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The Effect of Environmentally Adaptive Interiors on Visually Impaired Students in the Schools of North-East

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ABSTRACT

This study investigates the effects of climate-responsive interiors on students with visual impairments in schools within the North-East region. It focuses on how customized interior design elements can improve the learning environment and well-being of visually impaired students. By evaluating existing literature and collecting empirical data (includes inputs/contexts from 15 research papers) through observations, interviews and surveys. The research aims to uncover the intricate relationship between adaptive interiors and the academic, social and emotional growth of visually impaired students. The study delves into aspects like spatial arrangement, acoustics, lighting, tactile cues and wayfinding aids. Ultimately, the goal is to provide valuable insights into creating inclusive educational spaces that promote accessibility, independence, inclusivity and engagement for visually impaired students in the schools of North-East.

Keywords: Climate-Responsive Interiors, North East Region, Schools, Visual Impairment, Inclusive Design

INTRODUCTION

In the captivating tapestry of North East India's landscapes and cultures, the educational journey of visually impaired students faces distinct challenges that are intricately woven with the region's climate nuances. The fusion of climate-adaptive interiors with inclusive design principles holds immense potential to not only mitigate the climatic challenges of this unique region but also enhance the learning environment for visually impaired students. This synthesis encompasses an understanding of sensory needs, architectural innovations, and modern technologies, all of which converge to establish an equitable and enriching educational atmosphere. [Almaz, Amira. (2022)].

The North East Indian states boast diverse climates characterized by heavy rainfall, humidity, and temperature variations, impacting the structural integrity of learning spaces. Concurrently, visually impaired students navigate a complex landscape fraught with obstacles that hinder their access to education. To bridge these gaps, a comprehensive approach is required—one that harmonizes architectural design, sensory augmentation, and assistive technology to create spaces that withstand climatic rigor while ensuring seamless navigation and effective engagement for visually impaired learners. [Singh, Manoj & Pahapatra, Sadhan & Sudhir, Atreya. (2008)]

Beyond the physical adaptations lie the critical dimensions of sensory experience and cognitive ease that must be considered for visually impaired students. By infusing environmental adaptability with the tactile and auditory needs of visually impaired individuals, schools can transcend conventional learning space paradigms. From the intricate world of central and binocular vision to the resilience of Braille and large-type readers, this integration envisages an inclusive ecosystem that enriches the education of all students. [Vermeersch, et. al, (2012)]

This exploration into the convergence of climate-responsive interiors and educational inclusivity unveils the potential of design to serve as an equalizer. The subsequent sections delve into the distinctive challenges faced by visually impaired students within the context of North East India's climatic milieu. We will explore the significance of climate-adaptive interior design and propose strategies that amalgamate architectural innovation and sensory consideration, offering a blueprint for learning spaces that nurture growth and learning for all. [Singh, et al. (2008)]

The aspiration of this study is to illuminate a path that binds environmental considerations with the diverse needs of visually impaired students, thereby fostering a holistic learning environment in North East India's schools. By transcending mere compliance and embracing a spirit of proactive inclusivity, educational institutions can lay the foundation for a more empowering and equitable academic journey—one that is attuned to both the region's climatic fluctuations and the unique requirements of visually impaired learners.

1.1 Climate in North-East India:

North East India features three distinct climatic zones, each with its own unique environmental characteristics:

- Warm and Humid Climatic Zone: This zone is marked by high temperatures and substantial humidity levels.
- Cool and Humid Climatic Zone: In this zone, the climate is cooler compared to the warm and humid zone, but humidity levels remain significant.
- Cold and Cloudy Climatic Zone: The third zone experiences colder temperatures and frequent cloud cover.

