

Deaf-Friendly Educational Spaces: A Case-Based Architectural Study

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Abstract

Deafness profoundly influences how individuals experience, communicate with, and interact with the world around them. For many, this is a reality that profoundly shapes their experiences and interactions. Deafness is not merely a limitation; it represents a unique journey filled with rich communication, vibrant expression, and deep connections. Contrary to common perceptions, the world of the deaf is alive with visual language, where every gesture and sign conveys meaning, emotion, and a sense of community. This study explores the architectural parameters that shape spatial accessibility, visual connectivity, and sensory legibility for Deaf and hard-of-hearing users in educational environments. Employing a comparative case-study, the research analyzes spatial configurations, circulation geometries, material, and lighting conditions at Gallaudet University (Washington, D.C., USA), Isinya Boarding School for the Deaf (Kajiado County, Kenya) and Central Secondary School for the Deaf (Naxal, Kathmandu, Nepal). Field observations in Nepali Deaf schools further expose systemic gaps in space and proximity, sensory reach, mobility and proximity, light and color, acoustics. The findings demonstrate that design interventions such as U-shaped classroom arrangements, widened and visually continuous corridors, acoustically absorptive surfaces, and diffused illumination significantly enhance visual communication, safety, and spatial comprehension for Deaf users. Design standards from Deaf Space guidelines, Universal Design principles, ADA design standards, International Building Code provisions, and National Building Codes of India and Nepal, the study formulates a set of context-responsive design recommendations applicable to low-resource educational settings. The article contributes to the theoretical and practical discourse on Deaf-friendly architecture by proposing an evidence-based framework for integrating sensory-oriented design within Nepal's evolving educational infrastructure.

Keywords: Hearing impaired, Visual communication, Sign language, Inclusive design, Deaf architecture, Sensory accessibility, Deaf space.

1. Introduction

Disability describes any condition that makes it harder for someone to carry out certain activities or access opportunities equally in society [1]. Disabilities can be cognitive, physical, sensory, or a mix of these, and may be present from birth or acquired later in life. Globally, about 1.3 billion people, 16% of the population live with a significant disability [2]. The World Health Organization (WHO) estimates that 466 million people, or 6.1% of the world's population, have hearing loss [2].

According to WHO (World Health Organization, 2024), "Hearing Impaired" refers to anyone with any level of hearing loss, from mild to profound, in one or both ears. People who are deaf or hard of hearing often rely on vision and touch for spatial awareness. Deaf schools are designed to provide accessible learning environments and use innovative teaching methods and technology to support inclusion.

Design guidelines for the hearing-impaired community focus on creating environments that encourage visual communication (like signing), and a sense of safety and well-being. The goal is to establish principles that help shape visually oriented spaces where deaf individuals can communicate, connect, and thrive.

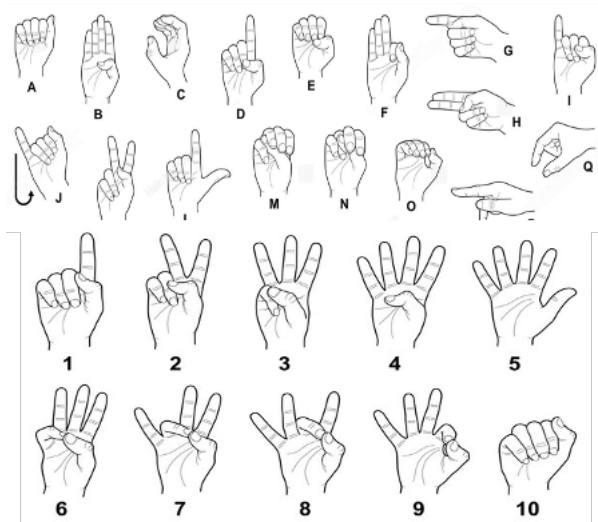


Figure 1. Sign Language

1.1 Research Problem

Despite the recognized importance of inclusive education, mainstream and specialized educational spaces in developing regions like Nepal are predominantly designed with auditory-centric parameters, inadvertently marginalizing Deaf and hard-of-hearing students. The core research problem lies in the

systemic neglect of sensory oriented architectural design such as adequate space for visual communication, glare-free lighting, obstacle-free mobility, and managed acoustics. While comprehensive frameworks like the DeafSpace guidelines and ADA standards exist globally, there is a critical knowledge and implementation gap in translating these principles into low-cost, context-responsive solutions for Nepali schools.

1.2 Significance of Research

The significance of this research lies in its potential to shift the architectural paradigm of educational facilities in developing regions from a predominantly auditory-centric model to a sensory-oriented, inclusive approach. While comprehensive global frameworks like Deaf Space and ADA standards exist, there is a profound lack of localized, cost-effective design strategies that apply these concepts to the specific spatial and resource constraints of Nepal.

By systematically analyzing existing conditions and translating theoretical principles into concrete architectural parameters such as anthropometrically precise spatial layouts, optimized lighting, and unhindered circulation geometries this study provides an actionable framework for architects, educators, and policymakers. Ultimately, the research bridges the critical gap between theoretical accessibility guidelines and practical application, ensuring that Deaf and hard-of-hearing students are provided with built environments that actively facilitate visual communication, safety, and equitable educational development.

1.3 Research Objectives

1) Major Objective

To analyze architectural design elements that support inclusive and visually accessible educational spaces for deaf or hard-of-hearing students.

