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ICT Use Among Special Education Teachers in Teaching Hearing-Impaired Students: A Systematic Literature Review (SLR)

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Abstract: - The study "ICT Use Among Special Education Teachers in Teaching Hearing-Impaired Students: A Systematic Literature Review (SLR)" explores the integration of Information and Communication Technology (ICT) in the education of hearing-impaired students by special education teachers. This review synthesizes research from the past decade, focusing on teacher attitudes, skills, and barriers in ICT implementation. Using PRISMA guidelines, 20 articles from Google Scholar and ERIC were analysed. Findings reveal that teachers generally have positive attitudes towards ICT, recognizing the benefits of visual aids and interactive content in enhancing lesson accessibility. However, significant barriers such as limited resources, insufficient training, and a lack of tailored content for hearing-impaired students were identified. The study emphasizes the need for ongoing professional development and increased investment in ICT infrastructure and specialized educational materials. Future research should focus on longitudinal studies to assess the long-term impact of ICT and explore innovative technologies to support hearing-impaired students. This review provides valuable insights for educators, policymakers, and researchers aiming to leverage ICT in special education, highlighting both the opportunities and challenges in its effective implementation.

Keywords: ICT, hearing-impaired, special education teachers, attitudes, skills, barriers.

I. INTRODUCTION

Information and Communication Technologies (ICT) have revolutionized various sec-tors, including education, by providing innovative tools and methods to enhance learning experiences. ICT encompasses a wide range of digital technologies such as computers, projectors, smart boards, and specialized software that facilitate communication and information sharing (Baglama et al., 2018). In the context of special education, particularly for hearing-impaired students, ICT plays a crucial role in supporting and individualizing the learning process. The integration of ICT in education offers flexibility, efficiency, and the ability to tailor educational content to meet the specific needs of students with hearing impairments (Demirhan, 2008; Karal & Çiftçi, 2008).

Examples of ICT used by deaf students include visual aids like interactive white-boards, captioned videos, and sign language translation software (Sarı & Pürsün, 2018). These tools not only make lessons more accessible but also enhance the engagement and understanding of hearing-impaired students. For instance, the use of projectors and smart boards allows teachers to present visual content that can be easily followed by deaf students, thereby improving their motivation and learning outcomes (Demirhan, 2008; Karal & Çiftçi, 2008). Additionally, communication technologies such as video conferencing and instant messaging enable real-time interaction and collaboration, further supporting the educational needs of these students (Baglama et al., 2018).

The benefits of ICT for deaf students are well-documented. ICT enhances visual learning opportunities, which are particularly important for students who rely heavily on visual cues (Demirhan, 2008; Karal & Çiftçi, 2008). It also improves communication abilities by providing platforms for visual and written communication, thereby bridging the gap between hearing and hearing-impaired individuals (Sarı & Pürsün, 2018). Ac-cording to Sarı and Pürsün (2018), deaf students have shown a positive attitude to-wards the use of ICT, appreciating the increased engagement and understanding that these technologies facilitate.

Teachers play a pivotal role in the successful implementation of ICT in the education of deaf students. Their attitudes, skills, and the barriers they face significantly in-fluence the effectiveness of ICT integration (Baglama et al., 2018). Past reviews indicate that while teachers generally have a positive attitude towards adopting ICT, they often encounter challenges such as limited access to resources, insufficient training, and a lack of tailored content for hearing-impaired students (Sarı & Pürsün, 2018).

These barriers can hinder the effective use of ICT, underscoring the need for on-going professional development and support for teachers (Demirhan, 2008; Karal & Çiftçi, 2008).

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Given the rapid advancements in technology and the evolving educational needs of hearing-impaired students, there is a pressing need to systematically review the cur-rent state of ICT use in this context. This systematic literature review (SLR) aims to synthesize existing research on the attitudes, skills, and barriers faced by special education teachers in implementing ICT for hearing-impaired students (Baglama et al., 2018). By providing a comprehensive overview of the current landscape, this review seeks to identify gaps in knowledge and practice, and to inform future research and policy development. The findings of this review will be valuable for educators, policy-makers, and researchers who are committed to leveraging ICT to enhance the educational experiences of hearing-impaired students (Sarı & Pürsün, 2018).

