MAKERERE UNIVERSITY

COLLEGE OF ENGINEERING, DESIGN, ART AND

TECHNOLOGY.

SCHOOL OF BUILT ENVIRONMENT

DEPARTMENT OF ARCHITECTURE AND URBAN PLANNING

AN EVALUATION OF THE SUITABILITY OF PRIMARY SCHOOLS FOR THE HEARING IMPAIRED. A CASE STUDY OF UGANDA SCHOOL FOR THE DEAF, NTINDA-KAMPALA.

BY

KAYONDO ALEX

15/U/6846/PS

SUPEVISOR: ARCH. JESSE TUKACUNGURWA

A DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF BACHELOR OF ARCHITECTURE, MAKERERE UNIVERSITY

SEPTEMBER 2021

DECLARATION

I Kayondo Alex, hereby declare to the best of my knowledge that this study is original and has not been submitted for any other degree award to any other University before.

AUTHOR:

KAYONDO ALEX

Signed: .....

Date: .....16/08/2021.....

This dissertation has been submitted for examination with the approval of the following supervisor,

SUPERVISOR:

ARCH. JESSE TUKACUNGURWA

Lecturer, Department of Architecture and Physical Planning

Makerere University

Signed: .....

Date: 11/05/2022

DEDICATION

This dissertation is dedicated to God the almighty for giving me the courage to undertake this research.

Dedication of this report also goes to my father, Mr. Jjuuko Stephen, my siblings, relatives and friends for their prayers and support in these trying days when the education system in Uganda has been affected by the COVID 19 pandemic.

ACKNOWLEDGEMENT

I thank the almighty God for giving me life, courage and the strength to push on during these trying days of the COVID 19 pandemic.

My sincere gratitude goes to my supervisor Arch. Jesse Tukacungurwa for his continued guidance and advice throughout the development of this report.

I also wish to extend my gratitude to administration of Ntinda school for the deaf for their tireless support and contribution towards the successful completion of this research.

Special thanks also goes to the management and staff of Uganda National Association for the Deaf (UNAD) who provided rich information for the research.

In a special way I would like to thank Kampala Capital City Authority (KCCA) Directorate of Education and social services for giving me the permission to conduct the research in Ntinda school for the deaf.

A final thanks to my family, relatives, classmates and friends who always encouraged me. I am grateful for the love and support.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS

WHO – World Health Organisation

USL – Uganda Sign Language

UNAD – Uganda National Association for the Deaf

DSDGs – DeafSpace Design Guidelines

ACT- Acoustic Ceiling Tiles

UNCR- Uganda National convention on the Rights of Children

KCCA – Kampala Capital City Authority

ABSTRACT

Hearing impairment is one of the neglected and rather hidden disabilities suffered by over 5% of the world population (360 million people) of whom 32 million are children. In Uganda, the hearing impaired make up close to 3.4% of the total population (about 1.5 million people) and according to Uganda National Association for the deaf, approximately 95% of the adult persons have never been to school.

"We build buildings for people we must know who and what those people are. "(Berenson 1968)

The hearing impaired inhabit a rich sensory world where vision and touch are primary means of spatial awareness and orientation. The group of people uses sign language and when they congregate together they tend to alter the space to fit their unique way of being. This is the first proof of the hearing impaired existence and their unique architecture way.

Some people involved in the education of the hearing impaired are justifiably concerned with what happens in the school or the institution every day and they disregard the unique sensibility of the physical environment in which the hearing impaired live.

I think architecture are people and it should not be forgotten by architects and other people involved in a constant changing physical world. It is therefore appropriate for designers and professionals to find the appropriate and relevant physical environment in which learning for the hearing impaired takes place.

This report focused on investigating the appropriateness of the design of primary schools for the hearing impaired in Uganda taking a case study of Ntinda school for the deaf by reviewing available literature on the subject matter, making observations, use of photography, sketches, having interviews with doctors and teachers of the hearing impaired. The research went ahead to find out why the schools are not appropriate for the hearing impaired and why designers have not embraced deaf friendly design, it also gave some recommendations on what should be done to make the schools suitable for the deaf.

DEFINITION OF KEY TERMS USED.

This dissertation defines the following key concepts used in the study.

Deaf: This is a community of people with varying degrees of hearing levels i.e. profound, severe, moderate, mild and those who use assistive listening devices such as hearing aids and cochlear implants (WHO 2020).

Deaf culture: Deaf culture are a set of learned behaviors and perceptions that shape the values and norms of hearing impaired people based on their shared or common experiences. (Warman 2012).

Deaf community: The deaf community is made up of both hearing and hearing impaired individuals with varying degrees of hearing loss. These hearing individuals may be siblings of the hearing impaired individuals, USL interpreters, spouses, friends etc. that interact with the greater deaf individuals. (Hauan 2017).

Deaf space: It is a set of principles providing understanding of the perceptions and special needs of the hearing impaired (Tsymbal 2010). Deaf space therefore analyses the principles needed when designing an environment for the deaf.

Audition: Audition is the power of hearing or listening.

Auditory channels: Auditory channels are forms of assistive listening devices such as hearing aids and cochlear implants.

Ocularcentrism: A term used to describe a relative state of the senses in a society where visual information is given priority.

Signers: People who acquire and use sign language as a primary means of communication.

1.0 CHAPTER ONE: INTRODUCTION

1.1 Introduction

Hearing impairment is one of the neglected and rather hidden disabilities suffered by over 5% of the world population (360 million people) of whom 32 million are children and the World Health Organization (WHO) further estimates that by 2050, over 900 million people will be having hearing loss (WHO 2020). In Uganda, the hearing impaired make up close to 3.4% of the total population (about 1.5 million people) and about 0.2% are adults aged between 18years above, 0.6% and 1.1% are children aged 2-4years and 5-17 years respectively. (Ministry of Gender, Labor and social development 2019).

Hearing impairment is the degree of hearing loss, from mild to profound, including those who are deaf and those who are hard of hearing. The hearing impaired inhabit a rich sensory world where vision and touch are a primary means of spatial awareness and orientation. To communicate with others, the hearing impaired use sign language, which involves movement of hands in a different directions and patterns to make a conversation, they also use lip reading in communication, which involves understanding the movement of the neighbor's lips.

Worldwide, learning is an important stage in life for everyone and in Uganda the Right to Education is guaranteed under Article 30 of the Constitution of the Republic of Uganda, that states that all persons have a right to Education. According to the Uganda Ministry of Education, Science, Technology and Sports, there are over 47,024 hearing impaired students in Primary one to Seven.

Over the recent years, education has improved for hearing impaired children in Uganda, the majority are now in schools for the hearing impaired with qualified teachers in special needs education located in different parts of Uganda. Learning is the central activity in schools and sometimes it occurs in classrooms (formal learning) and other times it results from serendipitous interaction among individuals (informal learning). Space whether physical of virtual can have an impact on learning, it can bring people together, encourage exploration, collaboration and discussion. Therefore, more and more often the way we shape the built environment has the ability to define how learners behave in schools. (Oblinger and Lippincott 2006)

The hearing impaired use space and the built environment in a unique way because of their unique way of life. In Uganda, schools are some of the best avenues where the hearing impaired collectively live, however the standards of the schools is highly questionable.

It is for this reason that this research comes forward to look at the suitability of these schools and how they suite the hearing impaired.

1.2 Problem statement

Our built environment presents a variety of surprising challenges for the people with hearing loss and there is need to find an appropriate physical environment in which learning for the hearing impaired takes place which will indeed catalyze, reinforce and stimulate learning.
In Uganda, the current schools for the hearing impaired mainly focus on the general learning activities and tends to disregard the unique environment and space in which of the hearing impaired live.

1.3 General objective

The main objective of the study is to assess the appropriateness of the existing architectural design of schools for the hearing impaired in Uganda taking a case of Ntinda school for the deaf.

1.3.1 Specific objectives

1. To explore the unique challenges and opportunities associated with the hearing impaired in a learning environment.
2. To explore architectural design strategies put in place in a learning environment for the hearing impaired.
3. To explore ways on how to improve the existing schools of the deaf.

1.4 Research questions

1. What are the unique challenges associated with the hearing impaired persons within the learning environment?
2. What are some of the design strategies that have been put in place to cater for the hearing impaired and what is lacking?
3. What are some of the ways to improve the existing schools for the deaf?

1.5 Significance

Over 5% of the world population (360 million people) have hearing loss of whom 32 million are children and the World Health Organization (WHO) further estimates that by 2050, over 900 million people will be having hearing loss (WHO 2020).

In Uganda, the hearing impaired make up close to 3.4% of the total population (about 1.5 million people) and about 0.2% are adults aged between 18years above, 0.6% and 1.1% are children aged 2-4years and 5-17 years respectively (Ministry of Gender, Labor and social development 2019). The statistics therefore show a high prevalence of hearing loss among ages 2-17 years of which this age is entirely spent in school. According to Uganda National Association of the Deaf (UNAD) approximately 95% of the adults in Uganda living with hearing loss have never been to school (UNAD) creating a deficiency of education among the hearing impaired.

In Uganda the hearing impaired can either learn from special needs schools or inclusive schools and according to Uganda National Association of the Deaf (UNAD) the country has only 6 special needs schools and 28 inclusive schools where the hearing impaired can enroll.

The aim of the schools is to provide planned and systematically monitored arrangement of teaching periods, adopted equipment and materials, accessible settings and other interventions designed to help learners with special needs to achieve a higher level of personnel self-sufficiency and success in the community (UNAD).

The hearing impaired use space and the built environment in a unique way because of their unique way of life. Therefore, as the schools aims to provide special education for persons with hearing loss, there is urgent need to provide an appropriate physical environment in which learning for the hearing impaired takes place.

1.6 Scope of research

1.6.1 Contextual scope

The research is limited to primary schools for the hearing impaired in Uganda and to be specific the research will be carried out in Uganda school for the deaf, Ntinda. The selected study is located in Ntinda at plot 18 Ntinda road, 5 kilometers from Kampala city.

Figure 1: Image showing the location of Ntinda school for the deaf.

1.6.2 Content Scope

The research is focused and limits itself to the physical environment in which learning for the hearing impaired children takes place. A physical environment is where individuals live, work and play, it can also be described as anything we can physically experience through our senses - touch, smell, sight and taste. The physical environment therefore includes both natural environment and human man environment

Under understanding the physical environment, aspects of spatial composition, acoustics, materials, light and color, mobility & proximity and sensory reach were identified as the focus for the content of this study.

1.6.2.1 Justification of selected scope

The study is limited to Uganda school of the deaf, Ntinda because it is the first and biggest school of the deaf in Uganda and it will be limited to specialized schools meant for the hearing impaired because these schools are collective avenues of the hearing impaired from all regions of the country through which their culture is most experienced.

The research is limited to primary schools because primary school is the foundation from which a child starts to understand their culture and values. Therefore, if deaf friendly design is to part of a child's experience, it should start at the early stages of life.

1.7 Justification

In Uganda the current schools for the hearing impaired mainly focus on the general learning activities and tends to disregard the unique environment in which they live. There is very little knowledge about the role architecture can play in defining the behaviors of learners especially those with special needs such as the hearing impaired. This research is aimed at raising consciousness for the need to appropriately design for the hearing impaired with in their learning environment. Therefore, knowledge related to design strategies for the hearing impaired is needed for a better integration into the built environment. This knowledge will be of great importance to architects, designers and other individuals in achieving the well-being of the hearing impaired.

.

2.0 LITERATURE REVIEW

2.1 Introduction

This section looks at literature review that is used to formulate criteria for review of the selected case study. It also entails what other researchers have written in relation to the topic and relevant theories and concepts in the present research are examined and discussed.

2.2 Deaf

This is a community of people with varying degrees of hearing levels i.e. profound, severe, moderate, mild and those who use assistive listening devices such as hearing aids and cochlear implants. For the case of this research when referring to Deaf, with an uppercase "D" in the word Deaf, it is used to mean someone within the hearing impaired community and when a lower case 'd' it is used to refer to deaf as a medical condition of hearing loss. This an important distinction to note because someone can be hearing impaired but identified in the hearing culture. This is more common with individuals who may have hearing loss later in life and have become deaf after acquiring English as their first language (Hauan 2017).

2.2.1 Deaf culture

Deaf culture are a set of learned behaviors and perceptions that shape the values and norms of hearing impaired people based on their shared or common experiences. (Warman 2012). Deaf culture therefore shares traditions, values, beliefs, attitudes and a language. In Uganda, the Uganda Sign Language (USL) remains the means of communication among hearing impaired individuals. Understanding the Uganda sign language plays a role in shaping and organizing the deaf community and is essential to discern the culture and spatial Organizations.

2.2.2 Deaf community

The deaf community is made up of both hearing and hearing impaired individuals with varying degrees of hearing loss. These hearing individuals may be siblings of the hearing impaired individuals, USL interpreters, spouses, friends etc. that interact with the greater deaf individuals. (Hauan 2017).

2.2.3 Hearing impairment, Hard of hearing and being Deaf.

Hearing impairment in its broadest meaning includes all degrees of hearing loss from slight to profound and is generally viewed as a disease or a disability. A person who is not able to hear with hearing thresholds of 20 dB or better in both ears is said to have hearing loss. Hearing loss

may be mild, moderate, severe, or profound. It can affect one ear or both ears, and leads to difficulty in hearing conversational speech or loud sounds (WHO 2021).

Deaf and hard of hearing are difficult to define because they simply refer to degrees of hearing loss. There are four clinically labeled degrees of hearing loss i.e. mild, moderate, profound and severe as explained in the diagram below.

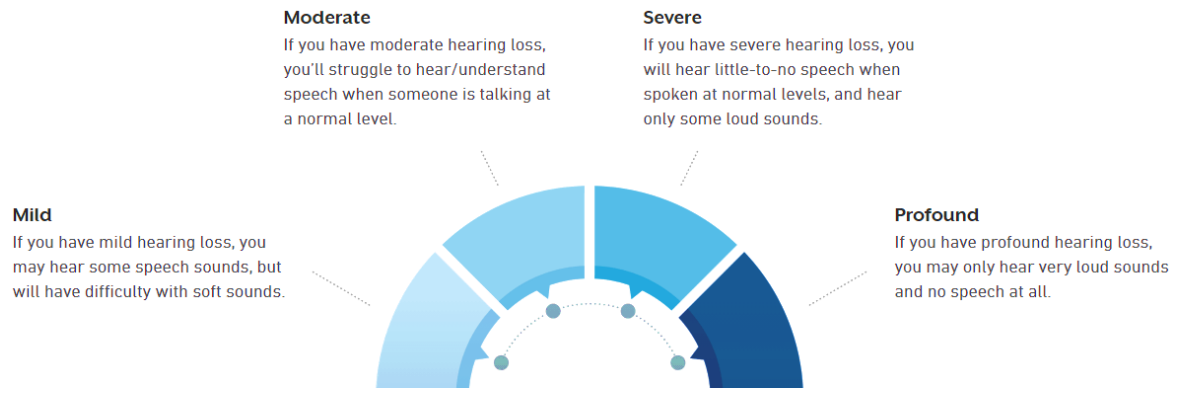


Figure 2: Image shows the degrees of hearing loss. (Source:Starkey.com)

For many individuals with hearing loss, the term "Deaf" and "hard of hearing" do not only connote levels of hearing loss but are associated with culture and identity. (Farmer, Donders et al. 2006),

'Hearing loss' refers to a reduction in the functional aspects of audition. These are people with hearing loss ranging from mild to severe. People who are hard of hearing usually communicate through spoken language and can benefit from hearing aids, cochlear implants, and other assistive devices (WHO 2021).

'**deaf** 'refers to hearing loss sufficient to prevent access to or reliance upon auditory channels for understanding speech. These people mostly have profound hearing loss, which implies very little or no hearing. They often use sign language for communication (WHO 2021).

'**Hard of hearing'** refers to a more modest hearing loss that allows for auditory input.

'Deaf' refers to a cultural identification of oneself with the deaf community. (Farmer, Donders et al. 2006).

2.2.3.1 The hearing impaired and their experience

Culturally the hearing impaired (mostly individuals with severe to profound hearing loss) is a natural condition and is often accompanied by the use of sign language. Most individuals with severe to profound hearing loss are referred to as deaf and they usually have very little or no functional hearing. Fernandas (2006, p3) tells us that the use of sign language by the deaf is a specific relationship between his /her surroundings and it creates a different way of being and learning. Deaf individuals view themselves as members of a linguistic cultural minority that shares traditions, values, beliefs, attitudes and a language. Therefore, the deaf belong to a culture known as the Deaf culture.

The Deaf culture is one of or not the only people with a culture and a language that does not have a building vernacular. Architecture has not yet responded to the needs of the deaf in a meaningful way, being deaf for many individuals isn't just a loss of sense as it is the identity marker of a profound culture. Architecture provides unique opportunity to embody values and to be shaped by people who inhabit it. Deaf populations tend to populate around access to education. In establishing a vernacular for deaf architecture, schools are the best to start with. Winston Churchill stated "we shape our buildings therefore they shape us ". Therefore, in exploring the needs and desires of the deaf community, a new type of architecture can emerge that does not simply accommodate deaf individuals but puts deaf needs first (Hauan 2017).

2.2.3.2 What does it mean to be hearing impaired.

What if it is Vision on which you depend? For hearing impaired people or people who are hard of hearing, this is the case. They have been brought up in a world in which they have to utilize all the remaining senses, of which vision is their primary. How now is it fair to neglect the sensory impaired, not just in architecture but within society (Warman 2012)?

Our five senses work in concert with one another such that the loss of one is compensated by increased sensitivity in the remaining four. Yes, hearing impaired individuals are able to utilize the remaining senses, and to a higher degree than that of the hearing individuals but it is the sense of vision on which the hearing impaired rely and so vision in their case remains the bias as it does, arguably so, even for the hearing individuals (Warman 2012).

The hearing impaired individuals' remaining four senses are therefore heightened above that of an average hearing person, their peripheral vision increases and it is the sense of vision that is able to relay their remaining senses. In conclusion vision plays a fundamental role in individuals with hearing loss because through sight, information about their world is collected.

2.2.3.3 The hearing impaired and their Architecture

The hearing impaired persons inhabit a rich sensory world where vision and touch are the primary means of spatial awareness and orientation. When the hearing impaired congregate they tend to alter space to their unique way of being and this is the first proof of their unique architecture. A concept of design known as 'Deaf space' has been developed by scholars which is meant to offer a new voice to the unique architecture for the hearing impaired by exploiting the ultimate experience surrounding Architecture and the senses.

2.2.4 Deaf space

Deaf Space is an architectural concept tailored to the hearing impaired experience in space. Buildings, hallways, and other spatial arrangements are designed to their way of seeing and being in their environment, Deaf Space is therefore a space where the hearing impaired individuals modify an environment to meet their specific needs (Johnson 2010).

The Deaf and hard of hearing share a lot of common experiences and when they enter a space, they change the seating in a room into a circular pattern so they can see each other better as they communicate with Sign Language, they adjust lighting and move objects or furniture so that their line of vision is unobstructed (Johnson 2010).

The concept Deaf Space is simply created by the modifications to the physical environment by the hearing impaired individuals. Deaf spaces are characterized as so dynamic with hands moving, signing and waving, uniting is a common shared experience in these spaces. However Deaf spaces are not just for the hearing impaired people but also for anyone in the hearing community who support deaf needs for example teachers and parents of the hearing impaired. Deaf space could be a space where the needs of the hearing impaired are well catered for to create a comfortable environment. Under the concept of Deaf Space, Deaf Space Design Guidelines (DSDGs) have been developed.

2.2.4.1 Deaf Space Architectural Design Guidelines.

Architecture for the hearing impaired has the opportunity to respond to a meaningful way. The idea of Deaf space is to ensure that it does not have a negative impact on its occupants. Under the concept of 'Deaf space' Deaf Space Design Guidelines have been developed. The guidelines are centered around five categories which are sensory reach, Mobility and proximity, Light and color, space and proximity and Acoustics & vibration (Bauman 2004).

2.3 Sensory reach

The hearing impaired have been brought up in a world in which they have to utilize all the remaining senses, of which vision is their primary. They have ability to take in a wider field of vision and it plays a fundamental role in their daily life because through sight, information about the visible world is collected. Therefore, an effective deaf space requires that a person relies on vision adequately (Johnson 2010).

The concept of Sensory reach relies on the capability of the visually centered children[1] to observe their surroundings with ease and clarity and the ability to see movements and facial expression of others is important. The concept introduces unique spatial ideas through an acute sense of visual and tactile cues such as movement of shadows, vibrations or even reading subtle shifts in the positions of others around them.

