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META-ANALYSIS OF LITERATURE REVIEW (2020–2025): THE ROLE OF SPECIAL EDUCATION TEACHERS IN THE LITERACY OF STUDENTS WITH HEARING IMPAIRED (SEN-HI) THROUGH MALAYSIAN SIGN LANGUAGE AND DIGITAL COMPETENCE

Nur'Hamizah Abdul Rahman [1]*, Grace Annamal Piragasam[2]

[1] Faculty of Human Development, Universiti Pendidikan Sultan Idris, Tanjong Malim, Perak, Malaysia
E-mail: P20241000233@mail.siswa.upsi.edu.my
[2] Faculty of Human Development, Universiti Pendidikan Sultan Idris, Tanjong Malim, Perak, Malaysia
E-mail: grace@fpm.upsi.edu.my
* Corresponding Author

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Abstract:

This study takes the form of a meta-analytic literature review that evaluates the role of special education teachers in strengthening the literacy development of students with hearing impaired (SEN-HI) through mastery of sign language and digital competence. A total of 35 articles published between 2020 and 2025 were systematically analyzed using both qualitative thematic and quantitative descriptive approaches. The analysis revealed three main themes: (i) special education teachers as mediators of language and culture; (ii) teachers' digital competence as a catalyst for literacy achievement; and (iii) structural challenges, professional training, and educational policy support. Global findings indicate that the systematic integration of sign language with formal literacy instruction, together with the use of digital technology supported by continuous professional development, enhances the literacy achievement of deaf students. However, in the Malaysian context, the literacy gap remains significant due to a shortage of teachers proficient in Malaysian Sign Language (BIM), limited bilingual learning materials, and unequal digital infrastructure. This study emphasizes the need for holistic strategies that involve professional training, the development of bilingual-bicultural literacy modules, and the strengthening of inclusive education policies to empower the literacy development of students with hearing impaired (SEN-HI).

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Keywords:

Special Education Teachers; Students with Hearing Impaired (SEN-HI); Literacy; Sign Language; Digital Competence; Inclusive Education; Meta-Analysis

Introduction

Special education teachers play a vital role in ensuring the learning success of students with special educational needs, including students with hearing impaired (SEN-HI). Within the context of inclusive education, literacy development is a fundamental aspect that requires serious attention, as it is not only related to language acquisition but also influences children's cognitive, emotional, and social processes (Luckner & Cooke, 2010; Alasim, 2020).

For SEN-HI students, sign language functions as the primary medium of communication and learning that supports their linguistic identity and cultural empowerment (Marschark & Knoors, 2020; Humphries et al., 2022). At the same time, digital competence has become increasingly significant in the 21st-century education era, as it provides access to broader, interactive, and user-friendly learning resources (UNESCO, 2022; Wang & Xu, 2023). Therefore, the integration of the role of special education teachers, the use of sign language, and the application of digital competence are seen as key factors in strengthening the literacy development of students with hearing disabilities.

In Malaysia, there are two main communication systems used in special education: Malaysian Sign Language (BIM), which is recognized as the natural language of the Deaf community, and Manually Coded Malay (KTBM), which is a manual code form of the Malay language officially used in special education schools and the Integrated Special Education Program (PPKI) (Ministry of Education Malaysia, 2021). Although both systems are related, BIM emphasizes its own linguistic structure, whereas KTBM maintains the grammatical structure of the Malay language. Hence, teachers' understanding and proficiency in both systems are crucial to ensure an effective and inclusive literacy learning process.

According to the Department of Social Welfare (2022), the level of hearing disability among SEN-HI students is divided into four main categories: mild, moderate, severe, and profound. This classification is determined based on the degree of hearing loss measured in decibels (dB HL) and serves as a guide for educators and therapists in determining appropriate teaching and communication strategies. Therefore, special education teachers need to understand these variations in hearing levels so that literacy teaching approaches whether through BIM or KTBM can be tailored to the individual needs of students in a more inclusive, effective, and responsive manner.

