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A Systematic Literature Review: Learning Practical Skills for Deaf or Hard-of-Hearing (DHH) Student

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ABSTRACT

A comprehensive literature review addresses the acquisition of practical skills by Deaf or Hard-of-Hearing (DHH) students in diverse educational settings. These skills are essential for their daily lives and future employability. Given the unique communication and sensory needs of DHH students, this study systematically reviews methodologies, tools, and pedagogical approaches facilitating practical skill development, adhering to PRISMA guidelines. The review encompasses 150 articles across three databases (Scopus, Institute of Electrical and Electronics Engineers (IEEE), and Education Resources Information Centre (ERIC)), with 30 articles meeting eligibility criteria. Three key themes emerged: innovation in pedagogy for DHH students, language and communication in DHH education, and accessibility and technology in DHH education. Innovative pedagogical approaches such as video, workshops, augmented and extended reality have proven effective for practical learning among DHH students. Language and communication themes stress using sign language as well as audiovisual translation (AVT) to enhance communication. Accessibility and technology-focused themes highlight the benefits of hearing aids, simulations, Universal Design for learners, as well as Universal Design for instructors in improving learning outcomes. These results underscore the positive impact of innovation and technology in enhancing knowledge, skill development, attitudes, grade point averages, learning experiences, and overall performance for DHH students. The review calls for future research and emphasizes inclusive educational practices to better support this unique student population, offering a comprehensive overview of practical skill development for DHH students.

Keywords:
Learning practical skills; Deaf or hard-of-hearing (DHH); Systematic literature review

1. Introduction

In an increasingly interconnected world, education serves as the cornerstone of individual empowerment and societal progress. However, the pursuit of knowledge is not without its

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challenges, and one marginalized group that has faced unique obstacles in the realm of education is the Deaf and Hard-of-Hearing (DHH) community [1-3]. As educators and scholars, it is our duty to ensure that all students, regardless of their inclusive education [4-6] or hearing abilities, have equitable access to practical skills education [7,8] and at the same time can meet the demands of the industry especially for industry 4.0 [6,7,9,10]. This systematic literature review explores the current state of research and practice in facilitating practical skill acquisition for DHH students.

The DHH student population is diverse, encompassing individuals with varying degrees of hearing loss [13,15], communication preferences [11], and cultural backgrounds [16]. Consequently, crafting effective educational strategies that cater to their specific needs requires a nuanced understanding of their challenges. Practical skills encompass a broad competencies range [17], which includes communication skills [18], technical abilities, and vocational training [19-21]. This review seeks to encompass this breadth, acknowledging that each facet of practical skill development may present distinct hurdles for DHH students.

Over the years, significant strides have been made in adapting teaching methodologies, technologies, and support systems to accommodate DHH students. Advances in assistive technology [22-25], sign language interpretation, and inclusive classroom practices have the potential to revolutionize their educational experiences [11,27]. This review will critically evaluate the efficacy of these interventions and identify gaps in current knowledge that necessitate further research.

In pursuing educational inclusivity, we must remain vigilant in our commitment to ensuring that DHH students can acquire practical skills and thrive in their chosen fields. By synthesizing existing literature, this systematic review aims to contribute to a broader understanding of the challenges and opportunities in practical skills education for DHH students, offering insights that can inform policy, practice, and future research in this critical area of education. For the purpose of steering the study, a set of research questions (RQ) has been formulated as follows:

RQ1: What is the DHH practical skills learning pattern of scientific production in the latest decade?
RQ2: What are the DHH practical skills learning pattern citations in the last decade?
RQ3: In which countries DHH practical skills learning have most related studies been performed?
RQ4: What have been the primary findings of the related studies pertaining to the use of innovative, language, communication, accessibility, and technology for the purpose DHH learning practical skills?

2. Literature Review

The collection of studies and research covers a wide range of topics related to deaf and hearing-impaired individuals, showcasing the diverse challenges and innovative solutions in education, communication, and technology. These studies collectively challenge conventional norms in deaf education, advocating for sociocultural constructivist approaches and addressing barriers in special education laws [28]. They explore the efficacy of virtual simulations in healthcare education [29] and investigate the emotional well-being of hearing-impaired students [30], emphasizing psychosocial challenges and potential solutions. Additionally, they recognize the potential of Extended Reality (XR) software for inclusive education [31] and highlight the value of sign language training for typically developing students to facilitate communication with hearing-impaired peers [32].