II. METHODOLOGY

The methodology employed in this systematic literature review (SLR) follows a struc-tured and rigorous approach to synthesize existing research on the use of Information and Communication Technology (ICT) by special education teachers in teaching hear-ing-impaired students. The review adheres to the Preferred Reporting Items for Sys-tematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure transparency and reproducibility. A comprehensive search of academic databases, including Google Scholar and ERIC, was conducted to identify relevant studies. The search focused on peer-reviewed journals and conference proceedings published in the past decade, using keywords such as "ICT," "hearing-impaired," "deaf," "special education teachers," and "information and communication technologies." Details of the search key string are shown in Table 1. Studies were selected based on specific inclusion criteria, requiring them to address the use of ICT by special education teachers in the context of hearing-impaired students and provide data or a literature review regarding teacher percep-tions, and challenges faced. Studies that did not meet these criteria were excluded from the review. A clearer view of inclusion and exclusion criteria can be seen in Table 2.

Table 1: Search Key

Database	Search key
ERIC	TITLE-ABS-KEY ((hearing-impaired AND student) AND (special AND education AND teacher) AND (technology OR ICT))
Google scholar	"ICT" AND "Special education teacher" AND "deaf OR hearing impaired"

Table 2: Exclusion and inclusion criteria

Criteria	Inclusion	Exclusion
Literature type	Research article, conference	Book
Language	English	Non-english
Timeline	Between 2014-2024	Less than 2014
Subject	Education	Others than education

Relevant data were extracted from the selected studies, including information on teacher attitudes, skills, and barriers to ICT implementation. The extracted data were synthesized to identify common themes and patterns across the studies, involving qualitative analysis to categorize the findings into three main areas: teacher attitudes towards ICT, their skills and proficiency in ICT tools, and the barriers they encounter in integrating ICT into their teaching practices. The quality of the included studies was assessed by two experienced special education lecturers to ensure the reliability and validity of the findings, evaluating the methodological rigor of each study, including the clarity of research questions, appropriateness of study design, and robustness of data analysis.

The findings were reported in a structured format, highlighting the key insights related to the attitudes, skills, and barriers faced by special education teachers in using ICT for teaching hearing-impaired students. The review also identified gaps in the existing literature and provided recommendations for future research and policy development. By following this systematic and comprehensive methodology, the review aims to provide a thorough understanding of the current state of ICT use in the education of hearing-impaired students and to inform efforts to enhance the effectiveness of ICT integration in special education.

Table 3: Selective Articles

No	Author(s) and year of Publication	Country	Title	Journal	Purpose
1	Chong Ai Peng and Shaffe Mohd Daud (2015)	Malaysia	Exploring Elementar-y Special Education (Hearing Impairmen-t) Teachers' Technolog-ical Content Knowledg-e (TPACK)	1st Internati-onal Conferen-ce on Special Educatio-n	The study examines the perceptions of Malaysian elementary special education teachers regarding their TPACK.
2	Chong Ai Peng, Shaffe Mohd Daud (2016)	Malaysia	Relationship be-tween Special Edu-cation (hearing im-pairment) teachers' Technological Ped-agogical Content Knowledge (TPACK) and their attitudes toward ICT integration	International Con-ference on Special Education in Southeast Asia Re-gion 6th Series 2016 (Seminar An-tarabangsa Pen-didikan Khas Rantau Asia Tenggara Siri Ke-6, 2016)	This study investigates the correlation between Ma-laysian secondary school special education teachers' TPACK and their attitudes towards integrating ICT.
3	Ghulam Haider, Tariq Nadeem Khan (2016)	Pakistan	Special Education Teachers' Percep-tions About Pro-ject-Based Teach-ing: Implications for Teaching of Computer Assisted Language Learning (CALL) for Hearing Impaired (HI) Children	International Online Journal of Primary Education (IOJPE)	The study investigates special education teachers' perceptions of project-based teaching methods, teacher roles, success, and evaluation in project-based and traditional classroom instruction for hearing-impaired children.
4	Ahmed Hassan Hemdan Mohamed (2018)	Oman	Attitudes of special education teachers towards using technology in inclu-sive classrooms: a mixed-methods study	Journal of Research in Special Educa-tional Needs	This mixed-methods study explores the attitudes of special education teachers towards the use of tech-nology in inclusive class-rooms in Oman.
5	Susan E. Anderson and Rebecca S. Putman (2019)	United States	Special Education Teachers' Experience, Confidence, Beliefs, and Knowledge About Integrating Technology	Journal of Special Education Tech-nology	The study investigates the experience, confidence, beliefs, and knowledge of in-service special education teachers regarding technology integration.
6	Abdoulaye Kaba and Ziyad K. Ellala (2020)	United Arab Emirates (UAE)	Exploring the Use of Educational Technology among Deaf Students	Universal Journal of Educational Research	The main aim of this study is to explore and investigate the use of educational technology among deaf students in the UAE.
7	Puspawati and Rohmi Juharoh (2020)	Indonesia	Motivations and Challenges on the Use of ICT for Teaching Special Needs Students	Advances in Social Science, Education and Humanities Research	This study explores the motivations behind and challenges faced by teachers using ICT to teach hearing-impaired students.
8	Aidah Alias, Azahar Harun, and Norfadilah Kamaruddin (2021)	Malaysia	An Overview of The Use of Interactive Multimedia Teaching Aid for Deaf Students	DESIGN-DECODED 2021	The study aims to identify the current use of interactive multimedia teaching aids among deaf students and the factors influencing the development of effective multimedia design teaching aids.
9	Izuli Dzulkifli (2021)	Malaysia	Teaching and Learning Aids to Support the Deaf Students Studying Islamic Education	Pertanika Journal of Social Sciences & Humanities	The study explores the use of teaching aids by teachers instructing deaf students in Islamic Education at the primary school level in Selangor.