Spatial awareness of activities within the surroundings is essential in maintaining a sense of wellbeing of a child with hearing loss and there are many strategies that increase spatial awareness for example:

2.3.1 Reflection

In a visu-centric world, reflections give awareness of spatial depth, the dimension of space and activities that lie behind the viewer. Reflective surfaces are an important means for extending one's sensory reach to encompass a full understanding of the surrounding environment. Reflection is very key in the visual world of the hearing impaired. Reflection in key areas helps to assist with boosting one's visual field. Mirrors placed on the corners of corridors and across doors could alleviate some of the visibility issues in school buildings. Reflective surfaces should

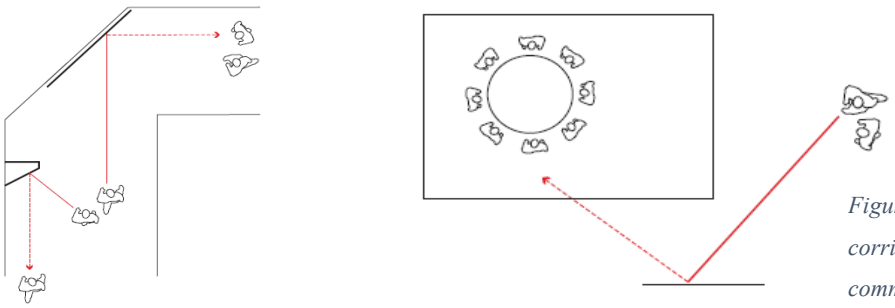


Figure 3:Figure 3: Use of mirrors in corridors (left) and outside to allow communication with those inside (right) (Bauman 2010).

[1] People who highly rely on vision as their primary sense

also be used in movement spaces to avoid collisions around corners and alert individuals when someone is approaching from behind (Bauman and Murray 2010).

For the concept of reflection to be effective and possible in an environment of children with hearing loss, children may have to be trained to look at the mirror when they are coming to the corner to avoid collision with their colleagues.

2.3.2 Transparency

Transparency is an important tool for connecting deaf individuals to each other and to their surroundings. It should be used to help make context and adjacencies legible while reinforcing a sense of security and well-being. It can be achieved through various means such as:

Addition of transparent or translucent glass on doors could prevents scenarios of collision since a child entering a room can clearly see who is coming from the other side (Johnson 2010).

Use of glass elevators which lessen the feeling of confinement, increase actual and perceived safety and allow visual connection to adjacent spaces (Bauman and Murray 2010).

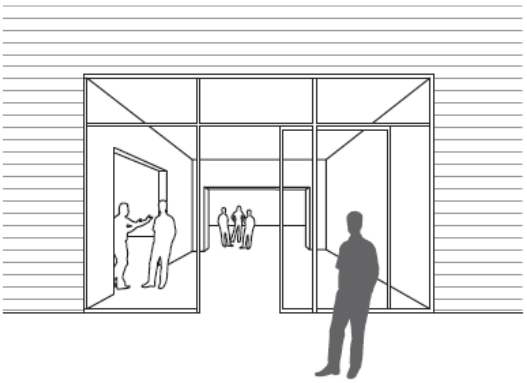


Figure 4:Illustration showing glass door

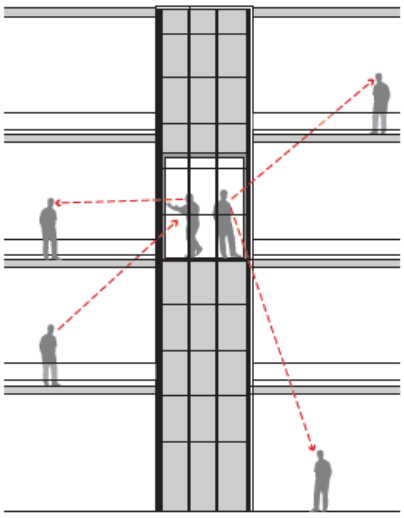


Figure 5:Illustration showing the effectiveness of a glass

In a country like Uganda that receives sunshine throughout the whole year, use of transparent glass in visually centered buildings could be a source of heat in spaces due to the greenhouse effect, therefore other strategies could be applied to connect individuals across spaces without necessarily heating it up the space.

Furthermore, in an environment with children, excessive use of glass in spaces could be dangerous, children can easily break the glass as they play and run around the building.

Minimizing glass in buildings that highly accommodate children is vital in creating a safe and comfortable environment where children can live and play freely.

2.3.2.1 Openings

Use of windows to allow individuals have a wider range of view and connection to the outdoors and surrounding spaces. This increases the range of view and helps provide greater visual access to activities taking place. It can be achieved through use of bay windows, having windows at stairs and having corner windows in spaces as illustrated below.

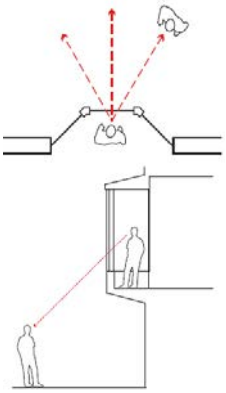


Figure 7: Bay window (Bauman 2010)

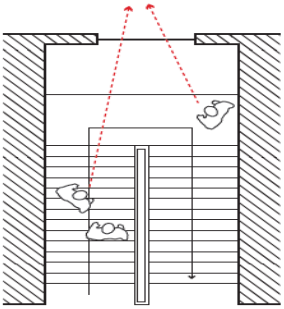


Figure 6: Opening at stair (Bauman 2010)

In addition, solid walls in and out of rooms can impede communication and spatial awareness in a negative way. Interior glass in key areas can help provide a vital connection instead of blocking it (Hauan 2017). However, in a negative way, use of transparent glass across spaces denies individuals privacy in spaces therefore there is need to use translucent glass that allows for privacy across spaces but still an individual can recognize another person behind the glass without necessarily seeing what they are doing.

Figure 8: Interior glass in walls.(Hauan 2017)

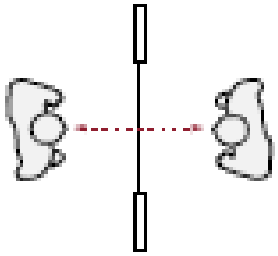


Figure 9: Transparency in walls.(Harahap, Santosa et al. 2019)

2.4 Display devices

Frequent display can assist with connecting the hearing impaired with the building and this could be a digital or an analog way of pointing areas of interest in the building for example, the use of signage to show an exit sign, evacuation route and a fire or hazard sign. With the presence of this signage, hearing disability children can know of any danger without having to be warned in the form of a visual alarm bell (Harahap, Santosa et al. 2019).

In addition to display in visually centered spaces, there is need to provide display devices in learning spaces such as projectors and smartboards to aid teachers while in classroom. However, in a third world country like Uganda some of these systems are expensive to install and maintain and therefore come with very many challenges.

2.5 Mobility and Proximity

Walking and talking at the same time for the hearing impaired using sign language can be challenging in a non visu-centric environment[2]. If two or more people are signing while talking simultaneously they must pay attention to their surroundings to avoid knocking obstacles (Johnson 2010). Usually the signers[3] will often shift between the conversation and their surroundings scanning for hazards and if one senses a hazard they alert their companion, adjust and continue. Some scholars say when they are walking they rely on their peripheral vision[4]. Therefore, the hearing impaired need a wide visual space while moving in space and this is influenced by the distance and extent of views needed.

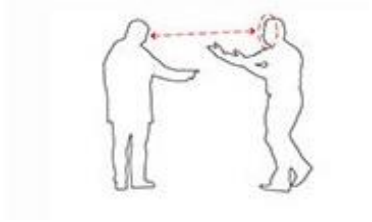


Figure 10:Sign language communication (Harahap, Santosa et al. 2019)

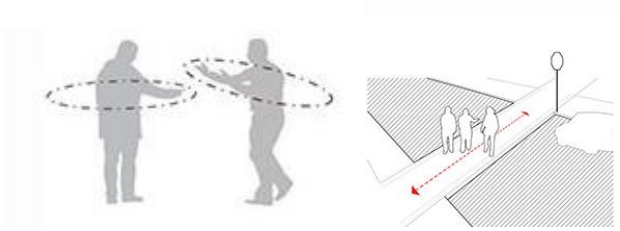


Figure 11:Illustration showing signers in transit

.

[2] Pertaining to a product, space, buildings or environments designed in a manner that is visually optimal for deaf, hard of hearing and pertaining to designs that focus on visual access.

[3] People using sign language

[4] Also indirect vision. It is the side vision of the eye that allows an individual to view objects around them without the need to turn their head or move around.

The mobility and proximity concept looks at how to make visual movements in space easier for the hearing impaired to navigate. The following strategies have been laid forward to support the concept;

2.5.1 Removing obstructions

Removing barriers in the environment that impede movement or visibility is vital for people living with hearing loss. Some strategies might be to use such as:
Using ramps instead of stairs however if the stairs are used it is better to have them wider.

Figure 12:Two signers moving along a path with obstructions (left) and on a path without obstructions right (Hauan 2017).

Since the visual focus of two signers is on the conversational partner not the ground, elements such as curbs or misplaced door mullions should be avoided as these can become a tripling hazard (Hauan 2017). Therefore, eased curbs and textured warning strips can provide a clue to the presence of the roadway while avoiding the use of a curb.

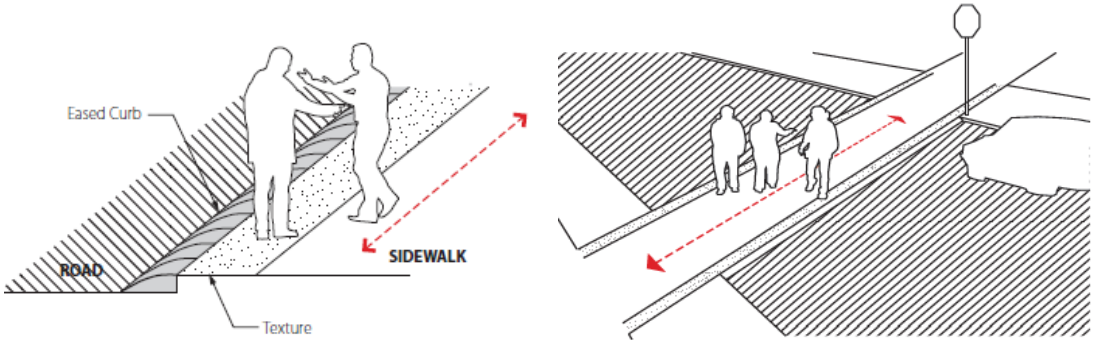


Figure 13: Eased curbs and textured warning strips on pathways (Bauman 2020)

Although eased curbs and textured warning strips give a clue to the presence of a roadway as the hearing impaired move along pathways, children with hearing loss may not be sensitive to this intervention therefore there is need to place a clear boundary between the road and pedestrian pathways to avoid scenarios of children accidentally entering into the road way as they sign

2.5.2 Paths and walkways

The width of pedestrian lanes, pathways and corridors should be wider almost to the width of a road so that the hearing impaired users can freely pay attention to the surroundings while using sign language. Bauman in his book Deaf space design guidelines states that Sidewalks and paths should be a minimum of ten feet (about 3m) wide, Primary corridors should be a minimum of 8 feet (2.4m) wide and secondary corridors should be a minimum of 6 feet (1.8m) wide as shown in the table below (Bauman and Murray 2010);

Table 1:Circulation standards for hearing impaired spaces.

Circulation	Minimum Distance (m)
Pathways and Pedestrian lanes	3m
Primary corridor (main)	2.4m
Secondary corridor (minor)	1.8m

In an environment of children with hearing loss, a wide pathway or corridor not only creates enough space for them to sign freely as they move but also creates enough circulation for the children to run around the building with less chances of collision with their colleagues.
Textured edges on the ground plane at transitions between different paths can provide subtle clues to the presence of thresholds, entrances and decision points. However, the idea of textured edges at transitions could only be possible if children are trained on how to use and respect them.

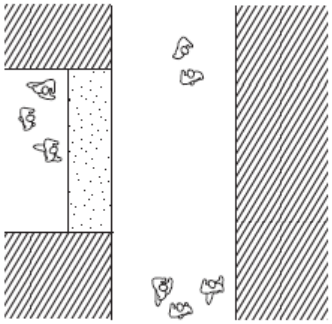


Figure 14:Textured surfaces at transitions.

Furthermore, Pathways should be kept as clear as possible. Bollards and other barriers such as street furniture, lighting, signage and planting should not be placed in pathways (Bauman and Murray 2010). Therefore, an environment with children should be barrier free to avoid

accidents, pathways should also endeavor to be free of obstacles as suggested by Architect Bauman.

2.5.3 Conversational nodes

Bauman also emphasizes the need for conversation nodes where hearing impaired groups can have conversations in circulation spaces, therefore he proposes the use conversational eddies along corridors, pathways and stairs to allow groups meet without distracting circulation as illustrated below. (Bauman and Murray 2010).

Permanent seats should be designed around conversational eddies to allow children seat and converse with sign language freely rather than just creating a space as proposed by the author. Providing seats around conversational not only makes the space functional but it also creates a breaking point along a long path or a corridor.

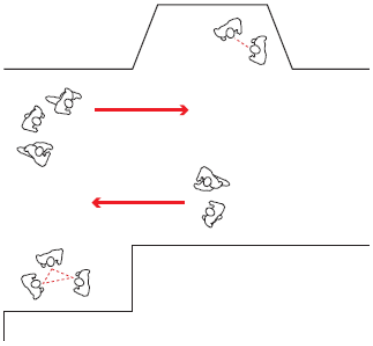


Figure 16; Conversation eddies along a path.

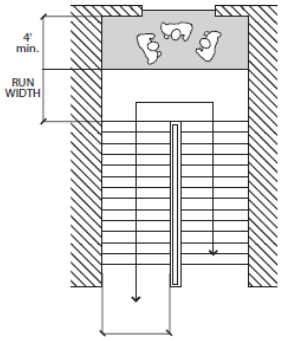


Figure 15: Conversational Eddie at a stair landing.

Very many corners and long corridors create a lot of bumping into each other of staff or students. Therefore, placing cornered glass or chamfering corners helps to prevent children from colliding when they are running down hallways or corridors in buildings.

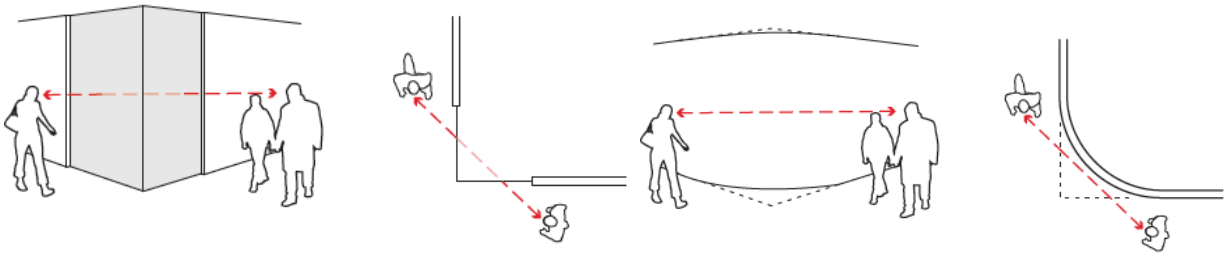


Figure 17: Corned glass (left) and chamfered corner (right)(Harahap, Santosa et al. 2019).

The author however does not give standard turning radii for the curved edges at corners, if provided these could guide architects and designers on what to use as they design corners in a visually centered environment. The turning radii is dependent on the width of the pathway and the number of the users in the facility.

2.6 Light and colour

The hearing impaired rely on light and color of spaces for effective communication and to create spaces that feel safe and comfortable. Color selection and light in space can influence hearing impaired behavior, so they can read situations. Many scholars refer to light and color as separate concepts, however in this specific research I will look at each as an individual entity.

2.6.1 Light

This concept mainly talks about lighting, lamps and openings (windows). Light in spaces should be good for visual communication between teachers and students and among students' communication. The hearing impaired depend on light to communicate, without light the student and teachers struggle to see each other.

The ideal processing of light according to Deaf space design guidelines is light that is soft on the eyes not dazzling and is not dark or dim**.** Poor lighting conditions such as glare, shadow patterns, backlighting interrupt visual communications and are major contributors to the cause of eye fatigue and eye strain that can lead to loss of concentration and even physical exhaustion. (Harahap, Santosa et al. 2019).

Therefore, since vision is the most developed of hearing impaired senses, it is important to ensure visual comfort by controlling glare and ensuring appropriate patterns of contrast.

2.6.1.1 Lighting standards

In Uganda, no comprehensive design light standards have been developed for the hearing impaired yet many schools could be victims of poor insulation. This research reviews the 'Building bulletin 93, Lighting design for schools' a document that gives lighting standards for schools that guides architects and engineers in London (England) through the process of lighting design in schools.

2.6.1.2 Building Bulletin, Lighting design for schools.

The aim of good lighting is not only to provide proper illumination for building users to perform their allotted task but also to pleasantly enhance the indoor environment. Good lighting in learning spaces for the hearing impaired should allow for cross communication across spaces between teachers and students (Loe, Watson et al. 1999).

The CIBSE code for interior lighting 1994, 'section 2.6.4.4 Public and educational buildings' provides figures for a wide range of specific interiors and activities. The document gives the minimum illuminance levels which should be provided all times in spaces depending on the

activity as tabulated below.

	Standard Maintained Illuminance lux	Uniformity Ratio	Limiting Glare Index
1. General teaching spaces	300*	0.8	19
2. Teaching spaces with close and detailed work (e.g. art and crafts rooms)	500*	0.8	19
3. Circulation spaces; corridors, stairs	80-120	-	19
entrance halls, lobbies & waiting areas	175-250	-	19
reception areas	250-360	-	19
4. Atria	400*	-	19

*Although particular illuminance values are quoted for the different areas, a small variation in these values is likely to be a problem.

Table 2; Illuminance, Uniformity Ratio and Lighting Glare index for schools (Loe, Watson et al. 1999).

According to the table above, spaces with much detailed work such as learning spaces need higher light levels compared to circulation spaces such as stairs, corridors and hall ways. Because of the special characteristics of learning spaces and in particular the spatial consideration, it is advisable that an illuminance of 500lux may be provided in learning spaces with detailed work such as art rooms and an illuminance of 300lux in general learning spaces such as classrooms. High uniformity levels should also be maintained in all these areas. Furthermore, measures to improve lighting in spaces for the hearing impaired are discussed in more detail below;

2.6.1.3 Adequate natural lighting

Use of large openings to allow natural light to enter the room so that there is no dim or dark corner. However, to avoid glare, proper shading devices should be added to windows to divert daylight without darkening the room.

Shading can be artificial shading which is obtained from proper orientation of spaces and openings, application of blur glass to diffuse light and the use of curtains and blinds or it can be natural shading obtained from placement of vegetation next to wide openings to filter the light (Harahap, Santosa et al. 2019)

.

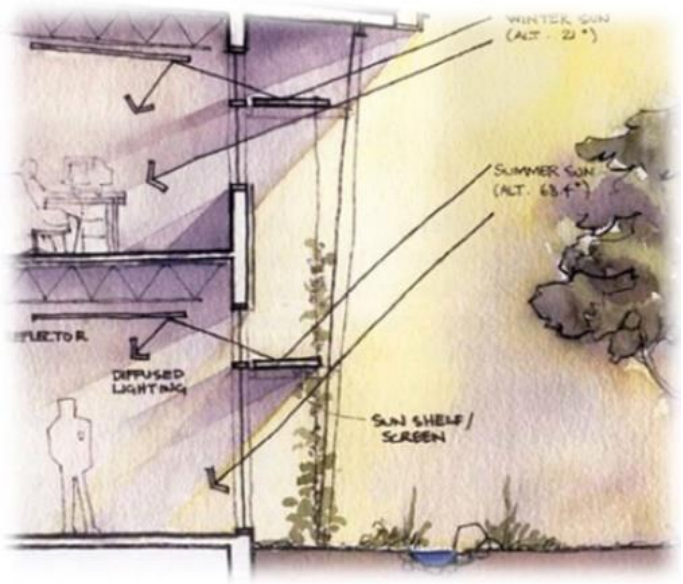


Figure 18:Daylighting strategies {Kariuki, 2016/2017)

2.6.1.4 Adequate artificial lighting

Appropriate artificial lighting with an anti-glare system to avoid shadows and reflections should be provided especially at night, this is a safety element for the hearing impaired and it increases visual communication and spatial awareness.

2.6.1.5 Reducing eye strain

Eyestrain occurs because of harsh light conditions. This can happen from poor electric lighting or from harsh outside conditions entering the room. This usually happens on a sunny day when the outside is bright and the inside is dark. Atypical of eyestrain comes from glare. Glare occurs when a large area of bright light shines into the eye. In a school setting it is important to have even light distribution and to eliminate any areas of glare. Some strategies to reduce glare are:

Use of light diffusers for example the use of cloth on artificial lights to reduce on the light illuminated into a space could help in reducing eye strain and therefore making sign language communication easy within spaces (Hauan 2017).

