author's work)

Discussion

Despite the promising opportunities, significant challenges must be addressed to fully harness the potential of technology in special education. The findings of this study, drawn from the reflective insights of 47 student-teachers engaged in diverse practicum placements, provide a rich basis for understanding the multifaceted barriers and enablers of technology integration in special education. This discussion critically aligns these findings with both theoretical frameworks and contextual literature to formulate concrete implications for practice, policy, and further research. The five emergent themes, limited resources, technical issues and training, customized tools, moderation, and thoughtful implementation mirror global concerns and provide grounded insights specific to the Malaysian context.

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Limited Resources: Structural Inequity in Access

A key barrier consistently echoed by participants was inadequate access to technological resources. Numerous schools, particularly in rural or semi-urban settings, lack sufficient devices, stable internet networks, or assistive technologies. This inequity threatens the quality of inclusive education while having a direct impact on the ability of educators to implement differentiated practices. Prior studies from Polat et al. (2019) and Goodley et al. (2020) corroborate the valid concerns about systemic inequities in digital infrastructures to create meaningful gaps in learning experiences.

The Malaysian data supports the existence of the issues. As reported by the National Digital Department (2024), only 38% of special education schools indicated having functioning ICT facilities. The work of Zulkifli and Yusof (2022) specifically found that there is a significant percentage of special education teachers who still do not use digital methodologies based to infrastructural and support limitations. These structural gaps threaten the vision outlined in the Digital Education Policy (MOE, 2023) to create digitally fluent students and educators with digital fluencies at all education levels.

Technical Issues and Professional Development Gaps

Frequent and troublesome technological issues, such as failing projectors, unresponsive applications, and unreliable internet, were serious barriers to effective lesson delivery. More importantly, the student-teachers in their case studies reported they did not receive any training on modifying digital tools for learners with a variety of disabilities, such as autism, ADHD, or dyslexia.

These findings are consistent with Anderson and Putman (2019), who reported that technical glitches and a lack of training proved to be a barrier preventing even the most enthusiastic teachers from using technology, and Park et al. (2022), who found similar barriers in technology with the ICT integration process even though the teachers wanted to use technology. In Malaysia, Nordin et al. (2023) found that teachers wanted to use applications like Canva and Google Slides; however, they noted that teachers did not have the skills to modify these applications for their students ' IEPs.

The findings suggest that professional development needs to address specific pedagogy related to disabilities, and not just generic digital literacies. The use of practical workshops, peer-to-peer mentoring, and embedded coaches may be important for developing the confidence and competence of teachers to harness technology in ways that ensure learning is meaningful.

Customized Tools: One Size Does Not Fit All

Tools that are specific to special education were recurring in the data collected. Student-teachers reported being frustrated with generic applications that are not conducive to personalized adaptation, the incorporation of multiple languages, or alignment with the Malaysian syllabus.

Zaharudin et al. (2024) found that apps that provided procedural routines supported student autonomy for students with learning disabilities. However, there are few apps overall that are customizable for varying cognitive profiles or languages. The need for co-design processes among teachers, students, and developers, as noted by Alimisis (2021), is vital in developing authentic educational technology products.

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The lack of personalization and cultural context indicates a default level of responsiveness by the educational technology market to educational needs and priorities of policymakers in the current context. Therefore, Malaysian edtech development efforts are challenged to respond to issues of accessibility, language, and consistently discontinuing what is outdated to the extent possible and incorporating current Malaysian curricula.

Moderation and Thoughtful Implementation: Balancing Innovation and Engagement

Digital tools can promote learner motivation and engagement; however, if misused or overused, they can lead to student distraction, burnout, or passivity. Participants in this study shared observations about the potential pitfalls of excessive reliance on gamified tools, namely, the potential reduction of instructional value.

Harry (2023) cautions that the novelty effect of technology will eventually fade and requires the teacher to consistently update their content or be creative pedagogically with presentation styles. This is especially important in special education situations where students might be particularly reliant on routine and consistency. The student-teachers in the study advocated for the moderate use of digital tools and stated that combining digital and traditional tools is the best approach, if the choice was intentional and matched to the readiness and learning goals of their students.

Moderation is also related to pedagogical engagement and objectives. Some student-teachers also noted that technology was often 'added' to lessons, without pedagogical intent, which meant it became an add-on rather than an integrated instructional mode. This is connected to the critique from Uygur et al. (2020), who stated that a valuable intervention is much more than just sticking a technology into a lesson plan, and requires appropriate planning, ongoing assessments, and feedback loops.