2) Specific Objective

- To study how spatial design variables - Space and Proximity, Sensory Reach, Mobility and Proximity, Light and Color, and Acoustics shape the learning environment for Deaf and hard-of-hearing students.
- To review and compare established design guidelines related to these aspects across different countries.
- To examine case studies from schools around the world to understand how these design aspects are applied in real settings.

1.4 Scope and Limitations

1) Scope

This study focuses on examining how architectural design can better support Deaf and hard-of-hearing students, with emphasis on the five key design guidelines: Space and Proximity, Sensory Reach, Mobility and Proximity, Light and Colour, and Acoustics. The research includes a detailed investigation of Central Secondary School for the Deaf in

Kathmandu, supported by surveys, interviews, and on-site observations. Comparative insights from international case studies Gallaudet University (USA) and Isinya Boarding School for the Deaf (Kenya) are incorporated to understand broader applications of inclusive design. The study aims to identify spatial needs, environmental qualities, and design strategies that enhance communication, safety, learning, and comfort for Deaf users.

2) Limitations

This research is limited to architectural and spatial design aspects that directly relate to the five selected guidelines. It does not encompass educational policies, curriculum design, or broader socio cultural factors influencing deaf education. While international case studies are referenced for comparison, the depth of analysis is greater for Central Secondary School for the Deaf due to direct fieldwork access. Additionally, the findings may not represent all deaf institutions in Nepal, as the study is based on a single primary case.

2. Literature Review

Architectural design plays a pivotal role in shaping inclusive educational environments, particularly for Deaf and hard-of-hearing individuals who rely primarily on visual and spatial cues for communication. Conventional design approaches, which are largely auditory-centric, often fail to address these sensory and communicative needs, resulting in environments that limit interaction, accessibility, and learning potential.

2.1 Visual Communication for Deaf people and Spatial Design for Educational environments

For Deaf and hard-of-hearing individuals, communication is fundamentally visual, relying on sign language, facial expressions, and body movements rather than auditory cues. In this context, architecture is not merely a physical container for learning but an active medium that either facilitates or restricts communication, interaction, and participation within educational environments.

The effectiveness of visual communication in schools is closely linked to spatial configuration. Classroom layouts play a crucial role in enabling interaction; arrangements such as circular or U-shaped seating allow all students to maintain direct visual contact with one another and with the teacher, supporting inclusive dialogue and group engagement. In contrast, conventional linear or row-based seating often obstructs sightlines and limits participation.

Visibility is a key spatial requirement in Deaf-friendly environments. Clear, unobstructed sightlines between students and teachers are essential for effective communication, as even minor visual barriers can disrupt the flow of sign language and non-verbal cues. Architectural elements such as furniture placement, partition design, and room proportions must therefore be carefully considered to ensure continuous

visual connectivity.

Circulation spaces further extend the role of architecture in communication. Corridors, transitional zones, and common areas should be wide and free of obstacles, allowing individuals to walk side-by-side while maintaining visual interaction. Additionally, spatial continuity—achieved through open layouts, transparent elements, and gradual transitions enhances situational awareness and strengthens social connectivity within the school environment.

2.2 Deaf Space principles in Architecture design

Deaf Space is a design framework developed at Gallaudet University to address the unique spatial and sensory needs of Deaf and hard-of-hearing individuals. Rooted in extensive research and user experience, the framework recognizes that the built environment plays a critical role in facilitating visual communication, spatial awareness, and social interaction.

Unlike conventional design approaches that prioritize auditory cues, Deaf Space emphasizes a visually oriented and sensory-responsive environment, where spatial configuration, lighting, and movement are carefully integrated to support communication and comfort. The framework is structured around five key principles: Space and Proximity, Sensory Reach, Mobility and Proximity, Light and Colour, and Acoustics, which collectively guide the creation of inclusive and accessible environments for Deaf users.

1) Space and Proximity

When communicating in Sign Language, more space is needed between speaking partners to obtain a good visual of the conversation. The space should be between 3 feet and 10 feet for the conversation to be clear to each of the individuals. The space and proximity principle influence the design of a building because it means that areas need to be wide instead of narrow. For example, hallways need to be wide enough 2.4 meters (approximately 8 feet) so that people can walk side-by-side when having a visual conversation. As shown in figure 3, the gradation from public to private not only enhances spatial clarity and wayfinding but also respects the sensory and communication needs of deaf individuals [3].

2) Sensory Reach

Deaf individuals have an acute situational and environmental awareness, with wide peripheral vision and increased sensitivity to movements around them. Deaf people are uncomfortable when their backs are to others and/or activities, because they are somewhat "blinded" to what is going on behind them. Therefore, in accordance with DeafSpace principles, it is best if the deaf person has greater than 180-degree vision. For example, as shown in figure deaf individuals can visually see where they are going, orient themselves easily, and maintain visual connections throughout the space (Gallaudet University, 2024).

