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Developing the Al Amal Center for the Deaf and Hard of Hearing in Derna City Using Smart Materials Technology in Interior Architecture

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ABSTRACT

This research addresses the challenges faced by deaf and mute individuals in educational settings in Libya, particularly in the Al-Amal Center for the Deaf and Hard of Hearing in Derna. Despite advancements in interior design and technology, schools for the deaf and mute in Libya remain underdeveloped, lacking modern educational tools and smart materials tailored to their unique needs. This study explores the role of smart materials and Deaf Space principles in enhancing the functionality and inclusivity of interior spaces for the hearing impaired. It emphasizes the integration of sensory and visual communication elements, such as transparent walls, adaptive lighting, and interactive surfaces, to create spaces that foster effective communication and comfort. By adopting a descriptive and analytical approach, the research proposes design solutions that align with the specific requirements of individuals with hearing disabilities, aiming to improve their educational experience and overall well-being. The findings highlight the importance of incorporating smart technologies and inclusive design principles to transform primitive educational spaces into modern, efficient environments.

1. INTRODUCTION

Discriminatory behaviors towards individuals with hearing disabilities, commonly referred to as audism, remain a significant obstacle in the design and management of public spaces (Humphries, 1977). This issue often compels those with hearing impairments to adapt to environments designed primarily for individuals without such disabilities (Harrington, 2002; Berke, 2019).

The growing number of individuals with hearing impairments has led to an increased need for educational facilities that cater to their specific requirements. Inclusive educational systems must ensure equal access to all features of education for individuals with disabilities, addressing and eliminating the impacts of audism within these systems (Bauman, 2004; Murray et al., 2014). Advancements in interior architecture during the late twentieth and early twenty-first centuries have introduced innovative technologies and materials tailored to diverse user needs. These developments aim to create spaces that meet individual requirements while adhering to the functional and structural constraints of the environment. A primary objective has been to optimize the functional performance of spaces through thoughtful architectural and interior design (Hossam & Dina, 2022). The design of lecture spaces significantly influences the behavior and engagement of students with hearing disabilities. Effective designs include U-shaped seating arrangements that promote visibility for lip reading and facial expressions, fostering interaction and communication. Bright, evenly distributed lighting, pastel-colored walls, plain finishes, and sound-absorbing materials further enhance accessibility and comfort. This study seeks to expand knowledge in DeafSpace design, focusing on creating environments that align with the cultural and social needs of the Deaf community. Despite advancements in interior design, the Al Amal School for the Deaf and Hard of Hearing in Derna lacks modern technology and smart materials. The school's facilities remain outdated, failing to provide the tools and amenities necessary for contemporary educational practices. Figure 1 highlights these deficiencies. This research emphasizes the application of integrated systems in interior design to align spaces with their intended functions. It explores the impact of smart materials on performance within educational institutions for individuals who are deaf, mute, or hard of hearing, proposing solutions to enhance these environments effectively.

2. RESEARCH METHODOLOGY:

The study is based on the descriptive and analytical approach within the spaces of schools for the deaf, mute, and hard of hearing affected by smart materials, and developing an advanced design system that keeps pace with the current era and has a positive impact on the recipient within the educational field. Also, providing spaces for the deaf and mute through designing integrated internal spaces for centers for the deaf, mute, and hard of hearing.

3. INTERIOR ARCHITECTURE AND ITS ROLE IN DESIGNING A SUITABLE AND MORE COMFORTABLE INTERIOR ENVIRONMENT:

Designing interior spaces for individuals who are deaf or non-verbal necessitates specific considerations to ensure comfort and functionality. Interior designers must carefully study the design philosophy, visual orientation, and spatial flow to create intuitive movement paths and enhance the spatial perception for these users. Incorporating smart materials, interactive surfaces, and advanced technologies is equally essential, ensuring the design aligns with contemporary trends and innovations in both interior design and architecture.