Figure 19:A typical classroom in Atlanta school for the deaf with cloth light diffusers (Hauan 2017).

There is need to avoid use of reflective surfaces on building skins and other elements that could be sources of glare in environments where the hearing impaired live. Reflective surfaces create eye strain and may hinder visibility among hearing impaired communicating using sign language.

Furthermore, one other common source of eye strain is backlighting, it can be very disturbing to communicate using sign language with someone in front of an opening, strategies should be put up to avoid backlighting in spaces where the hearing impaired live as these could hinder the comfort in a space, some of the strategies could be use of clerestory lighting and use of light shelves in spaces to avoid direct sunlight into the space (Hauan 2017).

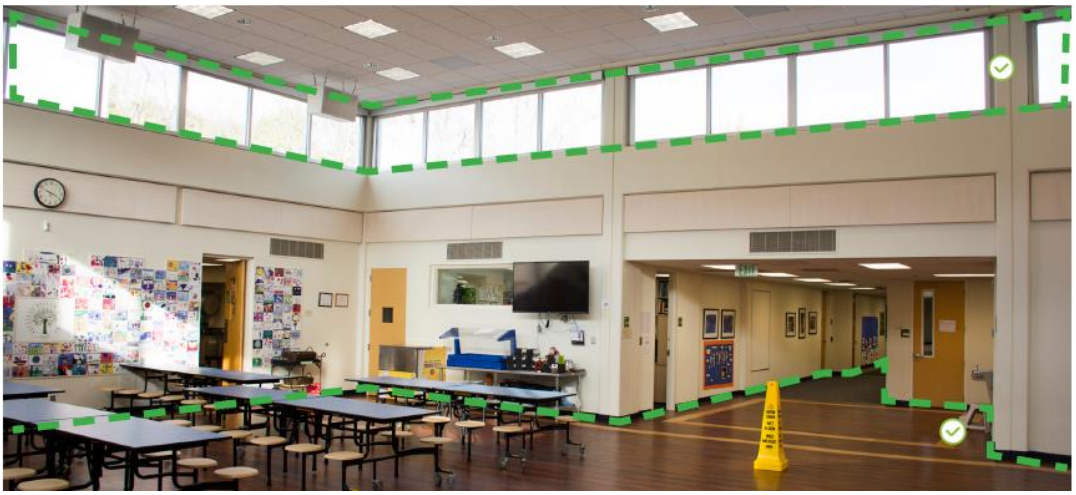


Figure 20:Atlanta speech school showing non reflective floor surface and clerestory windows(Hauan 2017).

2.6.1.6 Emergency systems

Light can be used as an emergency response; it can also be part of an alert system. Since most of the hearing impaired cannot hear sounds so they cannot react to bells , there is need to provide a system they can respond to and light can be that emergency system through visual alarms that are made of different colours to which each colour can be attached to a meaning for example in case of fire, in case of an intruder and in case of class change Atlanta speech school showing wooden floor and clerestory windows(Hauan 2017)..

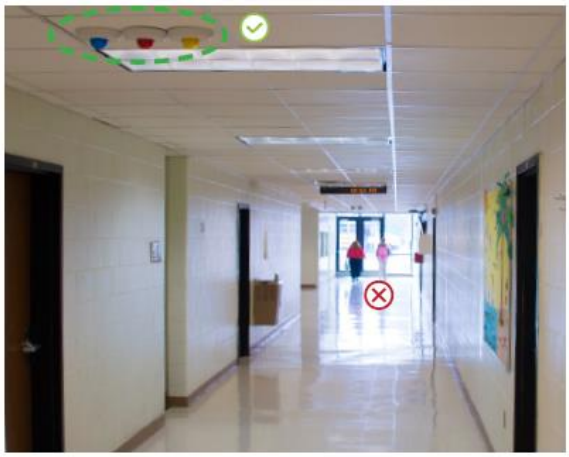


Figure 21:3 alarm system at Georgia School for the Deaf (Hauan 2017)

However, this device could only display basic information, according to my thinking in order to tailor messages and information to all students a device must be able to communicate efficiently and one of the strategies is to use large display devices predominantly throughout the building.

For a hearing impaired individual occupying a room, there is need to identify a visitor on the door and use of a visual doorbell could solve the problem. The visual doorbell is simply a light fixture switched from outside the entry point of an enclosed space such as an office that allows a visitor contact the room occupant by switching the light within the room (Bauman and Murray 2010).

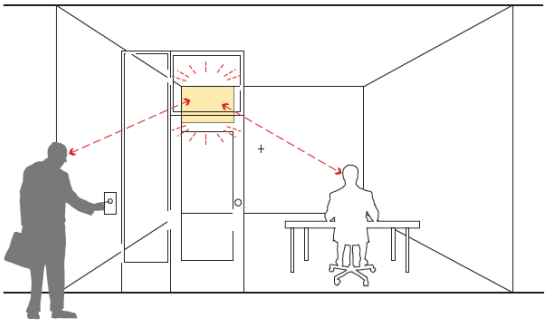


Figure 22: illustration showing how a visual bell functions (Bauman 2010).

Furthermore, light fixtures should be easily accessible so that a person can turn on the lights as one enters an unlit space so that they can make sense of their surroundings. School buildings should also not have very long corridors and rooms without windows as these could be dangerous for the people with the hearing disability.

2.6.2 Colour

The use of colour when designing for the hearing impaired is an extensive tool that is usually discussed along with light. Colour is more than just a fashionable or aesthetic aspect and It is important as a way to shape space and aid in orientation and wayfinding. Colour selection in a space can also influence the behavior and mood of individuals with hearing loss. Architectural strategies to achieve ideal coloring that brings comfort in space are discussed below;

Contrasting backgrounds

Since communication between deaf and hard of hearing individuals is so dependent on visual clarity. Signing conversations require a clear contrast between the background environment and the signer. Therefore, colors that are contrasting and complimentary to skin colors are best for backgrounds to use sign language. Blues and greens contrast with most skin colors. In addition, blues and greens visually calm space by avoiding overstimulating eyes and providing a restful backdrop for movement and signing. In large and active spaces, painting surfaces blue or green will help the hearing impaired individuals communicate comfortably.

Figure 24:Colour wheel showing range of skin

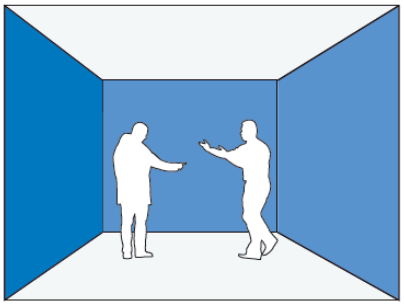


Figure 23:Contrasting background

Figure 25: Living and learning residence at Gallaudet University with a blue wall that contrasts with flesh tones, making gestures easy to see.

2.7 Space and Proximity

Proxemics is the study of the cultural, behavioral, and sociological aspects of spatial distances between individuals. An example of this is how far apart individuals engaged in conversation stand depending on the degree of intimacy between them. The hearing impaired have a set has a set of proxemics requirements that are tailored to their unique way of communicating. These needs must be accounted for when designing when designing for them (Bauman and Murray 2010).

Hearing impaired individuals using sign language need to initiate communication with eye contact and to maintain clear visual communication, individuals stand at a distance where they can see facial expression and full dimension of signers, the space between two signers tends to be greater according to the number of signers to allow visual connection (Harahap, Santosa et al. 2019).

As groups of the hearing impaired individuals grows, they will form a circle or a U pattern so that they can see every one, they always avoid squares or elongated shapes that block views and with bigger conversation groups the spaces in-between them increases to allow communication from all parties. Therefore, spaces designed must be able to accommodate large circles of gatherings.

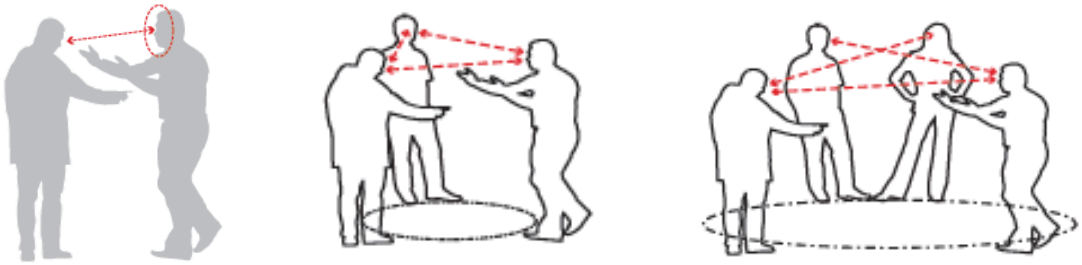


Figure 26: Illustrations showing groups of individuals using sign language (Bauman and

In an architectural approach the various strategies have been availed by scholars on how to achieve the concept of space and proximity.

2.7.1 Furniture layout

Layouts of furniture and spaces are the first proof of a unique architecture for the hearing impaired for example the use of round and horseshoe shaped tables allows for hearing impaired individuals seated in a group to make eye contact with all participants and communicate effectively. Square and rectangular tables present problems for individuals in groups larger than four and it gets worse with the larger groups.

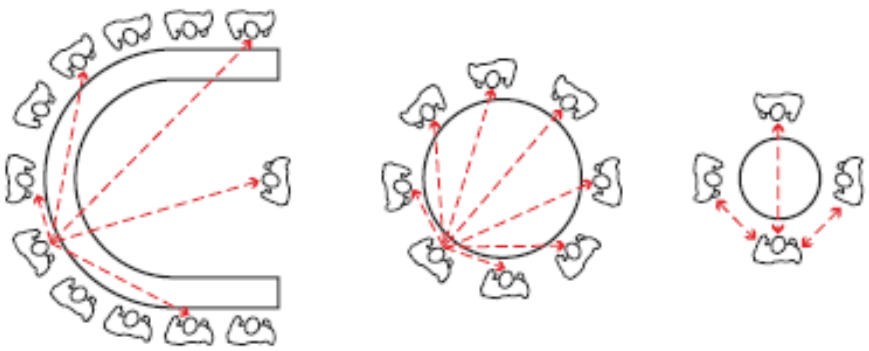


Figure 27: Illustration showing ideal furniture layout for group discussions (Baunman,2010)

In his book The deaf and the classroom design, Martins illustrates a model of a classroom for deaf children, the classroom relies on a concept of visual access between the teachers and the students as illustrated below (Martins and Gaudiot 2012);

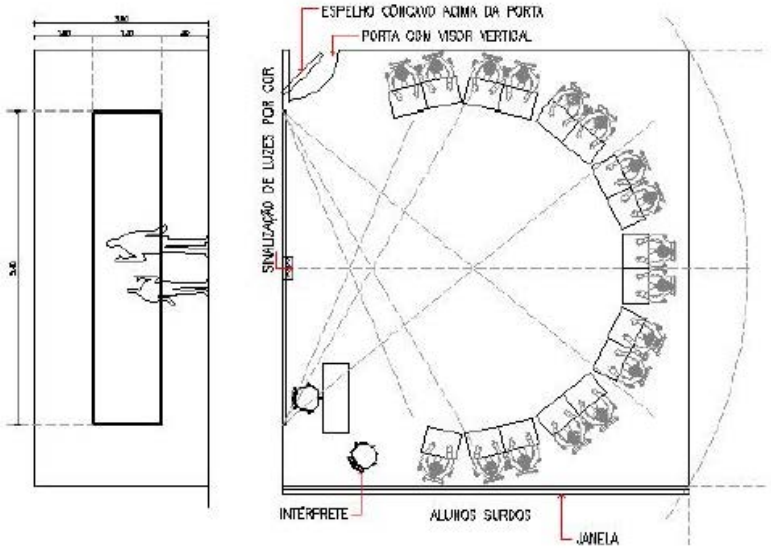


Figure 28: Classroom layout in circle form.(Martins and Gaudiot 2012)

A U – shaped furniture arrangement in a classroom allows for un obstructed views across tables therefore children seated in a classroom can easily communicate with their colleagues across the room.

Although this kind of furniture arrangement has its merits in a visually centered environment, it limits the number of people that can sit in a space as compared to other furniture arrangements. When used in a classroom, it can only accommodate a limited number of students, this would be difficult to execute in Ugandan schools where classrooms accommodate large numbers of students, it means that more classrooms would have to be provided in schools to achieve the system.

2.7.2 Spatial layout

Connecting of spaces within a building through use of openings such as windows, proper orientation and arrangement of space and use of transparent materials to give large obstructed views as earlier talked about in sensory reach. My understanding of the relevancy of spatial layouts in a hearing-impaired environment is that the positioning of spaces right away form site planning should allow visually centered people to communicate with each other across spaces using sign language. Spaces therefore ought to connect to each other such that the hearing impaired can communicate with sign language across spaces, this can be achieved through transparency of spaces, positioning of spaces for example spaces placed adjacent to each other and connecting of floors through use of balconies adjacent to each other.

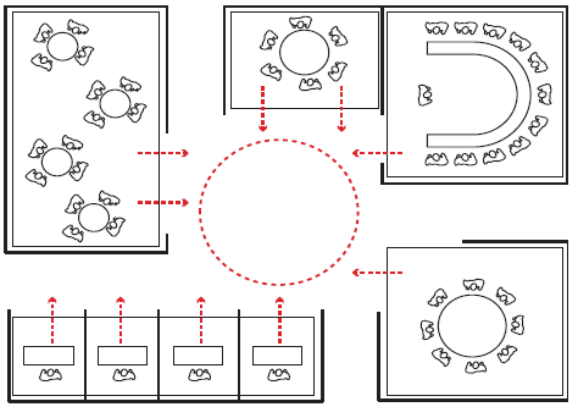


Figure 30: Connection of interior space through orientation and arrangement (Bauman 2010).

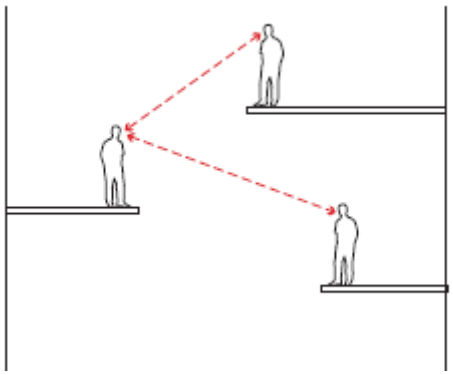


Figure 29: Visual connection between floors (Bauman 2010).

2.8 Acoustics

Architectural acoustics is defined as the science and engineering of achieving good sound levels in a space and it is concerned with speech intelligibility (Daniels and Unit 2003). Speech intelligibility is greatly dictated by background noise levels and reverberation effects. Sound waves in a space tend to be broken up as it bounces back and forth among reflecting surfaces, this creates an effect called reverberation. Reverberation has direct effect on the ambient noise level and apparent loudness of sound within a space. This is a very important factor to consider in acoustic design of deaf space.

Although the hearing impaired have a hearing deficiency some have auditory abilities and they use assistive devices such as hearing aids or cochlear implants to enhance sound. Cochlear implants and hearing aids operate by amplifying the direct first arrival signals sent from a

speaker. Problematic conditions occur because they also amplify late multiple arrivals of the voice and other background sounds. This can cause distraction and physical pain.

It can therefore be a challenge for a hearing impaired individual who relies on auditory ability to pick up sounds when in a room that does not have sound protection and is reverberating.

Spaces should be designed to reduce reverberation and other sources of background noise. The ideal acoustics in a room must be quiet and comfortable.

Distracting background noise can arise from a number of different sources, from mechanical equipment, to traffic outside a building to pathways and rain. In all cases, both program adjacency and noise dampening should be carefully considered in the design. If background noise is not controlled, individuals using these devices can lack concentration.

In Uganda, no comprehensive design regulations on learning spaces have been developed for the hearing impaired, many schools in Uganda suffer poor acoustics, the most serious acoustic problems are due to noise transfer between rooms and excessive reverberation sound in rooms.

2.8.1 Building Bulletin 93. Acoustic design of schools

The Building Bulletin; acoustic design is a document that sets out minimum numerical standards which are mandatory under building regulations and it therefore defines the lowest standards acceptable. Guidance on achieving good rather than minimum standards is provided in the Bulletin. The paper addresses special aspects for children with special needs including those with hearing impairment.

According to the Bulletin, acoustic design of school spaces should meet the performance standards for indoor ambient noise level, air borne, sound insulation and reverberation time more so considering a group of people that has a heightened sense of vibrations and background noise that can be distracting. Pupils with special needs are more sensitive to the acoustic environment than others. Consequently, required reverberation time are shorter, sound insulation between adjacent spaces is higher and indoor quality noise lower.

2.8.2 Acoustic standards

The Bulletin specifies that the noise levels in a core learning spaces for the hearing impaired should not exceed 35dB throughout each classroom (unoccupied). The 35dB maximum noise level ensured that direct instructions (approximately 50-60dB depending on the location of the teacher and the student) would achieve the appropriate sound level required by a student to hear their teacher and fellow colleagues without difficulty. The Bulletin also specifies that the reverberation time should not exceed 0.4s across a frequency 500Hz to 2000Hz, this would

greatly improve the speech intelligibility by students within learning spaces (Daniels and Unit 2003).

To achieve the above acoustic standards in spaces for the hearing impaired, several acoustic measures should be applied such as;

2.8.3 Noise insulation

Spaces such as classrooms should not be placed next to busy streets or mechanical rooms, if unavoidable insulation and other sound dampening techniques should be used to avoid sound interference from adjacent collective and circulation spaces (Bauman and Murray 2010).

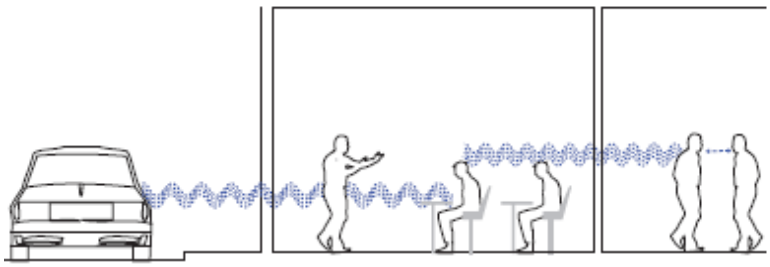


Figure 31: External noise that affects acoustics of a classroom (Bauman 2010).

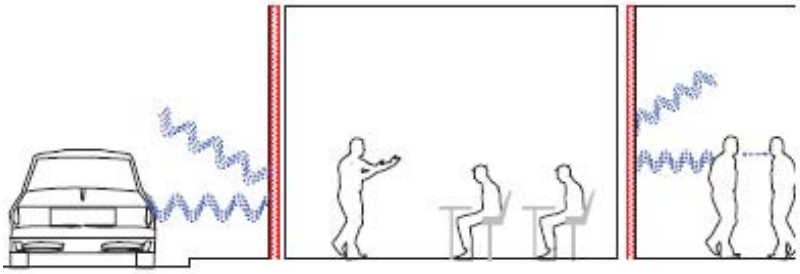


Figure 32: Sound absorption on walls to dampen reverberation (Bauman 2010)...

Hauan 2017 made a study around schools of the deaf and found out that in some schools that embraced hearing assistive devices dampening was highly reliable. Elements such as Sound-absorbing floor coverings, walling soft boards and Acoustic Ceiling Tiles (ACT) were used throughout the spaces to help dampen reverberation (Hauan 2017).

Figure 33:Atlanta speech school, cafeteria showing acoustic ceiling tiles and soft board walling (Hauan 2017).

Acoustic soft boards when used in spaces are a source of darkness and shadows since they limit the number of window openings in a space, if openings are to be used in such a space they have to be clerestory openings which do not bring sufficient light into a space.

2.8.4 Vibrations

Vibrations in spaces do not only have negative effects but also have positive ones for example the use of vibrations to provide a subtle clue of someone approaching as a means to mitigate abrupt interruptions.

Floor surfaces such as wood that allow for some degree of noticeable vibration should be used in defined spaces where occupants with hearing disability may desire to initiate contact with one another through a tap on the floor or furniture. Some of these spaces could be corridors or hallways, offices and classrooms (Bauman and Murray 2010).

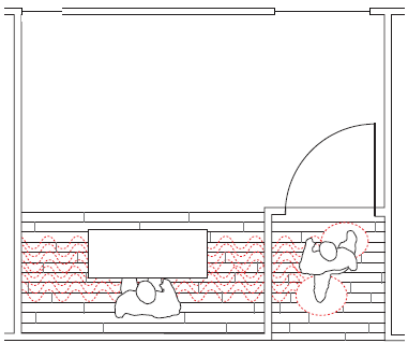


Figure 35:Ideal flooring in an office (Bauman 2010).