In each climatic zone, thoughtful design and architectural considerations are essential to ensure that indoor spaces are comfortable, energy-efficient, and well-suited to the specific environmental conditions of North East India (Image 1.1)

1. Warm and Humid Climatic Zone: To optimize comfort in warm and humid areas, situating buildings on the windward side or high points to capture cooling breezes is recommended. Due to the prevailing high humidity, it's prudent to avoid water bodies in the design. Creating ample open spaces to encourage unrestricted airflow and orienting buildings along an east-west axis to minimize solar exposure on surfaces are key. In these lush areas, effective shading through vegetation can be employed. Roofs with low thermal mass, like asbestos cement or tin sheets, need insulation to mitigate rapid heat transfer. Leveraging local materials like cane or bamboo for false ceilings can aid in reducing heat gain. Ventilation is crucial due to humidity, and cross ventilation should be facilitated through well-designed windows and doors equipped with shading devices. The use of smaller windward openings and larger leeward openings promotes natural ventilation, while external overhangs provide shading. Ventilation outlets at higher levels help dissipate hot air, and light pastel shades or whitewashing on walls can enhance the indoor environment. (Image 1.2)

2. Cool and Humid Climatic Zone: In cool and humid regions, optimal ventilation can be achieved by placing structures on windward slopes to capture cool breezes. Open layouts are preferred, with a north-south orientation for buildings, allowing controlled sunlight entry. Tilted roofs are advisable, and mud plastered walls, when protected, contribute to thermal comfort. Window arrangement is crucial to reduce heat gain, with larger windows on the south side and shading devices like chajjas or overhangs for proper light and heat control. Light colors are preferable, especially in overcast regions where the sky itself provides light. (Image 1.2)

3. Cold and Cloudy Climatic Zone: In cold climates, south-facing locations on hills or mountains are advantageous for solar access, while shelter from cold winds can be achieved on the leeward side. Clustering buildings minimizes exposure to cold winds. Compact designs with small surface-to-volume ratios are effective in reducing heat loss. South-facing windows capture direct solar heat, and incorporating solar air collectors for space heating is advisable. Skylights can be employed for natural light and heat, with shading mechanisms to prevent overheating. High thermal capacity walls on the south side can store daytime heat, while cavity walls on the windward side minimize cold exposure. Maximizing window area on the southern side, preferably double-glazed, optimizes solar gains and mitigates heat losses. Dark-colored exteriors aid heat absorption, and prioritizing day lighting enhances occupants' well-being. (Image 1.2) [Singh, et. al.(2008), (2011)]

Image 1.1 Geographical demarcation of North East

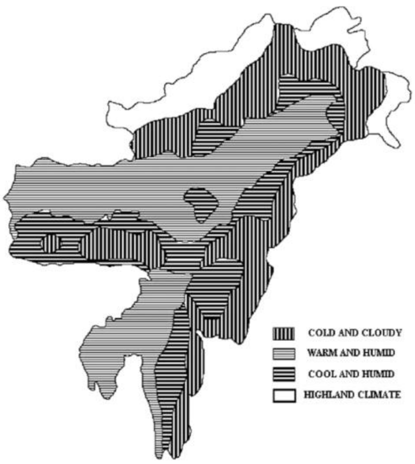

Image 1.2 Climate of North East India

In each climatic zone, thoughtful architectural strategies can significantly enhance comfort and energy efficiency by adapting to the specific challenges posed by the prevailing climate.

1.2 Challenges faced by Visually Impaired Students:

Visual impairment, according to DeMott, encompasses deficiencies in the five main visual functions, namely central vision, visual adaptation, binocular vision, color vision, and optical refraction, resulting from anatomical distortion or disease. The visually impaired population can be categorized into two groups. The first category involves Braille readers, blind individuals who read using their fingertips. The second group comprises those with partial sight who read with their eyes and are referred to as large-type readers. [Almaz, Amira. (2022)]

Disability provides a unique perspective on architecture, challenging conventional models and offering new insights. There are three main approaches to understanding disability: the medical model, the social model, and the cultural model.

The medical model views disability as a physical impairment requiring prosthetic solutions. The social model places disability within the context of a person's interactions with their environment, suggesting that altering the environment can address disabling situations. The cultural model considers disability as a culturally constructed concept that can critique and question existing norms.