Literacy is not merely the ability to read and write but serves as the foundation of education and social development, as it is the key to knowledge acquisition, social interaction, and access to future economic opportunities (UNESCO, 2022). In the context of SEN-HI students, literacy is also closely related to linguistic and cultural identity, which shapes their learning experiences (Marschark & Knoors, 2020). However, they often face significant challenges in literacy acquisition due to limited access to the dominant spoken language in mainstream education systems. A lack of early exposure to a complete, consistent, and systematic language

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environment leads to slower literacy development compared to their hearing peers (Wang & Xu, 2023).

In this regard, special education teachers serve as mediators between language, culture, and technology. They function not only as instructors but also as linguistic facilitators who help SEN-HI students build literacy foundations through sign language. At the same time, teachers act as cultural agents introducing bilingual-bicultural perspectives while integrating digital technology to broaden access to more interactive and inclusive learning materials (Humphries et al., 2021; Moreno & Rodríguez, 2022). Teachers' mastery of pedagogical, linguistic, and digital competencies is therefore critical in supporting holistic literacy development.

In Malaysia, gaps in literacy development among SEN-HI students remain evident. The Ministry of Education Malaysia (2021) reported that the literacy achievement of students with hearing disabilities is lower than that of typical students, particularly in reading and writing skills in the Malay language. Contributing factors include the shortage of teachers proficient in BIM, limited suitable bilingual teaching materials, and inconsistent levels of special education technology integration between urban and rural schools (Ismail & Mahamod, 2020). This situation indicates that although inclusive education policies have been introduced, their implementation continues to face challenges in terms of structural barriers, professional training, and adequate digital infrastructure (Nor & Alias, 2022).

Given the rapid development of educational technology and the growing global emphasis on inclusive education, there is a need to systematically evaluate the latest empirical evidence concerning the role of special education teachers in enhancing the literacy of SEN-HI students. Therefore, this article employs a meta-analysis of literature review covering studies published between 2020 and 2025. The rationale for this approach is to integrate recent research findings involving the use of sign language as the main medium of literacy and the level of digital competence among special education teachers in supporting the learning process. This analysis is expected to provide a comprehensive overview of effective strategies, current challenges, and implications for policy and practice in special education.

Methodology: Meta-Analysis

This study employed a meta-analysis of literature review focusing on publications between 2020 and 2025. The adoption of this approach enabled the researcher to systematically integrate empirical findings from various previous studies, thereby providing a comprehensive overview of the patterns, gaps, and effectiveness of special education teachers' roles in enhancing the literacy of students with hearing impaired (SEN-HI) through sign language and digital competence (Borenstein et al., 2021).

For this purpose, article searches were conducted across several international and local databases, including Scopus, Web of Science, ERIC, SpringerLink, Taylor & Francis Online, ScienceDirect, Google Scholar, and local special education journals such as *Jurnal Pendidikan Bahasa Melayu* and the Malaysian Journal of Special Education. Search keywords were used in both English and Malay, including: "special education teachers" OR "*guru pendidikan khas*," "hearing impaired" OR "*murid berkeperluan pendidikan khas ketidakupayaan pendengaran* (MBPK KUP)," "literacy development" OR "*pembangunan literasi*," "sign language" OR "*bahasa isyarat*," "digital competence" OR "*kompetensi digital*," and

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"bilingual-bicultural education" OR "*pendidikan dwibahasa-dwibudaya*." These keywords were combined using Boolean operators (AND, OR) to ensure precise search results.

The screening process was carried out based on specific inclusion and exclusion criteria. Selected articles had to be published between 2020 and 2025 and take the form of empirical studies (quantitative, qualitative, or mixed methods) or systematic reviews related to special education teachers, literacy among SEN-HI students, sign language, and digital competence. The study population had to include SEN-HI students at the preschool, primary, or secondary levels. Only articles written in English or Malay were accepted. Conceptual papers without empirical data, studies published before 2020, and those involving adult populations or unrelated topics were excluded.

From an initial total of 156 articles identified, 82 were excluded at the title and abstract screening stage for lack of relevance. Subsequently, 39 articles were removed after full-text reading for not meeting the inclusion criteria. In the end, 35 articles were selected and analyzed. Data were examined using a combination of qualitative thematic analysis to identify the main themes (roles of special education teachers, effectiveness of sign language, digital competence, and bilingual-bicultural education models) and descriptive quantitative analysis to determine the frequency of themes, country of study origin, research methods, and literacy-related findings.