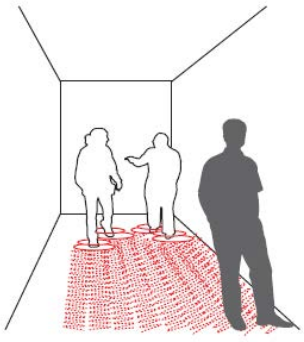


Figure 34: Vibration on a floor surface in a corridor to alert an individual of someone behind them (Bauman 2010).

Table 3: Summary of DeafSpace Architectural Design guidelines.

Summary of Deaf space Architectural Design Guidlines.

Guideline	Sensory reach	Mobility and Proximity	Light and colour	Space and proximity	Acoustics
Description	Spatial awareness of spaces. Ease in reading ones' surroundings.	Making movements easier while communicating. Maintaining signing distance while walking and scanning for hazards while walking.	Visual comfort in space while ensuring there is no glare and darkness in spaces.	Maintaining clear sightlines among large groups of signers.	Noise is painful to the hearing impaired that use cochlear implants. Acoustic insulation for speech intelligibility.
Application	Reflecting surfaces such as mirrors should be placed properly to extend sensory reach. Enhance transparency to connect individuals across spaces. Wide openings give visual access to activities outside increasing sensory reach. It is advisable to use display devices such as signage to assist the hearing impaired in way finding.	Remove obstacles that could be hazardous to signers. Wide paths, walkways and corridors to allow 2 signers to walk while signing. Texturing edges of walkways to give a subtle clue to signers in case of a diversion or an intersection.	Adequate daylighting that avoids direct sunshine and glare into spaces. Use of contrasting colour to the human skin in building interiors that are the best for backgrounds to use sign language. Use of light as an emergency system for example use of visual bells.	Co-centric furniture arrangements such as horse-shoe and U-shape advisable to allow cross communication among signers in a space. Positioning of spaces adjacent to each other through use of transparency and balconies to give clear sign lines across spaces.	Eliminating background noise and maintaining low reverberation time in spaces. Endeavor to insulate spaces that are prone to noise interference from adjacent spaces. Vibrations can be used in a positive way when applied in corridors through use of wooden floors to give subtle clues to someone approaching.

3.0 RESEARCH METHODOLOGY

3.1 Introduction

This Chapter outlines the the method undertaken to achieve the aims and objectives of the research as outlined in Chapter one. It seeks to form a research template that will guide the research carried out on how the data is analyzed and presented.

3.2 Research design

Research design is a master plan specifying the methods and procedures for collection and analyzing the needed information (Pandey and Pandey 2015). A research design will typically include how data is to be collected, what instruments will be employed, how the instruments will be used and the intended means to analyze the data collected.

The study takes a qualitative approach to gain a deeper understanding of the environment in which individuals with hearing impairment live. The aim of the research is to understand the various design strategies that have been employed in creating a comfortable environment for the hearing impaired in schools, taking a case of Uganda school of the deaf, Ntinda.

Emphasis will be placed on the five major design guidelines that were identified in the literature review and how they affect the comfort and safety of the hearing impaired community in the learning environment.

3.3 Conceptual Framework.

The conceptual framework is arrived at by reading literature from several authors and identifying intersections and differences. The information is then categorized in overlaps to create the key concepts as seen in the framework below. The information is organized in relation to Ontology which are concepts emerging from the literature and Epistemology which are the variables that can be observed in the field. The framework also relates the concepts and concept definitions to suggested research methods.

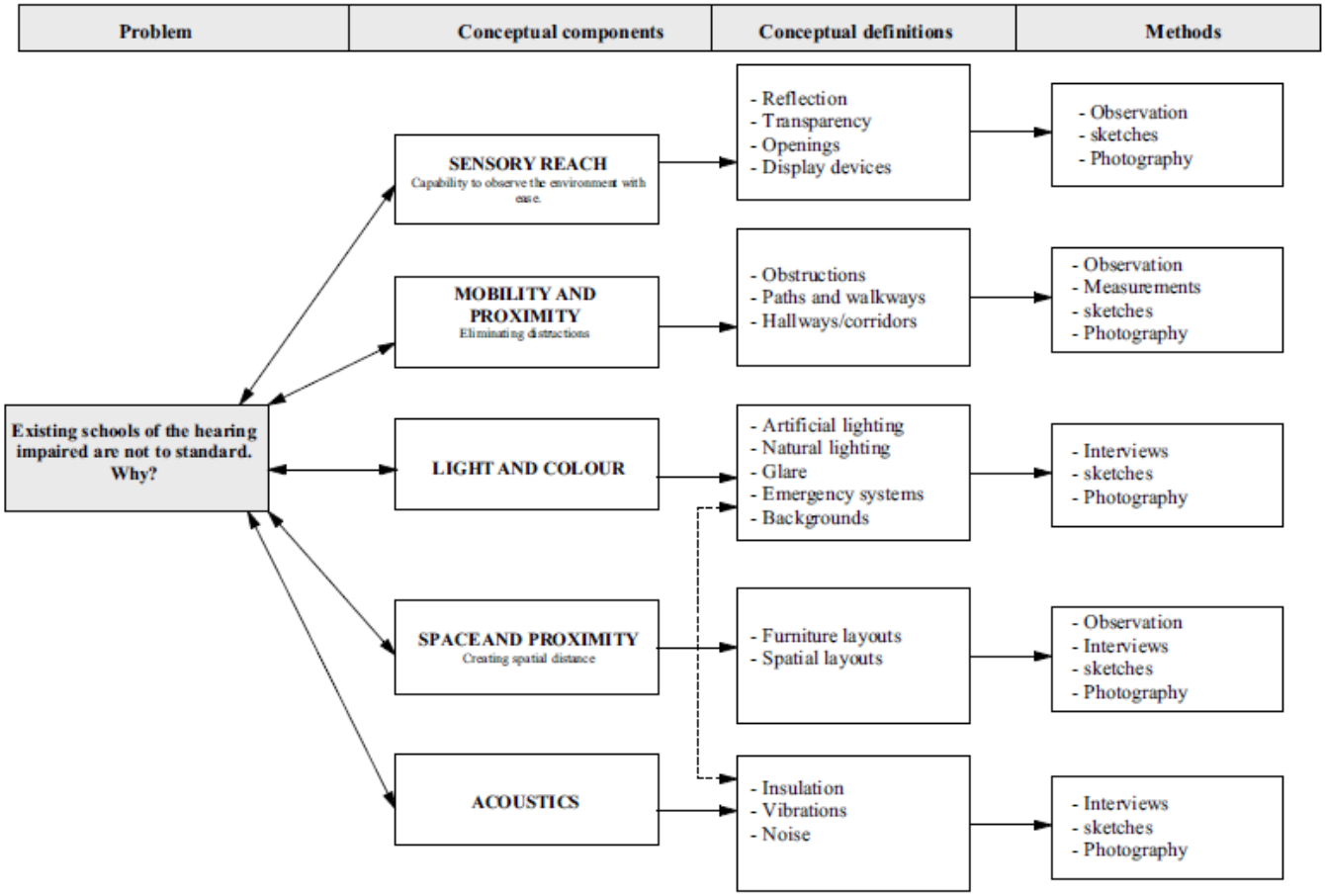


Figure 36: Conceptual and operational components architectural strategies for the hearing impaired . (Source; adopted from Nachmias and Nachmias, (1997:33) and modified to relate to the context of this study)

3.4 Research strategy

The research will focus on Uganda school of the deaf, Ntinda as a case study. Basing on the selected area of the case study, the research methodology will adopt a three step strategy to explore the existing conditions, identifying what is appropriate and there after making possible recommendations as discussed below.

i) Exploring the existing situation of the selected study.

This will involve establishing the conditions in the selected case study and the extent to which children living with hearing loss and their staff have modified their space to suit their needs. It will also involve critiquing the design visa vis their performance towards comfort and safety and safety of the individuals living with hearing loss.

ii) Identifying what is appropriate

This will involve looking out for unique architectural interventions that have been put to make better the existing situations of the hearing impaired children.

iii) Making recommendations

iv) After a careful study and analysis of the topic, appropriate recommendations will be made. This will look at evaluating possible solutions to the selected study.

In order to find answers to the research questions, the conceptual design aspects as identified in the previous chapter will be investigated through looking at how they can be incorporated in the case study. The aspects include; Sensory reach, Space and proximity, Mobility and proximity, Light & colour and Acoustics.

2.8 Sample Design

Sampling is the process of selecting a number of units for a study in such a way that the units represent the larger group from which they are selected. The purpose of sampling is to get information about a population without responses from the whole population.

The research will therefore undertake a purposive sampling technique. According to Kothari Chakravanti (2004), purposive sampling is a type of non-probability sampling where items for a sample are selected deliberately by the researcher. In other words, under the sampling technique the researcher chooses the particular unit of the universe for constituting a sample on the basis that the small mass that they so select out of a huge one will be a typical representative of the whole (Kothari 2004).

The case study rationale is such that the cases are selected after careful analysis of the relevancy in effective representation of the subject matter and their comparability with the given context. Therefore, the choice of the case study at Ntinda school for the deaf is purposively selected for intense study on the principle that it can represent all the primary schools of the hearing impaired in the country.

3.6 Choice of case study.

The study was chosen at Uganda school of the deaf, Ntinda. The study is selected on the basis that it is the first and biggest primary school for the hearing impaired in Uganda enrolling the largest number of children with hearing loss. The research will therefore focus on the existing architectural design of the school for the hearing impaired to examine the extent to which the school suites the users. Schools were selected since they present the best avenues where individuals living with hearing loss collectively live together therefore giving a suitable environment of studying their culture.

3.7 Methods of data collection

A researcher requires data gathering tools, these tools guide the researcher in data collection and are also used in evaluation, these may vary in complexity, interpretation, design and administration and each tool is suitable for collecting a certain type of information (Pandey and Pandey 2015). Therefore, this researcher will use the following instruments to collect the required data:

1. Personal observation

2. Interviews

3. Questionnaires

4. Literature review

3.7.1 Personal observation

The primary data collection methods include observations made in the study area through use of sketches, photographs and measured drawings. The major strength of direct observation is that it is unobtrusive and does not require direct interaction with participants (Adler and Adler 1994). Observation supplements other methods and illuminates the discrepancies between what people said in the interviews and casual conversations and what they actually do (Pettigrew 1990).

The research will employ both structured and unstructured observation techniques. The structured observation method will ensure that the study is able to answer the research questions while the unstructured one is to make sure any other relevant information found in the field is not left out purely because it was not covered in the predefined observation list.

Information gathered with the observation method will be the conceptual design aspects as identified in the literature review and it will entail looking at how they have been incorporated in the selected study.

Observation will also be used to determine the user comfort levels through gauging the patterns and behaviors of the occupants towards their environment. Sketches, measured drawings and photographs will be used to capture the observations made.

- Sketches and Measured Drawings

In this research sketches and measured drawings will be given the major role in recording of findings and observations in the course of the field work and analysis since they offer a wide variety and flexibility of presenting the findings of the research. Drawings such as plans,

sections, elevations will be sketched out to communicate information on areas and general layouts.

- Photography

All the subjects of study will be captured in photographs and analyzed in sketches and computer generated models. Photographs will be the major tool in capturing the existing situation in the Uganda school of the deaf, Ntinda. Images of both the exterior, interior and the context of the typologies will be taken to give a clear understanding of the study.

3.7.2 Interviews

In line with the explorative nature of the study, the goal of the interviews is to see the research topic from the perspective of the interviewee, and to understand why he or she has this particular perspective.

Interviews shall be carried out with the following individuals;

People with hearing loss: Interviewing individuals with hearing impairment to get their perspective of how they experience different spaces, the challenges they face and perhaps what they think can be done better. This is mainly because these are the people that have been affected.

The teachers and staff: Interviewing teachers and other members of staff, to get their view on what has been done to create a comfortable environment for the children with hearing loss within the build environment. These people are part of the deaf culture since they entirely spend their days with children living with hearing loss.

Organizational Leaders; Leaders of organizations that advocate for the rights of persons with hearing loss such as Uganda National Association for the deaf (UNAD) and Ministry of Education - Department of special needs. These interviews shall be carried out to discover if there are any architectural guidelines that have been put into place to guide designers on how to compose spaces for the hearing impaired in the built environment.

3.7.3 Questionnaires

Questionnaires will be developed for the architectural research to catch a glimpse into the architectural design of spaces that are meant for children living with hearing impairment. The collected responses will be analyzed and used in the architectural research for information.

Questionnaires will be distributed to key informants such as teachers of children leaving with hearing loss and older pupils, this will guide in getting answers to questions, where the researcher cannot see personally all the people from whom they desire responses.

Participants were asked the following questions.

1. What is the most favorite room /space for children in this school and why?
2. What are some of the challenges deaf children face in the school buildings?
3. What are some of the challenges deaf children face on the school compound?
4. What do you think is good about this school in terms of buildings/spaces?
5. What do you think is bad about this school in terms of buildings/spaces?
6. What do you think can be done better to improve comfort of deaf children in school buildings?
7. Did I leave anything out that you would like to add about?

3.7.4 Literature review

An evaluation of existing literature on the subject will be done to compare the findings with those of other studies that have already been done on the subject.

3.8 Ethical considerations

Approval to conduct this study was obtained from Makerere University, Department of Architecture and physical planning. Administrative permission to conduct the study in Kampala was obtained from Kampala Capital city Authority(KCCA) under the Directorate of Education and social services, a body in charge of all primary schools in Kampala district. Furthermore, permission was obtained from the Uganda Association of the deaf, a body that advocates for rights of individuals with hearing loss in Uganda.

The United Nations Convention on the rights of children (UNRC) draws international attention to children's rights to protection of children from participation in maters that affect them including research, therefore in this study direct engagement of children was avoided. The study engaged adults such as their parents, teachers and doctors an all data collected was kept confidential and secured in a protected computer only accessed by the study team.

4.0 FINDINGS AND ANALYSIS

4.1 Introduction

The research element of this study involved conducting personal observations, key informant interviews, questionnaires and use of literature review as explained in the previous chapter. The main goal of the research is to discover the status of existing primary schools for the hearing impaired taking a case of Ntinda school of the deaf. It aims to understand some of the architectural interventions that have been put in place for children living with hearing impairment in the built environment.

The architectural aspects considered have been identified through a critical analysis of the literature review as shown in in the conceptual framework in fig 2. An emphasis is given to the five selected architectural aspects (Sensory reach, Space and proximity, Light and colour, mobility and proximity and acoustic) and how they have been incorporated in the institution design.

The following levels of the built environment are used for analysis purposes;

1. Site planning; Choice of site, unit plans, spacing of units, vegetation.
2. Building plan; Orientation, access, inter unit connection, group spaces and private spaces
3. Unit planning: unit size and shape, Verandahs, Unit floor, walls and ceiling design, type of opening, location of opening.

The research will be explanatory in nature and therefore a precedent has been identified as the main research strategy. The approach shall provide the best opportunity of comparing and contrasting the findings with the studies that have already been studied.

4.2 CASE STUDY; UGANDA SCHOOL OF THE DEAF, NTINDA

4.2.1 About the school

Uganda school of the deaf, Ntinda is a primary boarding school for children living with hearing loss, located in Ntinda a town northeast of Kampala.

It is the first school for the Deaf in Uganda established in 1960 by Mrs. Julia Lule with help of Miss Brown and the support of the Uganda Society for the Deaf, the Kabala's government and the Church of Uganda. It started in a block of offices at Mengo primary school, moved to independent premises adjacent to Namirembe Infants school and finally moved to its own current premises at Ntinda.

It is a Government aided Primary School bringing together all categories of Deaf children, including Deaf children with multiple disabilities. The school's primary task is to cater for the education, interests and special needs of the Deaf children in Uganda.

Ntinda is a boarding school with an enrolment of 196 pupils in classes ranging from the Nursery to Primary 7. After P. 7, children join the few available secondary schools at Ngora High School (integrated into the regular secondary school), and now Wakiso Secondary School for the Deaf. The ones who do not qualify for academic secondary education join vocational training.

Research findings from the above selected study will therefore be presented under the levels below;

1. Site planning; Choice of site, unit plans, spacing of units, vegetation.
2. Building plan; Orientation, access, inter unit connection, group spaces and private spaces
3. Unit planning: unit size and shape, Verandahs, Unit floor, walls and ceiling design, type of opening, location of opening.

The research findings will be presented under the above levels giving an analysis on how they respond to creating a suitable environment for the hearing impaired.

4.2.2 Site planning

The school is generally bordered by a low rise neighborhood, on the south it is bordered by Ntinda primary school, St Luke church of Uganda to the North, Ntinda minister's village to the East and to the West it is bordered by Ntinda – Nakawa road. The author notices that the school being bordered by a low rise neighborhood gives the ability to have a wider field of vision across its neighborhood of which vision plays a fundamental role for the individuals leaving with hearing impairment.

The school has a vast site planned on 4.5 acres of land, out of these 0.48 acres is built space and the rest is designated for green spaces, school pitch and kids play area. Currently the school has seven classes for primary school, three for nursery school, an administration block, accommodation for both girls and boys, a dining hall, children play areas and staff quarters.

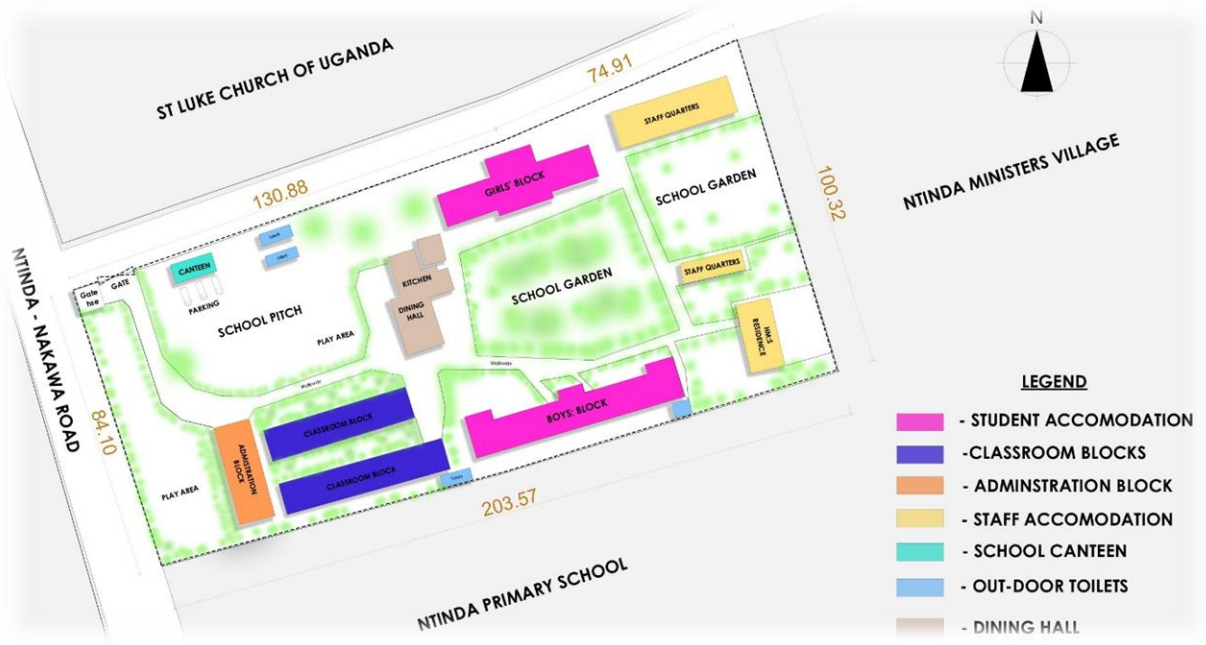


Figure 37: Site plan of Ntinda School for the deaf showing the built structures. Source Google earth – Author edited,2021

Built in 1980s, the school has a typical antique architecture style with linear buildings planned around green courtyards creating clear sightlines across the buildings. It mainly comprises of low rise structures and not a single storied building was seen with in the school premises.

The institution is well planned with the placement of the school pitch just after the main gate giving a clear way finding towards the main school facilities when one just enters the school.