Communication involving individuals with hearing disabilities prioritizes the use of visual space. The DeafSpace concept in interior design is designed to meet the specific needs of individuals with hearing impairments, particularly in public environments. This approach emphasizes enhancing the quality of visual space for those with hearing disabilities. DeafSpace is guided by five core principles (as shown in Fig 2) 1. space and proximity, 2. sensory reach, 3. mobility and proximity, 4. , and 5. acoustics (Bauman, 2005; Worrel, 2011; Chiambretto & Trillingsgaard, 2016).

In interior design and vision, people with hearing impairments use different methods to communicate, combining written language, assistive devices, sign language, or spoken language ("visual communication") as in Figure 2 in some cases.

According to the Disability Act, on average only a third of spoken words can be understood through speech reading or lip reading), and therefore it is necessary to design an internal environment for effective communication within different spaces, which means that the interlocutors must always be able to face each other comfortably without having to stop looking at each other while speaking.

In the opposite figure, No. 2, the optimal methods for visual communication in internal spaces between deaf and mute people are shown through the personal space of the individual and the personal spaces of a group of individuals to achieve the highest standards of understanding and communication between these individuals within the different spaces.

Visual communication aims to improve human health and well-being, reconnect with the surrounding internal environment, and bridge the gap in the relationship between humans and the internal environment, as the communication method has a positive impact on human health, performance, and general safety.

Methods of communication in the centers for the deaf and dumb through the methods of guidance within the internal spaces, which are represented in the following points:

1.Improving vision, which means improving the visual field and removing visual obstacles within the spaces, especially since the field of vision more than 180 degrees.

2.Space and proximity: This refers to the judiciary and internal spaces, as well as the determinants and elements of interior design. Proximity constitutes comfortable space for hearing impaired users to move around.

3.Sensory access: is access to a place visually or through any other sense without movement.

4.Vibration and sound: After vibration, as an alternative to sound, for the centers and spaces of the deaf and dumb, it is evidence for Access.

5.The possibility of movement, by facilitating movement, whether horizontally or vertically, including stairs and electric elevators. Users also need a horizontal space for communication or sign language.

6.Transparency: This is in spaces, either through surfaces, whether completely transparent through completely transparent surfaces or completely transparent. Partially by semi-transparent or perforated surfaces and controlled either mechanically or electrically fixed surfaces. Of course, these points enhance the ease of communication between deaf and dumb individuals (Hossam & Dina, 2022) .

Interiority for individuals with hearing disabilities refers to a concept encompassing specific criteria related to body movements and communication methods (visual cues) that influence the accessibility quality within a space. Key elements include visibility, lighting, spatial layout, acoustics, colors, and materials. When these criteria are not adequately addressed, the functionality of interior elements within the space may be compromised. This could lead to challenges for people with hearing disabilities, such as difficulties in communication or understanding certain spatial conditions (Kloese and Ramadani, 2013 in Harahap, 2019).

Interiority combines non-physical images from the mind with the experiences of physical or internal spaces, shaping the emotional connection between people and places (Kole 2017; Harahap 2019). Human experience is inseparable from the perception of space. Leslie (1998 in Kole 2017) highlights that processing and reconstructing human experience often manifest through storytelling about past events. The experience of a place can be seen as personalizing it—imbuing a space with personality or identity. This spatial identity is achieved by integrating the exterior elements of a building with interior components such as furniture, color, lighting, movement, finishing materials, and more (Rice 2006).

Figure 3 illustrates the behavior of individuals with hearing disabilities, emphasizing the need for gestures (body language) and visual cues to facilitate communication within a space. It provides an example of spatial planning that integrates the DeafSpace concept, supporting effective communication for those with hearing challenges.

Columbia University Chicago creates unique spaces for the deaf community. Considering wide or circular distributions rather than linear distributions for spaces larger than 4 people can facilitate an open communication channel for the recipient within the space. Where all participants can see each other as in the opposite figure No. 4.

It is essential to create ways that allow people to see each other while walking and still cross spaces safely. Ramps, automatic doors, graphic safety elements and signage are equally useful in this situation.