Theoretical Integration: Rogers' Diffusion of Innovation in Practice

The results of this study exemplify the essential qualities of Rogers' Diffusion of Innovation Theory, specifically focusing on how teachers view and respond to technology integration when working with students with disabilities. Teachers recognized the relative advantage of educational technology in that it may boost student engagement and increase access to instructional content. Compatibility concerns were surfaced by teachers regarding the available tools' alignment with the unique learning needs of students with disabilities and the national curriculum requirements of Malaysia. Complexity was also prevalent; many teachers reported feeling overwhelmed, and lacked confidence and capability, because of not received adequate training to use even the more basic digital tools.

The trialability component had a restricted value because teachers did not have the devices readily available, and the internet infrastructure was lacking, resulting in reduced opportunities to trial, play with, and adjust instructional technology blending. Regarding observability, few teachers adequately demonstrated positive technology use; although some reported positive results, they were sporadic and not planned, easily replicable, or shareable, inhibiting a comprehensive institutional observation process. Teachers who had sufficient exposure and support demonstrated characteristics of early adopters: enthusiastic, experimental, and confident. In the right circumstances, they could initiate peer influence and adoption more broadly, supported through a program of peer mentorship or a school-wide support structure.

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Comparative and Global Contexts

These challenges are not unique to Malaysia. Research from Turkey (Arı et al., 2022; Hamutoğlu et al., 2022) as well as the United States (Anderson & Putman, 2019) has revealed similar issues in these countries of inadequate training, inequities in resources, and an inability to customize tools for use in education. These cross-national parallels demonstrate the widespread need for collaboration at this level to create inclusive edtech ecosystems.

In sum, the alignment between the study's empirical findings and established theoretical and policy frameworks underscores the robustness and relevance of this research. Addressing the multifaceted challenges of technology integration in special education calls for collaborative strategies that span teacher education, policy reform, technology development, and school-level innovation. By grounding these strategies in evidence and theory, stakeholders can work collectively toward inclusive, effective, and sustainable edtech integration for learners with special needs.

Implications And Contributions

This study has also highlighted the innovation of qualitative data analysis with the use of Word Comment Analyzer, which is evident in Microsoft Word, and the use of ChatGPT in analyzing code, subthemes, and themes. This study makes several important contributions to both theory and practice, with specific relevance to the Malaysian education system and the broader field of special education technology integration.

Theoretical Contributions

Theoretically, this research advances the application of Rogers' Diffusion of Innovation Theory within the context of special education, a domain that has seen limited theoretical exploration from this lens. By mapping each of the five key innovation attributes (relative advantage, compatibility, complexity, trialability, and observability) onto empirical findings, this study deepens our understanding of how these constructs manifest in inclusive education settings. Unlike general education contexts, where trialability and observability may be more easily achieved, special education environments present unique barriers due to infrastructural limitations, the need for individualized tools, and diverse student needs. This study highlights how these constraints complicate the innovation adoption process and suggests that the theory may benefit from refinement to account for systemic inequities and the need for adaptive leadership in inclusive schools. Moreover, it emphasizes the critical role of early adopters in special education teachers who, when adequately supported, can serve as catalysts for broader institutional change.

Practical and Policy Contributions

From a policy perspective, the findings yield several actionable recommendations tailored to Malaysian education stakeholders. To address the systemic challenges identified in this study, several policy recommendations are proposed for Malaysian education stakeholders. First, targeted infrastructure investment is essential; the Ministry of Education must prioritize the equitable distribution of ICT resources, especially within PPKI programs, to bridge the digital divide and ensure all students have access to meaningful technological integration. Second, localized EdTech development should be pursued through public-private partnerships aimed at creating culturally and linguistically appropriate digital tools. These tools must be aligned with the national curriculum and capable of supporting the diverse learning needs of students with disabilities.

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Third, there is an urgent request for a specialized professional development model that goes beyond generic digital literacy. Professional development initiatives for special education should be planned, ongoing, and experiential. The focus should be on pedagogical and technical aspects of special education, including disability specific strategies. Fourth, the government should expand existing models of digital mentoring, such as SIP+, to include mentoring in digital competencies for special education teachers. This would allow early adopters to mentor their peers, particularly in low-resource settings, and implement a collaborative innovation culture. Finally, there is a need for a strong data-led monitoring and evaluation framework for measuring educational technology implementation for special education that uses both qualitative and quantitative measures. A monitoring and evaluation framework designed in this manner would promote evidence-informed decision making and ongoing improvement.

This study also adds to the ever-growing catalogue of literature indicating the urgent need for differentiated policies for digital education that address the complexity of inclusive pedagogy. As Malaysia is progressing with its implementation of Digital Education Policy (DEP) 2021-2030, this research provides relevant, timely, empirical, and contextualized recommendations that can assist in more fully inclusive policy development and program planning that are considerate of the existing realities of practice.