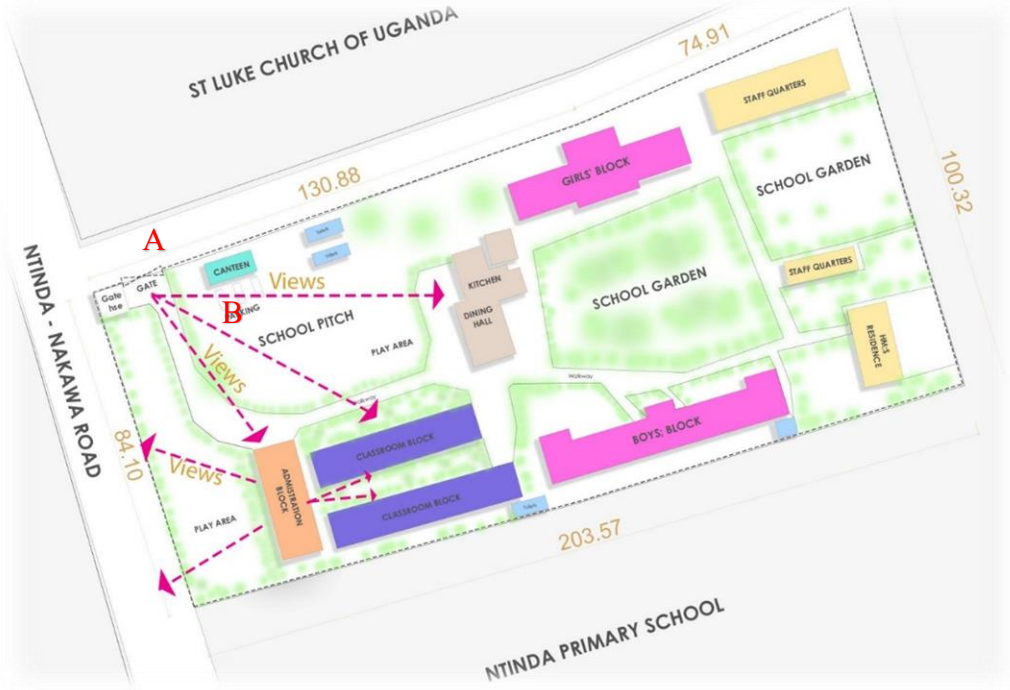


Figure 38: Site plan of the existing school showing clear sight lines towards the school facilities. Source; Google earth – Author, 2021

Figure 39: image showing the views at point A as shown in figure 42. Source – Author,2021

The school is fully fenced off with a perforated fence comprising of a chain link and foliage, this allows for a slight visual connection to the adjacent neighborhoods which lessens the feeling of confinement within the institution.

Figure 40: Image showing the perforated fence bordering the school.

In conclusion, some of the school buildings are just shelters against weather elements. However, a few strong elements of site planning can be associated with deaf space. Such includes:

- The court yard design- creates a strong visual link across buildings for example across the two classroom blocks.
- Linear plans- these extend clear lines of sight
- Un obstructed gate entry - gives a clear way finding towards the main school facilities.

- Orientation- majority of the building are designed in the East-West orientation avoiding direct sunlight.

4.2.3 Building plan

4.2.3.1 Administration block

The administration block is directly in front of the main gate, therefore, visitors can easily orient themselves to the block without asking for directions. The block consists of the headmaster's office, bursars' office, staffroom and a computer lab. It is properly planned with the front facing the kids play area and the back side (with openings) facing the classroom quadrangle allowing for full time surveillance of the children.

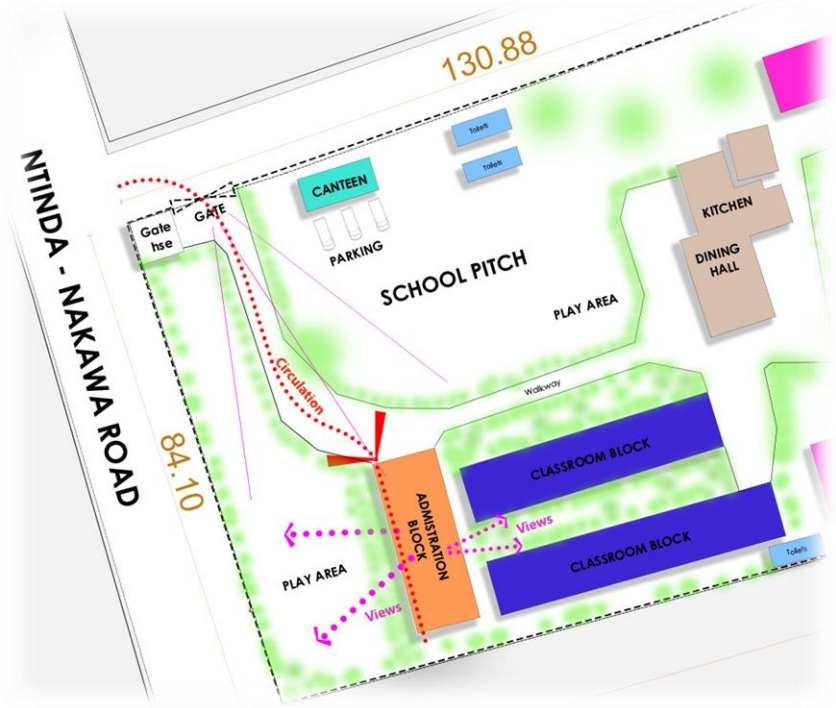


Figure 41: Site plan showing circulation towards the block and available views away from the block..

The administration block has a passage 1.6m wide which does not allow for a group of children to sign freely. According to Deaf space design guidelines 2020 by Bauman the standard minimum distance of a primary passage is 2.4m. The passage also has waiting benches for the offices and this even makes it smaller and inadequate for its use.

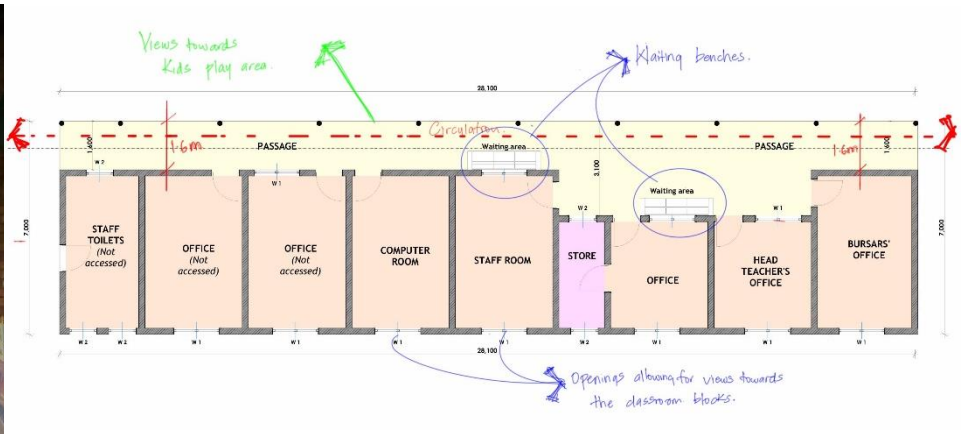


Figure 42: Image showing the space layout of the administration block.

Figure 43:Image showing passage at administration block.

4.2.3.2 Classrooms

The class section is made of two linear classroom blocks with each block consisting of 6 classes. The blocks are planned around a green quadrangle 6.5m wide and each building has a passage of 2m facing the green quadrangle. The positioning of the blocks to face each other allows for clear sight lines across the 2 buildings therefore children can communicate with sign language across the blocks.

Figure 44: Image showing the 2 classroom blocks planned around a quadrangle with the passages facing inwards.

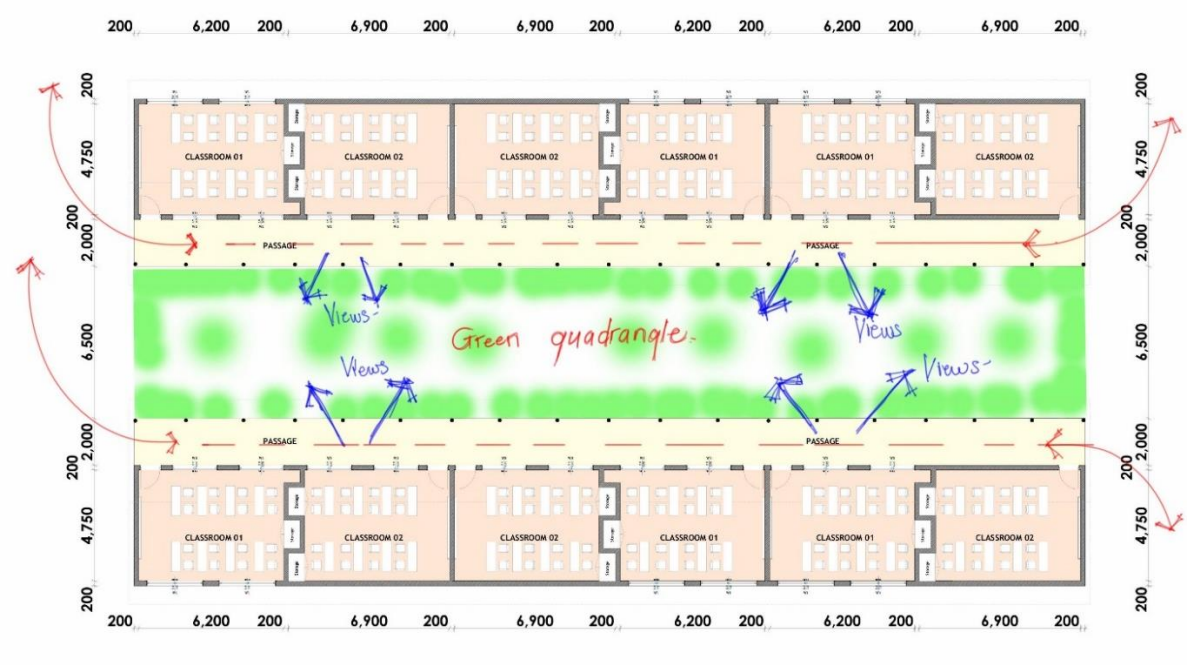


Figure 45: Image showing the plan layout of the classrooms.

4.2.3.3 Dormitories

Just like the classrooms, the dormitories are planned around a wide quadrangle with a thick school garden. The dormitories are linear blocks containing sleeping areas, laundries, bathrooms & toilets. Most of the activities such as laundry and toilet related activities happen inside the blocks therefore giving total privacy to the units.

In addition, the thick garden between the girls and boy's dormitory cuts off visual sightlines across the two sections therefore blocking visual access across the two blocks.

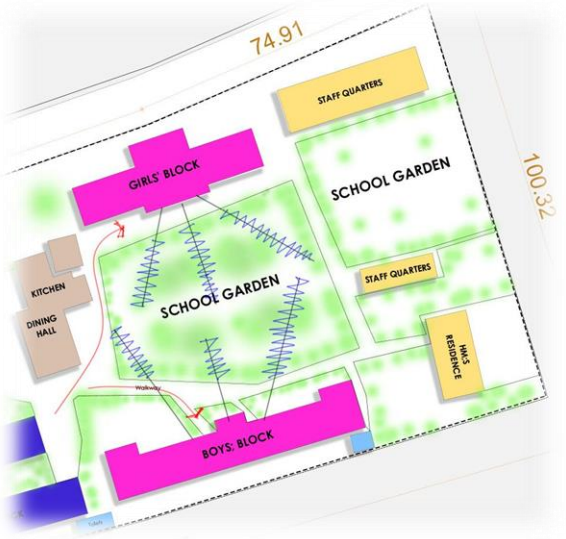


Figure 47: Site plan showing the dormitory planning.

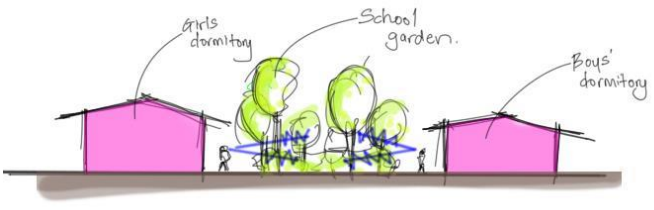


Figure 46: Image showing a sketch section across the dormitories.

4.2.4 Unit planning

4.2.4.1 Classroom

Each classroom has a rectangular shape, the shorter side has a blackboard and the back side is used for storage. The black board is fitted 0.7m off the ground creating clear sight line for every student. The classroom is lit from the longer sides, with one side having 2 wide windows (2.4m wide by 1.2m high) while the other side has a door and 2 clerestory windows (1.9m wide by 0.75m high). The clerestory windows are 1.5m off the ground that prevents children from being distracted by activities along the passage adjacent to the classroom.

In addition to preventing distraction, the clerestory windows also regulate light into the classroom thus reducing on glare into the space which would lead to eye strain.

Each classroom has approximately 29.5m^2 and seats to a maximum of 25 children, the layout is organized in rows and columns which hinders visual access by all the children, often children at the front had to turn back when an individual at the back was chosen to contribute in class.

Figure 48: Image showing a typical classroom layout at Ntinda school for the deaf.

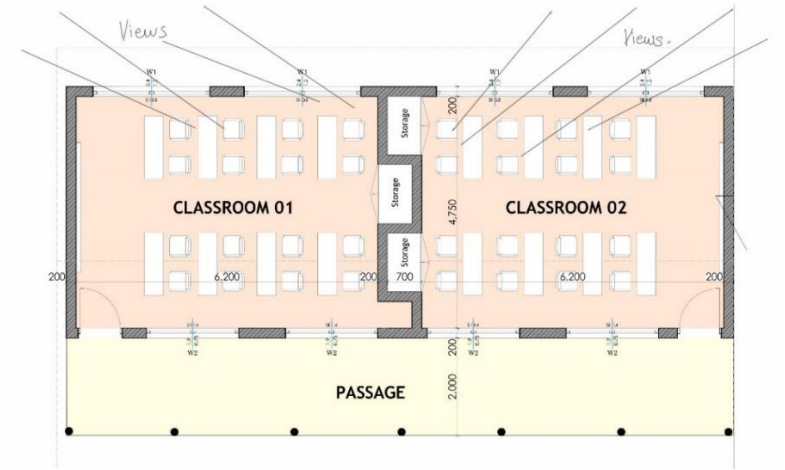


Figure 49: Image showing a typical class plan layout.

4.2.4.2 Dormitory

A typical dormitory has a rectangular shape. It resembles the plan of the classrooms. The windows are on either side of the building, however, the lighting inside the dormitory is very poor due to the wooden openings.

Communication using sign language is very hard due to the darkness in the rooms. The beds are organized in rows and columns creating a challenge of clear sightlines in the dormitory. The corridors between beds are 1.1m which does not allow two signing children to walk together and make a communication at the same time scanning for hazards.

Figure 51: Image showing the interior of the girls dormitory

Figure 50: Image showing the exterior of the boy's dormitory

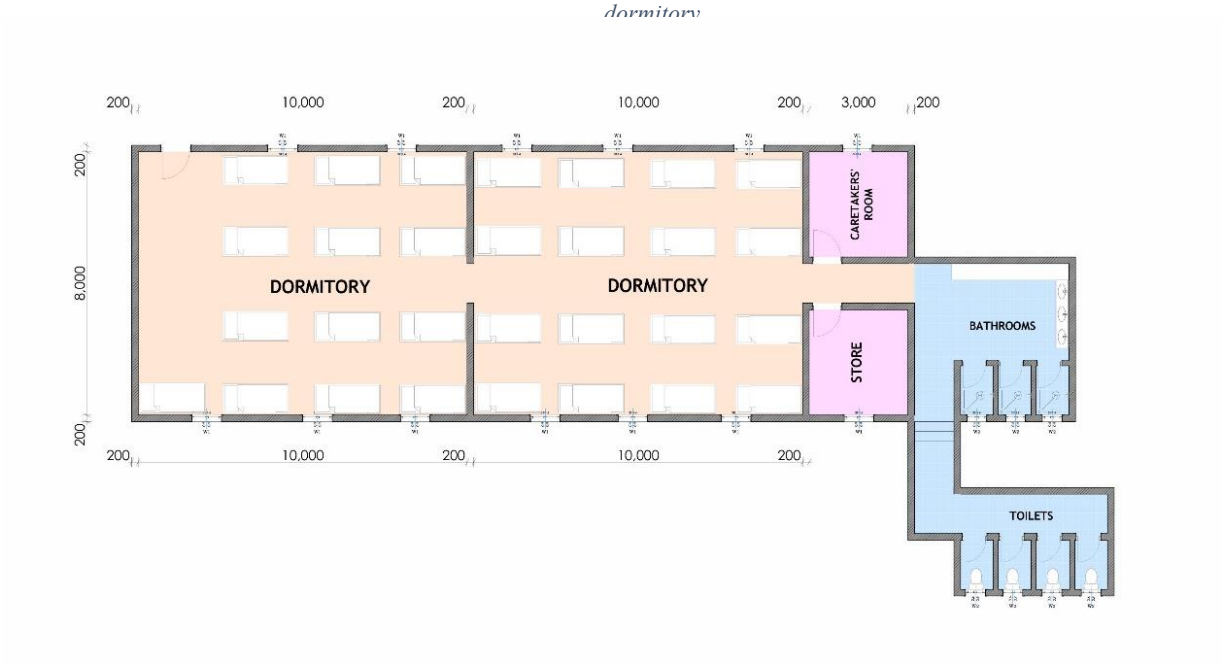


Figure 52: Plan layout of the boys' dormitory

4.3 Deaf Space Architectural design strategies – Uganda school of the deaf, Ntinda

Deaf Space Architectural Design guidelines as described in Literature review are guidelines put in place to provide a suitable and comfortable environment for the hearing impaired. Architect Hansel Bauman (H.D.L Bauman 2004) clearly identifies five basic concepts (figure 57 below) considered when designing deaf spaces. The concepts include sensory reach, mobility & proximity, Light & color, space & proximity and acoustics.

The following sub chapter therefore looks at the data collected at Ntinda school for the deaf examining each concept and how it has been addressed while making comparison with existing literature as in chapter 3.

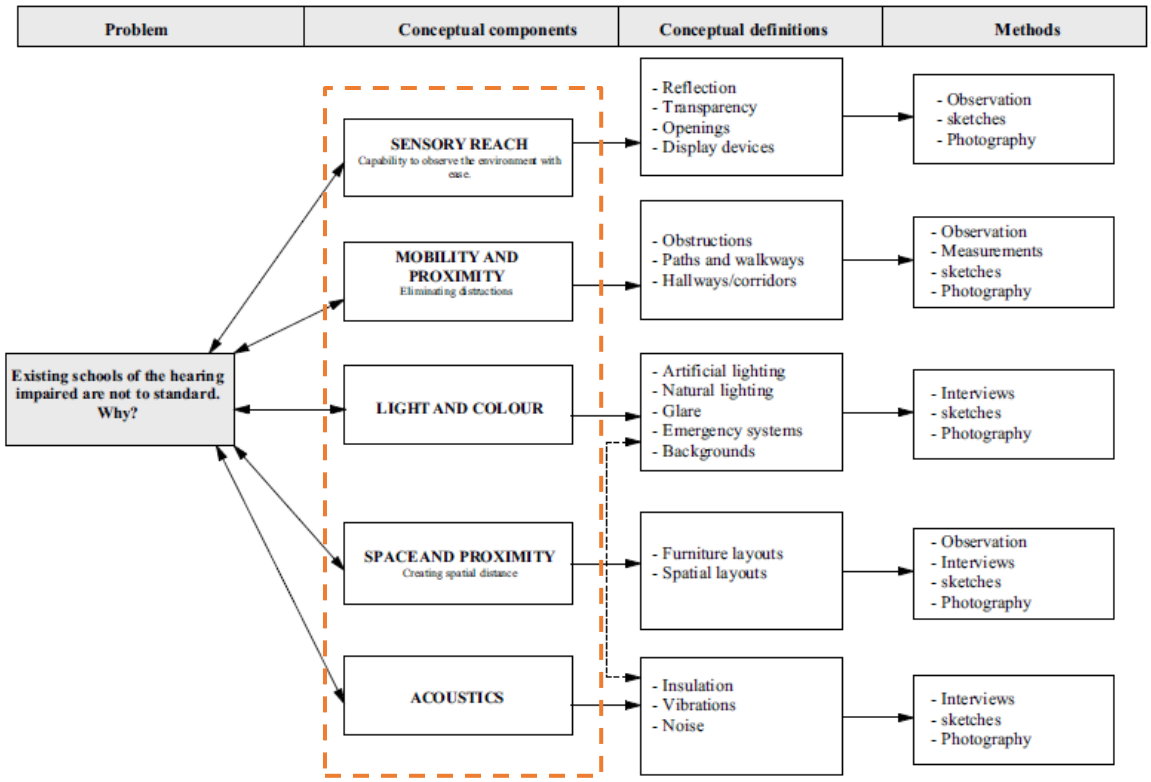


Figure 53:Conceptual and operational components architectural strategies for the hearing impaired . (Source; adopted from Nachmias and Nachmias, (1997:33) and modified to relate to the context of this study)

4.3.1 Sensory reach

The concept of Sensory reach relies on the capability of the visually centered individuals [5] to observe their surroundings with ease and clarity and the ability to see movements and facial expression of others is important. Spatial awareness of activities within the surroundings is essential in maintaining a sense of wellbeing of someone with hearing loss.