In addition to assessing global patterns, this meta-analysis placed special emphasis on the Malaysian context. This focus is crucial, as despite the implementation of inclusive education policies, literacy gaps among SEN-HI students in Malaysia persist. The Ministry of Education Malaysia (2021) reported that the literacy achievement of deaf students remains lower than that of typical students. Contributing factors include the shortage of teachers proficient in Malaysian Sign Language (BIM) (Ismail & Mahamod, 2020), the limited availability of bilingual literacy materials, and inconsistent integration of special education technology between urban and rural schools (Nor & Alias, 2022). Therefore, this meta-analysis not only aims to provide an initial overview of international findings but also to assess their relevance within the Malaysian special education context before conducting more detailed investigations.

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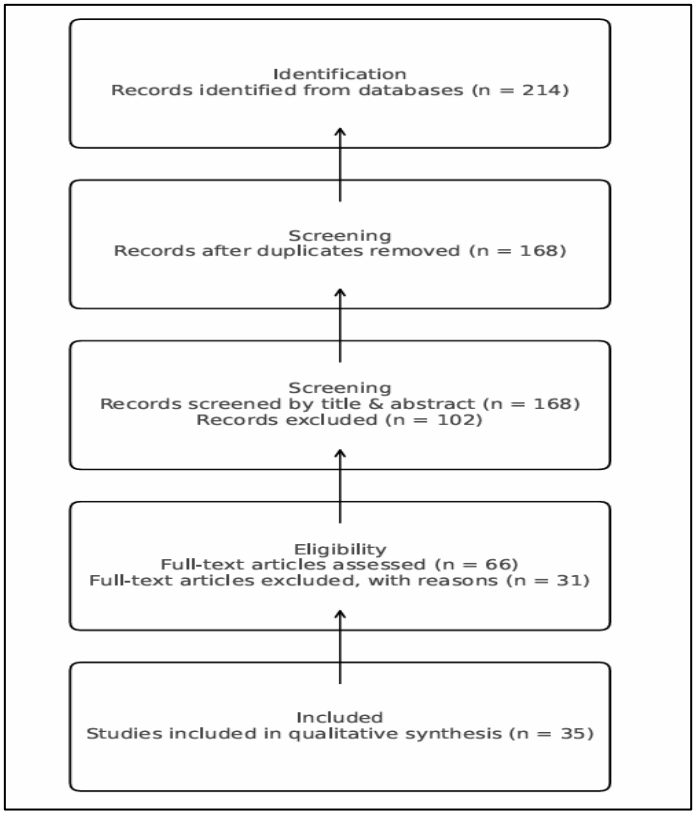

Figure 1: PRISMA 2020 Flow Diagram Showing the Process of Study Identification, Screening, Eligibility Assessment, And Inclusion in the Meta-Analysis

Findings of the Meta-Analysis

This meta-analysis involved 35 articles published between 2020 and 2025. The results of the analysis revealed several interrelated themes that explain the role of special education teachers in enhancing the literacy of students with hearing impaired (SEN-HI) through the use of sign language and digital competence. The identified themes are as follows:

The Role of Special Education Teachers as Linguistic and Cultural Moderator

International studies have found that special education teachers play a crucial role as intermediaries between the native language of students with hearing impaired (SEN-HI), sign language, and formal literacy. For instance, García and Sánchez (2021) in Spain reported that bilingual-bicultural education enhances the motivation and literacy achievement of deaf students. Similarly, Miller (2022) in the United States found that the use of sign language in early reading instruction helps strengthen visual phonological comprehension. In Malaysia, Ismail and Mahamod (2020) emphasized that teachers' proficiency in Malaysian Sign Language (BIM) is a key determinant of literacy achievement among deaf students. However, the level of teacher competence in BIM remains uneven, particularly among novice teachers. This indicates the need for continuous professional training to ensure that teachers can effectively function as linguistic and cultural mediators.