Furthermore, the research delves into strategies for integrating hearing-impaired and deaf children into education, focusing on the theory of mind, cognitive intelligence, and academic achievement [33]. It advocates for the inclusion of American Sign Language (ASL) as well as Deaf

cultural prospects in higher education humanities programs to enhance cultural understanding and services to the Deaf community [34].

This collection of studies explores various aspects of improving communication and support for deaf individuals. The first study introduces Wi-Phrase, a Wi-Fi-based sign language recognition system achieving high phrase recognition accuracy, with potential applications in assisting the deaf [26]. Another study assesses the impact of a swimming course on freestyle swimming performance as well as life skills among deaf students, noting significant improvements in both domains [35]. Additionally, the research highlights the increasing demand for lip recognition in computer vision, presenting a deep learning-based lip recognition application system to aid hearing-impaired individuals in social interactions and pronunciation with promising feasibility and effectiveness [36]. The National Deaf Children's Society's implementation of e-learning due to resource limitations is discussed, offering a cost-effective training solution for charities [37]. Another study addresses the need for effective awareness training for health professionals by developing highly-rated workshops led by DHH individuals, enhancing students' knowledge, practical skills, and attitudes to promote better care for DHH patients and increase awareness among health professional students [14]. Furthermore, an innovative method for automatically translating Arabic Sign Language into spoken Arabic is introduced, achieving a high translation accuracy rate and offering the potential for improved communication in the deaf and mute community [38]. Lastly, an evaluation of undergraduate pharmacy curricula in Brazil assesses the inclusion of sign language courses and content related to caring for deaf patients, highlighting the need for better integration to support comprehensive care by pharmacy professionals [39]. The utilization of cutting-edge technologies, like Wi-Fi-driven sign language recognition systems [8] and accessibility learning systems designed for lip-reading [40], holds promise for enhancing communication and education opportunities for individuals with hearing impairments.

Moreover, the research explores the implementation of Universal Design for Learning (UDL) as well as Universal Design for Instruction (UDI) in higher education, emphasizing their positive impact on motivation, comprehension, and competence development among students [17]. It addresses the marginalization of semiotic resources and practices in visually oriented communities, emphasizing the need to integrate such research into the broader study of human interaction [41]. Furthermore, the studies delve into genetic aspects of syndromic deafness led by PTPN11 gene mutations [13] and the advancements in sign language recognition employing convolutional neural networks (CNNs) and machine learning (ML) algorithms [42].

Additionally, the research focuses on improving distance library services for DHH users by aligning with accessibility guidelines [43]. It highlights the Audiovisual Translation (AVT) versatility as a resource in language classrooms, promoting communicative competence and intercultural competence [44]. It investigates feedback perception among new medical residents during their transition from medical school to residency [45] and introduces highly stretchable and robust strain sensors for wearable electronics [46].

Furthermore, the research assesses the effectiveness of video tutorial methods for delivering instructional content to deaf students [47], addresses challenges faced by young DHH learners using sign language in Taiwan [48], and explores recent advancements in real-time sign language translation systems, including integrating IoT technology [49]. It also discusses deaf children's bilingualism, focusing on linguistic, cognitive, and social aspects [50], and examines prospective physical education (PE) teachers' efforts to interrupt phono centrism through visual pedagogies [51].

Additionally, the study outlines guidelines for enhancing literacy achievements among students with DHH [27]. In contrast, it discusses the provision of real-time online tutoring for the virtual academic community (VAC) of the Deaf STEM Community Alliance [52]. Finally, it discusses the

challenges of teaching geometry to students with hearing impairments and introduces interactive learning media with augmented reality to enhance learning experiences [53].

These studies collectively contribute to a deeper understanding of the challenges and opportunities in education as well as the well-being of DHH individuals while highlighting innovative approaches and technologies to support their diverse needs.