Sensory reach at Ntinda school of the deaf is analyzed below;

4.3.1.1 Site planning

The site is planned such that the gate has extended visual link to all buildings on site. Clear sightlines exist from every building to the gate across the field and therefore anyone approaching the school buildings from the gate will be easily identified. This is currently important for safety and comfort of the deaf community.

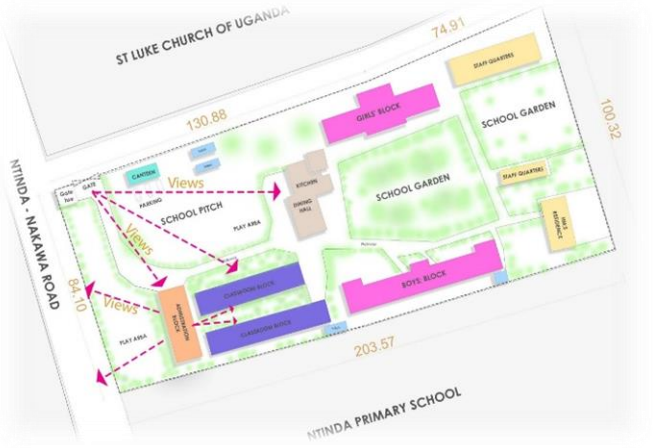


Figure 54: Site plan of the existing school showing clear sight lines towards the school facilities.

4.3.1.2 Transparency

Transparency is key to communication for the visually impaired, it's general importance is seen right from a broader context such as site planning through visually connecting spaces, it also zeros down to the connectivity with in the individual spaces through use of doors, windows and walls. In Ntinda school for the deaf, to a certain extent transparency was achieved at the site planning stage, where the most buildings visually connected to others however the individual spaces in the school lacked bit of the transparency concept as discussed below.

The doors to the classrooms and all the other office buildings are made of wood so a child entering a room cannot clearly see who is coming from the other side. However, according to

[5] People who highly rely on vision as their primary sense.

Johnson 2010, transparency or translucent doors are very important as they prevent scenarios of collision since a child entering a room can clearly see who is coming from the other side.

Figure 55: Opaque door at one of the classes

Figure 56:Opaque door at one of the dining hall

Figure 57: Opaque door in the girls dormitory towards the corridor leading to the toilet.

In addition to transparency, sensory reach was achieved through use of perforated brick work in the corridor that led to the bathroom, this prevented children from colliding with their colleagues as maneuvered the sharp corner leading to the toilets and toilets. The perforated wall extends views to the outside and makes the space feel outdoor but indoor.

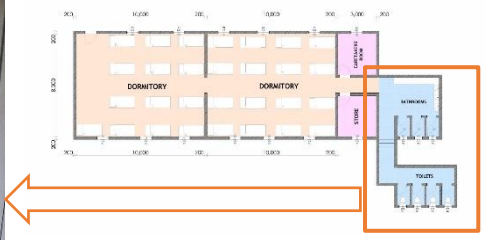


Figure 58: Perforated brick wall in the girls toilet allows for sensory reach

4.3.1.3 Openings

According to Benjamin. J. Bahan a professor of ASL and deaf studies at Gallaudet University "Door is to hearing as window is to hearing impaired." This means hearing impaired individuals have to communicate through the window and transparency is key in this case.

At Ntinda school for the deaf, sensory reach was achieved in some spaces such as the classrooms where the windows are wide enough allowing for extended views across the

surroundings. However, In the dormitories, the use of wooden windows reduces sensory reach to the outside and it creates a sense of confinement within the space, this makes hearing impaired individuals feel unsafe and hinders the use of sign language.

Figure 59: Image showing windows in one of the classes.

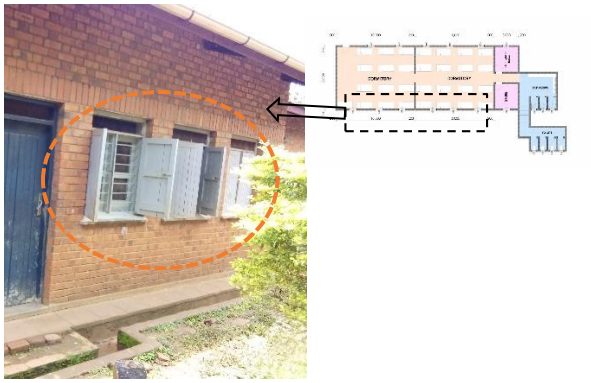


Figure 60: Wooden windows at the dormitories

4.3.1.4 Reflection

Mirror reflection is critical in increasing sensory reach especially around corners. Hearing impaired individuals fix mirrors in the space to extend sensory reach behind them and scan for someone approaching around the corner. There were no mirrors captured in any of the school buildings expect for a dressing mirror in one of the boy's dormitory. This might be contributing to reducing sensory reach for the community especially in most of the dormitories where we had long corridors.

4.3.1.5 Display devices

Frequent display can assist with connecting the hearing impaired with the building. Adequate display of information was observed on the school compound that helped to deliver special messages to the students. However, there were no door tags on most of the school buildings except for the school library, this makes it very hard for a child to tell the different rooms and their functions. For this case, the door tags in the school were improvised using chalk markings which meant there was need for them.

Figure 61: improvised door tag at one of the classrooms.

Figure 62: Display of messages on the school compound

In addition to display, painted phrases were often seen on the walls of the dormitories with motivating quotes such as “am loved”, “am not forgotten” and so many others. This increases sensory reach and connects the hearing impaired children with their building.

Figure 63: Painted motivational phrases on a wall in the boy's dormitory.

In conclusion, although sensory reach was achieved at the site planning stage through use of sign posts, most of the sign posts were damaged and some had fallen off the posts, the school also lacked sign posts showing directions to the different facilities in the institution. The author noticed that there need to replace the damaged sign posts and also introduce ones showing directions at strategic points in the school.

In addition to achieving sensory reach through use of display devices, the motivational phrases in some of the spaces such as the dormitories added richness to the space however, there is need to display the information in a more meaningful way for example through use of sign language to which the visually impaired are attached.

4.4 Mobility and Proximity

Mobility and proximity concept looks at how to make visual movements easier for the hearing impaired to navigate. The hearing impaired often move in pairs using sign language, usually much of the attention is given to the colleagues they are communicating with and less attention is given to the surroundings therefore, space has to be designed to allow them move easily as they communicate with sign language. Mobility and Proximity at Ntinda school of the deaf is analyzed below;

4.4.1 Obstructions

According to Bauman 2020, Barriers that impend movement should be avoided in deaf spaces as these may cause tripling hazards. Mobility and proximity in the case of Ntinda school for the deaf resolved around the classrooms, offices, dormitories and the dining hall as discussed below.

The entire school is designed such that there is no clear distinction between pedestrian footpaths and the vehicular driveways yet deaf space design guidelines demand that the two are distinct with crossing points properly marked to enable individuals to scan hazards while transiting from one point to the other.

According to Bauman 2020, Barriers that impend movement for the hearing impaired should be avoided and use of ramps instead of stairs is one of the ways. Through observation, all the facilities in Ntinda school for the deaf were designed with ramps, this avoided scenarios of tripling over as children ran around the school premises.

Figure 64: image showing a ramp leading to the classrooms.

4.4.2 Paths and walkways

The ability of two signers to move within space and communicate at the same time is determined by the width of the path and the edges of the circulation path.

Most of the circulation paths on the school compound range between 2m to 3.5m in width, the author observed that some of the paths could not allow for groups of children to move while making a conversation without some of them stepping out of the path to maintain signing distance.

Figure 65: Circulation path at the school premises.

The figure below shows the different circulation routes and in the school and their respective widths.

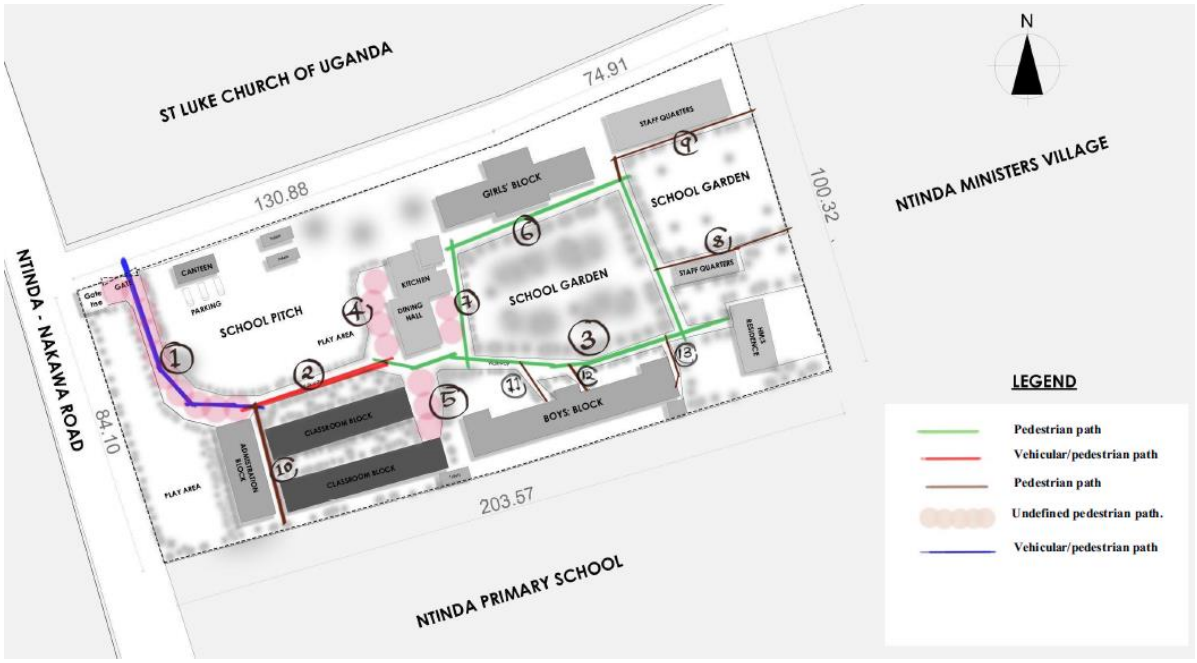


Table 4:Shows widths of different circulation routes in Ntinda school for the deaf.

Circulation route	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Measured width	∞	3.5	3.8	9.6	∞	∞	∞	n/a	n/a	3.4	1.5	1.5	n/a

Legend: ∞ - *represents a circulation route that is undefined i.e. it has no clear boundaries.*

n/a – *represents a circulation route that was not accessed by the author.*

According to Bauman 2020, the minimum width of a circulation route is 3m. However, in Ntinda school for the deaf, the author observed that most of the paths were undefined and one could not tell the difference between the vehicular driveway from the pedestrian pathway. Therefore, the circulation routes were rather inappropriate in a sense that pedestrians had to share circulation with vehicles which could create accident scenarios.

Furthermore, the passages at the classrooms and offices are 2m wide and 1.6m respectively inadequate for a group of signing children to communicate while walking, the same passage has a waiting area furnished with seats causing tight space that does not facilitate sign language while transiting.

Figure 66: Passage along the classrooms

Figure 67: Passage at the administration block

Below is a table that shows the existing widths of both passages and corridors in the different buildings with in the school in comparison to the minimum required standards as provided by Architect Bauman. 2020 in his publication 'DeafSpace design architectural guidelines.'.

Table 5: Shows the existing circulation measurements in comparison with the minimum required standards.

Space	**Passage width (m)**	**Recommended width (m)**	**Corridor width (m)**	**Recommended width (m)**
Administration block	1.6 m	3.0 m	--	--
Classrooms	2.0 m	3.0 m	--	--
Boy's dormitory	--	--	1.1m	2.4 m
Girls' dormitory	--	--	1.1m	2.4 m

Note: -- *means the specific item is not available in the specific space.*

As shown in the table above, it clearly indicates that none of the circulation spaces met the minimum required standards as recommended by Architect Bauman.

4.4.3 Conversation nodes

According to Bauman 2020, there is need for conversational nodes where the hearing impaired can have conversations in circulation spaces therefore he proposed eddies along corridors and pathways. At Ntinda school for the deaf, no defined conversation eddies were observed however, children created their own conversational nodes for example the school pitch was a hotspot for conversations as students moved to and from the toilet.

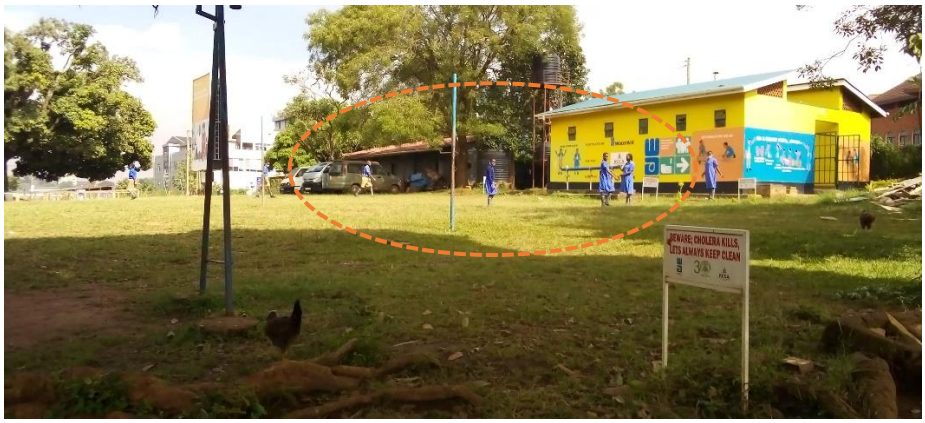


Figure 68: Conversations in the school pitch

In the school premises, no chamfered or glass corners were seen, this created dangerous scenarios of children running into each other as they maneuvered corners especially in places that had long corridors such as dormitories.

In conclusion, most corridors in the school were narrow and they limit conversations of children while walking and most of the circulation pathways were not clearly demarcated from the vehicular driveways. Therefore, there is need to extend mobility and proximity both at site planning stage and at building planning stage.

4.5 Space and Proximity

The concept of Space and proximity emphasizes that the hearing impaired have adequate space to move their arms and hands and enough distance to view the other person's signs comfortably without obstruction.

Furniture layout

Arrangement of furniture is key in aiding sign language communication, In Ntinda school for the deaf a typical classroom has a linear furniture arrangement, this arrangement of furniture does not support child to child communication. The author observed that not even a single

classroom had a concentric arrangement of furniture as recommended by Martins and Gaudiot 2012 in his book “the deaf and classroom design.”. The author also observed a lot of obstruction with in the classrooms and children often had to stand and turn to communicate to their colleagues at the back of the class. It is therefore led to the conclusion that the existing arrangement of furniture did not support effective communication while using sign language in the classrooms.

Figure 69: Image showing a typical classroom arrangement in Ntinda school for the deaf.

The images below illustrate the existing classroom furniture arrangements as compared to the recommended furniture arrangement in a visually centered classroom.

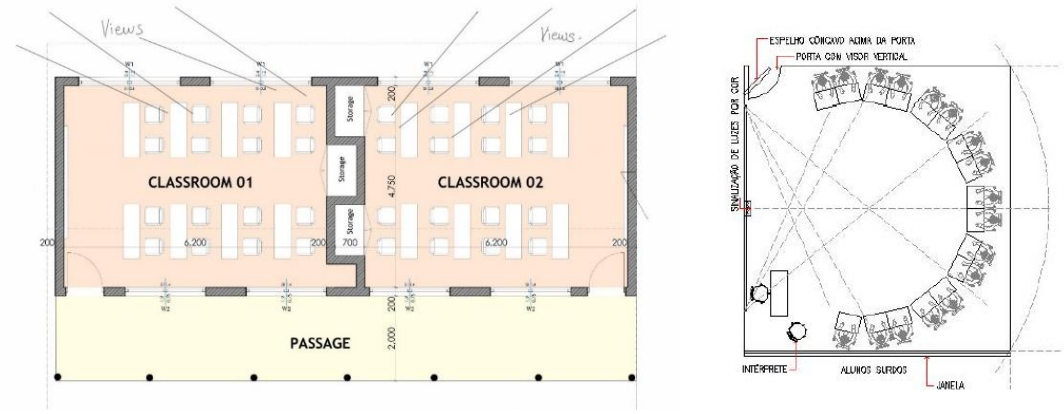


Figure 70: a) typical layout of a classroom in the school. b) Classroom layout in circle form. (Martins and Gaudiot 2012)

Furthermore, the dormitory arrangement in Ntinda school for the deaf was in rows and columns, this hinders communications among children while in the dormitory and it gives obstructive views across the dormitory so children cannot easily communicate.

Figure 71:Image showing a typical dormitory arrangement in Ntinda school for the deaf.

The images below illustrate the existing dormitory furniture arrangements as compared to the recommended furniture arrangement in a visually centered dormitory.

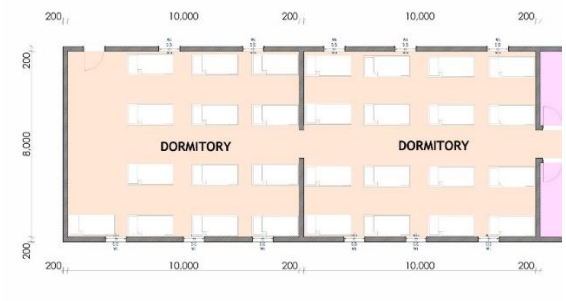


Figure 73: Typical arrangement of furniture in the dormitory.

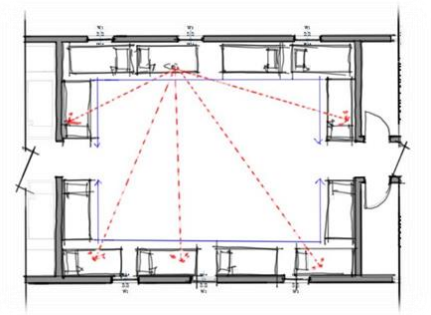


Figure 72: Recommended dormitory furniture layout in circle form.

Apart from furniture arrangements, the concept of space and proximity also gives a unique identity to the furniture shapes within spaces. The concept officiates that the furniture used in visually centered spaces should allow for clear sightlines across the furniture and therefore individuals using sign language should easily communication with their colleagues without obstructions.

In Ntinda school for the deaf, the author observed that none of the spaces, not even the interactive spaces such as the dining hall and the library was furnished with tables that favored cross communication using sign language, the dining and library spaces were furnished with rectangular tables that hindered communication across the tables. DeafSpace architectural design guidelines recommends the use of round and horse shaped tables that allows individuals seated in a group to communicate with all participants on the table as opposed to the square tables.

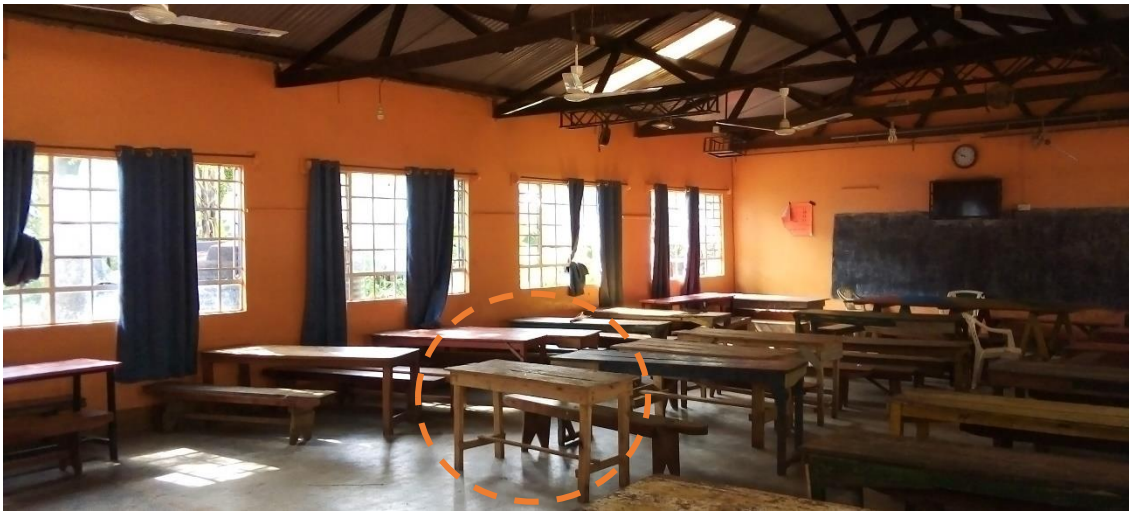


Figure 74: Image showing the furniture sets in the dining hall that hardly favors sign language communication,

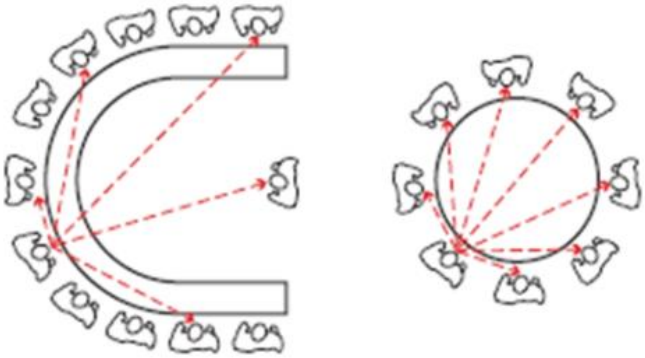


Figure 75::Recommended furniture for group discussions

In conclusion, although space and proximity was achieved at site planning stage by having clear sightlines across buildings, it was not appropriately achieved at unit planning stage, there were obstructive sightlines with in most of the spaces due to the linear furniture arrangements. Therefore, there is need to increase space and proximity within the spaces to allow for easy communication.