A general practical principle in interior design for the deaf is to maintain sufficient distance between two or more people, so that everyone can have a full view of each other's faces. For example, buildings need wider aisles, so that two people can walk to each other, maintaining a safe distance, and sufficient for communication.

Even when designing interior features with flexible furniture especially in collaborative workspaces, allowing participants to arrange their individual spaces, preferably with the seating arrangement in the direction of natural light, because the eyes of deaf people are in the main receiver of information and are therefore constantly strained.

- The role of brightness, light and reflections in the interior design of deaf and dumb centers.

Light plays a fundamental role in the interior design of deaf and dumb centers. It is not only comforting, but in this case it achieves. An element of communication between individuals within different spaces, natural or artificial lighting must be sufficient to ensure clear vision but avoid glare, and continuous to avoid sudden changes in the atmosphere that can be disturbing, and It should be organized to achieve function and comfort for the recipient within the space, as well as using glass and mirrors (Hossam & Dina, 2022).

Placing mirrors in the interior design helps enhance spatial awareness, and the abundance of glass walls allows people to see and encourage each other, even on different floors, giving them a sense of connection, belonging and presence with people in different parts of the building.

Colors that contrast with skin tones help other people better perceive facial expressions and hand movements, so it is recommended to use windows, interior lighting, and mirrors to maintain greater visual control over the interior environment as long as they are well-placed and do not contribute to confusion in understanding the space.

When a person loses one of his senses, the rest of the senses become stronger and more intense, and thus the multi-sensory design (Multisensory spaces) achieves satisfaction for the recipient within the spaces on a wider range of users through the senses.

Colors, shades, and even vibrations can help people with hearing difficulties better understand or pay attention to their surrounding environment. In a highly visual culture, we must not forget that dealing with interior space includes all the senses (Hossam & Dina, 2022).

There are elements and techniques in addition to the cladding materials that can make the recipient feel more comfortable in daily work by translating sound into visual communications, which achieves the highest levels of acoustic comfort for everyone without using sounds or elements that are difficult for the deaf and dumb. Therefore, visual signs such as light or digital alerts, or written communication through writing boards or color codes can be considered as simple solutions for daily communication, as in Figure 8.

There are also techniques new ones that can translate sound into images and vibrations to make you more comfortable, or apps that recognize ambient sound or translate (Hossam & Dina, 2022)..

The role of interior design in rehabilitating the hearing impaired.

In the following figure No. 9, we show the horizontal projections of a proposed model for a center for the deaf and mute, showing the movement paths to achieve well-being and comfort within the interior space for people as a whole, and the deaf and mute in particular (Shekho,2019).

1. **Interactive walls and partitions:**

There are many shapes and types of interactive walls and dividers. In figure No. 11, we show triangular thinking and the art of origami were used in the design of interactive walls and interactive partitions to direct the recipient to the interior space and make it distinctive and flexible, to improve functional performance, raise efficiency within the interior spaces, and create a flexible and fluid environment. Interactive environment (Mohamed, 2022).

2. **Interactive surfaces:**

The sensible image is a flexible video surface with multiple shapes and colors, and this technology uses a display interface that connects Surfaces of all shapes and sizes, and can be placed on floors, walls and ceilings alike.

3. **Interactive floor:**

The new thermally reactive piezoelectric materials remain effective at high temperatures as shown in Figure 13. This image shows a flexible piezoelectric material, which is a thermally reactive floor that converts mechanical vibrations into electrical energy (Mohamed, 2022).

4. . **Bright Colorful:**

Colors were used to determine the visual path in the interior spaces for the deaf and dumb to raise the efficiency of the interior space and to become an integrated interior space design as in Figure No. 14, and also as shown in Figure No. 14 the colors change according to the function with the change of time, and this achieves the highest efficiency of the interior space for the deaf and dumb and achieves flexibility of movement within the interior environment without the need for assistance and thus achieves the success of the motor paths (Mohamed, 2022). Also changing the colors of the floors according to the specific function of each floor, this achieves high efficiency of the internal space for people inside the deaf and dumb centers (Mohamed, 2022).