Teachers' Digital Competence and HearingImpaired Children Literacy

Studies conducted during the COVID-19 pandemic revealed an increase in the use of digital platforms, interactive applications, and multimedia materials for literacy instruction. Zhang et al. (2022) in China demonstrated that interactive applications support vocabulary development

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and reading comprehension among students with hearing impaired (SEN-HI). Smith and Lee (2023) further emphasized that the effectiveness of technology integration largely depends on the level of teachers' digital competence. In the Malaysian context, Nor and Alias (2022) highlighted a clear digital divide between urban and rural schools, where deaf students in rural areas have limited access to digital materials. Ali and Hassan (2022) also found that the combined use of Malaysian Sign Language (BIM) and technology increases deaf students' motivation to read, although teachers face additional workload in preparing materials. Therefore, teachers' digital competence must be strengthened through specialized training to ensure that technology truly functions as an inclusive literacy medium.

Structural Challenges, Training, and Policy Support

Many international studies have emphasized the structural challenges in literacy education for students with hearing impaired (SEN-HI). Brown (2022) in the United Kingdom found that the absence of a specific bilingual literacy curriculum hinders teachers from implementing consistent instruction. Similarly, Chen and Huang (2024) in Taiwan highlighted the additional workload faced by teachers when required to integrate technology without adequate policy support and professional training. In Malaysia, Rahim and Abdullah (2021) reported that special education teachers often act as "cultural bridges," yet still lack systematic bilingual literacy modules. The Malaysian Ministry of Education (2021) also indicated that the literacy achievement of deaf students remains lower compared to their typical peers, with major contributing factors being the shortage of teachers proficient in Malaysian Sign Language (BIM) and the limited availability of literacy materials. This situation signals the need for a more comprehensive special education policy, particularly concerning digital and bilingual literacy modules.

Global vs. Malaysian Patterns

The comparative analysis revealed that global patterns place greater emphasis on the systematic integration of sign language with literacy education, supported by teachers' formally trained digital competence. Overall, the global trend demonstrates consistent effectiveness when these two factors are combined. In contrast, in Malaysia, efforts toward inclusive education do exist; however, the overall achievement remains moderate due to several factors a) the gap in Malaysian Sign Language (BIM) proficiency among teachers (Ismail & Mahamod, 2020), b) the shortage of bilingual literacy materials suited to the local cultural context (Rahim & Abdullah, 2021) and 3) unequal digital infrastructure between urban and rural schools (Nor & Alias, 2022). This meta-analysis confirms that the role of special education teachers as mediators of language, culture, and technology is a determining factor in the literacy development of students with hearing impaired (SEN-HI). However, the success of this role depends on teachers' level of BIM proficiency, ongoing professional training, and the presence of clear and consistent educational policy support.

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Table 1: Summary Of 35 Articles (2020–2025) On the Role of Special Education Teachers in Hearing Impaired Children Literacy

No	Year	Author(s)	Country	Focus	Method	Key findings	Challenges	Implications
1	2020	Ismail & Mahamod	Malaysia	Teachers' mastery of BIM & literacy of deaf students	Qualitative (interviews)	BIM supports early reading comprehension	Lack of teachers proficient in BIM	Need for intensive BIM training
2	2020	Li & Zhang	China	Teachers' role in bilingual literacy	Quantitative (quasi-exp)	Bilingual model improves literacy scores	Limited materials	Develop contextual bilingual resources
3	2021	García & Sánchez	Spain	Bicultural education for deaf children	Qualitative (case study)	Bicultural approach enhances motivation and comprehension	Lack of specific curriculum	Integrate bilingual policies in schools
4	2021	Wang et al.	China	Digital literacy of deaf students	Mixed methods	Interactive apps support vocabulary	Digital access gap	Device-sharing programs
5	2021	Rahim & Abdullah	Malaysia	Implementation of inclusive literacy	Qualitative (school survey)	Teachers as cultural mediators	Limited teacher training	Professional development plan
6	2021	Miller	USA	Sign language & visual phonology	Quantitative (experiment)	Sign-based teaching improves phonological awareness	Limited teaching time	Structured teaching modules
7	2022	Zhang et al.	China	Interactive apps for literacy	Quantitative (small RCT)	Apps increase reading interest	Low digital skills among teachers	Focused ICT training
8	2022	Brown	UK	Inclusive literacy curriculum	Qualitative (policy analysis)	Integrated curriculum yields positive outcomes	Inconsistent policy support	National policy alignment
9	2022	Nor & Alias	Malaysia	Technology integration in special education	Qualitative (interviews)	ICT supports BIM + text teaching	Urban–rural divide	Invest in infrastructure