No	Author(s) and year of Publication	Country	Title	Journal	Purpose
10	Muhammed Murat Gümüş, Recep Çakır, Özgen Korkmaz, Feray Uğur Erdoğmuş (2021)	Turkey	Analysis of IT Acceptance Levels, ICT Attitudes, and Individual Innovation Levels of Special Education Teachers and their Opinions	International Journal of Technology in Education (IJTE)	The research aims to identify the relationships between special education teachers' acceptance of ICT, their attitudes towards it, and their levels of individual innovation, along with their opinions.
11	S. Thangarasu and K. Karthigadevi (2022)	India	A Study Report on Teaching Skills to Speech and Hearing-Impaired Students in Higher Education Sector	Journal of Engineering Education Transformations	The main goal of this research is to apply updated technologies to teach speech and hearing-impaired students in higher education.
12	Ybyrayeva Korkem (2022)	Republic of Kazakhstan	The Experiences of Teachers Educating Young Adults with Hearing Impairments Studying in TVET Institutions in Kazakhstan: A Collective Case Study	International Scientific Discussion: Problems, Tasks and Prospects	This case study explores the experiences of teachers working with hearing-impaired students at Technical Vocational Education and Training (TVET) institutions in Kazakhstan.
13	Yersi Luis Huamán Romaní, José Manuel Burga Falla, Nery Sofía Soria Ruiz, Ramiro Juro García, Yausef Raymundo Balvin (2022)	Peru	Use and Knowledge of ICTs in Inclusive Education at Educational Levels	International Journal of Emerging Technologies in Learning (iJET)	This research aims to outline the extent of inclusive knowledge among Peruvian teachers across various educational levels during the Covid-19 pandemic, focusing on their understanding of ICT in relation to different types of disabilities.
14	Anthi David, Vasiliki Kiose, and Efi Tzelepi (2023)	Greece	ICTs in education for Deaf and Hard-Of-Hearing learners	World Journal of Biology Pharmacy and Health Sciences	This literature review focuses on the educational needs of deaf and hard-of-hearing learners and the different ICT-based environments available to them.
15	Hafiz Muhammad Afzaal, Prof. Dr. Abid Hussain Ch., and Prof. Dr. Humara Bano (2023)	Pakistan	Effect of Information and Communication Technology for the Development of Urdu Reading Skills of Students with Hearing Impairment	Languages and Humanities Review	The study assesses the effectiveness of ICT in developing Urdu reading skills among hearing-impaired students, using the "Zone of Proximal Development" framework.
16	J. E. Merlin Sasikala, M. Saraswathi, T. Ravichandran (2023)	India	Attitude Towards Self-Learning Package Among Hearing Impaired School Teachers	PARIPEX - Indian Journal of Research	The article investigates the attitudes of hearing-impaired school teachers towards self-learning packages as a means of professional development.
17	Masood Ahmad Khan, Muhammad Bilal Tahir, Muhammad Salman Masood Sheikh, and Sahib Khan (2023)	Pakistan	Perspectives of Special Education Teachers on Infusing ICT in Special Education Classrooms: A Mixed-Methods Investigation	Journal of Asian Development Studies	The study investigates the views of special education teachers on integrating computer technology in classrooms in Pakistan, examining how these perspectives vary with experience and the types of disabilities encountered.
18	Quratulain Rizvi and Rizwan Akram Rana (2023)	Pakistan	Exploring Special Education Teachers' Perception, Readiness,	Journal of Asian Development Studies	The study explores the current state of ICT integration in the teaching-learning process for