5. **Alert and calls by lighting:**

Lighting was used inside the deaf and dumb spaces as in Figure No. 16 In order to achieve a suitable environment that suits the requirements of the individuals inside it according to the specifications imposed by the scope of these spaces. Also in Figure No. 17 It is shown that the lighting changes based on changing the function according to the fourth dimension, “time,” (Mohamed, 2022).

Visual communication between spaces and transparent walls:

Visual path and visual communication within spaces can be an effective tool for safely managing the movement and flow of people, and encourage social distancing as shown in Figure No18.

Visual connection between spaces, transparent/semi-transparent walls, and the visual path to meet the requirements of the interior space and increase its efficiency, as in Figure No 19.
Visual communication within different spaces is achieved through the use of signage, color, light, and other design elements to help the deaf and dumb in different spaces, it is necessary to use it for deaf and dumb people, especially in places such as health care and educational places to facilitate different tasks for individuals in different spaces.

4.DISCUSSION

The research highlights a significant gap in the integration of modern design principles and smart materials in educational spaces for the deaf and mute, particularly in developing countries like Libya. Current architectural and interior design practices in such schools often fail to address the unique needs of individuals with hearing disabilities, thereby limiting their ability to fully engage and benefit from the learning environment. This discussion elaborates on the findings by synthesizing the insights from the referenced literature to propose an enhanced understanding of interior design's role in supporting the deaf and mute community.
As emphasized by Bauman (2004) and Worrel (2011), inclusive design requires prioritizing accessibility and user-specific needs in educational spaces. The DeafSpace concept, with its five core principles—space and proximity, sensory reach, mobility and accessibility, light and color, and acoustics—provides a robust framework for creating environments conducive to visual communication and interaction. The emphasis on clear sightlines, avoidance of visual obstacles, and utilization of pastel-colored walls aligns with the sensory and cognitive requirements of individuals with hearing disabilities. This is supported by Harrington (2002) and Berke (2019), who underscore the importance of designing spaces that counteract audism and promote inclusivity.
Hossam and Dina (2022) highlight the transformative potential of smart materials in enhancing the functionality and comfort of spaces for the deaf and mute. Materials such as thermally reactive piezoelectric floors and interactive walls not only elevate the aesthetic value of a space but also improve its usability. For example, piezoelectric floors convert mechanical vibrations into electrical energy, creating an interactive environment that can guide or alert users without reliance on auditory cues. Similarly, transparent and semi-transparent walls enhance visual communication, fostering a sense of connection and spatial awareness.
The emphasis on visual communication, as discussed by Kloese and Ramadani (2013) in Harahap (2019), highlights the need for unobstructed visual paths and the strategic use of lighting and colors. Mirrors and glass walls allow for greater spatial visibility and connection, enabling users to perceive activities across different areas. Moreover, color schemes contrasting with skin tones improve the perception of facial expressions and hand movements, as noted by Bauman (2005) and Chiambretto & Trillingsgaard (2016). These elements are crucial for facilitating effective communication in educational settings, where reliance on non-verbal cues is paramount.
Interactive surfaces and technologies, as described by Mohamed (n.d.), further augment the functionality of interior spaces. Flexible video surfaces and adaptive lighting systems create dynamic environments that cater to the varying needs of users. For example, lighting systems that change according to time or function provide visual alerts and cues, enhancing user comfort and engagement. Such innovations align with the recommendations of Hossam and Dina (2022), who advocate for multisensory design to accommodate the heightened sensory reliance of individuals with hearing disabilities.
The application of these principles and technologies to Al-Amal Center for the Deaf and Hard of Hearing in Derna can significantly improve its functionality and inclusivity. By incorporating DeafSpace principles and smart materials, the center can transition from a primitive setup to a modern, efficient educational facility. Wide aisles, interactive partitions, and enhanced lighting systems can facilitate better movement and communication among students and staff. Additionally, the integration of multisensory design elements, such as vibration-based alerts and color-coded pathways, can further support the unique needs of users.