Disability challenges established architectural practices and encourages alternative thinking. For instance, when architect Pereira became blind, he questioned the visual bias in architecture and explored multisensory design. An example is his exhibition space at the International Architectural Model Festival in Budapest, featuring a wooden model filled with water, meant for tactile exploration. The water was scented, and sounds of the site were added to engage olfactory and acoustic senses. The space also included textual descriptions in Braille and audio formats, promoting inclusivity. [Hajivalie, et. al (2022)]

1.3 Climate Responsive Interiors:

Bioclimatism is a holistic approach that seeks to align micro-climate conditions with architectural design to ensure optimal human thermal comfort. Meanwhile, vernacular architecture encompasses construction techniques that utilize locally available resources to address specific community needs. The significance of energy-efficient buildings lies in their potential to substantially reduce carbon emissions by more than 60%, equivalent to a staggering 1.35 billion tons of carbon. In the context of warm and humid bioclimatic zones, central factors influencing comfort include elevated humidity levels, copious rainfall, solar radiation intensity, and prevailing wind patterns. Traditional architectural responses in these zones encompass strategies such as the integration of backed brick masonry at the base of structures, transition to wooden walls above, and the implementation of slanting roofs to effectively manage heavy precipitation. The configuration of houses with raised platforms is another adaptation that prevents rainwater from damaging sidewalls.

Additionally, the deployment of intelligently designed slanted roofs, extending as overhangs, serves the dual purpose of safeguarding walls from rainfall and optimizing natural ventilation. Notably, the utilization of surkhi—a mortar blend—emerges as a common practice in this climatic zone, as research indicates that walls ranging from 0.38 m to 0.51 m in thickness, constructed using surkhi, exhibit heat gain or loss time lags ranging from 10 to 15 hours. Furthermore, the implementation of advanced passive design features, such as an air gap within ceilings constructed from layers of bamboo and wood, contributes to improved insulation. Wooden elements also play a pivotal role in windows and doors, offering flexible control over natural ventilation. This is exemplified in the strategic placement of verandas along the east and west sides of structures, as observed in a historic school building from 1863, where vertical wooden structures effectively block afternoon sun rays from entering classrooms. These design strategies, coupled with the prevailing ceiling heights of 4.57m to 5.49m and wall thicknesses of 0.46 m to 0.51m in most houses, foster natural drafts that enhance ventilation. [Singh, et.al (2008)]

1.4 Creating Climate-Responsive Interiors for Visual Impairment:

Architect Pereira's innovative approach to designing climate-responsive interiors takes into account the needs of individuals with visual impairment, ensuring their comfort and inclusion. Here's how this approach is framed:

1. Inclusive Design: Pereira's work exemplifies inclusive design principles, acknowledging the diverse needs of occupants, including those with visual impairments. His interiors prioritize accessibility, ensuring that everyone can navigate and enjoy the spaces comfortably.

2. Multisensory Experience: Pereira recognizes the importance of sensory experiences in interior spaces. For individuals with visual impairments, sensory cues like temperature, texture, and acoustics play a crucial role. By carefully considering these factors, his designs create rich, multisensory environments. (Image 1.4)

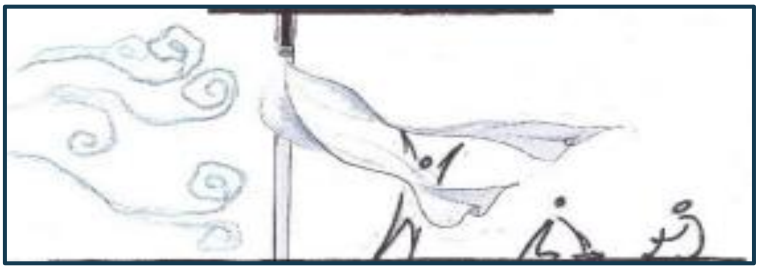

Image 1.3 Experience of airflow (such as the breeze)

3. Tactile Elements: Pereira incorporates tactile elements into his interiors, such as textured surfaces or handrails, to provide orientation and guidance for individuals with visual impairments. These elements not only serve functional purposes but also enhance the overall sensory experience.