3. Material and methods

There have been several recent research on systematic assessments conducted across the world. However, in the context of an overview of ARIL, only a few studies from Malaysia [54-58] were conducted for the purpose of learning practical skills [57]. The selection of several pertinent papers for this study was done using the systematic review technique, which involves three fundamental parts. Using a thesaurus, dictionaries, encyclopaedias, and previous research, the first phase comprises identifying keywords and the search for linked terms.

3.1 Identification

After choosing all relevant keywords, search terms have been created for the Scopus, IEEE, and Eric databases (see Table 1). The initial stage concerning the systematic review process for the current study project resulted in the successful retrieval of 150 papers from these selected databases. The specification search string for the primary data searching process is in Table 1.

Table 1
The specification search string for primary data in searching

Database	Search string
Scopus	TITLE-ABS-KEY (learn* AND practical AND deaf) AND PUBYEAR > 2012 AND PUBYEAR < 2024 AND (LIMIT-TO (DOCTYPE, "ar")) AND (LIMIT-TO (LANGUAGE, "English")) AND (LIMIT-TO (PUBSTAGE, "final"))
IEEE	learn* AND practical AND deaf
Eric	learn* AND practical AND deaf pubyearmin:2013 pubyearmax:2023

3.2 Screening

During the initial screening step, the removal of duplicate papers is a necessary procedure. In the initial phase, a total of 81 articles were eliminated. In comparison, the subsequent phase involved the assessment of 69 articles relying on distinct exclusion as well as inclusion criteria formulated by the authors. Here, the initial criterion focused on literature in the form of research articles, as it stands as the primary source with respect to applicable insights. This criterion also encompassed the exclusion of systematic reviews, reviews, meta-analyses, conference proceedings, books, chapters, book series, as well as meta-syntheses from the present research. Additionally, the review process was confined to articles composed in the English language. It is important to highlight that the time frame chosen for this review spanned a duration of three years (2013–2023). Consequently, a total of 81 publications were eliminated based on specific parameters.

3.3 Eligibility

The eligibility stage, designated as the third level, encompasses a pool of 67 items that are prepared for evaluation. During this phase, meticulous scrutiny was applied to both article titles and key content to ensure their alignment with the inclusion criteria and their relevance to the objectives

of the ongoing study. Consequently, 37 papers were excluded due to their divergence from the subject area, titles that lacked substantial relevance to the study's objectives, abstracts that did not align, and a lack of full-text accessibility containing empirical data. As of the current moment, a total of 30 articles remains available for comprehensive review. Note that Table 2 provides the selection criterion for searching.

Table 2
The selection criterion for searching

Criterion	Inclusion	Exclusion
Language	English	Non-English
Timeline	2013 – 2023	< 2013
Literature type	Journal (Article)	Conference, Book, Review
Publication Stage	Final	In Press

3.4 Data Abstraction and Analysis

This research used an integrative analysis among the methodologies for examining and synthesizing several research designs (quantitative, qualitative, as well as mixed methods). Furthermore, the expert study focus was on creating related subtopics as well as subjects. The data collection phase was the initial step in developing the theme. Note that Figure 1 illustrates a flowchart of the suggested search investigation. Thirty papers were thoroughly examined by the researchers for claims or details pertaining to issues elevated in this recent research. The writers and experts then conduct an analysis of learning practical for DHH, make decisions, and create substantive groupings.

