Towards Digital Pedagogical Communication: A Conceptual Framework for Training Teachers of Deaf and Hard-of-Hearing Students

Siti Farisah Yahya, Syar Meeze Mohd Rashid and Khairul Farhah Khairuddin

Abstract – **This paper presents a conceptual framework for reconceptualizing pedagogical communication in the education of Deaf and Hard-of-Hearing (DHH) students in the context of digitalization. The study adopts a conceptual paper design and employs a narrative synthesis of purposively selected literature, integrating theoretical perspectives and insights from existing studies on DHH communication, multimodal pedagogy, technology-mediated learning, and teacher preparation. Rather than conducting a systematic review, the paper draws on selected literature to identify key conceptual patterns and structural gaps in current approaches to pedagogical communication. The analysis highlights that multimodal communication strategies such as visual, gestural, written, and assistive forms are widely implemented but often treated as discrete techniques rather than as an integrated pedagogical system. Based on this conceptual integration, this paper proposes a framework comprising multimodal communication, technology-mediated interaction, and adaptive pedagogical responsiveness, with teacher training as the central enabling component. The framework provides a structured basis for advancing teacher training and instructional design in DHH education, supporting the development of more integrated and communication-responsive learning environments.**

Keywords – **Deaf and Hard-of-Hearing (DHH), Digital Pedagogical Communication, Multimodal Communication, Inclusive Education, Teacher Training, Technology-Mediated Learning**

I. INTRODUCTION

The education of Deaf and Hard-of-Hearing (DHH) students has increasingly been shaped by the broader shift toward inclusive and equitable educational practices. Within this shift, communication functions as the central medium through which access to knowledge, classroom participation, and social inclusion are realized (Akhmad, 2014; Karuppannan et al., 2021). This is particularly critical in DHH education, where access to language, communication, and interaction directly shapes learning opportunities and classroom participation (Marschark & Hauser, 2012). However, inclusive placement often creates an illusion of inclusion without ensuring meaningful access to communication and learning, as many classroom environments remain structured by linear, speech-dominant models that do not align with the communicative realities of DHH learners (Hanafi et al., 2019; Husin et al., 2023).

Pedagogical communication is understood as a structured process of interaction between teachers and learners that encompass the exchange of information, the organization of interaction, and the development of mutual understanding (Akhmad, 2014). Recent empirical evidence indicates that pedagogical communication for DHH students is inherently multimodal, involving the coordinated use of sign-supported interaction, visual scaffolds, written supports, gestures, and assistive technologies (Bilovus et al., 2020; Bintoro et al., 2023; Q. Zhang et al., 2025). These strategies have been associated with improved comprehension, participation, and engagement (Karuppannan et al., 2021). However, while multimodal strategies are widely reported, their implementation remains fragmented and lacks a coherent pedagogical foundation (Dzulkifli et al., 2020).

At the same time, digitalization has introduced new possibilities for supporting communication. Digital environments enable the integration and synchronization of multiple communication modes, offering a potential response to the complexity of DHH pedagogy (Farhan & Razmak, 2022). Yet, despite these advancements, fragmentation persists across both multimodal practices and technological applications (Biletska et al., 2022).

This paper argues that the primary challenge in DHH education is structural rather than technical. Despite the growing body of research on multimodal communication, technology-mediated learning, and inclusive pedagogy, existing studies tend to address these elements in isolation rather than as components of an integrated pedagogical system. This fragmentation limits the ability to systematically support communication and learning in DHH contexts.

The absence of a coherent framework that aligns multimodal communication, technology-mediated interaction, and pedagogical responsiveness, combined with insufficient teacher preparation, continues to result in fragmented instructional practices. This indicates that the issue is not the lack of strategies or technological tools, but the absence of a system-oriented approach that integrates these elements within instructional design.

Therefore, this paper proposes a conceptual framework for digital pedagogical communication, positioning digital environments as structurally aligned with the demands of multimodal communication and identifying teacher training as the central enabling mechanism for effective implementation. By addressing this gap, the proposed framework provides an integrated foundation for aligning communication, technology, and pedagogy within a unified structure.

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II. PROBLEM STATEMENT

Pedagogical communication in DHH education remains fundamentally fragmented across linguistic, instructional, and systemic dimensions (Biletska et al., 2022). Although multiple communication modes are widely employed, including sign language, speech, and written forms, these modes are often implemented in isolation rather than as part of a structured and coordinated system (Bilovus et al., 2020).