To conclude, integrating technology into special education should not merely be regarded as providing access, but as an instrumental part of innovation and educational equity. Malaysia can begin to make progress on the barriers identified in this research through systemic reforms and capacity building for the larger educational community. Addressing these barriers will advance inclusive digital education to its fullest potential.

Limitations And Recommendations For Future Research

While this study provides valuable insights into how educational technology can be integrated into special education, it is important to recognize some limitations in providing a balanced reading of the findings.

First, the research design employed was qualitative and involved a relatively small, purposely selected sample (n = 47) of student-teachers. While data saturation was reached and sufficient richness of data was achieved, these findings are not generalizable across all contexts of special education in Malaysia. The sample mostly captures the situation experienced in a PPKI program and does not represent the wide range of practices in other settings, such as special schools or inclusive mainstream classrooms.

Secondly, the use of AI-assisted tools such as ChatGPT and Microsoft Word Comment Analyzer in the coding and thematic analysis, while innovative, introduces potential biases in interpretation. Although the final themes were validated by the research team, reliance on automated suggestions may have influenced the coding process. Future studies should consider triangulating AI-generated themes with independent manual coding or using mixed-method approaches to enhance the robustness of qualitative analysis.

Thirdly, the study's reliance on self-reported data from digital questionnaires introduces the possibility of social desirability bias, where participants may report more favourable views or downplay challenges. Additionally, contextual variables such as school location,

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administrative support, and student demographics were not deeply explored but may significantly influence technology integration outcomes.

In terms of future research directions, there is a strong need for longitudinal studies that follow teachers over time to assess how their technology usage evolves with experience and training. Moreover, quantitative validation of the themes identified in this study could be undertaken through surveys with larger and more diverse samples, enabling statistical generalization of findings. Intervention-based studies that evaluate the impact of specific training modules, mentoring programs, or customized educational tools on teaching efficacy and student outcomes would also be valuable.

Additionally, comparative studies across different educational settings, rural vs urban schools, PPKI vs inclusive classrooms, or Malaysian vs international contexts can further elucidate contextual differences and inform scalable policy models. Finally, researchers are encouraged to investigate the student perspective more deeply, particularly focusing on how learners with disabilities experience and respond to different digital tools, to inform more learner-centered technology design.

By addressing these limitations and pursuing the suggested research pathways, future work can build on this study's foundation to further enhance the integration of technology in special education and contribute to the advancement of inclusive, equitable digital learning environments.

Conclusion

This study has provided a timely and in-depth exploration of how technology is experienced and integrated by student-teachers within Malaysia's special education settings. Through a qualitative thematic approach, supported by AI-assisted analysis, the research uncovered five key themes: limited resources, technical issues and training, customized tools, moderation, and thoughtful implementation, that collectively reflect both the opportunities and persistent challenges in leveraging educational technology for inclusive teaching and learning.

Importantly, the findings contribute meaningfully to theoretical discourse by applying and extending Rogers' Diffusion of Innovation Theory in a special education context. This application illuminated how the adoption of innovation in under-resourced and diverse educational environments may deviate from more generalist assumptions. The study reveals the nuanced interactions between teacher readiness, system infrastructure, and tool compatibility, offering refinements to the theory that can inform its use in similarly complex educational contexts globally.

From a policy perspective, the study underscores the urgent need for targeted interventions ranging from equitable ICT distribution and localized edtech development to customized training and digital mentoring models to create more inclusive digital ecosystems within special education. These recommendations are congruent with national priorities such as the Malaysian Digital Education Policy (2021–2030) and can support planning and strategic decision-making at the institutional and ministerial levels.

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Furthermore, on a global stage, the study contributes to the larger educational conversation on how best to support technology integration for learners with disabilities. The barriers mentioned, such as resource disparity, limited professional development, and no accessible or localized tools, are not unique to Malaysia; but the context specific recommendations and theory constructed in this study can offer a model for other nations who are engaging in digital transformation in education that is equally committed to supporting inclusive outcomes.

Final thoughts: This study reinforces that effective technology integration in special education is far more than a technical development; it entails pedagogical, foundational, and equity elements that must be addressed to be successful. It will take systemic commitment, transdisciplinary collaboration across educational sectors, and ongoing policy support. The study has made original empirical contributions, with theoretical model development and practical recommendations that further the discourse on inclusive education and technology policy both in Malaysia and globally.

Declaration of Conflicting Interests

The author(s) declare no potential conflicts of interest regarding this article's research, authorship, and/or publication. AI software, specifically InstaText, was used for proofreading and editing purposes to enhance the clarity and coherence of the manuscript. The software was used to improve language quality and ensure adherence to academic writing standards. ChatGPT has been discussed on its roles in data analysis to analyse the data.

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