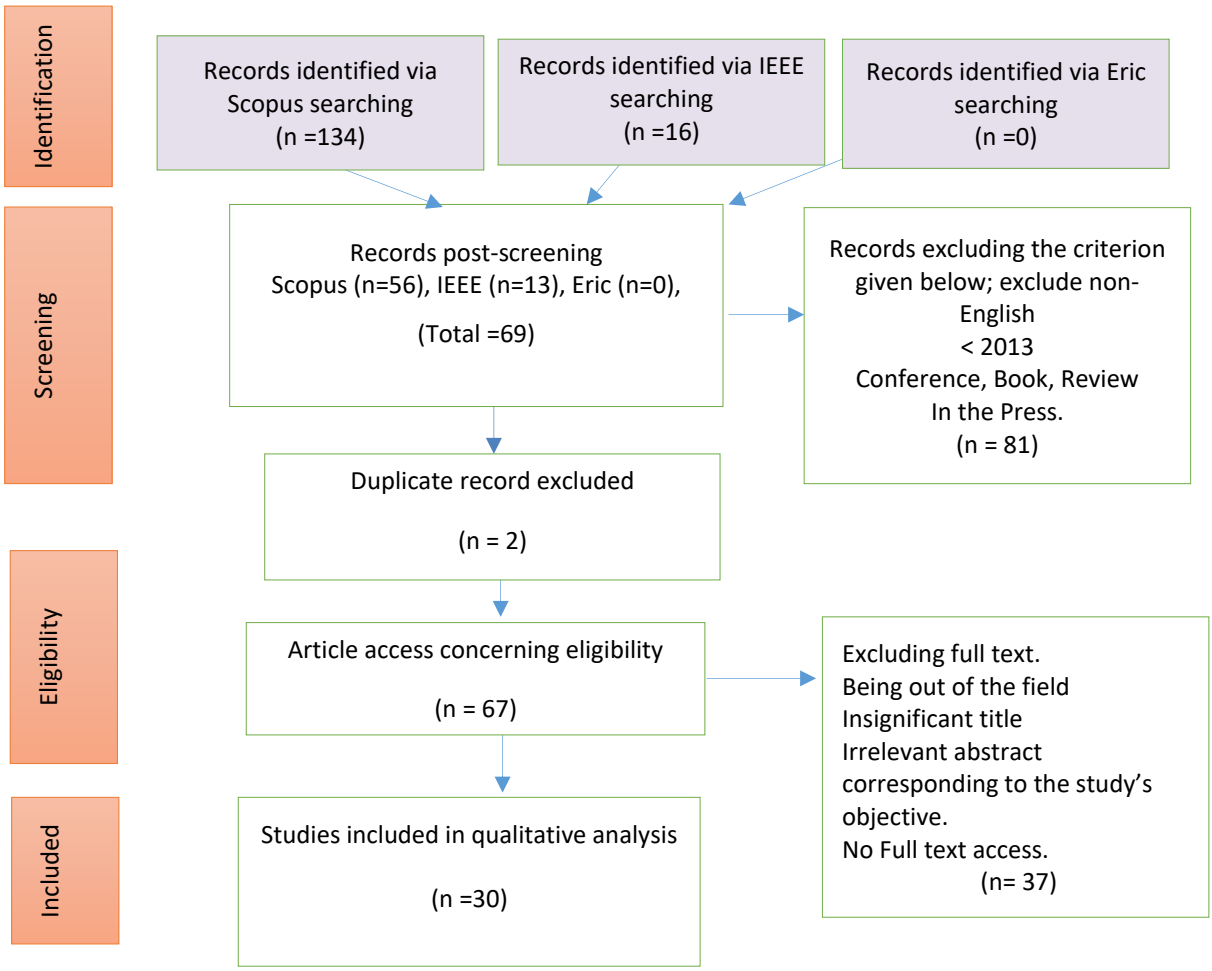

Fig. 1. Flow diagram of the proposed search study

Innovative Pedagogical Approaches for Deaf Education, Language and Communication in Deaf Education, and Accessibility and Technology in Deaf Education are the three primary themes that resulted from the method. From here onward, the researchers proceeded to explore as well as expand upon the established themes, encompassing associated ideas and concepts. The principal researcher worked in conjunction with fellow researchers to further establish these themes within the framework of the research. To facilitate the interpretation of the data, a log was diligently maintained throughout the analysis, documenting various analyses, perspectives, challenges, as well as relevant insights. In order to handle variations in the theme generation process, the researchers additionally assessed the outcomes. It is important to mention that any disparities in the themes are addressed by the researchers when they arise. The formulated ideas were subsequently fine-tuned to ensure their coherence. Two experts, one specializing in DHH while the other in practical skill acquisition, conducted the assessments to ensure the accuracy of the challenges. Through the establishment of domain validity, the expert review phase guaranteed that each sub-theme was significant, clear, as well as appropriate. The author made adjustments based on reader feedback and professional input as deemed necessary. Figure 2 shows annual scientific production per year.