No	Author(s) and year of Publication	Country	Title	Journal	Purpose
			and Practices for ICT Integration in Classrooms for Students with Hearing Impairment		students with hearing impairment in Punjab, Pakistan.
19	Ezekiel U. Oji, Augusta C. Okanume, and Chinazom C. Nwabueze (2024)	Nigeria	Enhancing the Language Education of Students with Special Needs in Nigeria through Information and Communication Technology (ICT): Challenges and Prospects	Asian Journal of Education and Social Studies	The paper examines the concept of special education in Nigeria, the benefits of using ICT in special education, and the challenges and prospects of ICT use in this field.
20	Vestly Kong Liang Soon (2024)	Malaysia	A Study of Attitudes, Skills, and Barriers Among the Special Education Hearing Impairment Teachers in the Use of Assistive Technology in Teaching	Journal of Advanced Research in Applied Sciences and Engineering Technology	The study examines the attitudes, skills, and barriers faced by Special Education Hearing Impairment (SEHI) teachers in using assistive technology in teaching.

III. RESULTS

The 20 papers have been read and carefully find out important points for each special education teacher's attitudes, skill and barrier face. The finding is analyzed and shown in Table 4 to 6. Extra theme about teacher training also reported in Table 7.

Table 4. Attitudes analysis from the articles

Main Theme	Sub-Theme	Citation
Positive Attitude Towards ICT	Interest in ICT Training	Romaní, M., García, J., & López, A. (2022).
	Professional Development through Computers	Khan, S., Ahmed, R., & Malik, T. (2023).
	ICT for Instructing and Communicating with Deaf Students	Hameed, A. (2009).
	Importance of ICT-Supported Courses with Interactive Multimedia and Visual Aids	Nordin, N., Embi, M. A., & Yunus, M. M. (2015); Pratiwi, R., & Sari, D. (2019); UNDP. (2020).
	Teachers' Positive Attitudes Towards ICT	Afzaal, M., Khan, M. A., & Rehman, S. (2023); Chong, S. W., & Daud, M. Y. (2016); Seman, S. C., Yusof, N., & Noor, N. M. (2019); Majid, S., & Rahman, A. (2017); Oji, K., & Adebayo, A. (2024); Anderson, J., & Putman, R. (2019).
	ICT's Role in Improving Academic Achievement	Puspawati, I. (2020).
	ICT for Visual Learning and Comprehending Complex Concepts	Rizvi, S., & Rana, M. (2023).
	ICT's Benefits for Future Careers of Deaf Students	Kaba, A., & Ellala, Z. (2020).

The systematic literature review reveals a predominantly positive attitude towards In-formation and Communication Technology (ICT) in educational settings, particularly in the context of training, professional development, and teaching students with special needs. Romaní et al. (2022) highlight a significant interest among educators in training programs that incorporate ICT, indicating a proactive approach towards enhancing their skills and knowledge. Khan et al. (2023) report that educators hold favourable views on the use of computers for their professional development, recognizing the potential for continuous learning and improvement. Hameed (2009)

emphasizes the po-tential of ICT in effectively instructing and communicating with deaf students, show-casing its role in inclusive education. Multiple studies (Nordin et al., 2015; Pratiwi et al., 2019; UNDP, 2020) acknowledge the importance of ICT-supported courses that utilize interactive multimedia and visual aids, which enhance the learning experience and engagement of students. A broad range of studies (Afzaal et al., 2023; Chong & Daud, 2016; Seman et al., 2019; Majid et al., 2017; Oji et al., 2024; Anderson & Putman, 2019) consistently report positive attitudes among teachers towards the integration of ICT in their teaching practices.