5.CONCLUSION

The research underscores the critical role of smart materials and inclusive design in creating educational spaces that cater to the deaf and mute community. By drawing on the principles outlined in the referenced literature, architects and designers can develop environments that not only meet the functional requirements of users but also foster a sense of belonging and empowerment. The findings call for a paradigm shift in the design of educational facilities in Libya and similar contexts, ensuring that the needs of all users are adequately addressed.

6. RECOMMENDATIONS

1.Optimal use of available smart materials benefits the interior design of deaf and mute patients.

2.Multi-sensory design is the main pillar that the interior designer must study and pay attention to with the categories that lose any sense of from the other senses.

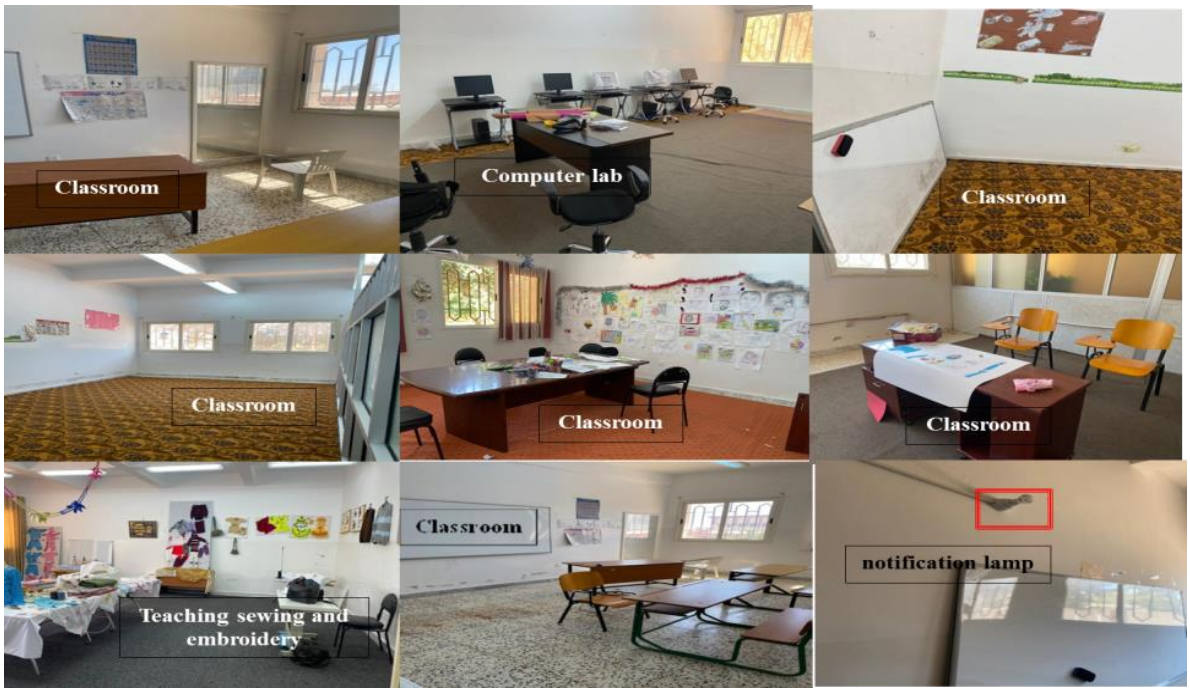

Figure (1) Al Amal Center for the Deaf, Dumb, and Hard of Hearing

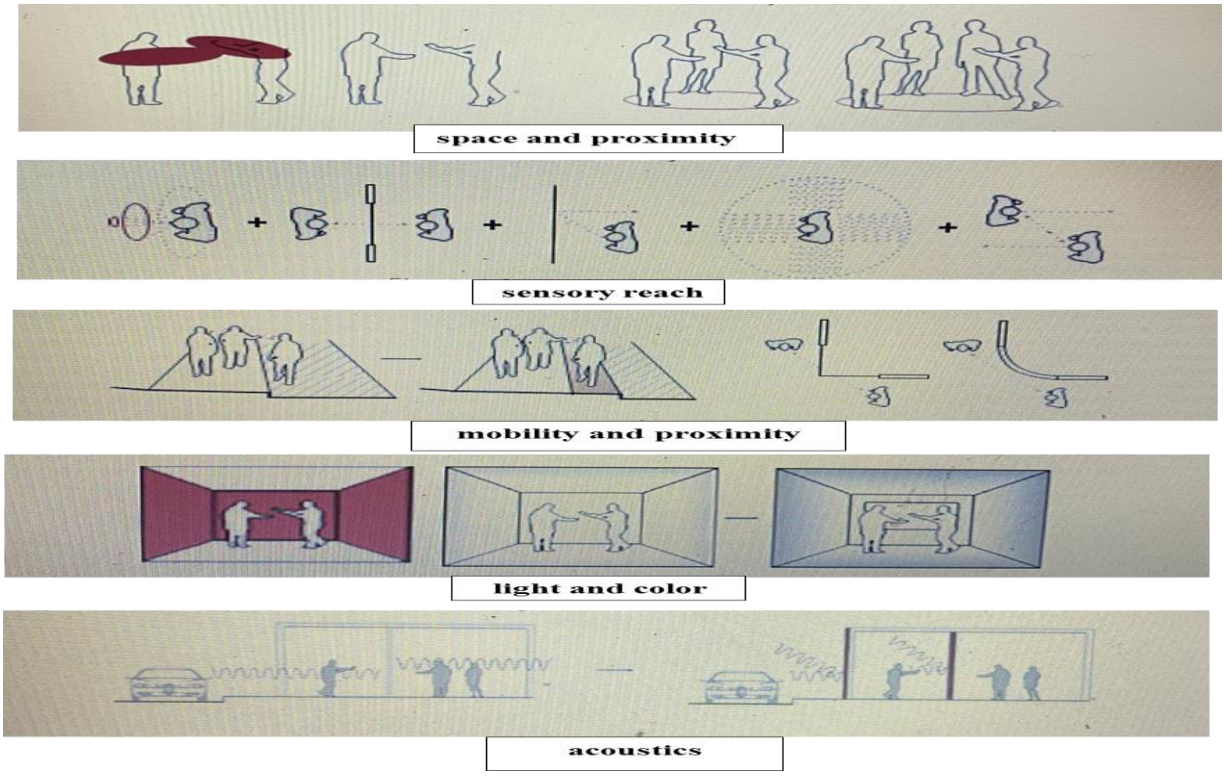

Figure (2) Core principles of Deaf Space

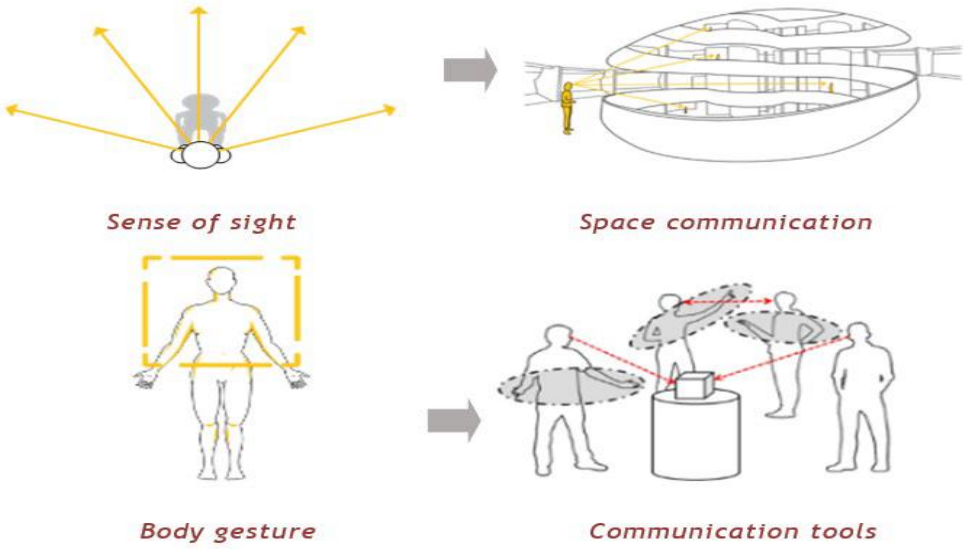

Figure (3) Phenomenon of hearing disabilities