At the linguistic level, the coexistence of multiple communication systems frequently leads to inconsistency and confusion. The simultaneous use of sign language, spoken language, and written text without systematic integration can hinder comprehension rather than facilitate it, as learners are required to process competing streams of information (Dostal et al., 2024). This suggests that the presence of multiple modes alone does not guarantee accessibility but instead requires deliberate coordination.

At the instructional level, classroom communication is often characterized by a lack of interactional structure. Evidence indicates that teacher–student communication tends to be uneven and poorly coordinated, particularly in environments involving multiple speakers, limited visual access, and unstructured turn-taking (Panic et al., 2017; Skrebneva & Fordham, 2024). These conditions result in frequent communication breakdowns and limit DHH students' ability to access instructional content effectively.

At the systemic level, the absence of standardized frameworks and structured teacher preparation further reinforces this fragmentation. In many cases, teachers rely on personal experience and improvisation rather than pedagogically grounded strategies, leading to inconsistent practices across contexts (Biletska et al., 2022; Husin et al., 2023; Musyoka & Gentry, 2020; Yahya et al., 2025). This reflects a broader issue in inclusive education, where teacher readiness in terms of knowledge, skills, and pedagogical competence plays a critical role in determining instructional effectiveness.

Taken together, these issues indicate that the fragmentation observed in pedagogical communication is not incidental but systemic. It reflects a fundamental misalignment between the multimodal nature of communication and the design of instructional practices in DHH education. Therefore, the central problem is not the lack of communication strategies or technologies, but the absence of an integrated pedagogical system that aligns multimodal communication, instructional processes, and teacher capacity to support meaningful learning.

III. CONCEPTUAL APPROACH

This study adopts a conceptual paper approach and employs a narrative synthesis of purposively selected literature to develop a theoretical framework for digital pedagogical communication in DHH education. This approach is appropriate as the aim of the study is to develop a theoretically grounded framework rather than to test empirical relationships, thereby requiring interpretive synthesis and conceptual integration of existing knowledge. Rather than employing a systematic or formal review methodology, the paper integrates theoretical perspectives and insights from existing studies on pedagogical communication, multimodal learning, technology-mediated instruction, and teacher preparation.

The selection of literature was guided by its relevance to key themes in DHH and inclusive education, with emphasis on studies that provide conceptual and empirical insights into communication practices, multimodal pedagogy, and the use of digital technologies in instructional contexts. The literature was not intended to be exhaustive but was purposively chosen to represent key strands of research most aligned with the conceptual focus of this study.

Relevant studies were examined to identify recurring themes, conceptual inconsistencies, and structural gaps in current approaches to pedagogical communication. The analysis follows a process of conceptual integration, involving the identification of key ideas, comparison of perspectives across studies, and synthesis of concepts to construct an integrated framework. The resulting framework is not intended as an empirical model but as a theoretically grounded proposition to guide future research and pedagogical practice.

IV. LITERATURE REVIEW

Pedagogical Communication as a Theoretical Foundation

Pedagogical communication in the education of DHH students must be understood not merely as a process of information exchange, but as a structured system of interaction that shapes how meaning is constructed and accessed within the classroom. Unlike hearing learners, DHH students rely on the integration of visual, gestural, and textual modalities, positioning communication as a central component of instructional design rather than as a supplementary element (Bilovus et al., 2020; Husin et al., 2023).

Existing theoretical perspectives conceptualize pedagogical communication as comprising communicative, interactive, and perceptual dimensions that collectively influence teaching and learning processes (Akhmad, 2014). From a systemic perspective, these dimensions operate as an interdependent structure in which meaning-making emerges through the alignment of interactional processes, teacher mediation, and learner engagement (Biletska et al., 2022; Panic et al., 2017). In DHH contexts, this alignment becomes particularly critical, as fragmented communication structures can disrupt comprehension and participation.

However, despite these theoretical contributions, pedagogical communication is often treated as a set of discrete techniques rather than as an integrated system within instructional practice. This conceptual limitation reduces its applicability in guiding coherent and context-responsive pedagogical design, particularly in environments that require the coordination of multiple communicative modes. Consequently, there is a need to reconceptualize pedagogical communication as a dynamic, system-oriented construct that integrates multimodal interaction, technological mediation, and adaptive responsiveness within a unified pedagogical framework.

Multimodal Pedagogical Communication

From a theoretical perspective, the systemic nature of pedagogical communication necessitates the coordination of multiple communicative modes within instructional processes, particularly in contexts where learners rely on visual and non-auditory forms of interaction. Multimodal communication can therefore be understood as a pedagogical manifestation of this systemic communication structure, involving the coordinated use of visual, gestural, textual, and assistive modes to support meaning-making (Bilovus et al., 2020; Husin et al., 2023). For DHH learners, these modes are not supplementary but foundational to communication, as access to information depends on the effective integration of multiple representational systems.