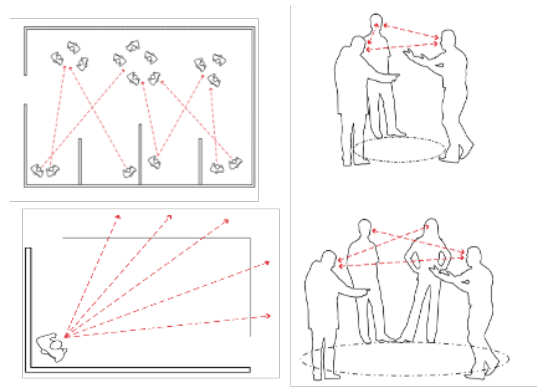


Figure 2. Private and Public Space [3]

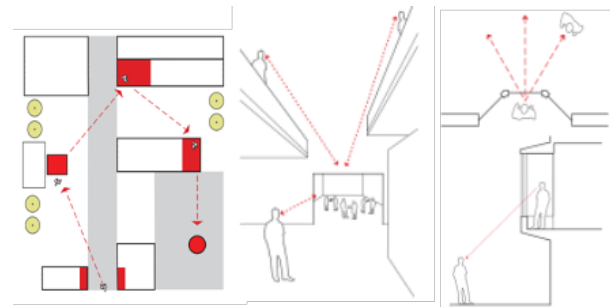


Figure 3. Visible Destinations [3]

3) Mobility and Proximity

When on the move, people need to observe possible barriers or obstacles ahead of them as they walk, jog, drive, or bike. In the case of Deaf individuals, conversing while walking requires that they take turns keeping an eye on what is in front of them in case there is an obstacle. For example, telephone poles on sidewalks can be harmful obstacles, especially considering how narrow the sidewalks are in most cities. Conversational signers would warn their partners if they are about to walk into an obstacle. In accordance with the concept of Deaf Space, it would be necessary to ensure that obstacles or barriers are moved away from general walking paths. For example, hallways should be free of objects or steps, unless in stairways. Circulation routes should be wide, well-lit, and strategically organized to support both visual communication and safe, intuitive movements shown in figure (Gallaudet University, 2024).

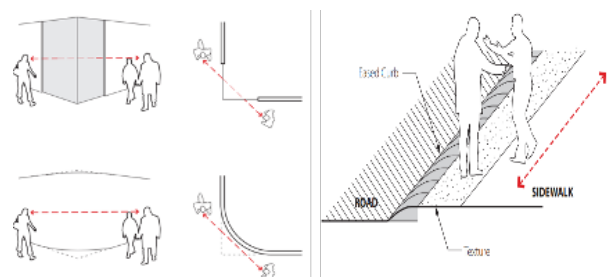


Figure 4. Pathways and Flow [3]

4) Light and Colour

Colour has a strong effect on everyone's vision. Considering that members of the Deaf community may experience more eye strain than others, as their language is visual rather than verbal, it has been suggested that soft green and blue tones are the best choices as background colors. The reason is that soft green and blue tones match everyone's skin color, which will cause less eye strain for Deaf people while conversing in Sign Language.

Light is also an important factor for the Deaf community because when the lighting is poor or too bright it may cause eyestrain or headaches. Soft, diffused lighting, similar to when the glare of the sun is blocked out, with toned down brightness. Natural, diffused lighting is better than bright, fluorescent light bulbs, for example [3].

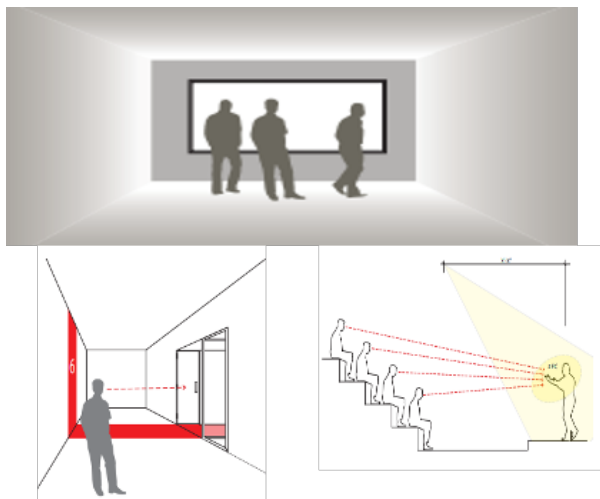


Figure 5. Color, Textures and Space [3]

5) Acoustics

Acoustics take into consideration the fact that Deaf individuals may have some type of hearing assistance device or have sensitivity to vibrations in buildings. It is important for buildings to be structurally designed to offset vibrations. For example, old houses are infamous for their creaking noises, which produce vibrations that disturb Deaf individuals. Reverberation needs to be reduced in buildings, along with muting of background noises, to minimize interference with hearing devices and other sensitivity to sounds/vibrations as shown in figure 8. (Gallaudet University, 2024)

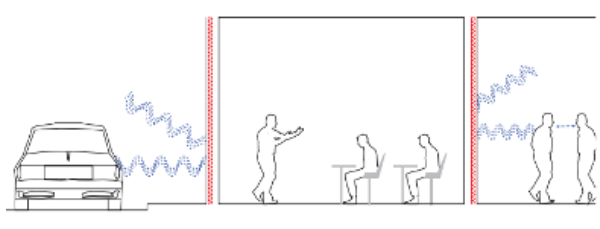


Figure 6. Sound Reverberation and Background [3]

2.3 International Accessibility Standards

International accessibility standards provide a regulatory framework for designing inclusive built environments that support the needs of diverse user groups, including Deaf and hard-of-hearing individuals. These standards translate theoretical principles of accessibility into measurable design requirements, ensuring that spaces are safe, functional, and equitable.