4. Climate Responsiveness: Pereira's interiors are climate-responsive, designed to adapt to changing environmental conditions. This includes considerations for temperature regulation, natural ventilation, and daylight optimization. These features contribute to the overall comfort and well-being of all occupants.

5. Sustainability: Pereira's approach aligns with sustainability principles. By optimizing natural resources like daylight and ventilation, his interiors reduce the reliance on artificial systems, promoting energy efficiency and environmental responsibility.

Pereira's climate-responsive interiors are rooted in inclusive design, prioritizing the needs of individuals with visual impairments. These spaces offer a multisensory experience, incorporate tactile elements, and embrace sustainability, ensuring comfort and accessibility for all occupants, regardless of their visual abilities. (Image 1.4) [Vermeersch, Peter-Willem & Heylighen, Ann. (2012)]

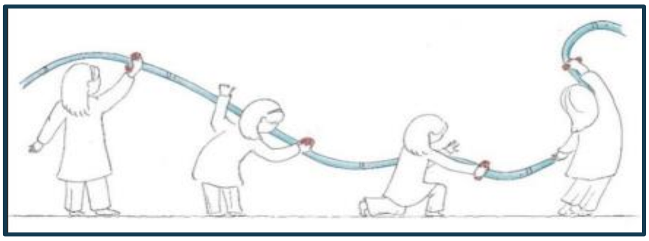

Image 1.4 Using educational aids on a larger scale as part of interactive architecture

1.5 Inclusive Education and Spatial Design

The design of school environments plays a crucial role in nurturing a sense of belonging and self-esteem among visually impaired individuals. Key aspects include movement pathways, openings, doors, flooring, stairs, ramps, furniture, lighting, colors, and acoustics. Incorporating textures into interior design can enhance the sensory experience for the visually impaired. [Vermeersch, Peter-Willem & Heylighen, Ann. (2012)]

Different flooring materials can create textural contrast to aid navigation. Texture on walls can assist in understanding directional spaces. Utilizing varied partitions can help define different areas based on wall and material textures. Design elements such as rhythm in wall panels contribute to improved spatial comprehension.

Creating a conducive environment involves avoiding design elements that can pose challenges for the visually impaired. Spiral staircases and complex passages should be avoided. Anti-slip materials ensure safe movement. Familiar materials aid navigation, while sliding doors and strategically placed lighting units enhance visibility. Elevators can be equipped with speaking devices and specially designed doors. [Mocová, Pavla & Mohelnikova, Jitka. (2021)]

Sound differentiation in various spaces, including water sounds and heating units, provides auditory cues for navigation. Tactile elements, like corrosion-resistant rubber flooring, offer additional sensory guidance. In school settings, ramps should be prioritized over stairs, adhering to specified technical requirements for slope, width, and length. Handrails with Braille text, along with tactile pathways and infrared headphones, facilitate navigation. Acoustic variations within spaces contribute to orientation, while defining spaces using distinct acoustic qualities aids spatial understanding. (Image 1.5, Image 1.6)