Research demonstrates that sign language learning requires the integration of spatial, temporal, and visual representations, highlighting the inherent complexity of multimodal communication processes (Q. Zhang et al., 2025). Similarly, classroom practices involve the coordination of gestures, speech-reading, and visual cues, indicating that effective communication relies on the interaction of multiple modes rather than isolated channels (Bintoro et al., 2023).

However, despite its widespread use, multimodal communication is often implemented in fragmented ways. Teachers frequently apply communication modes independently rather than as part of a structured pedagogical system (Biletska et al., 2022). This lack of integration results in inconsistencies in instructional delivery and may reduce learners' comprehension (Dzulkifli et al., 2020). This indicates that while multimodality is present in practice, it remains insufficiently theorized and operationalized as an integrated pedagogical framework. Consequently, the limitation lies not in the availability of multimodal strategies, but in the absence of a system-oriented approach that coordinates these modes within coherent pedagogical communication.

Technology-Mediated Communication

Given these limitations, digital environments emerge as a structurally appropriate medium for addressing the integration demands of multimodal communication. Technology-mediated communication has significantly expanded the possibilities for integrating multimodal elements within educational settings. Digital environments enable the synchronization of text, audio, sign language, and visual representations, thereby enhancing accessibility and interaction (Borozan & Ţurcan-Balţat, 2023; Farhan & Razmak, 2022; Husin et al., 2023).

Advancements in artificial intelligence further support communication through features such as real-time captioning, sign language recognition, and adaptive learning systems, transforming communication from static delivery into dynamic and interactive processes (Khandaqji et al., 2025). These developments demonstrate the potential of digital technologies to address the complexity of multimodal communication in DHH education.

However, despite these advancements, technological development has largely outpaced pedagogical integration (Borozan & Ţurcan-Balţat, 2023). Existing research and applications tend to focus on isolated functionalities rather than on how digital tools can be systematically embedded within instructional design. As a result, technology use often remains fragmented, supporting discrete tasks rather than facilitating coherent communication processes. This indicates that the effectiveness of technology-mediated communication depends not on the availability of digital tools, but on their integration within a pedagogically grounded and system-oriented framework. This reflects current perspectives that emphasize the integration of technological, pedagogical, and communicative dimensions in digitally mediated learning environments (Mishra & Koehler, 2006).

V. CONCEPTUAL FRAMEWORK DEVELOPMENT

Taken together, the preceding analysis reveals a fundamental conceptual gap in current approaches to pedagogical communication in DHH education. While multimodal communication, digital technologies, and pedagogical strategies are widely discussed in the literature, they are rarely conceptualized as components of an integrated system (Biletska et al., 2022; Borozan & Ţurcan-Balţat, 2023; Husin et al., 2023). This fragmentation continues to constrain the development of coherent and effective instructional practices.

The inherently multimodal nature of DHH communication creates structural demands for coordination, simultaneity, and adaptability that are not adequately supported within conventional instructional models (Bilovus et al., 2020; Bintoro et al., 2023; P. Zhang et al., 2025). Digital environments offer affordances that align with these demands by enabling the synchronization and dynamic integration of multiple communication modes (Farhan & Razmak, 2022; Martínez-Agut & Monzó-Martínez, 2022). However, such affordances can only be realized when embedded within a pedagogically grounded framework that systematically aligns communication, technology, and instructional processes (Akhmad, 2014; Borozan & Ţurcan-Balţat, 2023).

This analysis therefore necessitates a reconceptualization of pedagogical communication as a system-oriented construct. Within this perspective, communication is not viewed as a set of isolated techniques but as an integrated design problem shaped by the interaction between multimodal practices, technological mediation, and pedagogical responsiveness (Akhmad, 2014; Biletska et al., 2022).

Accordingly, this paper advances the concept of digital pedagogical communication as a theoretically grounded framework that integrates these elements into a coherent and interdependent system. This represents a shift from strategy-based approaches toward system-oriented pedagogical design, thereby providing a conceptual foundation for addressing the structural limitations identified in existing DHH educational practices (Dzulkifli et al., 2020; Husin et al., 2023).

VI. CONCEPTUAL FRAMEWORK

This paper proposes a framework that conceptualizes digital pedagogical communication as an integrated system

rather than a collection of isolated practices. It consists of three interdependent dimensions multimodal communication, technology-mediated interaction, and adaptive pedagogical responsiveness with teacher training positioned as the central enabling component that operationalizes the entire system.