1) ADA Standards for Accessible Design

The ADA Standards for Accessible Design recommends:

- (i) Space and Proximity Space and Proximity is ensured through clear sightlines and unobstructed circulation in classrooms, hallways, and common areas, supporting effective visual communication and interaction.
- (ii) Sensory Reach Sensory Reach is enhanced by synchronized visual alarms flashing at 1–2 times per second (ADA Standards for Accessible Design, 2010), assistive listening systems (ALS) covering at least 4% of seating in assembly areas, and telecommunication devices for the deaf (TDDs) on each floor, along with high-contrast signage featuring the International Symbol of Access for Hearing Loss [4].
- (iii) Mobility and Proximity Mobility and proximity are supported with obstacle-free pathways and safe stairways to enable smooth movement.

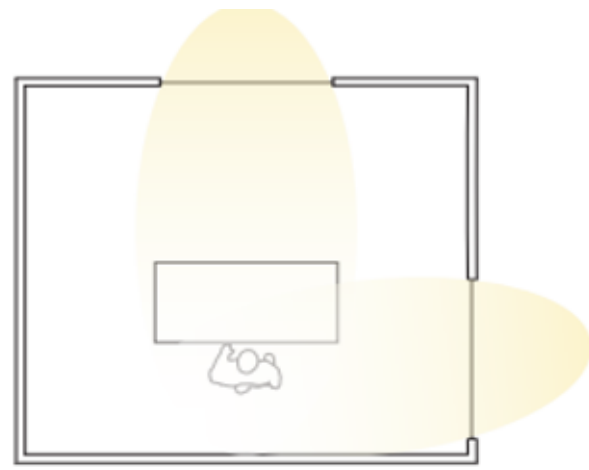


Figure 7. Mobility and Proximity

- (iv) Light and Colour Light and Colour are optimized to improve visibility, reduce glare, and aid wayfinding in all functional spaces.
- (v) Acoustics Acoustics are addressed through ALS and amplified audio signals, ensuring clarity of communication and accessibility for Deaf and hard-of-hearing individuals, integrating these five design aspects numerically and functionally to create inclusive environments [4].

2) International Building Code (IBC)

The International Building Code (IBC) establishes precise quantitative requirements to ensure the accessibility of built environments for individuals who are deaf or hard of hearing.

- (i) Space and Proximity Space and Proximity is addressed by maintaining accessible routes with a minimum clear width of 36 inches, while ramps are limited to a slope of 1:12 to ensure safe movement and interaction.
- (ii) Sensory Reach Sensory Reach is enhanced through visual alarm systems installed no more than 100 feet apart in corridors, mounted at heights between 80 and 96 inches, and by providing Telecommunication Devices for the Deaf (TDDs) on each floor with appropriate shelving and electrical outlets. Signage adjacent to doorways incorporates raised characters, Braille, and high-contrast elements to improve legibility and accessibility for all users [5]
- (iii) Mobility and Proximity Mobility and Proximity are supported through well-defined emergency egress pathways, including illuminated exit signage and visual alarms, ensuring safe and efficient evacuation.
- (iv) Light and Colour Light and Color are integrated in emergency and functional areas to enhance visibility.
- (v) Acoustics Acoustics are addressed with Assistive Listening Systems (ALS) in assembly areas, with at least 25% of receivers compatible with hearing aids, ensuring clear communication and auditory accessibility in spaces frequented by Deaf and hard-of-hearing individuals [5].

3) Universal Design (UD) principles

Universal Design (UD) principles emphasize equitable use by providing information through multiple modes such as text and visual signals. Flexibility in use supports various communication methods, including text messaging, video calls with sign language interpretation, and visual alerts [6].

- (i) Space and Proximity Space and Proximity is supported by size and space guidelines, ensuring that displays, devices, and communication tools are placed at accessible heights with sufficient surrounding space for ease of use.
- (ii) Sensory Reach Sensory Reach is enhanced through multi-sensory communication, including synchronized visual alarms and visual alerts that complement text or video-based information, allowing Deaf and hard-of-hearing users to receive information effectively [6].
- (iii) Mobility and Proximity Mobility and Proximity benefit from low physical effort principles, where communication devices and interfaces are easy to operate, minimizing strain and facilitating smooth interaction within spaces.
- (iv) Light and Color Light and Color are optimized through clear and intuitive visual cues, ensuring instructions, alerts, and emergency information are easily perceptible.
- (v) Acoustics Acoustics are addressed by providing alternative modes of communication, such as text messaging, video calls with sign language interpretation, and visual alerts, which reduce reliance on auditory cues. Collectively, these Universal Design principles create inclusive, efficient, and safe environments tailored to the specific needs of the Deaf and hard-of-hearing population [6].

2.4 National Policies and Guidelines in Regional Context

In developing regions, these frameworks guide inclusive education and spatial accessibility; however, they often lack detailed architectural directives for Deaf-friendly environments.

1) The National Building Code (NBC) of India

The National Building Code (NBC) of India provides comprehensive guidelines to ensure building safety, accessibility, and usability for all, including individuals with hearing impairments. Key provisions include the integration of visual fire alarms alongside audible systems to alert deaf individuals effectively, and clear, universally understandable signage using pictograms and symbols to aid navigation [7].