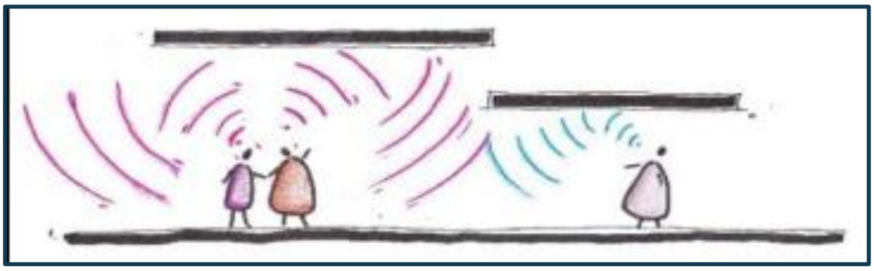

Image 1.5 Different ceiling heights and sound qualities

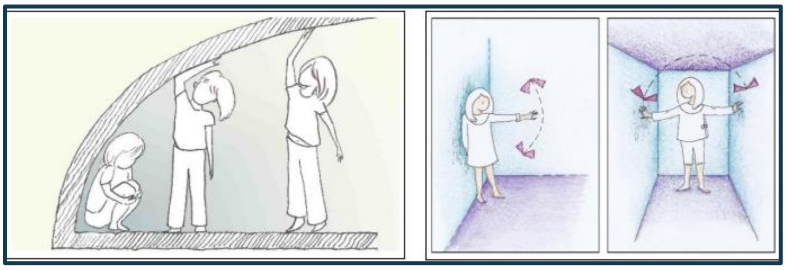

Image 1.6 Ceiling Concept and Children's Space Preference: Comparing Small and Large Areas

Architectural solutions encompass several strategies for enhancing accessibility and functionality within educational spaces for visually impaired and physically challenged individuals. Adjusting area proportions and ceiling heights can contribute to a more accommodating environment. Additionally, introducing sound cues along extended pathways in educational facilities can prevent disorientation among blind children. [Hajivalie, et.al (2022)]

Central to these designs is the concept of a single spine, serving as a cognitive map within educational settings. Innovative units, crafted from materials like ceramics, concrete fibers or epoxy are carefully designed not to obstruct wheelchair or stroller movement. Various methods offer crucial information, such as audio cues, banners, symbols, tactile maps, color contrast, chromatic coding, and landmarks.

Classroom spaces hold particular importance, necessitating larger dimensions to facilitate easy circulation, especially within specialized rooms and proximity to main entrances. These classrooms are thoughtfully divided into sections for individual and group work, fostering an inspiring environment for collaboration. Accommodating group sizes ranging from 8 to 15 children with intermediate needs to smaller groups with more severe requirements, the furniture should be versatile, smooth, and free of sharp edges. It should also adhere to fire safety standards and provide ample space for both students and assistants. Visual contrast, noise reduction, and appropriate coloring are essential design considerations. [Vermeersch, et. al (2012)]

Outdoor flooring materials like gravel mixed with cement are preferred, ensuring easy movement without causing skidding. Sand, asphalt, and gravel should be avoided in outdoor areas to prevent hindrance to strollers and wheelchairs. (Image 1.7)

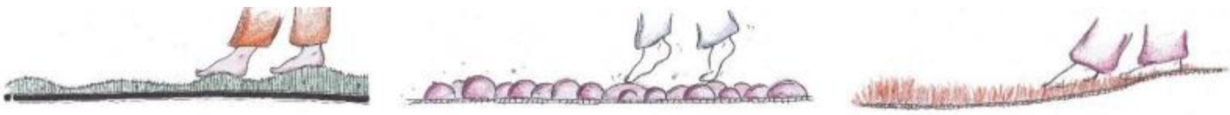

Image 1.7 Enhancing a child's sensory stimulation by incorporating a combination of artificial and natural flooring materials.

Equipping walls with hand supports at specified heights, (Image 1.8) along with protective bumpers, contributes to safety and assistance. Contrasting colors, distinct fabric, and clear indicators enhance visibility and orientation. In summary, these architectural adaptations prioritize inclusivity and functionality, creating an environment where all students can thrive. [Mocová, et. al (2021)]

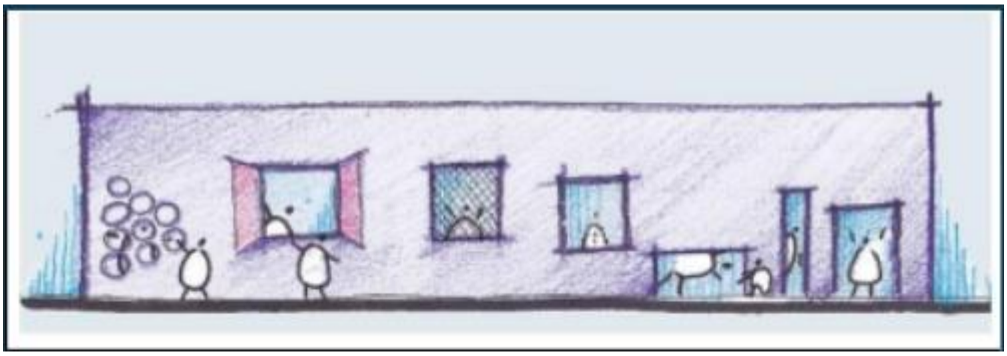

Image 1.8 Children's interaction with different types of openings

2. Case Study and Optimal Approaches

A study examined indoor air quality in a school classroom before and after renovation, focusing on CO2 levels and microbial testing. Here's a concise summary:

- ***Ventilation Guidelines:*** Emphasized the need to balance fresh air and energy efficiency, favoring natural ventilation.
- ***CO2 Levels:*** Specified recommended CO2 levels based on outdoor air supply rates, with 1500 ppm as the upper limit for natural ventilation.
- ***Measurement Tools:*** Employed TESTO 535 for CO2 levels and TESTO 645 for outdoor temperature and humidity.
- ***Renovation Impact:*** Surprisingly, renovated classrooms had higher CO2 levels due to sealed windows, limiting air exchange.
- ***Ventilation Solution:*** Proposed practical installation of local heat recovery units in classrooms for improved air quality.
- ***Microbial Testing:*** Found acceptable indoor air quality in the renovated school, with tolerable fungal growth in the former classroom.
- ***Overall Air Quality:*** Acknowledged the impact of construction, occupancy, ventilation, and cleanliness on indoor air quality.
- ***Shading Strategy:*** Recommended optimized shading using automatic systems to manage solar gains. [Mocová, et. al, (2021)]

In summary, the study underscores the importance of effective ventilation, especially in renovated spaces with sealed windows, for maintaining school indoor air quality. It also highlights the significance of microbial testing and shading strategies in creating a comfortable and healthy indoor environment.

2.1 Sensory Enhancement Through Architecture

1. Vision: Approximately 80% of visually impaired individuals can distinguish light, shadow, and darkness. Design factors include adjustable lighting, avoiding glare, using appropriate colors, sizes, shapes, and arrangements of objects for orientation, and creating contrasts to help with object perception.

2. Hearing: Sound is crucial for perceiving the environment, as it conveys information about activities, directions, and object characteristics. Acoustic qualities, such as surfaces' materials and shapes, aid in environment identification and orientation.

3. Touch: Information gathered through touch is slower to process than vision or hearing. Tactile design, including changing surface materials, defining edges, and incorporating prominent textures, enhances the environment's richness and perception for visually impaired individuals.
4. Smell: Smells from various materials and environments can help visually impaired individuals identify their surroundings and orientation. [Vermeersch, et. al (2012)]

3. Results and Discussion

3.1 Design considerations for visually impaired children :

- Incorporate children's perceptual tools (senses) in design to engage them in the environment perception process and strengthen their abilities.
- Consider an educational approach to environment design, including addressing special learning needs, matching the environment to the learning subject, and integrating educational concepts into design.
- Facilitate children's independent use of the environment, taking into account their needs and difficulties.
- Provide constant and clear clues in different parts of learning environments to convey information, quality, and potential hazards.
- Create a sense of security by keeping the environment familiar, stable, and predictable.
- Design flexible furniture to accommodate individual and group activities.
- Make the learning environment attractive by considering the children's interests.

Create opportunities for different experiences in a safe and controlled environment, such as incorporating building elements and interaction with nature.