Multimodal Communication

This dimension emphasizes the integration and coordination of visual, gestural, textual, and assistive modes as the foundation of pedagogical communication (Bilovus et al., 2020). Rather than functioning as separate techniques, these modes must be deliberately synchronized to support meaning-making. For DHH learners, communication is inherently multimodal; therefore, effective instruction requires the structured alignment of these modalities to ensure clarity, reduce cognitive load, and enhance comprehension. This perspective aligns with contemporary understandings of multimodality, which emphasize that meaning is constructed through the coordinated orchestration of multiple modes within communicative contexts (Cope & Kalantzis, 2020). Without such integration, the use of multiple modes may result in fragmentation rather than accessibility (Biletska et al., 2022).

Technology-Mediated Interaction

This dimension highlights the role of digital environments as the enabling medium for integrating and synchronizing multimodal communication. Digital tools provide affordances such as real-time captioning, visual layering, interactive feedback, and adaptive content delivery, which allow communication to be structured dynamically rather than linearly (Borozan & Țurcan-Balțat, 2023). However, the value of technology lies not in its presence but in its integration. When embedded within pedagogical design, technology functions as a coordinating mechanism that enhances accessibility, interaction, and engagement across multiple communication modes (Farhan & Razmak, 2022; Husin et al., 2023).

Adaptive Pedagogical Responsiveness

This dimension focuses on the teacher's capacity to continuously interpret and respond to learners' communicative needs within dynamic classroom contexts (Panic et al., 2017). It involves monitoring understanding through visual and behavioural indicators, adapting communication strategies in real time, managing interactional flow, and designing inclusive participation structures. In this framework, adaptability is not an additional skill but a core mechanism that ensures alignment between communication design and learner needs.

Integrated System Perspective

Unlike existing approaches that treat multimodal strategies, technology, and pedagogy as separate components, this framework conceptualizes them as an interdependent system centered on teacher-mediated integration. Multimodal communication defines the communicative foundation, technology-mediated interaction provides the structural medium for integration, and adaptive pedagogical responsiveness ensures contextual alignment. Teacher training acts as the enabling core that connects and operationalizes these dimensions.

This integrated perspective shifts the focus from implementing individual strategies toward designing coherent communication systems, thereby addressing the fragmentation identified in current DHH educational practices. Taken together, the limitations identified across existing studies point to a central issue: the absence of an integrated pedagogical system that aligns multimodal communication, digital technologies, and teacher-mediated interaction. While each element has been explored individually, their disconnection continues to result in fragmented instructional practices. Therefore, a system-oriented conceptual framework is required to bring these elements into a coherent and interdependent structure.

Figure 1 shows the conceptual framework that illustrates digital pedagogical communication as an integrated system. The framework comprises three interdependent dimensions: multimodal communication, technology-mediated interaction, and adaptive pedagogical responsiveness, with teacher training as the central enabling component.

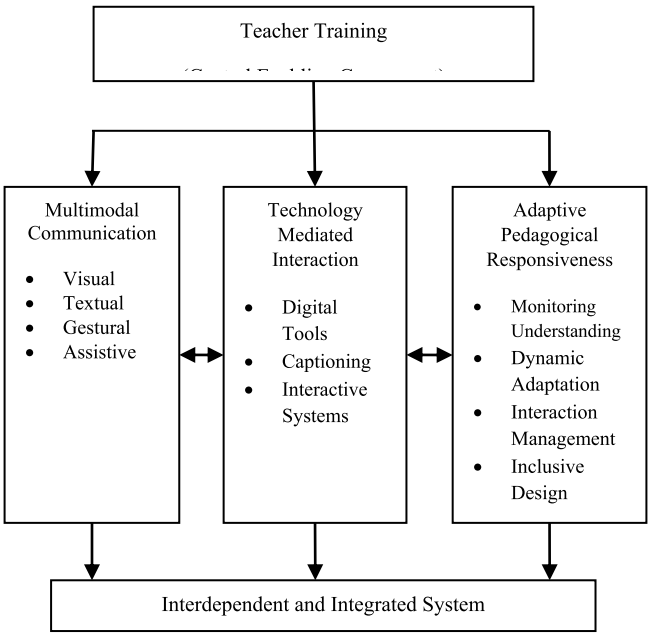


Figure 1. Conceptual Framework for Digital Pedagogical Communication in DHH Education

VII. DISCUSSION

The proposed framework positions teacher training as the central enabling mechanism for operationalizing digital pedagogical communication. Effective professional development should be sustained, content-focused, practice-oriented, and connected to teachers' classroom contexts (Darling-Hammond et al., 2017). Rather than functioning as a supplementary component, teacher capacity is conceptualized as a structural condition that determines whether multimodal communication and digital technologies can be effectively integrated within

instructional practice (Martínez-Agut & Monzó-Martínez, 2022; Musyoka & Gentry, 2020).