- (i) Space and Proximity Space and Proximity is ensured through seating arrangements and transparent counters for better visual interaction.
- (ii) Sensory Reach Sensory Reach is enhanced with visual alarms, clear pictogram signage, and emergency visual instructions (Bureau of Indian Standards, 2016).
- (iii) Mobility and Proximity Mobility and Proximity are supported by clearly marked evacuation routes and accessible pathways.
- (iv) Light and Color Light and Color in classrooms provide proper illumination for lip-reading and sign language.
- (v) Acoustics Acoustics are optimized to reduce background noise, complementing visual communication. These measures collectively promote inclusive environments and involve the Deaf community in design decisions [7].

2) The National Building Code (NBC) of Nepal

The National Building Code (NBC) of Nepal, supported by the National Policy and Plan of Action on Disability (2006), outlines measures to support the deaf and hard-of-hearing community through inclusive education, communication, accessibility, and healthcare services.

- (i) Space and Proximity Inclusive education is promoted by ensuring access to mainstream schools with trained teachers skilled in sign language, while specialized institutions and vocational training centers provide opportunities for skill development and employment.
- (ii) Sensory Reach Communication is enhanced by using sign language as a primary medium in education and public services, ensuring qualified interpreters are available in critical sectors such as healthcare and legal services.
- (iii) Mobility and Proximity Accessibility is supported through the use of assistive technologies, including hearing aids, video relay services, and visual aids, enabling Deaf and hard-of-hearing individuals to navigate educational, professional, and public environments effectively.
- (iv) Light and Color Information is made available through visual cues, subtitles, and other aids to ensure clarity and reduce reliance on auditory input, enhancing participation in various spaces.
- (v) Acoustics Specialized healthcare and rehabilitation services, including audiology and mental health support, are mandated to address communication barriers, while public awareness campaigns and advocacy protect the

rights of the deaf community and encourage their active involvement in policymaking and law enforcement. [8].

3. Methodology

This research adopts a qualitative and comparative methodology, combining literature review, case study analysis, field observations, and user-based surveys and interviews. International and local design guidelines were reviewed to establish theoretical principles, while selected case studies were analyzed to understand their practical application. A primary case study was conducted through on-site observations and stakeholder interactions to assess existing spatial conditions. The collected data were comparatively analyzed and synthesized to derive architectural design considerations responsive to the needs of the deaf community.

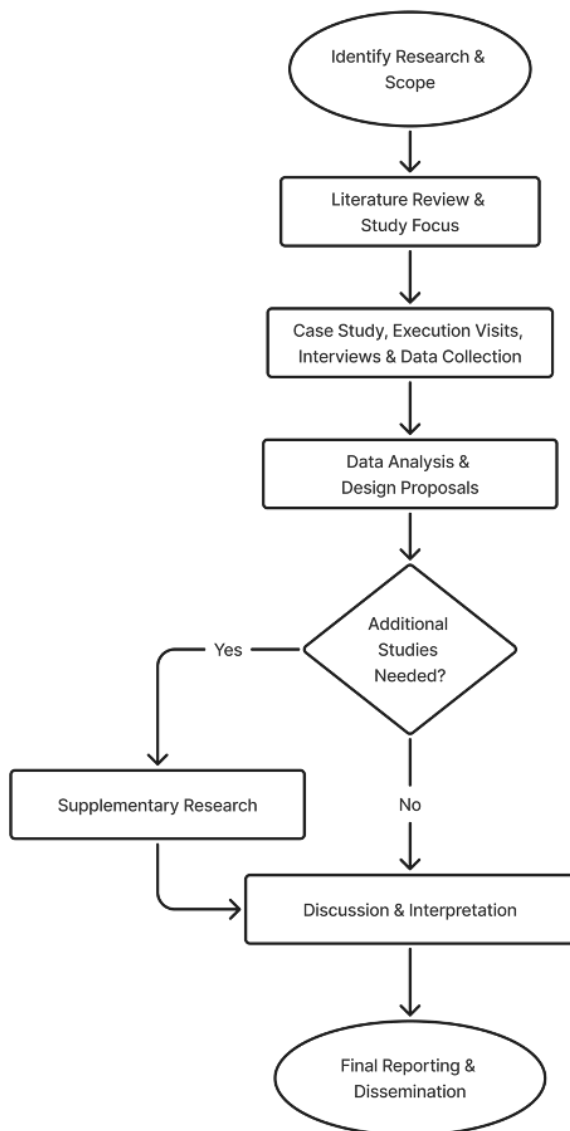


Figure 8. Methodology Flowchart

4. Case Study (Analysis)

4.1 Case study 1: Gallaudet University

Gallaudet University, located in Washington, D.C., is a globally recognized institution dedicated to the education of Deaf and hard-of-hearing individuals and the origin of the Deaf Space design framework. The campus demonstrates a comprehensive integration of spatial planning, visual connectivity, and sensory-oriented design strategies that support communication, interaction, and spatial awareness for Deaf users.

- (i) **Space and Proximity** The campus is designed with wide classrooms, open gathering spaces, and appropriate spatial distances that support clear visual communication and group interaction through sign language.
- (ii) **Sensory Reach** Strong visual connectivity is achieved through open layouts, transparent spatial divisions, and uninterrupted sightlines, allowing users to maintain awareness of surrounding activities.
- (iii) **Mobility and Proximity** Circulation paths are wide, smooth, and often curved, enabling safe movement while maintaining visual communication between individuals.
- (iv) **Light and Colour** Natural and artificial lighting is carefully controlled to reduce glare and enhance visibility of facial expressions and hand movements. Neutral color palettes support visual clarity.
- (v) **Acoustics** Acoustic environments are stabilized using sound-absorbing materials and vibration control, ensuring minimal sensory disturbance.