4.6 Light and color

Light and color in spaces should be ideal for visual communications between teachers and students. The concept of light and color mainly talks about natural lighting, lamps and openings.

4.6.1 Light

4.6.1.1 Natural lighting

The hearing impaired need adequate natural lighting in space such that they can clearly see the hand movements and facial expressions of their colleagues as they communicate. The amount of light in a room depends on the size of the opening, its glazing and the colour of the surfaces within the space, however emphasis should also put to avoid glare as this could be a distracting factor as the hearing impaired communicate.

Although light was not quantified in Ntinda school for the deaf, the author made observations in some of the key spaces such as classrooms, dining hall and the dormitories as discussed.

Classrooms

The classrooms are designed to maximize natural lighting. A typical classroom layout has 2 wide windows (2.4x1.2m) on one side and 2 clerestory windows (1.9x0.75m) on the other side, these allowed in enough lighting into the space to support visual communication between teachers and students without straining the eyes. Furthermore, vegetation along one side of the classrooms with wide windows helped to reduce direct sunshine into the classroom thus reducing on glare.

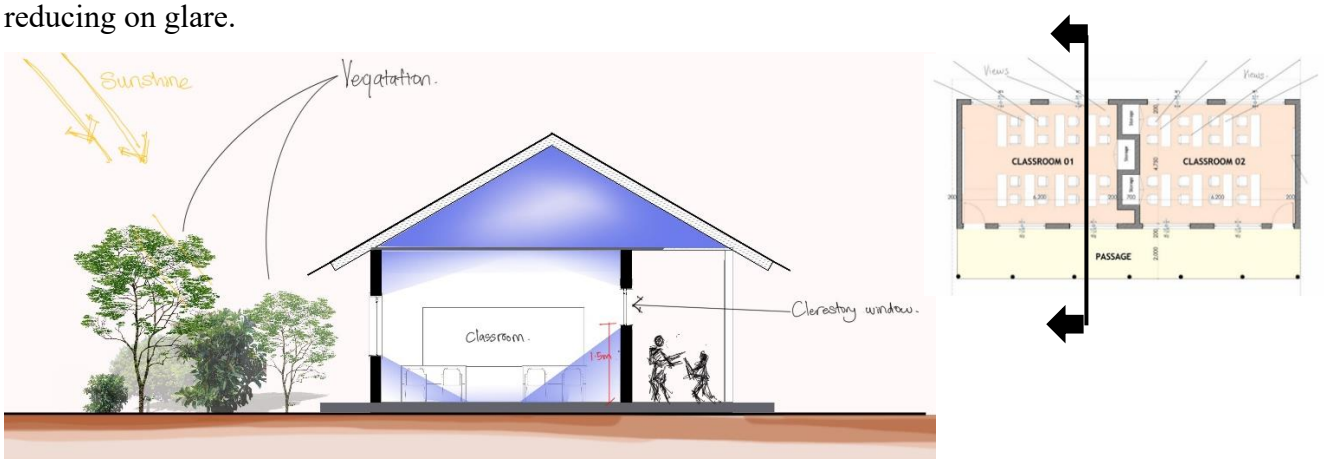


Figure 76: A section through one of the classroom blocks showing lighting..

Dormitories

In the dormitories, the author observed that the natural lighting was quite inadequate, the dormitories were dark throughout the whole day no matter whether the windows were open and this forced the dormitory attendant to keep the artificial lights on all day. The author observed that the darkness in the dormitories could be attributed to the small wooden openings and the dark colors with in the space. A typical dormitory elevation in Ntinda

school for the deaf has a band of small wooden openings on either side of the dormitory.

Figure 77: A band of wooden openings on the dormitory block.

Dining hall

Although the openings in the dining hall are wide enough and glazed to bring in light in the communal space, the space still felt dark and children could hardly communicate across the facility. The author attributes the cause of darkness to the dim colours within the space, the dark screed flooring and the lack of a ceiling in the facility.

Figure 78: A photo taken in the dining hall.

4.6.1.2 Emergency system

Light can also be used as an emergency response for example through use of visual alarms. (Hauan 2017). In Ntinda school of the deaf no single emergency system seemed to be used. When asked the author was informed that the school relied on clocks to inform students about change of periods, this seemed impractical since not every child can read the clock. In addition to this, no visual door bell was seen in the school not even in the offices creating a challenge of knowing who is knocking at a door.

The school should adopt emergency systems such as visual door bells on classroom doors, dormitory doors and office doors to enable individuals tell a person on the door. Visual alarms should also be installed in classrooms and other strategic points on the school compound to inform students and teachers about change of periods. Through observation the author identified strategic locations suitable for visual alarms and some include along the classroom passages, within the dormitories, along the administration passage and in the quadrangles as illustrated in the sketch below.

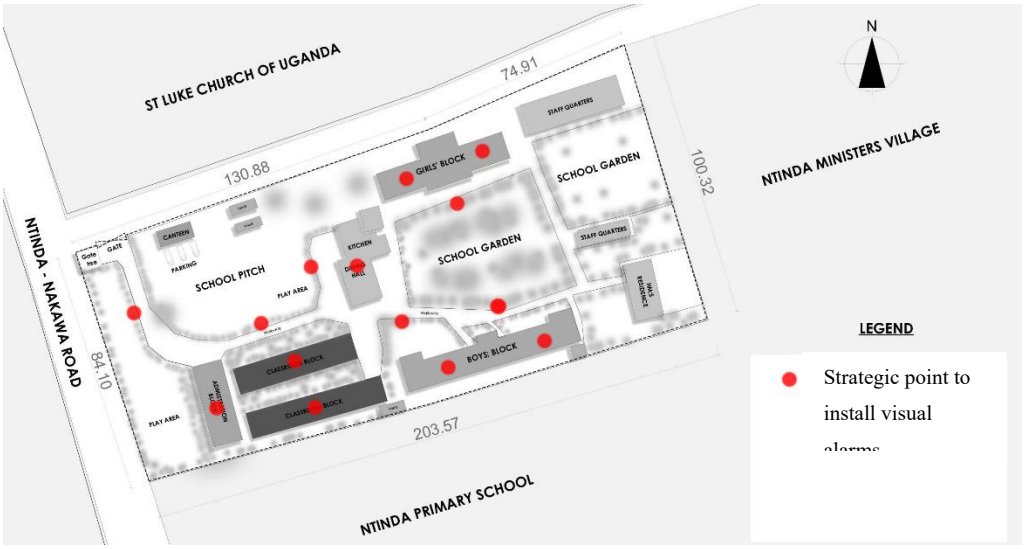


Figure 79: Site plan showing strategic locations of visual alarms in the school.

4.6.2 Color

Colour influences the behavior and the mood of the hearing impaired. Communication using sign language is dependent on visual clarity. A visually centered environment requires clear contrast between the background and the signer for effective communication. According to Bauman 2020, designers should embrace use of colours that are contrasting and complimentary to the skin and therefore blues and greens are recommended.

Contrasting backgrounds

In Ntinda school for the deaf, the idea of a contrasting background was partially achieved in some of the spaces in the school such as the classes and some of the few dormitories. It however remains true that some of the spaces did not achieve the concept of contrasting backgrounds for example in most of the dormitories and in the dining hall which made the spaces hard for use of sign language. In more detail the author endeavored to tabulate the rooms and their respective interior colors as shown below.

Table 6:Table showing the colours in some of the spaces in Ntinda school for the deaf in comparison to the recommended colours.

Space	**Classrooms**	**Dining hall**	**Boys' lower dormitory**	**Boys' upper dormitory**	**Girls' dormitories**	**Offices**
Colour painted in the space.	Green & white Blue &White	Orange	Green & yellow	Dark grey & light grey	Light blue	White
Recommended colour.	Blue / Green	Blue / Green	Blue / Green	Blue / Green	Blue / Green	Blue / Green
Pass/Fail	P	F	P	F	G	F

F - represents failure to achieve the recommended colour.

P - represents partial fulfillment of the recommended colour.

G - represents achievement of the recommended colour.

The table above clears stipulates that most of the spaces in the school did not achieve the idea of a contrasting backgrounds that makes sign language communication easy. There is therefore urgent need to adopt colours that are contrasting to the human skin such as blues and greens in most of the spaces in the school.

Figure 80: Image showing color blue used in one of the classrooms.

Figure 81:Image showing a green wall in one of the dormitories.

4.7 Acoustics

Noise can be distracting and extremely painful to a hearing impaired individual who uses cochlear implants. The implants work in a way that they amplify sound received therefore when there is unnecessary sound, it could be distracting to the individual using them. Although no student was seen with a cochlear implant in Ntinda school for the deaf, the administration still has hope to avail cochlear implants to some of the students with partial hearing. This did not stop the author from making discussions and conclusions about the noise levels in the school and how it has been handled.

4.71 Noise control

Although the author was not able to quantify the quality of sound in the school, general discussions and conclusions were made based on observation.

The school is generally located in a quiet neighbourhood and therefore it was generally quiet with less sources of external noise. The only source of external noise was from the Ntinda-Nakawa road of which the designer did a recommendable job to screen of the noise as discussed below.

Noise from traffic along Ntinda – Nakawa road was controlled by creating an open green field buffer between the road and the buildings (as illustrated in the figure below), the open green field buffer of about 25m width between the school buildings and the Nakawa-Ntinda road creates a reduction in the traffic noise affecting the spaces close to it.

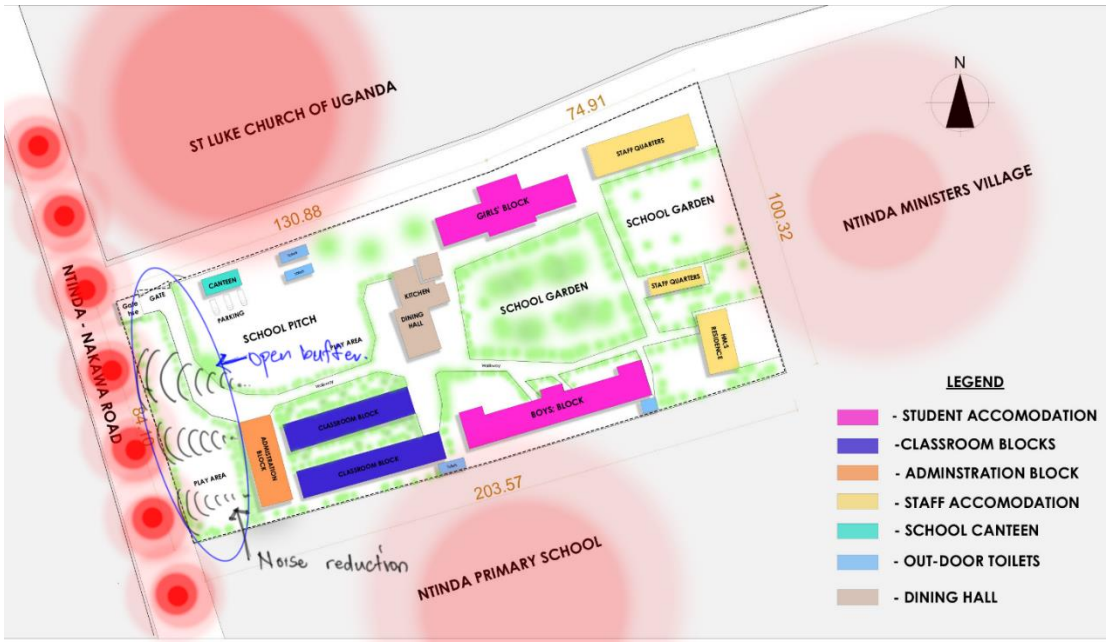


Figure 82: image showing external noise sources at Ntinda school for the deaf.

Apart from external noise, other sources of noise such as internal noise from vehicular driveways and other rooms could also be disturbing to the hearing impaired with cochlear implants. The author observed that internal noise in the school was from mainly vehicular driveways and corridors/ passages along buildings.

Internal noise along passages in the classroom block was controlled by designing a typical classroom with 2 clerestory windows on the side with a passage, this helped to reduce noise from the passage into the classroom. On the opposite end, the classroom was neighbored by a vehicular drive way leading to the dining hall which was also a source of disturbing noise, however placement of vegetation between the classroom and the drive way did much to reduce on the disturbing noise into the classroom.

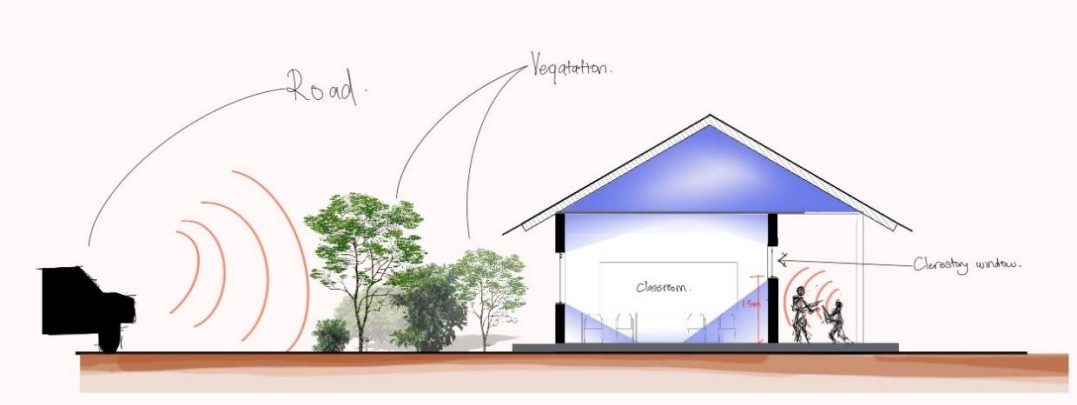


Figure 83: Image showing external noise sources in the classrooms.

The author observed minimal sources of internal noise in some of the spaces such the dormitories and the staff quarters since they were placed far apart from most sources of noise such as driveways and kids play areas.

In conclusion, well as some effort was put in place to protect spaces from external and internal noise within spaces, less effort was put in place to create ideal acoustics within the spaces and no single space was insulated not even in the multipurpose/dining hall where much noise is expected.

4.8 Summary of findings and discussions on Ntinda school for the deaf.

Summary of data findings and discussions in Ntinda school for the deaf.

Conceptual component	Sensory reach	Mobility and proximity	Space and proximity	Light and color	Acoustics
Findings/ comments	Doors and windows are purely opaque reducing on the sensory reach beyond the spaces. No mirrors were observed not even in spaces with long corridors. No door tags were seen on door openings affecting way finding for new individuals in the community. The compound has adequate display information , the school uses this as a mean to communicate messages to hearing impaired children. Display phrases within dormitories helped to create an attachment of the deaf children with their building.	The school has no distinction between footpaths and vehicular driveways , this could be dangerous for the children. Use of ramps instead of stairs increased sensory reach , this avoided scenarios of trippling over of children as they run around buildings. Narrow passages and corridors in spaces limits signers to communicate while walking. Sharp edges in spaces with long corridors created scenarios of children colliding with each other as they maneuvered corners.	Furniture arrangement in classrooms and dormitories did not allow for sign language communications.	Expansive window openings in classrooms bring in enough light into the the spaces. Opaque window openings in dormitories create dark spaces hindering sign language commununication. Use of clerestory windows in classrooms regulates lighting into the space reducing scenarios of glare. Classrooms are well shaded with vegetation reducing on glare into the spaces. No emergency system is in the school. Most of the interior spaces are painted green and blue giving a contrast between the signer and the background.	External noise from Ntinda – Nakawa stretch is controlled from reaching the classrooms by an open green buffer . No ideal acoustics within spaces were observed.

5.0 CONCLUSIONS AND RECOMMENDATIONS.

5.1 Introduction

This chapter presents conclusions and recommendations based on findings from Ntinda school for the deaf and analysis of Literature review. The study was undertaken to discover the current status of the school and check if the school is suitable for the hearing impaired taking a comparison with the literature review. The objectives and research questions posed in the introductory chapter 1 of the research were used as guides to the case study analysis.

From the findings, it is clear that to a greater extent, not much concern has been put in place to design spaces suitable for the hearing impaired children in the selected case study.

Some outstanding challenges have been identified in data collection and analysis chapters above that still hinder the comfort of the hearing impaired children with in the built environment.

5.2 Summary of conclusions and recommendations.

This section gives a brief analysis and suggestions arrived at from data presented and analyzed on ways to improve the spaces for the hearing impaired. The section however focusses on conclusions and recommendations that should be adopted for Ntinda school for the deaf under aspects of sensory reach, mobility & proximity, light and color, space & proximity and acoustics.

5.2.1 Site planning

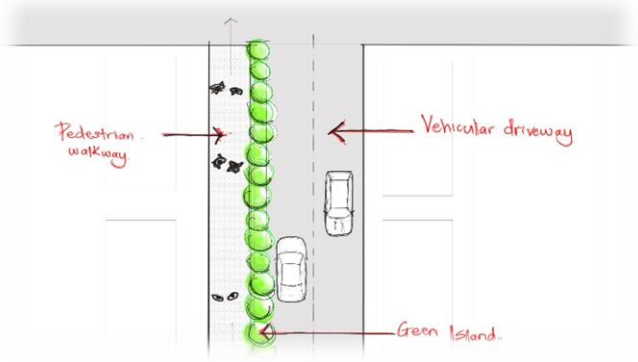
In Ntinda school for the deaf, the study established that most of the buildings in the school are arranged around a series of courtyards, this lead to extended visual link across buildings in the school which is very important for people with hearing loss.

The study also established that the school is designed with no clear distinction between pedestrian paths and vehicular driveways which could result into scenarios of children run into vehicles.

Recommendations

Design of the pedestrian pathways and vehicular driveways should ensure that the two are distinct with crossing points properly marked to enable individuals scan for hazards while transiting from one point to another. This should be achieved through the following ways;

Introduce landscape elements such as shrubs and lawns between the pedestrian pathways and the vehicular drive way to avoid scenarios of collision.



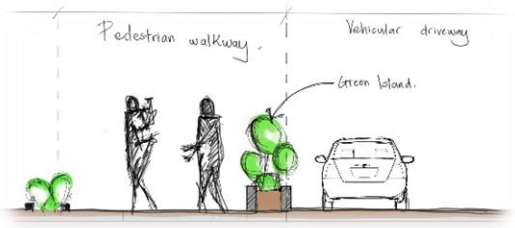


Figure 84: Sketch section across the pedestrian walkway.

Figure 85: Sketch plan showing introduction of a green island between the pedestrian walkway and the vehicular driveway.

Introduce texture edges where pedestrian walkways meet drive ways to provide a clue to signing children as they approach these points.

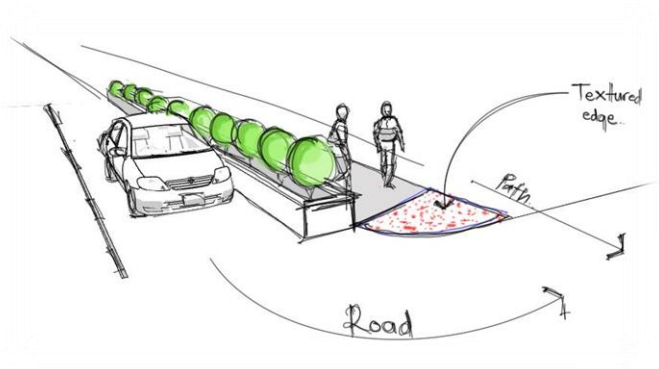


Figure 86: A sketch showing the introduction of a textured edge where a path meets the drive way.