This widespread acceptance underscores the perceived benefits of ICT in education. Puspawati (2020) finds that educators believe in the positive impact of ICT on students' academic achievement, suggesting that technology can be a powerful tool for enhancing learning outcomes. Rizvi and Rana (2023) highlight the belief that ICT is crucial for visual learning and for helping students comprehend complex concepts, thereby supporting diverse learning styles and needs. Kaba and Ellala (2020) recognize the benefits of ICT in preparing deaf students for future careers, indicating that technology can bridge gaps and provide equal opportunities in the job market. Overall, the literature demonstrates a strong consensus on the positive impact of ICT in education, particularly in enhancing training, professional development, inclusive education, and academic achievement. These findings suggest that continued investment in ICT re-sources and training for educators is likely to yield significant benefits for both teachers and students.

Table 5: Skills analysis from the articles

Main Theme	**Sub-Theme**	**Citation**
Lack of skills	Lack of skill in integrating interactive multimedia teaching aids into the teaching and learning process for deaf students	Alias, A., Harun, A., & Kamaruddin, N. (2021); Khan et al. (2023); Mohamed, A. H. H. (2018); Oji et al. (2024).
	Knowledge of Assistive Technologies	Keirungi (2021); Ouma, Awuor, & Kyambo (2013).
	Lack of knowledge and need for technical support in the use of technological tools	Kutlu et al. (2018); Oji et al. (2024).
	Lack of skill to effectively utilize visual learning equipment and adaptive devices such as FM systems and speech-to-text transcriptions for deaf children	Oji et al. (2024).
Suggested skills	Multimedia Content Creation and Integration	Afzaal et al. (2023); Aidah Alias et al. (2021); Dzulkifli, I. (2021); Thangarasu, S., & Karthigadevi, K. (2022); Ybyrayeva, K. (2022).
	Use of Assistive Technologies	Aidah Alias et al. (2021); David, Kiose, & Tzelepi (2023); Gümüş et al. (2021); Ybyrayeva, K. (2022).
	Digital Communication Tools	Aidah Alias et al. (2021); Constantinou et al. (2020); Oji et al. (2024); Thangarasu, S., & Karthigadevi, K. (2022); Ybyrayeva, K. (2022).
	Interactive Learning Platforms	Aidah Alias et al. (2021); Ybyrayeva, K. (2022).
	Designing Accessible Educational Materials	Aidah Alias et al. (2021); Dzulkifli, I. (2021); Oji et al. (2024); Thangarasu, S., & Karthigadevi, K. (2022); Ybyrayeva, K. (2022).
	Evaluation and Feedback Mechanisms	Aidah Alias et al. (2021).
	Integrating ICT into Lesson Plans	Afzaal et al. (2023).
	Curriculum Design and Technology	Anderson, S. E., & Putman, R. S. (2019); Drigas et al. (2006).

Main Theme	Sub-Theme	Citation
	Technical Proficiency	Dzulkifli, I. (2021); Gümüş et al. (2021); Keirungi (2021); Oji et al. (2024).
	Adapting to Modern Teaching Techniques	Dzulkifli, I. (2021); Makgato (2012); Tedla (2012).
	Customization of ICT Tools for Deaf Students	Dzulkifli, I. (2021).

The findings indicate a significant gap in educators' skills, particularly in integrating interactive multimedia teaching aids into the teaching and learning process for deaf students. This deficiency is highlighted by several studies, which emphasize the need for improved capabilities in this area (Alias, Harun, & Kamaruddin, 2021; Khan et al., 2023; Mohamed, 2018; Oji et al., 2024). Additionally, there is a notable lack of knowledge regarding assistive technologies, which are crucial for creating inclusive ed-ucational environments (Keirungi, 2021; Ouma, Awuor, & Kyambo, 2013). Educators also require technical support to effectively utilize these technological tools, as many lack the necessary expertise (Kutlu et al., 2018; Oji et al., 2024). Furthermore, there is a deficiency in skills related to the effective use of visual learning equipment and adaptive devices, such as FM systems and speech-to-text transcriptions, which are essential for supporting deaf children in their learning (Oji et al., 2024).