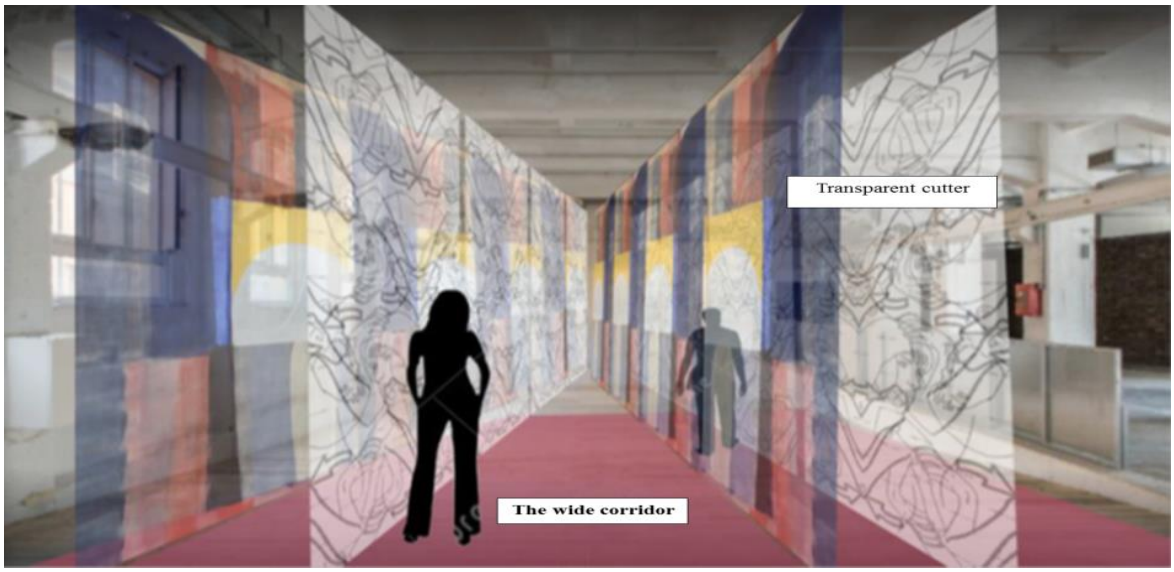

Figure (4) circular distributions rather than linear distributions for spaces larger than 4 people

Figure (5) Glass walls in the interior design of the deaf-mute center.

Figure (6) Shows the light and mirrors in the deaf and dumb centers.

Figure (7) Designing multi-sensory spaces.

Figure (8) Translating audio into visual communication.

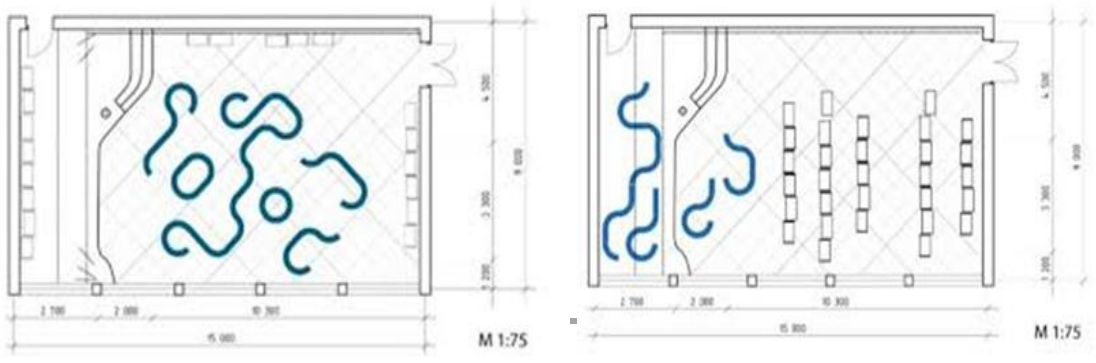

Figure (9) The horizontal projection shows healthy ways of interior design for play and entertainment areas.