4.2 Case Study 2: Isinya School for the Deaf

Located in Kajiado County, Kenya, Isinya School for the Deaf provides an important example of a resource-sensitive educational environment designed for Deaf students. The school reflects how spatial design strategies respond to climatic conditions, available materials, and local constraints while still supporting visual communication. Its inclusion offers a contrasting perspective to more developed institutional settings, highlighting practical adaptations, strengths, and limitations in implementing Deaf-friendly architectural principles in a low-resource context.

- (i) **Space and Proximity** Classrooms provide basic functional space with partial openness, allowing limited group interaction but not fully optimized for visual communication.
- (ii) **Sensory Reach** Open courtyards and natural lighting support partial visual awareness, though spatial continuity between areas remains limited.
- (iii) **Mobility and Proximity** Circulation routes are functional

but occasionally narrow or interrupted, limiting seamless visual communication during movement.

- (iv) Light and Colour Abundant natural daylight improves visibility, but lack of control leads to occasional glare and inconsistent visual comfort.
- (v) Acoustics Minimal acoustic interventions are present, with limited control over environmental noise or vibration.

4.3 Case Study 3: Central Secondary School for the Deaf (Nepal)

Located in Naxal, Kathmandu, Nepal, Central Secondary School for the Deaf represents a key local context for understanding the spatial and architectural conditions of Deaf education within the country. The school reflects existing practices shaped by resource limitations, policy frameworks, and user adaptations, offering insight into how Deaf-friendly design principles are interpreted in real settings. It provides a grounded perspective on the challenges and opportunities in creating inclusive, sensory-responsive educational environments in Nepal.

- (i) Space and Proximity U-shaped classroom layouts enhance visual communication and group interaction, though spatial consistency across the campus remains limited.
- (ii) Sensory Reach Transparent elements and open classroom designs improve visual awareness, supporting better spatial orientation for students.
- (iii) Mobility and Proximity Corridors are relatively narrow but improved compared to similar local institutions; movement while signing remains partially supported.
- (iv) Light and Color Dual-sided windows enhance daylight penetration, improving visibility for sign language communication and reducing reliance on artificial lighting.
- (v) Acoustics Informal solutions such as drum-based signaling are used for communication; however, structured acoustic design interventions are absent.

5. Results and Discussion

Field observations in Nepali schools for the Deaf indicate notable gaps in architectural dimensions. Classrooms often have obstructed sightlines and narrow circulation paths, limiting visual communication and safe movement, while common areas provide minimal support for group interactions, reflecting a lack of awareness and resources for effective spatial design. Teachers and administrators explained that government funding constraints prevent investment in visual alarm systems, assistive technologies,

and clear egress pathways. Similarly, perceptible information systems remain largely conceptual, with most facilities relying on auditory cues, which limits accessibility for Deaf students. Accessibility efforts predominantly focus on physical disabilities, while sensory and communication needs of Deaf learners are frequently overlooked.

Despite these challenges, some context-sensitive adaptations have been implemented. Staff noted that dual-sided windows help reduce glare and daylight variation, enhancing Light and Color conditions, while U-shaped classroom layouts improve Space and Proximity and support better Sensory Reach for group communication. Circulation paths with wider corridors and fewer obstacles improve Mobility and Proximity, and visual alarm systems or alternatives like drums for signaling partially address Acoustics.

However, such interventions are inconsistently applied, highlighting the need for structured implementation of low-cost adaptations of ADA standards and Deaf Space principles tailored to Nepali educational settings, guided by direct observation and user insights to enhance safety, communication, and overall learning outcomes for Deaf students.

5.1 Comparative Analysis of International Accessibility Standards

This section presents a comparative analysis of key international accessibility frameworks—ADA Standards for Accessible Design, International Building Code (IBC), and Universal Design principles. The analysis is structured across five key architectural dimensions: Space and Proximity, Sensory Reach, Mobility and Proximity, Light and Color, and Acoustics. The aim is to understand how each framework contributes to the creation of inclusive and Deaf-friendly built environments and what architectural implications they generate in practice.

The analysis shows that ADA and IBC primarily focus on regulatory compliance and functional accessibility, while Universal Design emphasizes inclusive and user-centered spatial experience. However, none fully address the sensory-spatial integration required for Deaf educational environments, particularly in low-resource contexts. This highlights the need for context-adapted design strategies combining global standards with Deaf Space principles.