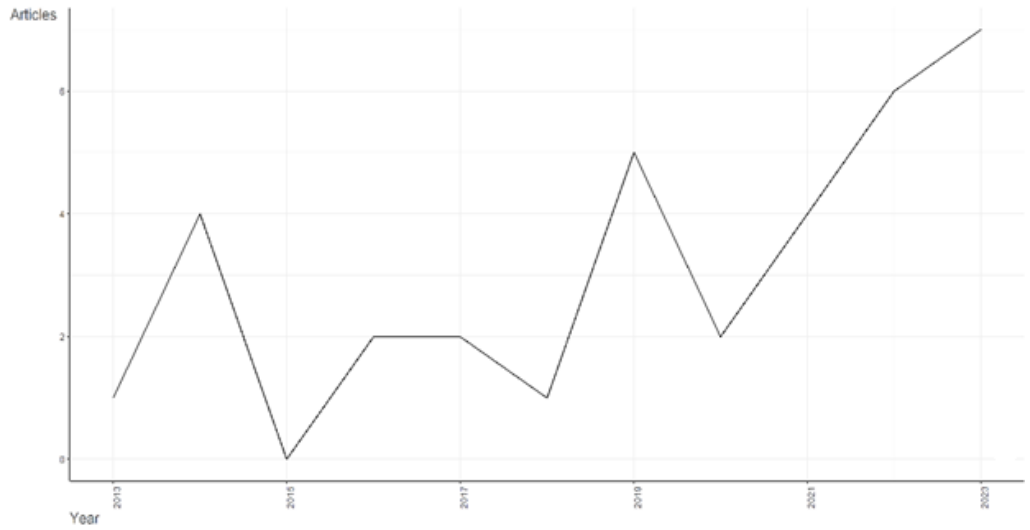

Fig. 2. Annual DHH practical skills learning scientific production per year

Figure 3 shows average citations per year.

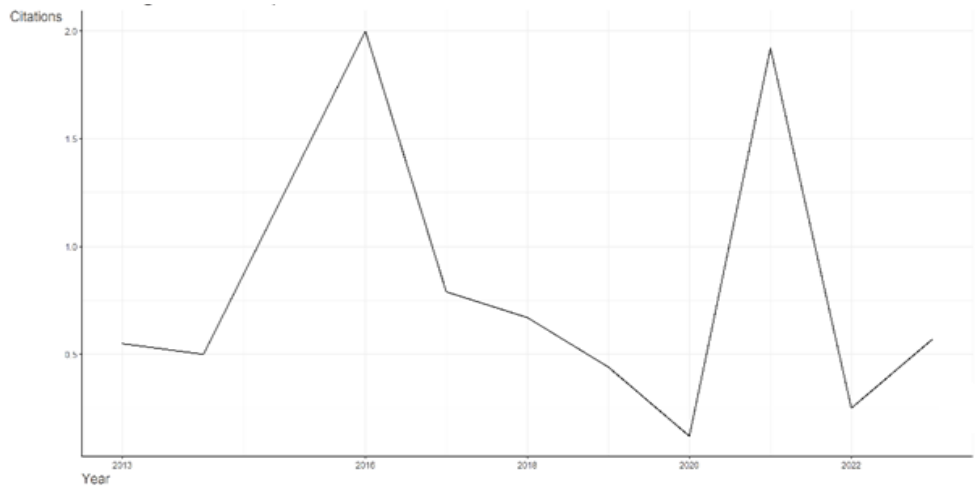

Fig. 3. Average DHH practical skills learning citations per year

Figure 4 shows Countries' scientific production.

Fig. 4. Countries' DHH practical skills learning scientific production

Table 3 shows Countries' production frequency per year.

Table 3
Countries' DHH practical skills learning production frequency per year

Region	Frequency	Region	Frequency	Region	Frequency
China	14	Indonesia	2	Portugal	1
USA	11	Pakistan	2	Saudi Arabia	1
Canada	6	Colombia	1	South Africa	1
Jordan	5	Croatia	1	South Korea	1
India	4	Finland	1		
Spain	3	Germany	1		
UK	3	Iraq	1		
Brazil	2	Mexico	1		

Figure 5 shows Word Cloud scientific production.

Fig. 5. Word Cloud DHH practical skills learning scientific production

4. Results

As the usage of practical skills learning for DHH brings a good impact for improvement, the teaching and learning process becomes more effective. Using the search technique, we extracted and analysed 30 articles and subsequently categorized all of them into three distinct groups.