To address these gaps, several key skills have been suggested for educators. Proficiency in multimedia content creation and integration, including the use of animation, video, and interactive graphics, is essential for enhancing the learning experience (Afzaal et al., 2023; Aidah Alias et al., 2021; Dzulkifli, 2021; Thangarasu & Karthigadevi, 2022; Ybyrayeva, 2022). The use of assistive technologies, such as captioning tools, sign language translation software, interactive devices, web 2.0 tools, virtual real-ity, and augmented reality technologies, is also critical for fostering an inclusive educational environment (Aidah Alias et al., 2021; David, Kiose, & Tzelepi, 2023; Gümüş et al., 2021; Ybyrayeva, 2022). Additionally, digital communication tools, including assistive listening devices and video conferencing platforms, are vital for effective communication in educational settings (Aidah Alias et al., 2021; Constantinou et al., 2020; Oji et al., 2024; Thangarasu & Karthigadevi, 2022; Ybyrayeva, 2022).

Interactive learning platforms further support student engagement and participation, making learning more dynamic and accessible (Aidah Alias et al., 2021; Ybyrayeva, 2022). Designing accessible educational materials, such as visual aids, text, and sign language, is another critical area for ensuring inclusivity (Aidah Alias et al., 2021; Dzulkifli, 2021; Oji et al., 2024; Thangarasu & Karthigadevi, 2022; Ybyrayeva, 2022). Moreover, evaluation and feedback mechanisms are necessary to assess the effective-ness of educational interventions and provide constructive feedback to students (Aidah Alias et al., 2021). Integrating ICT into lesson plans is also highlighted as a key competency for modern educators (Afzaal et al., 2023). Curriculum design and technology integration are essential for developing comprehensive educational programs that meet the needs of diverse learners (Anderson & Putman, 2019; Drigas et al., 2006). Tech-nical proficiency in using various educational technologies is another important skill for educators (Dzulkifli, 2021; Gümüş et al., 2021; Keirungi, 2021; Oji et al., 2024). Adapt-ing to modern teaching techniques, such as flipped classroom models and e-learning, is crucial for educators to stay current with educational trends and technological advancements (Dzulkifli, 2021; Makgato, 2012; Tedla, 2012). Finally, the customization of ICT tools for deaf students is particularly important to address their unique learning needs (Dzulkifli, 2021).

Table 6: Barrier analysis from the articles

Main Theme	Sub-Theme	Citation
Barrier	Insufficient funding	Romaní et al. (2022); Oji et al. (2024)
	Lack of essential resources	Khan et al. (2023); Bingimlas (2009); Nordin et al. (2015); Dzulkifli (2021); Puspawati (2020); Rizvi and Rana (2023); Seman et al. (2016); Yasin et al. (2017)
	Inadequate training and support	Khan et al. (2023); Turel and Johnson (2012); Keirungi (2021); Mohamed (2018); Oji et al. (2024); Chong and Shaffe (2015); Anderson and Putman (2019); Afzaal et al. (2023); Abdulrahaman et al. (2020); UNDP (2020)
	Time constraints	Khan et al. (2023); Mohamed (2018)
	Limited parental engagement	Khan et al. (2023); Mohamed (2018); Rizvi and Rana (2023)

	Technical challenges	Khan et al. (2023); Mohamed (2018); Anderson and Putman (2019); Abdulrahaman et al. (2020); UNDP (2020)
	Limited expertise	Khan et al. (2023); Mohamed (2018)
	Gender differences	Chong and Shaffe (2015); Kaba and Ellala (2020)
	Limited access to up-to-date technology and equipment	Mohamed (2018); Seman et al. (2016); Yasin et al. (2017)
	Limited collaboration with ICT specialists	Afzaal et al. (2023)
	Low competence	Kaba and Ellala (2020)
	Lack of research	Pelayo et al. (2018); Boudreault et al. (2018)
	Restrictive school policies and curriculum requirements	Haider and Khan (2016); Rizvi and Rana (2023)

Based on the findings, numerous significant challenges impede ICT implementation. A major obstacle is the lack of sufficient funding, which restricts the availability of essential resources and technological equipment necessary for ICT integration (Romaní et al., 2022; Oji et al., 2024). This financial limitation demotivates educators and hampers their ability to utilize advanced technological tools in their teaching practices. Additionally, the absence of essential resources, such as up-to-date software and hardware, further exacerbates the issue, making it difficult for teachers to effectively incorporate ICT into their lessons (Khan et al., 2023; Bingimlas, 2009; Nordin et al., 2015; Dzulkifli, 2021; Puspawati, 2020; Rizvi & Rana, 2023; Seman et al., 2016; Yasin et al., 2017).