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10	2022	Ali & Hassan	Malaysia	Motivation in literacy via BIM+ICT	Quantitative (survey)	BIM + ICT improves motivation	Teacher workload	Additional teaching support
11	2022	Humphries et al.	USA (review)	Importance of early language input	Systematic review	Strong support for bilingual-bimodal input	Oral-only policy misconceptions	Early sign language support
12	2022	Monteneg ro-Rueda	Spain	Teachers' digital competence	Quantitative (perception study)	Competence gaps hinder ICT use	Lack of formal training	Adapt digital training programs
13	2023	Smith & Lee	Australia	Multimodal literacy & signed videos	Quantitative	Signed videos improve narrative comprehension	Broadband limitations	Low-bandwidth content design
14	2023	Chen & Huang	Taiwan	Digital competence & literacy	Quantitative	Teacher competence correlates with literacy outcomes	Insufficient training	Continuous training policies
15	2023	Rahman et al.	Malaysia	Availability of bilingual materials	Inventory & content analysis	Very limited bilingual materials	Low publication output	Incentives for BIM materials
16	2023	Dostal et al.	USA/Europe	Signed language literacy interventions	Scoping review	Evidence of benefits of sign-based interventions	Study design variation	Need for high-quality RCTs
17	2023	Cabero-Almenara	UK/Spain	Digital competence to support disability	Case study	Teachers need digital knowledge	Limited access & training	Professional development curriculum
18	2023	Osei & Mokoena	South Africa	Bilingualism in deaf literacy classes	Qualitative (case study)	Bilingualism supports academic achievement	Local language constraints	Community & policy support
19	2023	Tan & Lim	Malaysia	Early learning: KTBM & BIM	Quantitative (preschool)	Hand codes aid early Malay comprehension	Weak code standardization	National KTBM/BIM standards
20	2024	Brown & Patel	UK/India	Evidence-based deaf literacy	Mixed methods	Structured approach yields short-term gains	Limited training resources	Develop structured modules

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				curriculum				
21	2024	Nguyen et al.	Vietnam	Digital access in rural areas	Quantitative	Lack of devices limits ICT use	Cost & connectivity issues	Public–private sharing initiatives
22	2024	Chen et al.	China	VR & sign language learning	Systematic review	Immersive tech shows promise	High cost & accessibility issues	Long-term impact studies
23	2024	Ministry of Education	Malaysia	Special education report	National report	Literacy gap between deaf & typical students	Shortage of BIM-trained teachers & materials	Policy for training & materials
24	2024	O'Connor	Ireland	Teachers' attitudes to bilingual pedagogy	Qualitative	Teachers support bilingualism if trained	Self-efficacy concerns	Mentor-based training model
25	2024	Park & Kim	South Korea	Captioning & transcription for DHH learners	Quantitative (usability)	Auto-captioning aids multimodal text access	Accuracy issues	Teacher-assisted editing
26	2024	Rahim & Chong	Malaysia	Video-based BIM literacy	Small experiment	BIM videos improve story comprehension	Time-intensive production	MOE/agency resource units
27	2024	Silva et al.	Brazil	Community in deaf literacy	Qualitative	Local community reinforces language use	Limited community resources	Community support programs
28	2024	Ahmed & Yusuf	Egypt	Teacher training for BIM/ISL equivalents	Quantitative	Intensive training improves skills	Training scalability	Blended learning training models
29	2025	D'Souza	India	Digital libraries & signed stories	Mixed methods	Signed libraries expand access	Copyright & publishing barriers	Open-source policy support
30	2025	Montenegro-Rueda et al.	Spain	Instrument for digital competence (Spec Ed)	Quantitative (instrument validation)	Valid instrument for assessing teachers' competence	Need for local adaptation	Use tool for national assessment