5.2.2 Sensory reach

Sensory reach refers to the ability of visually centered individuals to observe their surroundings with ease and clarity. This concept looks at spatial awareness and the ability to see movements and facial expression of others is important.

Conclusions on sensory reach.

The study established that some spaces for example the dormitories were very dark and prohibited communication across the spaces. It further documented that most of the spaces in Ntinda school had solid core doors that blocked visibility across spaces, a child entering a room

could easily collide with a colleague coming from the other end. The research also revealed that the dormitories had long corridors with sharp corners, this created scenarios of collision of children as they maneuvered corners.

The research further established that most of the spaces and buildings in the school for the deaf lacked signage while the ones available were not legible, therefore, it was very hard for a new child in the school to identify the different rooms and buildings.

Recommendations on sensory reach.

Replace the wooden windows in the dormitories with glazed windows to extend sensory reach beyond the dormitories. This will also increase lighting within the dormitory allowing for children to communicate with sign language easily.

Introduce doors with insulated glass panels in spaces to extend visibility across rooms. Glass panel doors according to Bauman (2020) allows a child approaching a space to clearly see a colleague coming from the other end and it prevents scenarios of collision as individuals move from one room to another. Preferably the glass panel should be 600mm from the bottom line of the door and its total height should be 1.5m as illustrated below.

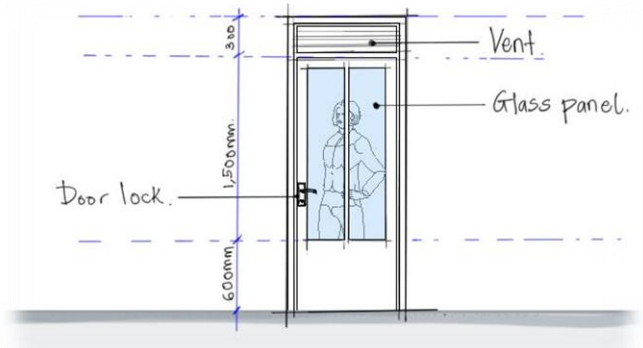


Figure 88: Sketch showing a door with glass panels.

Figure 87: Sketch showing visibility across the door.

Provide all buildings and spaces with signage and replace the existing ones with legible signs. Introduction of signs ensures proper way finding for the hearing impaired individuals. Signs showing fire escape routes, evacuation routes and hazardous areas should be placed at the necessary points in the school to guide the children.

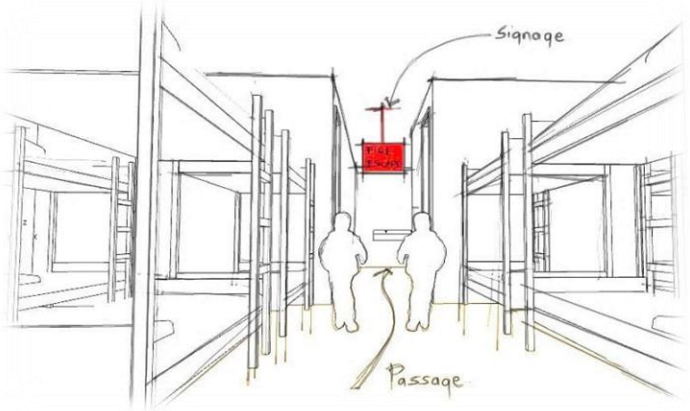


Figure 89: Sketch showing a signage at the end of the passage.

Introduce chamfers at corners and place angle mirrors at the end of passages to extend sensory reach beyond. For example, in the case of the dormitory layouts as shown in figure 87, chamfer the corners between the sleeping area and the washrooms and place angle mirrors at the chamfered edges to allow children maneuvering corners to see each other.

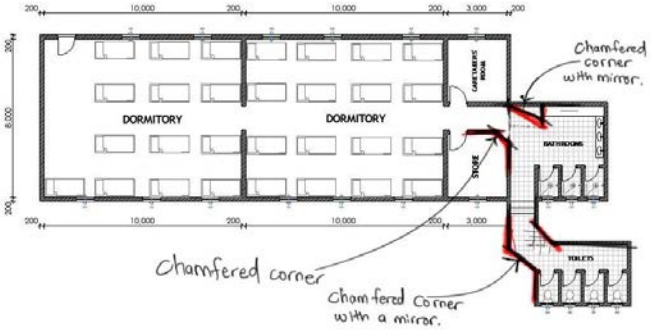


Figure 91: Sketch plan of the dormitory showing corners to be chamfered

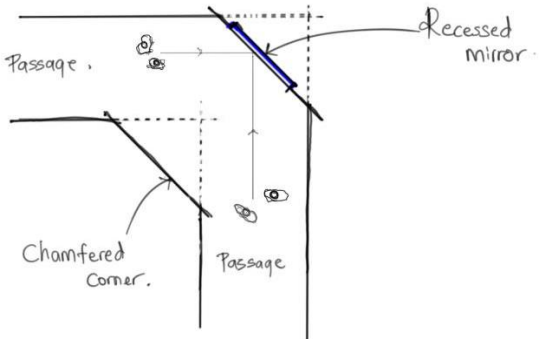


Figure 90: Sketch plan illustrating movement around a chamfered corner

5.2.3 Mobility and proximity

Mobility and proximity looks at how to make visual movements easier for the hearing impaired to navigate.

Conclusions on mobility and proximity.

The study established that corridors and passages in the school were very narrow and did not accommodate groups of children to sign while moving. The passages in the school range between 1.6m to 2m, however according to Bauman (2020) visually centered individuals require wider passages to accommodate movement while signing.

Recommendations on mobility and proximity.

Widen all the passages and corridors to atleast 2.4m and introduce curving edges at all corners to enhance mobility. According to Bauman (2020), the minimum width of a primary passage of visually centered individuals should be 2.4m.

5.2.4 Space and proximity

The concept of space and proximity emphasizes that the hearing impaired should have adequate space to move their arms and have enough distance to view each other persons' signs comfortably without obstruction.

Conclusions on space and proximity.

The study established that furniture arrangement in most of the spaces was linear which hindered communication among the visually centered children. According to Johnson (2010), linear arrangements of furniture is unfavorable to visually centered communication. The study also established that the interactive spaces such as the dining hall and the library had rectangular shaped tables which hindered sign language interaction among groups of children sharing a table.

Recommendations on space and proximity.

Adopt concentric layouts of furniture in the classrooms that are favorable for visual communications among visually centered individuals. Preferably a U-shaped furniture arrangement should be adopted to allow individuals to have eye contact with all their colleagues within the space.

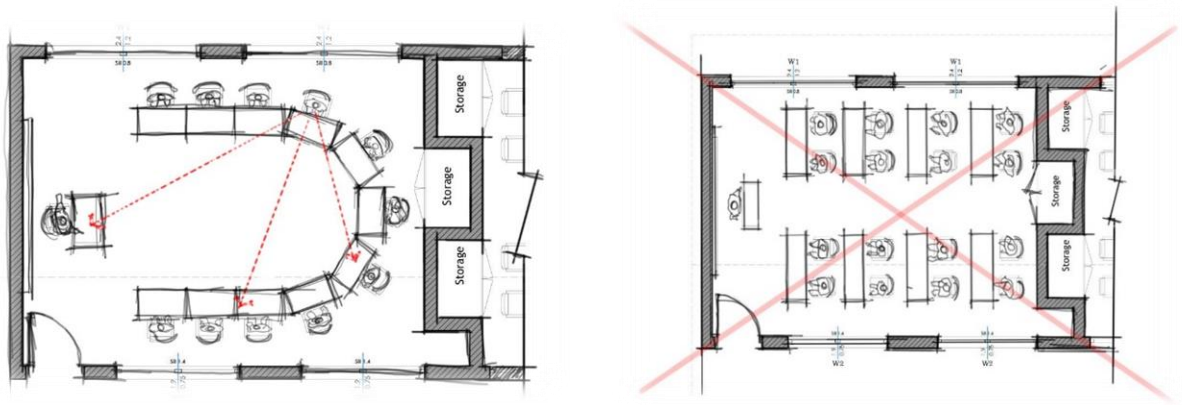


Figure 92: A sketch showing U-shaped furniture arrangement in a class verses the linear arrangement.

In addition to furniture arrangement, organize the beds in the dormitory such that there is no obstruction. Preferably organize the beds in a regular shape to allow children communicate with ease across the dormitory.

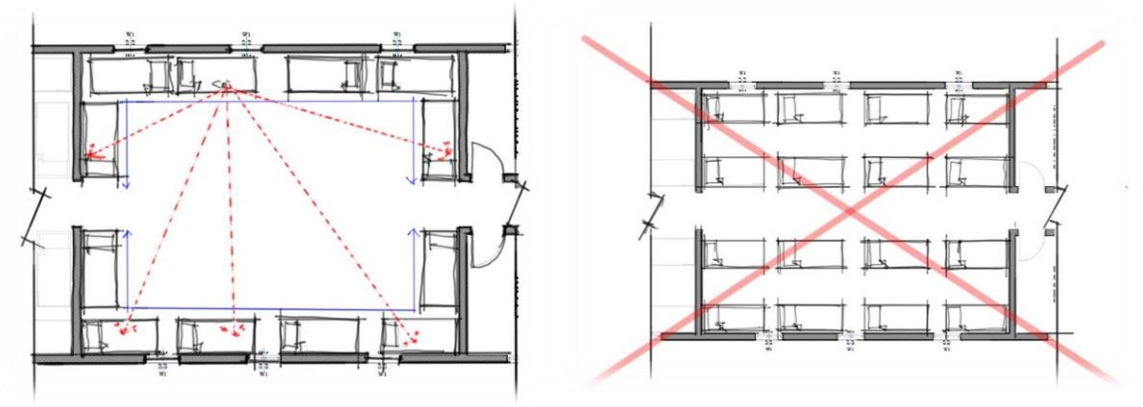


Figure 93: A sketch showing a rectangular shaped furniture arrangement verses the linear arrangement .

Replace rectangular tables in the dining hall and library with round tables that favor visual interactions across the table.

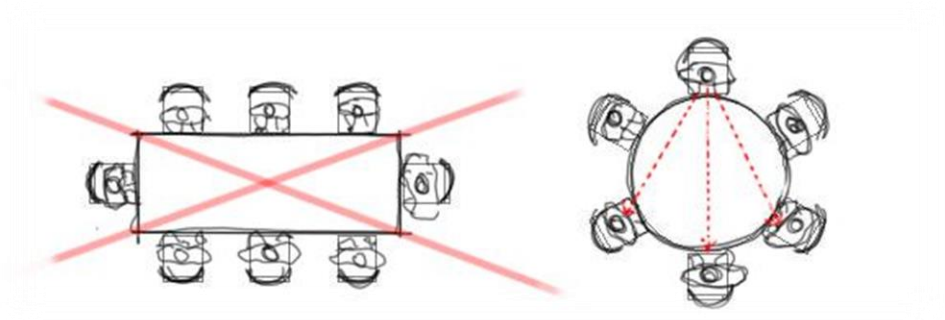


Figure 94: A sketch showing a rectangular table seating arrangement verses the round table.

5.2.5 Light and colour

The hearing impaired rely on light and color of spaces for effective communication and to create spaces that feel safe and comfortable. Color selection and light in space can influence hearing impaired behavior, so they can read situations. The concept of light and color entails natural lighting, choice of artificial lighting and type of openings.

Conclusions on light and colour

The study established that the school had no emergency system in place to alert students in case of danger. It further established that the school lacked a communication system to alert students when its came to change of programs such as break time, lunch time, assembly time and many others. The research established that there is evidence of a lot of shadows and

darkness in the dormitories that hindered sign language communication and made the space feel unsafe. It further revealed that some of the windows in the school are exposed to direct sunshine especially in the dining hall and in the offices and this created a lot of glare within the spaces that hindered sign language communication. Finally, the study revealed that internal walls in some of the spaces were painted with reflective colors that created visual competency for the signers.

Recommendations on light and colour

Install a light sensor alarm system to alert someone when a visitor is approaching, this is applicable in offices and classes to alert a teacher when a child is at the door. In addition to emergency systems, install visual alarms to alert students in case of danger and change of program. According to Deaf Space design guidelines by Bauman, it requires that visual strobes be installed in conjunction with emergency alarm systems to alert visually impaired individuals (Bauman 2020).

Replace the wooden openings in the dormitories with wider windows that are glazed to allow in more light into the space and provide sun shading devices for windows exposed to direct sunshine.

Finally, introduce a range of colors ranging from blue to green on the interior walls. According to Hauan (2017), colors that contrast with the human skin color tones are vital for users of sign language to ease eye strain and increase visual dominancy therefore colors that range from blue and green are ideal since they lie on the opposite side of the color wheel with the skin color tones.

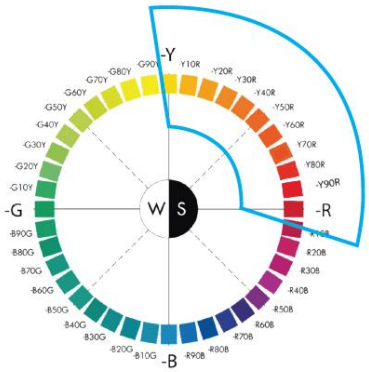


Figure 95:Image shows skin color tones in a color wheel Hauan(2017)

5.2.6 Acoustics

Although the hearing impaired have a hearing deficiency some have auditory abilities and they use assistive devices such as hearing aids or cochlear implants to enhance sound. Cochlear implants and hearing aids operate by amplifying the direct first arrival signals sent from a

speaker. Problematic conditions occur because they also amplify late multiple arrivals of the voice and other background sounds. This can cause distraction and physical pain.

Conclusions on acoustics.

The study revealed that most of the school buildings have damaged ceiling boards which may contribute to noise entry into the spaces, a distracting factor to the hearing impaired individuals and it also established that minimal efforts were put in place to control entry of background noise into most of the spaces therefore there is need to insulate the spaces.

Recommendations on acoustics

Replace the ceiling soft boards with a coffered gypsum ceiling to diffuse sound which may be a distracting a factor for the hearing impaired.

To reduce on background noise, use acoustic doors and windows to reduce break-in noise from the outside. In addition to noise control, fit furniture with rubber feet to reduce on disturbing noise across spaces.

Introduce soft boards on internal walls to diffuse sound to avoid sound interference from adjacent noise sources and replace cement sand screed flooring with acoustic absorbent materials. Preferably replace with dampened wooden strip flooring.

5.3 General Recommendations

From Literature review standards, there is urgent need to develop DeafSpace Architectural Guidelines on schools for the hearing impaired in Uganda and the government should come up with a comprehensive enforcing strategy. The following general recommendations were made:

Limited DeafSpace Design Guidelines in the school has been a major cause of poor Architectural design in deaf learning spaces, professionals are sometimes ignorant of the need to develop and apply these standards when there is critical need. They are forced to rely on their basic knowledge on DeafSpace and in the end they create containers where children study from rather than understanding the ideal spatial qualities for a hearing impaired individual. Therefore, there is urgent need to develop comprehensive standards to guide the development of physical facilities for hearing impaired in schools so that we can create spaces that are supportive.

As mentioned above, the schools for the hearing impaired are just containers where students only go to study, designers are ignorant to understand and apply the best indoor environment quality needed for them. As seen in the report, best indoor quality boosts productivity. Therefore, extended sensory reach, good lighting and colour rendering, eased mobility and proximity, proper space proxemics, proper space layouts and good acoustic performance contribute to better learning and comfort for the hearing impaired.

The failure to understand the needs of the hearing impaired is one of the major causes of poor architectural designs in schools for the deaf in Uganda. If the above guidelines are taken as solutions to create a favorable environment for the hearing impaired , it will be possible to awaken their experience in learning institutions.

References

Adler, P. A. and P. Adler (1994). "Observational techniques."

Bauman, H.-D. L. and J. J. Murray (2010). "14 Deaf Studies in the 21st Century:"Deaf-gain" and the Future of." The Oxford Handbook of Deaf Studies, Language, and Education, Vol. 2 **2**: 210.

Bauman, H. (2010). "DeafSpace Design Guidelines, Working Draft." Washington, DC: Gallaudet University.

Berenson, B. J. A. a. o. t. d. (1968). "The Educational Implications of Architecture for the Deaf." 1030-1039.

Daniels, R. and D. J. L. T. S. O. Unit (2003). "Acoustic Design of Schools."

Farmer, J. E., J. Donders and S. A. Warschausky (2006). Treating neurodevelopmental disabilities: Clinical research and practice, Guilford Press.

Harahap, R. M., I. Santosa, D. Wahjudi and W. J. S. Martokusumo (2019). "Interiority of public space in the deaf exhibition center in Bekasi." **23**(3): 245-252.

Hauan, T. (2017). Deaf-First Architecture: An Educational Design Framework for Deaf and Hard of Hearing.

Johnson, C. A. (2010). "Articulation of deaf and hearing spaces using deaf space design guidelines: A community based participatory research with the Albuquerque sign language academy."

Kothari, C. R. (2004). Research methodology: Methods and techniques, New Age International.

Loe, D., N. Watson, E. Rowlands and K. Mansfield (1999). Building Bulletin 90: Lighting Design for School, Architects and Building Branch, Department for Education and Em.

Martins, L. B. and D. M. F. J. W. Gaudiot (2012). "The deaf and the classroom design: a contribuition of the built environmental ergonomics for the acessibility." **41**(Supplement 1): 3663-3668.

Oblinger, D. and J. K. Lippincott (2006). Learning spaces, Boulder, Colo,.: EDUCAUSE, c2006. 1 v.(various pagings): illustrations.

Pandey, P. and M. Pandey (2015). Research methodology: Tools and techniques, Bridge Center.

Pettigrew, A. M. J. O. s. (1990). "Longitudinal field research on change: Theory and practice." **1**(3): 267-292.

Tsymbal, K. (2010). Deaf Space and the Visual World-Buildings that Speak: An Elementary School for the Deaf.

Warman, C. B. (2012). Architecture speaks: A music school for the deaf.

WHO (2020). Deafness and hearing loss. Geneva, World Health Organisation.

Bauman, H. (2010). *"Gallaudet University DeafSpace Design Guidelines*." (Volume 1).

Martins, L. B. and D. M. F. J. W. Gaudiot (2012). "*The deaf and the classroom design: a contribution of the built environmental ergonomics for the accessibility."* **41**(Supplement 1): 3663-3668.

Kakooza, M. (2019). *Raising and educating deaf children*. Foundation for Policy and Outcomes.

Yazid, N.H (2020). *Designing spaces for the hearing impaired*. University Tecknologi Malaysia

Jamshed, S. J. J. o. b. and c. pharmacy (2014). "*Qualitative research method-interviewing and observation*." **5**(4): 87.

Noor, K. B. M. J. A. j. o. a. s. (2008). "Case study: *A strategic research methodology*." **5**(11): 1602-1604
Uganda National Association of the Deaf. *Information about deaf people & services for deaf persons in Uganda*.

APPENDIX A: QUESTIONNAIRE

To the teachers of the hearing impaired

1. What is the most favorite room /space for children in this school and why?
2. What are some of the challenges deaf children face in the school buildings?
3. What are some of the challenges deaf children face on the school compound?
4. What do you think is good about this school in terms of buildings/spaces?
5. What do you think is bad about this school in terms of buildings/spaces?
6. What do you think can be done better to improve comfort of deaf children in school buildings?
7. Did I leave anything out that you would like to add about?

APPENDIX B: LETTER OF CONSENT TO COLLECT DATA

KCCA
KAMPALA CAPITAL CITY AUTHORITY
For a better City

DIRECTORATE OF EDUCATION AND SOCIAL SERVICES

REF: DESS/KCCA/508

KAMPALA CAPITAL CITY AUTHORITY
NAKAWA DIVISION EDUCATION OFFICE
17 MAY 2021
RECEIVED

4th May 2021

The Head Teacher
Uganda School for the Deaf - Ntinda
KAMPALA

RE: INTRODUCTION OF MR. KAYONDO ALEX

This is to introduce to you Mr. Kayondo Alex who is pursuing a Bachelors of Architecture at Makerere University. He is conducting research on **"Evaluation of the Suitability of Primary Schools for the Hearing Impaired Pupils"**

The purpose of this letter is to request you to accord him any necessary support as he conducts his final year research project.

Any assistance rendered to him will be highly appreciated.

HEADTEACHER
UGANDA SCHOOL FOR THE DEAF
17 MAY 2021
P. O. BOX 16150,
KAMPALA-UGANDA

Namuddu Juliet Nambi
DIRECTOR EDUCATION AND SOCIAL SERVICES

Copy: Supervisor Education Services, Nakawa Division