4.1 Themes 1: Innovative Pedagogical Approaches for Deaf Education

This theme includes studies that focus on innovative approaches and technologies to improve education as well as support for DHH individuals, as in Table 4.

Table 4
Result Innovative Pedagogical Approaches for Deaf Education

No	Authors	Title	Journal	Method	Result and Advantages
1	Potier K.R.; Givens H. [28]	Synthesizing Vygotsky's Sociocultural Theory and Deaf Pedagogy Framework Toward Deaf Education Reform: Perspectives from Teachers of the Deaf	American Annals of the Deaf, 2023	Examines U.S. deaf education through Vygotskian sociocultural theory and deaf pedagogy.	Proposing practical solutions for equitable, accessible environments.
2	Ham J.; Towle A.; Shyng G. [14]	DHH awareness training: A mentor-led workshop	Clinical Teacher, 2021	Three sessions workshop involving 49 students from various health disciplines.	Knowledge, skills, and attitude development.
3	Elliot L.B.; Rubin B.; DeCaro J.J.; William Clymer E.; Earp K.; Fish M.D. [52]	Creating a virtual academic community for STEM students	Journal of Applied Research in Higher Education, 2013	Mixed method utilized Google+ Hangouts with regard to remote tutoring and recorded 57 tutoring sessions.	The GPAs and rates of student retention showed no significant changes.
4	Buliali J.L.; Andriyani; Pramudya Y. [53]	Developing Interactive Media with Augmented Reality for Prospective Solution Quota-Friendly Learning and Physical Limitation in the Pandemic Era	Mathematics Teaching-Research Journal, 2022	Augmented reality in teaching geometry to hearing-impaired students during the pandemic	Meets validity, practicality, and effectiveness criteria, engagement and meaningful learning experiences.
5	Abu Altaieb M.H.; Mousa Ay K.; Al Dababseh M.F.; Bataineh M.F.; Al-Nawaiseh A.M.; Taifour A. [35]	Impacting educational course for swimming on freestyle swimming performance and life skills for deaf students	Journal of Human Sport and Exercise, 2017	6-week swimming course on freestyle swimming performance as well as life skills development involving 10 male deaf students at the University of Jordan.	Significant enhancements in both life skills and freestyle swimming performance.
6	Almalhy K.M. [47]	Effect of video tutorial delivery method on D/HH students' content comprehension	Frontiers in Psychology, 2022	Mixed methods video tutorial delivering instructional for deaf students, sign language, captioned text, and combination. 54 undergraduate DHH in Saudi Arabia	Combination content was the most effective method.
7	Zhang N.; Zhang J.; Ying Y.; Luo C.; Li J. [26]	Wi-Phrase: Deep Residual-Multihead Model for Wi-Fi Sign Language Phrase Recognition	IEEE Internet of Things Journal, 2022	Context-aware using Wi-Fi signals for English phrase translation.	Accurate phrase recognition 95.03%.
8	Segura M.; Osorio R.; Zavala A. [31]	Extended Reality Model for Accessibility in Learning for Deaf and Hearing Students (Programming Logic Case)	International Journal of Modern Education and Computer Science, 2023	Extended reality (XR) video game programming logic learning.	Improved knowledge acquisition as well as skill development for both DHH and hearing students.

9	Sharma A.; Sharma N.; Saxena Y.; Singh A.; Sadhya D. [42]	Benchmarking DNN approaches for Indian Sign Language Recognition	Neural Computing and Applications, 2021	Evaluate the effectiveness of ML as well as CNN algorithms in recognizing gestures.	Hierarchical model's highest accuracy is 98.52% and 97% for one-hand and two-hand gestures, respectively.
10	Ma H.; Qin H.; Xiao X.; Liu N.; Wang S.; Li J.; Shen S.; Dai S.; Sun M.; Li P.; Pan X.; Huang M.; Lu B.; Chen J.; Wu L. [46]	Robust hydrogel sensors for unsupervised learning enabled sign-to-verbal translation	InfoMat, 2023	Liquid metal (LM) A motion monitoring system utilizing this material enables hand gesture monitoring as well as sign-to-verbal translation.	Benefiting communication for DHH and expanding wearable electronics applications.