3.2 Design Considerations for Accessibility and Visual Impairment:

Designing spaces with accessibility for visually impaired individuals in mind requires careful attention to various elements. Here's a concise summary of key design considerations:
1. Tactile Guidance: Install tactile guidance elements at the top and bottom of stairs, ensuring they run parallel to the steps. These elements, such as fabric, help individuals with visual impairments navigate safely.
2. Contrasting Edges: Add contrasting tape or colors to the edges of steps to provide a visual indication of each step's location, enhancing safety and awareness.
3. Railings: Install easily accessible railings on both sides of staircases, even if local codes require them on only one side. This provides additional support and guidance.
4. Flooring Materials: Choose non-slip materials like vinyl, leather, epoxy, or parquet for floors to prevent accidents.
5. Color Considerations: Be mindful of color choices. Some individuals may have color blindness, particularly with red and green. Consider using dim, soothing pastel colors.
6. Lighting: Design lighting to avoid glare, shadows, and visual conflicts. Use dark curtains to control sunlight and provide privacy. Opt for low-glare, LED lighting to simulate daylight, ensuring homogeneous, efficient, and long-lasting illumination.
7. Sound Control: Use materials that absorb sound for ceilings and floors to create an environment with optimal sound quality. Avoid echoing spaces and consider adding audio signals in critical areas, such as intersections, to enhance safety.

***8. Orientation*:** Design spaces with clear orientations. Consider incorporating tactile and sensory cues, like using wood for touch and sound differentiation, to help individuals recognize their surroundings.
In summary, creating accessible and visually impaired-friendly spaces involves thoughtful design choices in materials, colors, lighting, and sensory cues to ensure safety, comfort, and inclusivity for all users.

4. Future Implications

The table below illustrates prospective benefits of a meticulously designed school for visually impaired children.It highlights the positive impact on their learning and overall well being.

Aspect	**Challenges & Considerations**	**Design Integration**	**Benefits**
Ladder Safety & Accessibility	Use of ladder fabric from top and bottom for tactile feedback.	Integration of high lines indicating stumbling possibilities for guidance.	Monitoring fabric by blind individuals for safety and alignment.
	Parallel lines on steps for alignment and avoiding missteps.	Tight tape or warnings on step edges for added safety.	Contrast in colors to determine step edges for better visibility.
	Implementation of contrasting colors for step edges to aid perception.	Airtight bars as a contrast to the step color for tactile feedback.	Provision of railings in stairwells for added safety and support.
Flooring Materials	Selection of optimal stair materials like Vinyl, leather floors, Epoxy, Parquet.	Choice of materials that offer slip resistance and traction for safety.	Ensuring safe and slip-resistant stair surfaces for all users.
Color Considerations	Use of dim pastel colors to create a soothing and visually comfortable environment.	Designing interiors with dim pastel color schemes for comfort.	Reducing visual stress and fatigue, promoting a calming atmosphere.
Design Lighting	Avoidance of glare and shadows to enhance visual comfort.	Minimizing glare and shadows in lighting design for a pleasant atmosphere.	Creating a comfortable, glare-free learning environment.
	Use of curtains for	Implementation of	Providing privacy in

	privacy and light control in various spaces.	curtains for privacy and management of light.	learning spaces and controlling daylight.
		Utilizing LED lamps that simulate daylight for natural illumination.	Simulating daylight for a more comfortable and productive environment.
Sound & Acoustic Design	Reduction of noise through double glass windows for a quieter atmosphere.	Designing spaces to minimize echoes and enhance sound quality.	Creating a quieter and more focused learning environment.
	Minimization of echoes in spaces to improve auditory clarity.	Incorporating absorbent surfaces for optimal sound quality.	Enhancing auditory information and reducing sound distractions.
Orientation & Sensory Design	Establishment of clear orientation axes for ease of navigation.	Creation of spaces with clear orientation axes for straightforward navigation.	Facilitating intuitive and effortless navigation for all users.
	Utilization of wood's sound-absorbing properties for acoustic comfort.	Using wood in design for its sound-absorbing qualities and improved acoustics.	Improving sound quality within interiors and reducing noise.
Information Conveyance	Provision of audio information through banners, symbols, and announcements.	Implementation of tactile indicators on maps and surfaces for wayfinding.	Ensuring accessible information for visually impaired individuals.
	Use of maps and tactile indicators to guide and convey information.		

CONCLUSION

In the diverse landscape and cultures of North East India, visually impaired students encounter unique educational challenges intertwined with the region's climate complexities. To address these challenges, a holistic approach is needed, blending climate-adaptive interiors with inclusive design principles, sensory considerations, and modern technologies.