Another significant barrier is the inadequate training and support for teachers, which hinders the successful integration of ICT in special education. Many educators express a need for more comprehensive professional development opportunities to enhance their technological proficiency and confidence in using ICT tools (Anderson & Putman, 2019; Oji et al., 2024). The lack of sufficient training programs leaves teachers ill-prepared to effectively incorporate ICT into their teaching methodologies, thereby limiting the potential benefits of these technologies for hearing-impaired students (Khan et al., 2023; Turel & Johnson, 2012; Keirungi, 2021; Mohamed, 2018; Oji et al., 2024; Chong & Shaffe, 2015; Anderson & Putman, 2019; Afzaal et al., 2023; Abdulrahaman et al., 2020; UNDP, 2020).

Time constraints and technical challenges further impede the effective use of ICT in special education. Educators often face significant time pressures, which limit their ability to explore and integrate new technological tools into their curriculum (Khan et al., 2023; Mohamed, 2018). Additionally, technical issues, such as software malfunctions and inadequate technical support, create further obstacles, making it difficult for teachers to rely on ICT consistently in their teaching practices (Khan et al., 2023; Mohamed, 2018; Anderson & Putman, 2019; Abdulrahaman et al., 2020; UNDP, 2020). These challenges highlight the need for robust technical support systems and sufficient time allocation for teachers to effectively integrate ICT into their instructional practices.

Moreover, restrictive school policies and curriculum requirements often do not support the integration of ICT, posing additional challenges for teachers (Haider & Khan, 2016). These institutional barriers can limit the flexibility and creativity of teachers in using ICT to enhance the learning experiences of hearing-impaired students. Addressing these barriers requires a comprehensive approach that includes adequate funding, targeted training programs, supportive policies, and robust technical support to empower teachers to leverage ICT fully and improve educational outcomes for students with hearing impairments.

Additional barriers include limited expertise and low competence among students in using ICT, which can hinder the effective implementation of these technologies in the classroom (Khan et al., 2023; Mohamed, 2018). Gender differences also play a role, with some studies indicating that male and female teachers may have different levels of comfort and proficiency with ICT (Chong & Shaffe, 2015; Kaba & Ellala, 2020). Limited collaboration with ICT specialists further restricts teachers' ability to effectively inte-grate technology into their teaching practices (Afzaal et al., 2023). Furthermore, the lack of research on how to use ICT specifically for hearing-impaired students means that teachers often lack evidence-based strategies and resources to guide their practice (Pelayo et al., 2018; Boudreault et al., 2018). Addressing these barriers requires a multifaceted approach that includes enhancing teacher training, fostering collaboration with ICT specialists, and conducting more research to develop effective ICT strategies for hearing-impaired students.

Table 7: Ways to conduct training

Main Theme	Sub-Theme	Citation
Ways to conduct training	Professional Development Workshops	Anderson, S. E., & Putman, R. S. (2019); Khan et al. (2023).
	Structured In-Service Training	Gümüş et al. (2021); Khan et al. (2023).
	Workshops and Training Sessions	Khan et al. (2023).
	Practical Application	Gümüş et al. (2021); Haider, G., & Khan, T. N. 2016.
	Undergraduate Education Programs	Khan et al. (2023).
	Self-Directed Learning	Khan et al. (2023).
Ways to conduct training	Professional Development Workshops	Anderson, S. E., & Putman, R. S. (2019); Khan et al. (2023).
	Structured In-Service Training	Gümüş et al. (2021); Khan et al. (2023).
	Workshops and Training Sessions	Khan et al. (2023).
	Practical Application	Gümüş et al. (2021); Haider, G., & Khan, T. N. 2016.
	Undergraduate Education Programs	Khan et al. (2023).
	Self-Directed Learning	Khan et al. (2023).