This perspective highlights a critical limitation in current approaches to DHH education. Existing evidence indicates that many teachers lack formal preparation in hearing impairment and demonstrate limited readiness to implement integrated communication strategies (Pérez-Jorge et al., 2021; Yahya et al., 2025). Consequently, instructional practices often rely on improvisation and isolated techniques, resulting in inconsistencies and reduced effectiveness (Al Hashimi, 2022; Husin et al., 2023).

Beyond teacher training, the framework has broader implications for curriculum design, instructional policy, and the development of digital learning environments. By positioning communication as an integrated system, it provides a basis for designing learning experiences that align multimodal interaction, technological affordances, and pedagogical responsiveness within coherent instructional structures (Borozan & Țurcan-Balțat, 2023; Farhan & Razmak, 2022).

Importantly, these findings suggest that the primary limitation in DHH education is not the absence of multimodal strategies or technological tools, but the limited capacity to integrate these elements within a unified pedagogical system (Biletska et al., 2022; Dzulkifli et al., 2020). Addressing this limitation requires a shift from the adoption of isolated techniques toward the development of system-oriented pedagogical competencies.

To operationalize this shift, teacher training must be structured around three interrelated domains:

Multimodal Competence

Teachers must develop the capacity to design and coordinate multiple modes of communication as an integrated system rather than as separate techniques. This includes understanding how visual, gestural, textual, and spatial elements interact to support meaning-making, as well as how to sequence and synchronize these modes during instruction. Without such integration, the use of multiple modes may increase cognitive load and reduce comprehension rather than enhance accessibility (Bilovus et al., 2020).

Digital Literacy for Pedagogical Integration

Digital literacy should be conceptualized in pedagogical rather than technical terms (Martínez-Agut & Monzó-Martínez, 2022). Teachers need to move beyond basic familiarity with digital tools toward the ability to integrate them into communication design. This involves selecting tools based on communicative objectives, coordinating multimodal elements within digital environments, and designing learning experiences that leverage digital affordances to enhance accessibility and engagement (Borozan & Țurcan-Balțat, 2023). Without such integration, digital technologies risk functioning as isolated tools rather than as components of a coherent communication system.

Adaptive Pedagogical Responsiveness

Adaptive responsiveness represents a core mechanism within the proposed framework. It refers to the teacher's capacity to continuously interpret and respond to learners' communicative needs in real time (Panic et al., 2017). This includes monitoring understanding through visual and behavioural indicators, dynamically adjusting communication strategies, managing interactional flow, and designing inclusive participation structures. In DHH education, where communication is inherently dynamic and context-dependent, such responsiveness is essential for maintaining alignment between instructional design and learner needs.

These three domains should not be treated as separate training components but as an integrated competency structure. Multimodal competence provides the foundation for communication design, digital literacy enables the integration of multimodal elements within technologically mediated environments, and adaptive pedagogical responsiveness ensures alignment with learner needs.

Overall, the framework proposed in this paper repositions teacher training as the mechanism through which multimodal communication and digital technologies are transformed into a coherent pedagogical system. Without such transformation, efforts to improve DHH education are likely to remain fragmented and limited in impact.

VIII. CONCLUSION

This paper has argued that pedagogical communication in DHH education remains structurally fragmented despite the increasing use of multimodal strategies and digital technologies. While these approaches offer significant potential to enhance accessibility and interaction, their effectiveness is constrained by the lack of integration across communication modes, instructional practices, and teacher capacity.

By reconceptualizing communication as a digitally mediated, multimodal, and adaptive system, this paper proposes a conceptual framework for digital pedagogical communication that addresses these structural limitations. The framework integrates multimodal communication, technology-mediated interaction, and adaptive pedagogical responsiveness, with teacher training positioned as the central enabling component.

The key contribution of this paper lies in advancing a system-oriented perspective of pedagogical communication, shifting the focus from isolated strategies toward the design of integrated communication systems. This perspective provides a conceptual foundation for more coherent, accessible, and communication-responsive learning environments in DHH education.

Future research should extend this framework through empirical validation and explore its application across diverse educational contexts.

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