The region's climate, marked by heavy rainfall, humidity, and temperature variations, affects learning spaces. Simultaneously, visually impaired students face obstacles in accessing education. To bridge these gaps, architects must harmonize design, sensory augmentation, and technology to create resilient and accessible learning environments.

Beyond physical adaptations, the sensory and cognitive needs of visually impaired students must be addressed. Integrating environmental adaptability with tactile and auditory requirements can revolutionize traditional learning spaces. This approach envisions an inclusive ecosystem, enriching education for all students.

This exploration highlights the potential of design as an equalizer, focusing on the challenges faced by visually impaired students in North East India's climatic context. It proposes strategies that combine architectural innovation and sensory considerations to create inclusive learning spaces. The goal is to pave the way for an empowering and equitable academic journey tailored to both the region's climate and the needs of visually impaired learners.

REFERENCES:

1. Almaz, Amira. (2022). The impact of sensory perception on interior architecture standards for visually impaired and blind students in educational facilities. Information Design Journal. 12. 263-273.
2. Singh, Manoj & Pahapatra, Sadhan & Sudhir, Atreya. (2008). Climate-responsive Building Design in North-East India.
3. Vermeersch, Peter-Willem & Heylighen, Ann. (2012). Blindness and multi-sensoriality in architecture. The case of Carlos Mourão Pereira..
4. Singh, Manoj & Mahapatra, Sadhan & Sudhir, Atreya. (2011). Solar passive features in vernacular architecture of North-East India. Solar Energy. 85. 2011-2022. 10.1016/j.solener.2011.05.009.
5. Hajivalie, Maryam, Eisa Hojjat, and Mohammad Farziyan. "Introducing Several Approaches to Upgrade the Interior of Visually Impaired Children’s Preschool Focusing on Effective Communication. Case Study: Narjes Girls’ Blind Pre-school." *Journal of Engineering* 10.1 (2022): 14-3
6. Ahmer, C. (2014). Making Architecture Visible to the Visually Impaired. In H. Caltenco, P. Hedvall, A. Larsson, K. Rassmus-Gröhn, B. Rydeman (eds.), Universal Design: Volume 35. Three Days of Creativity and Diversity (pp. 204 – 213). doi:10.3233/978-1-61499-403-9-204
7. Preiser, Wolfgang. (2008). Universal Design: From Policy to Assessment Research and Practice. Archnet-IJAR : International Journal of Architectural Research. 2. 10.26687/archnet-ijar.v2i2.234.
8. Singh MK. Mahapatra S. Atreya SK. Sustainability through Bioclimatic Building Design in North-East India. 3rd International Solar Energy Society Conference, Asia Pacific Region; 46th ANZSES Annual conference (ISES-AP 2008), Sydney, Australia, 25-28 November 2008
9. Brager, GS. Dear de RJ. (1998) Thermal adaptation in the built environment: a literature review. Energy & Buildings 1998; 27(1): 83-96. [5] Kua HW.
10. Lee SE. Demonstration of intelligent building – a methodology for the promotion of total sustainability in the built environment. Building and Environment 2002; 37(3):231-240.
11. Singh MK. Mahapatra S. Atreya SK. Bioclimatism and Vernacular Architecture of North-East India. Building & Environment (2008) (http://dx.doi.org/10.1016/j.buildenv.2008.06.008)
12. Sayigh A. Introduction. Renewable and Sustainable Energy Reviews. 1998: 2(1-2): 1-2.

13. Manual on Solar Passive Architecture. First Edition: Solar Energy Centre, Ministry of New and Renewable Energy Sources, Government of India, New Delhi. Project No. 3/5(02)/99-SEC, December 1999.
14. Plemenka S. Vernacular architecture: a lesson of the past for the future. Energy and Buildings 1982; 5(1):43–54.
15. Mocová, Pavla & Mohelnikova, Jitka. (2021). Indoor Climate Performance in a Renovated School Building. Energies. 14. 2827. 10.3390/en14102827.