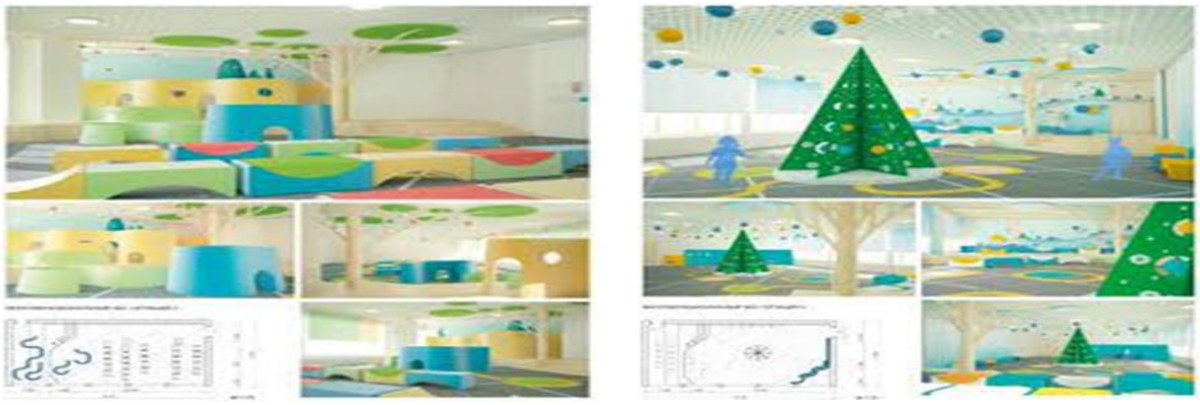

Figure (10) Shows perspective shots of the interior design of the play and entertainment areas at the Center for the Deaf and Dumb.

Figure (11) Triangular thought in designing interactive walls.

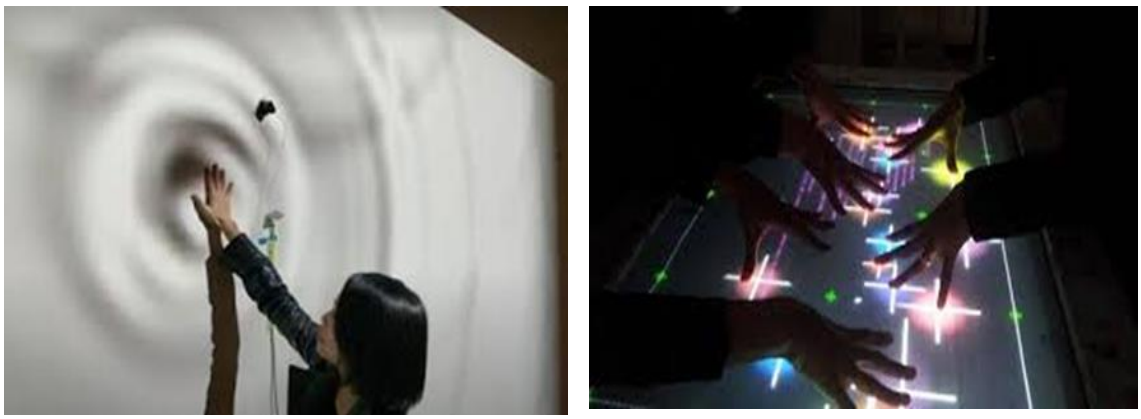

Figure (12) Shows the physical image.

Figure (13) Shows a flexible piezoelectric material.

Figure (14) Shows the use of bright colors in planning corridors in centers for the deaf and dumb.

Figure (15) Change the color of the floor according to the change of function.

Figure (16) Using lighting in deaf and dumb spaces.

Figure (17) Lighting changes in deaf and dumb spaces.

Figure (18) Visual communication between spaces and transparent walls.

Figure (19) Shows visual communication within different spaces through different elements.

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