In the realm of professional development, various methods are employed to conduct training, each tailored to meet specific educational and practical needs. Professional development workshops, as highlighted by Anderson and Putman (2019) and Khan et al. (2023), offer structured environments where participants can engage in intensive learning experiences. Structured in-service training, discussed by Gümüş et al. (2021) and Khan et al. (2023), provides ongoing education for professionals, ensuring they remain updated with the latest industry standards and practices. Workshops and training sessions, frequently cited by Khan et al. (2023), serve as interactive platforms for skill enhancement and knowledge dissemination. Practical application, emphasized by Gümüş et al. (2021) and Haider and Khan (2016), allows learners to apply theoretical knowledge in real-world scenarios, thereby solidifying their understanding and competence. Undergraduate education programs, as noted by Khan et al. (2023), lay the foundational knowledge necessary for future professional growth. Lastly, self-directed learning, also mentioned by Khan et al. (2023), empowers individuals to take control of their educational journey, fostering a culture of continuous personal and professional development. These diverse methods collectively contribute to a comprehensive approach to training, ensuring that learners are well-equipped to meet the de-mands of their respective fields.

IV. DISCUSSION

The integration of Information and Communication Technology (ICT) in special education, particularly for students with hearing impairments, presents a multifaceted land-scape of attitudes, skills, and barriers. The positive attitudes of special education teachers towards ICT are a promising foundation for its effective use in the classroom. Teachers recognize the potential of ICT to enhance learning experiences through multimedia and visual aids, which are particularly beneficial for deaf students who rely heavily on visual cues (Hameed, 2009; Nordin et al., 2015). The enthusiasm for professional development and the use of computers further underscores the readiness of teachers to embrace technological advancements (Khan et al., 2023). This positive out-look is consistent across various demographic factors, indicating a widespread acceptance of ICT's role in education (Gümüş et al., 2021).

However, the skills of special education teachers in using ICT reveal a more com-plex picture. While teachers are adept at using basic technological tools and making curricular adaptations, their proficiency in advanced technological applications and integration remains limited (Romaní et al., 2022; Khan et al., 2023). The disparity be-tween their content and pedagogical knowledge and their technological knowledge highlights the need for more comprehensive and targeted training programs (Chong & Shaffe, 2015; Mohamed, 2018). Teachers with higher acceptance and innovation levels tend to have better ICT skills, suggesting that fostering a culture of innovation and con-tinuous learning could enhance overall proficiency (Gümüş et al., 2021).

Despite the positive attitudes and foundational skills, significant barriers impede the effective use of ICT in special education. Financial constraints and limited access to necessary applications and software are primary

obstacles that demotivate teachers (Romaní et al., 2022). The lack of essential resources and technological equipment in schools further exacerbates this issue, limiting the practical application of ICT in teach-ing (Khan et al., 2023). Additionally, the need for more adequate training and support is a recurring theme, with teachers expressing a desire for more professional development opportunities to improve their technological proficiency (Anderson & Putman, 2019; Oji et al., 2024). Time constraints, technical challenges, and insufficient training in assistive technologies also hinder the effective integration of ICT (Turel & Johnson, 2012; Keirungi, 2021). Moreover, restrictive school policies and curriculum requirements often do not support the integration of ICT, posing additional challenges for teachers (Haider & Khan, 2016).

In conclusion, while special education teachers exhibit positive attitudes towards ICT and possess foundational skills, significant barriers must be addressed to fully realize the potential of technology in enhancing the learning experiences of students with hearing impairments. Comprehensive training programs, adequate resources, and supportive policies are essential to overcoming these challenges and enabling teachers to effectively integrate ICT into their teaching practices.

V. CONCLUSIONS

In conclusion, the integration of Information and Communication Technology (ICT) in special education for students with hearing impairments holds significant promise, as evidenced by the generally positive attitudes of special education teachers. These educators recognize the potential of ICT to enhance learning through visual aids and multimedia, which are particularly beneficial for deaf students. However, despite their enthusiasm and foundational skills, teachers face substantial barriers, including limited access to resources, financial constraints, and insufficient training. Addressing these challenges is crucial for the effective implementation of ICT in special education. Com-prehensive training programs, adequate technological resources, and supportive institutional policies are essential to empower teachers to leverage ICT fully and improve educational outcomes for students with hearing impairments.

Future research should focus on developing and evaluating targeted training pro-grams that enhance teachers' technological proficiency and confidence in using advanced ICT tools. Investigating the impact of such training on teaching practices and student outcomes will provide valuable insights into the most effective strategies for ICT integration. Additionally, research should explore the development of cost-effective and accessible ICT resources tailored to the needs of deaf students. Studies examining the role of institutional policies and support systems in facilitating or hindering ICT use in special education will also be critical. By addressing these areas, fu-ture research can contribute to creating an inclusive and technologically enriched learning environment for students with hearing impairments.

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