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31	2025	Lim & Noor	Malaysia	Urban–rural comparison	Quantitative	Tech access gap affects literacy	Infrastructure disparities	Focus on rural investment
32	2025	Tanaka	Japan	Early sign exposure & reading	Quantitative (longitudinal)	Early sign exposure linked to better reading	Need for long-term research	Preschool sign language support
33	2025	Oliveira	Portugal	Teachers' perceptions of bilingual pedagogy	Qualitative	Positive perception if supported	Time & workload	Teacher workload management
34	2025	[Frontiers Review]	International	VR in sign language education	Systematic review	VR offers feedback & motivation	Cost & accessibility	Cost-benefit and implementation guidelines
35	2025	Chen & Huang	Taiwan	Teachers' digital competence & feasibility	Quantitative	Digital competence impacts feasibility	Resource limitations	Policy-driven digital integration

Discussion

The findings of this meta-analysis emphasize that the role of special education teachers is critical in strengthening the literacy development of students with hearing disabilities (SEN-HI) through three key dimensions: mastery of sign language, digital competence, and functionality as cultural mediators. Globally, bilingual-bicultural educational models that integrate sign language with formal literacy have demonstrated consistent effectiveness (García & Sánchez, 2021; Miller, 2022). This aligns with the perspective of Marschark and Knoors (2020), who stress that the linguistic and cultural identities of SEN-HI students must be recognized and integrated into literacy learning.

In the Malaysian context, the analysis revealed more pronounced gaps. Although inclusive efforts have been initiated, factors such as the shortage of teachers truly proficient in Malaysian Sign Language (Ismail & Mahamod, 2020), the absence of systematic bilingual literacy materials (Rahim & Abdullah, 2021), and the unequal digital infrastructure between urban and rural schools (Nor & Alias, 2022) have hindered literacy achievement among deaf students. This indicates that literacy success does not depend solely on teaching strategies, but also on a supportive special education ecosystem encompassing professional training, structured instructional modules, and consistent educational policies.

In addition, the findings show that teachers' digital competence has emerged as a crucial catalyst in the post-COVID-19 era. Interactive technologies such as mobile applications, BIM-based videos, and digital libraries have been shown to enhance the motivation and reading comprehension of deaf students (Zhang et al., 2022; Rahim & Chong, 2024; D'Souza, 2025). However, the effectiveness of these technologies depends on teachers' level of digital literacy, the availability of equipment, and institutional support (Smith & Lee, 2023; Chen & Huang,

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2024). Therefore, systematic strengthening of professional development strategies focusing on teachers' digital competence is essential.

From a policy perspective, international findings indicate clearer support through inclusive literacy curricula and ongoing teacher training (Brown, 2022; O'Connor, 2024). Conversely, in Malaysia, official reports from the Ministry of Education Malaysia (2021) acknowledge that literacy achievement gaps among deaf students remain significant. This calls for stronger policy investment, including the development of digital bilingual literacy modules, intensive BIM training, and alignment of special education infrastructure.

Overall, this meta-analysis underscores that the role of special education teachers should not be viewed in isolation but rather as part of an interconnected educational ecosystem involving policy support, professional training, and equitable digital access.

Conclusion

The conclusion of this meta-analysis underscores that special education teachers serve as the primary bridge connecting language, culture, and technology in strengthening the literacy development of students with hearing impaired (SEN-HI). Globally, numerous studies have shown that integrating sign language with digital competence is an effective approach to enhancing the literacy abilities of this group. However, within the Malaysian context, significant gaps remain that require attention particularly concerning teachers' proficiency levels, the availability of culturally appropriate bilingual literacy materials, and limitations in digital infrastructure. Accordingly, the implications of this study indicate that improving the literacy of SEN-HI students must be driven through comprehensive and systematic strategies. First, special education teachers should receive continuous professional training to strengthen their mastery of Malaysian Sign Language (BIM) while simultaneously enhancing their competence in the use of digital technologies. Second, the development of bilingual-bicultural literacy modules that are aligned with local cultural and linguistic contexts should be reinforced to ensure more relevant and inclusive learning experiences. Third, inclusive education policies must be strengthened by emphasizing equitable access to digital resources, especially for students in rural areas. Through the consistent implementation of these strategies, the literacy achievement of SEN-HI students in Malaysia has the potential to be elevated to a level comparable to their typically developing peers. This, in turn, will contribute to reinforcing the national inclusive education agenda and promoting more holistic social development.

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