4.2 Themes 2: Language and Communication in Deaf Education

This theme includes studies that focus on Language and communication are central to the experiences of DHH individuals, as in Table 5.

Table 5
Result of Language and Communication in Deaf Education

No	Authors	Title	Journal	Method	Result and Advantages
1	Goswami S.P.; Ggr A.R.; Sharma K. [32]	Introducing Indian sign language in inclusive education	Disability, CBR and Inclusive Development, 2019	Indian Sign Language (ISL) to improve communication, theoretical, practical manual alphabets to daily-life vocabulary and conversations.	Improved awareness of non-verbal communication, ISL skills, and positive attitudes.
2	Dadey R.; Sabo J. [34]	A transformational approach to infusing American sign language and deaf perspectives in humanities education	International Journal of Critical Cultural Studies, 2014	Promotes the cultural- integration of ASL and Deaf culture into higher education Humanities programs.	Strategies, experienced educators, a student-centred connection, and interdisciplinary cooperation are essential components for success.
3	Nemčić R.M.; Bradarić-Jončić S. [59]	The relations between cultural identity and demographic characteristics of deaf and hard-of-hearing persons	Hrvatska Revija Za Rehabilitacijska Istrazivanja 2016	Analysed DHH cultural 443 Croatian.	It found significant relationships between cultural identity and various demographic factors.
4	De Araújo D.C.S.A.; Santos J.S.; Da Cunha Barros I.M.; Cavaco A.M.N.; Mesquita A.R.; De Lyra D.P., Jr. [39]	Sign language in Brazilian pharmacy education	American Journal of Pharmaceutical Education, 2019	Categorized sign language courses based on type, nature, duration, and workload.	18 of 35 pharmacy students (51.4%) preferred sign language courses.

5	Nahar K.M.O.; Almomani A.; Shatnawi N.; Alauthman M. [38]	A Robust Model for Translating Arabic Sign Language into Spoken Arabic Using Deep Learning	Intelligent Automation and Soft Computing, 2023	Translation innovative method for automatic into spoken Arabic, image recognition models for mapping sign language gestures to text.	93.7% translation accuracy.
6	Liu H.T.; Andrews J.F.; Liu C.J. [48]	Literacy and deaf students in Taiwan: Practices, Issues and directions for future research: Part II	Deafness and Education International, 2014	DHH Taiwanese written text through various means such as pictures, speech, sign language, and visual cues.	Help students associate meaning with written Chinese characters.
7	Maher A.J. [51]	Disrupting phono centrism for teaching Deaf pupils: prospective physical education teachers' learning about visual pedagogies and non-verbal communication	Physical Education and Sport Pedagogy, 2021	75 Physical Education (PE) teachers were training ear defenders qualitative analysis.	Challenging to offer effective non-verbal feedback to facilitate learning as well as growth.
8	Dostal H.; Gabriel R.; Weir J. [27]	Supporting the Literacy Development of Students with Deaf/Hard of Hearing in Inclusive Classrooms	Reading Teacher, 2017	Help students by 1) enhancing the clarity of their content and thought processes, as well as 2) improving language accessibility and comprehension for all writers and readers.	Offer practical tips as well as strategies for students using listening and spoken language.
9	Kaplunov E. [60]	Mistrust between Deaf patients and hearing staff in healthcare settings	Empedocles, 2023	Emphasizing contribution to health inequities through practical experiments and theoretical.	Guidance to healthcare staff on avoiding miscommunication.
10	Bobadilla-Pérez M.; de Santiago R.J.C. [44]	Exploring audiovisual translation as a didactic tool in the secondary school foreign language classroom	Porta Linguarum, 2022	Highlights the educational value of AVT in language classrooms.	It enhances communicative, linguistic, digital, and intercultural competencies while promoting mediation skills.

4.3 Themes 3: Accessibility and Technology in Deaf Education

This theme revolves around creating inclusive learning environments and addressing accessibility issues for DHH students, as in Table 6.