5.2 Comparative Analysis of National Policies and Guidelines in Regional Context

This section compares regional frameworks: National Building Code (NBC) of India and National Building Code (NBC) of Nepal, to understand how accessibility and inclusive design principles are interpreted at the national level. The analysis focuses on five key architectural dimensions: Space and Proximity, Sensory Reach, Mobility and Proximity, Light and Colour, and Acoustics. The aim is to evaluate how effectively these guidelines support Deaf-friendly spatial design in real

Table 1. Comparative Analysis of International Accessibility Standards

S.N.	Aspect	ADA Standards	IBC	Universal Design Principles
1.	Space and Proximity	—	—	Principles: Equitable use for all. Applications: Designs usable by people of all abilities without segregation.
2.	Sensory Reach	Principles: Visual alarms and notification systems. Applications: Flashing lights for fire alarms; synchronized visual signals. Quantitative: Flash rates of 1–2 Hz; light intensity requirements.	Principles: Ensures visibility of visual alarms throughout spaces. Applications: Placement of visual alarms in corridors and rooms. Quantitative: Maximum spacing of 100 ft for strobes in corridors.	Principles: Perceptible information using multiple modes. Applications: Visual, tactile, and auditory signals for information.
3.	Mobility and Proximity	Principles: Clear accessible routes. Applications: Clear paths for emergency egress. Quantitative: Routes at least 36 inches wide.	Principles: Accessible routes and egress. Applications: : Wide, obstacle-free pathways. Quantitative: 36-inch minimum width; maximum slope of 1:12	Principles: Low physical effort. Applications: Designs that require minimal effort to use.
4.	Light and Color	Principles: Proper lighting for visibility. Applications: No specific color guidelines. Quantitative: Lighting levels to avoid glare.	—	Principles: Perceptible information Applications: Clear and easy-to-understand visual elements.
5.	Acoustics	Principles: Acoustic adjustments in assembly areas. Applications: Assistive listening systems and reduced reverberation.	Principles: Reduced reverberation; proper placement of ALS. Applications: Placement of hearing aid-compatible systems.	Principles: Tolerance for error. Applications: Minimize risks of mistakes due to environmental factors.

built environments.

Regional policies support basic accessibility and inclusive intent, but they remain limited in translating these principles into detailed Deaf-friendly architectural design strategies, highlighting the need for context-specific spatial design frameworks.

5.3 Comparative Analysis of Case Studies on the basis of Use of Design Guidelines in Architectural Design

The implementation of design guidelines across the three-case studies Gallaudet University, Isinya Boarding School for the Deaf, and Central Secondary School for the Deaf demonstrates varying levels of adherence to Deaf-friendly principles. Observations, surveys, and interviews at Central School provide critical insights into the practical application of these guidelines in a resource-constrained Nepali context.

- (i) Space and Proximity: U-shaped classroom layouts for younger students at Central School enhance visual communication and group interaction. Surveys indicate that this arrangement is appreciated by both students and teachers, outperforming Isinya's rectangular layouts in facilitating group signing. Gallaudet University remains the benchmark with strategically planned spaces that maximize visual communication.
- (ii) Sensory Reach: Open sightlines and transparent partitions at Central School allow students to maintain visual awareness of their surroundings, contributing to a sense of safety and connection. Compared to Isinya, where visual access is limited beyond one floor, Central School provides better situational awareness, although Gallaudet University still maintains the widest and most structured sensory reach.

- (iii) Mobility and Proximity: Narrow corridors and staircases at Central School restrict movement, a challenge noted by staff and students. However, compared to Isinya, where sharp corners further obstruct communication, Central School's circulation spaces are relatively better, allowing safer movement while conversing. Gallaudet University's wide, curved corridors exemplify optimal mobility.

- (iv) Light and Color: Classrooms at Central School benefit from dual-sided windows, ensuring ample daylight and reducing reliance on artificial lighting. Teachers noted that this improves visibility during sign language communication, making it more effective than Isinya School, where direct sunlight causes glare and reflections. While Gallaudet University applies optimized daylighting with precise color rendering, Central School demonstrates a practical and context-sensitive approach within its limitations.

- (v) Acoustics: Vibrational cues using drums are a low-cost, innovative solution at Central School, compensating for limited acoustic treatment. While reverberation remains an issue, teachers emphasized that this method is more effective locally than Isinya's insufficient metal stands or ceiling treatments. Gallaudet University still offers the most controlled acoustic environment.

In summary, Central Secondary School for the Deaf demonstrates significant practical adaptations to enhance learning and communication for Deaf students within its resource constraints. Observations and interviews indicate that, in several aspects especially daylighting, sensory reach, and classroom layout Central School performs better

Table 2. Comparative Analysis of National Policies and Guidelines in Regional Context

S.N.	Aspect	NBC India	NBC Nepal
1.	Space and Proximity	—	—
2.	Sensory Reach	Principles: Visual fire alarms in public areas. Applications: Placement of visual alarms and clear signage.	Principles: Inclusive communication strategies. Applications: Use of visual aids and accessible information.
3.	Mobility and Proximity	Principles: Clear accessible routes. Applications: Obstacle-free paths and routes.	Principles: Clear pathways, no obstacles. Applications: Emphasis on obstacle-free walkways.
4.	Light and Color	Principles: Not specifically addressed. Applications: General focus on proper lighting.	Principles: Proper lighting for visual comfort. Applications: Use of soft and diffused lighting.
5.	Acoustics	Principles: Acoustic adjustments. Applications: Compatibility with hearing aids and reduction of background noise.	Principles: Acoustic considerations in building design. Applications: Reducing vibrations and noise interference.

than Isinya School, while Gallaudet University remains the benchmark for comprehensive implementation. These insights highlight the potential for low-cost, locally adapted strategies that align with Deaf Space principles and international accessibility standards.

The analysis shows that national policies in India and Nepal are broadly aligned with international accessibility standards such as ADA, IBC, and Universal Design in promoting inclusive education and basic accessibility. However, these frameworks remain largely policy-oriented rather than design-specific, limiting their translation into detailed Deaf-friendly architectural strategies.

In Nepal, challenges such as limited resources, lack of technical design guidelines, and minimal Deaf-specific architectural integration result in environments that meet basic accessibility needs but fail to fully support visual communication and sensory-oriented spatial experience. This highlights the need for context-responsive architectural approaches that bridge international standards with practical, low-cost design solutions tailored to Deaf educational environments.

6. Conclusion

The research on design guidelines for the hearing-impaired community highlights the importance of creating inclusive and supportive environments that cater to the unique needs of Deaf individuals. By implementing principles from renowned institutions like Gallaudet University and adhering to international standards such as ADA, IBC, and Universal Design principles, we can significantly enhance the quality of education and overall well-being of Deaf students. The case studies of Gallaudet University, Isinya Boarding School for the Deaf, and Central Secondary School for the Deaf provide valuable insights into practical implementations of these guidelines. These examples demonstrate the positive impact of thoughtful design on the social integration, safety, and academic success of Deaf students.

To further enhance inclusivity and accessibility, it is essential

to continue researching and refining design practices to better serve the Deaf community. By prioritizing inclusivity and accessibility in architectural design, we can create environments that empower Deaf individuals to thrive academically, socially, and professionally.

7. Recommendations

The research highlights the importance of Space and Proximity, Sensory Reach, Mobility and Proximity, Light and Color, and Acoustics in creating inclusive educational environments for Deaf students. Strategic spatial planning, such as circular or U-shaped seating arrangements, improves Space and Proximity by enhancing visual interaction and group communication, while optimizing Sensory Reach ensures that students can perceive and respond to visual cues across classrooms and common areas. Clear circulation paths and wider corridors support Mobility and Proximity, enabling safe and efficient movement within the school. Incorporating sound-absorbing materials and minimizing background noise improves Acoustics, while soft, diffused lighting and well-positioned windows optimize Light and Color, supporting concentration and visual clarity for lip-reading and sign language communication. Visual alarms and assistive technologies further enhance accessibility and safety across all areas.

The comparative case studies illustrate practical applications of these design principles. At Gallaudet University, emphasis on Light and Color and Space and Proximity enhances visual communication and engagement. Isinya Boarding School for the Deaf demonstrates effective Sensory Reach through natural lighting and expansive visual access, while Central Secondary School for the Deaf in Nepal applies concentric classroom layouts and dual-sided windows to improve Space and Proximity, Light and Color, and Sensory Reach for better sign language communication. These examples show that integrating inclusive design across all five aspects not only improves learning outcomes but also supports social integration, safety, and overall well-being for Deaf students, demonstrating the value of context-sensitive, thoughtful architectural planning

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References

- [1] Centers for Disease Control and Prevention, "Disability and health overview," [Online], 2024, accessed: Aug. 6, 2026. [Online]. Available: <https://www.cdc.gov/ncbddd/disabilityandhealth/disability.html>
- [2] World Health Organization, "World health organization," [Online], 2024, accessed: Aug. 6, 2026. [Online]. Available: <https://www.who.int/>
- [3] Gallaudet University, "Gallaudet university," [Online], 2024, accessed: Aug. 6, 2026. [Online]. Available: <https://gallaudet.edu/>
- [4] U.S. Department of Justice, "2010 ada standards for accessible design," [Online], 2010, accessed: Aug. 6, 2026. [Online]. Available: <https://www.ada.gov/assets/pdfs/2010-design-standards.pdf>
- [5] UpCodes, "International building code (ibc) 2021," [Online], 2021, accessed: Aug. 6, 2026. [Online]. Available: <https://up.codes/code/international-building-code-ibc-2021>
- [6] H. Bauman, "Deafspace principles," [Online], Rochester Institute of Technology, 2020, accessed: Aug. 6, 2026. [Online]. Available: <https://infoguides.rit.edu/deafspace/principles>
- [7] Bureau of Indian Standards, "National building code of india 2016," [Online], New Delhi, India, 2016, part 3: Development Control Rules and General Building Requirements, Annex B: Access and Facilities for Persons with Disabilities. [Online]. Available: <https://www.bis.gov.in/standards/technical-department/national-building-code/>
- [8] Government of Nepal, "National policy and plan of action on disability," [Online], Kathmandu, Nepal, 2006, accessed: Aug. 6, 2026. [Online]. Available: <https://rcrdnepa.wordpress.com/wp-content/uploads/2008/05/national-policy-and-plan-of-action2006-eng.pdf>
- [9] Listen Technologies, "Assistive listening systems: Ada compliance for the corporate world," [Online], n.d., accessed: Aug. 6, 2026. [Online]. Available: <https://www.listentech.com/assistive-listening-systems-ada-compliance/>
- [10] Edusanjal, "Central secondary school for the deaf," [Online], n.d., accessed: Aug. 6, 2026. [Online]. Available: <https://edusanjal.com/school/central-higher-secondary-schoolfor-the-deaf/>
- [11] Isinya School for the Deaf, "Isinya school for the deaf," [Online], n.d., facebook page. Accessed: Aug. 6, 2026. [Online]. Available: <https://www.facebook.com/people/Isinya-School-for-the-Deaf/61556601955468/>