Table 6
Result of Accessibility and Technology in Deaf Education

No	Authors	Title	Journal	Method	Result and Advantages
1	Jian Z.; Liu W.; Lijuan S.; Zhejun K.; Di Z. [40]	An accessibility learning system for higher integrated education of hearing-impaired students' technology	International Journal of Computer Applications in Technology, 2020	Aid hearing-impaired students in capturing teachers' lip language and voice information.	Help DHH better understand.
2	Halley M.; Connelly L. [29]	"It Made Me Think Like a Nurse": Virtual Simulations with Interpreters	Journal of Nursing Education, 2022	Virtual patient education simulations involving nursing and deaf standardized patients, mediated by interpreting students.	Described recent educational encounters as well as the acquisition of practical, alongside the enhancement of analytical thinking capabilities.
3	Human Resource Management [37]	NDC's top team taught the merits of online training: Evidence-based reporting of two pilot projects	Human Resource Management International Digest, 2014	Offers insights on gaining board member support for e-learning in charitable organizations.	E-learning, ultimately receiving a Charity Learning Award.
4	Bibi A.; Khalid M.A.; Hussain A. [61]	Perceived organizational support and organizational commitment among Pakistan's special education teachers	International Journal of Educational Management, 2019	Investigates the level of job contentment experienced by special education educators in Pakistan.	Positive correlations between job satisfaction, affective and normative commitment, as well as POS.
5	Bogdanova T.G.; Thomson V.A. [62]	Problems of studying the personality of adolescents and children with hearing disorders in foreign psychology	Voprosy Psikhologii, 2020	Foreign psychology studies on DHH children.	Influencing self-esteem and social maturity, visual-tactile communication and sign language in early development.
6	Tapio E. [41]	The Marginalisation of Finely Tuned Semiotic Practices and Misunderstandings in Relation to (Signed) Languages and Deafness	Multimodal Communication, 2014	Incorporating communities' communication practices into multimodal research	Enhance its perspective through the recognition of communication methods within visually focused domains using multiple modes.
7	Espada-Chavarria R.; González-Montesino R.H.; López-Bastías J.L.; Díaz-Vega M. [17]	Universal Design for Learning and Instruction: Effective Strategies for Inclusive Higher Education	Education Sciences, 2023	DHH Spanish Sign Language Degree, using UDI as well as UDL.	High student satisfaction, improved motivation, comprehension, and competency development.

8	Estrella Á.M.C.; Pareja E.M.D.; Ortega-Tudela J.M. [63]	Service-learning at university: Helping schools respond to diversity using ICT; [Aprendizaje-servicio en la universidad: Ayudando a la escuela a atender a la diversidad a través de las TIC]	Bordon. Revista de Pedagogia. 2018	University undergraduate students created over 200 ICT materials for diverse learning needs.	Enhancing students' skills and social awareness.
9	Boileau É.; Talbot-Lemaire M.; Bélanger M.; St-Onge C. [45]	"Playing in the Big Leagues Now": Exploring Feedback Receptivity During the Transition to Residency	Health Professions Education, 2019	A qualitative 9 medical residents participated in individual semi-structured interviews.	Educators must be mindful of learners' stress and uncertainty during transition, as well as provide guidance and feedback.
10	Krasavina J.V.; Ponomarenko E.P.; Serebryakova Y.V.; Zhuikova O.V. [11]	The use of information and communication technologies when teaching students with hearing impairment at a technical university;	Perspektivy Nauki i Obrazovania, 2021	Adapted techniques, questionnaires, and experiments for both DHH and hearing students in Engineering at Kalashnikov Izhevsk State Technical University.	Electronic boards enhance short-term memory, printed tables improve attentiveness in DHH, and printed text aids reading skills. Combining media is recommended.

5. Conclusions

This systematic review of 150 articles from three databases (Scopus, IEEE, ERIC) identified 30 eligible articles. It revealed three key themes: innovative pedagogy, language and communication, as well as accessibility and technology for DHH students. Innovative pedagogical methods, such as video and augmented reality, improve practical learning. Language and communication strategies involving sign language and AVT enhance communication for DHH students. Additionally, accessibility and technology, including hearing aids and Universal Design, improve learning outcomes and performance for DHH students. This review emphasizes the importance of innovation, technology, and inclusive education practices for DHH students' skill development.

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