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RE-THINKING EXPERIENTIAL LEARNING IN THE DIGITAL AGE: MAKING LEARNING MORE ADAPTIVE AND INTERACTIVE BY VIRTUALLY EXPERIENCING THE BUILT ENVIRONMENT

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Abstract

This study explores the transformative potentials of experiential learning within the contemporary digital era, emphasizing the significant roles of adaptability and interactivity enabled by virtual interactions with the built environment. Traditional teaching methodologies have been significantly affected by the introduction of digital technologies. This technological intervention is offering an innovative pedagogical framework that is reshaping the learning dynamics and offering a holistic experience that changes the way knowledge is created, delivered, and experienced as a whole. This research is experimenting with a human-centered design approach that critically evaluates the learning experiences using interactive and immersive technologies in an educational scenario. By closely examining the learner interaction, the study reveals how a tailored design solution can effectively enhance the adaptability of the learner and their educational outcomes. The conclusions offer significant understandings of optimizing educational practices with innovative technologies that ensure accessibility, adaptability, and effectiveness in dynamically changing educational settings.

INTRODUCTION

This paper examines the concept of experimental learning in the contemporary digital age with technological innovation, emphasizing the significance of adaptability and interactivity through virtual engagement with the built environment. The integration of technology in academics has become inevitable, and at the same time, it has posed multifaceted challenges, varying significantly in application and anticipated consequences. These approaches range from digital replication of traditional educational practices to transformative models that pursue innovative learning objectives. Educational practices today are profoundly affected by rapidly evolving technologies, which in turn affect the socio-economic and environmental dynamics of the society that demands to rethink the learning structure worldwide. Using human centered design approach, we can have precise and contextualized tailored outcomes. A central design challenge identified is the creation of an adaptive and interactive learning experience, particularly critical in the contemporary digital post-pandemic context. This study offers an in-depth exploration of digital learning interactions, offering insights into learners' experiences across a variety of adaptive technologies. Eventually, this human-centered design approach aims to transcend both physical and technological barriers, optimize educational workflow, and strengthen educational resilience during crises such as global pandemics.

Literature Review

The integration of virtual reality (VR) into education has revolutionized experiential learning. By creating

immersive and interactive environments, VR enables learners to engage in ways that go beyond traditional physical and cognitive boundaries, fostering a more dynamic and effective educational experience. Allcoat et al., in their research, underscore the pedagogical benefits of VR and mixed media reality in creating engaging learning experiences that enhance comprehension and motivation. Their research reveals that such technologies support active learning by simulating real-world scenarios, thereby enriching the cognitive and emotional dimensions of learning (Allcoat et al., 2021).

Asad et al. (2021) further strengthen this claim through a systematic literature review. He suggests that VR not only facilitates deeper engagement but also aligns well with constructivist and experiential learning theories (Asad et al., 2021). Another study expands this discourse by emphasizing VR's ability to support the full experiential learning cycle. The use of this new technology makes abstract concepts tangible and fosters critical thinking (Fromm et al., 2021).

Similarly, Crogman et al. (2025) and Rahman et al. (2022) explore how VR, AR, and MR technologies are redefining the boundaries of traditional learning, offering new pedagogical paradigms for experiential education (Crogman et al., 2025; Rahman et al., 2022). Furthermore, Hutson & Olsen (2022) and Lin et al. (2024) reinforce that VR significantly improves engagement and performance, particularly in art history and general classroom settings (Hutson & Olsen, 2022; Lin et al., 2024). This new technology is also facilitating less-resourced teachers. Nyaaba et al. (2024) emphasize VR's potential in resource-limited regions, making quality education more equitable and immersive for pre-service teachers (Nyaaba et al., 2024).

This shift toward digital experiential learning is also transformative for inclusive education. Platforms like Class VR (n.d.) also showcase the widespread adoption of VR in education, providing tailored experiences for learners with special needs (Class VR, n.d.). Studies by Chiţu et al. (2023) and Jeffs (2010) present VR as a powerful tool for educating children with disabilities. This new approach allows children with disabilities to participate in simulations they might otherwise be excluded from (Chiţu et al., 2023; Jeffs, 2010). Another study by Chen et al. (2024) demonstrates how VR enhances understanding and evaluation skills in undergraduate students, particularly those studying assistive technologies (Chen et al., 2024). Likewise, Siejca (2022) and the American SPCC (2023) highlight the role of AR/VR in breaking down physical barriers and improving accessibility in learning environments (American SPCC, 2023; Siejca, 2022).

As awareness and potential use of VR and mixed reality increase, there is a growing need for designs that prioritize human usability. The design of such learning tools must be human-centered. IDEO (2005) and Ulrich & Eppinger (2016) outline frameworks for designing user-focused products (IDEO, 2005; Ulrich & Eppinger, 2016), which are further contextualized in education by Williams and Matta (2017), who argue that student-centric design leads to better learning outcomes (Matta, 2017; Williams, n.d.).

Human-centered design methodology & Product design process

The manufacturing cycle begins with the identification of a product's needs, primarily influenced by customer needs, expectations, market demands, and evolving societal requirements. From the initial step of concept generation through to the final stage of product realization, two integral processes play pivotal roles: the design process and the product development process. The continuous incorporation and planned coordination between these two processes considerably affect the efficiency of the production workflow and the ultimate success of the finished product.

Implementing the human-centered design methodology not only improves the efficacy of this process by placing the end user at the center of the design and development process but also makes the process more authentic and meaningful. This philosophy is based upon the fact that important challenges faced by societies, such as poverty mitigation tactics, gender equity, and ensuring access to basic human needs, can be addressed through inclusive, participatory, and empathetic design practices. Through active engagement of the affected individuals firsthand, designers and manufacturers can get deeper insights about the requirements of the target users, which are essential for crafting an effective solution for the end users. (IDEO.org, 2015) Jones further elaborates on this methodology,

highlighting the important steps in human-centered design: comprehensive user research, empathetic understanding of user experiences, iterative prototyping, and continuous feedback integration. This iterative cycle makes sure that products and services grow directly in response to user contribution, leading to advanced receiving rates, better functionality, and improved user contentment. (Jones)

The adoption of human-centered design significantly enriches the traditional product design and development processes. By prioritizing user experiences and directly involving users throughout the design lifecycle, HCD generates solutions that are innovative and deeply relevant, ultimately leading to products that users genuinely embrace and value.

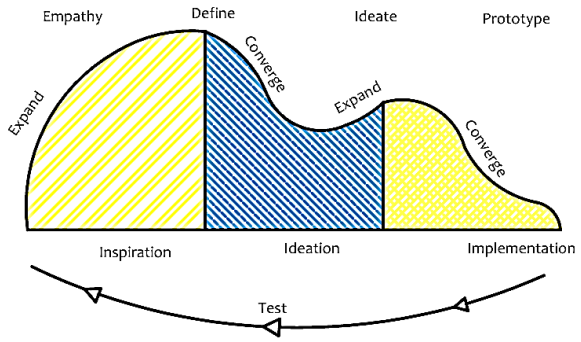

Figure 1: Human-centered design process (source: Author, Inspiration from IDEO.org)

The human-centered design approach follows some steps that lead towards a refined end product or outcomes.

Those steps are:

1. **Inspiration Phase-** Engage yourself in the life of people you are crafting for, to accurately comprehend their necessities.

2. **Ideation Phase:** Analyze what you have learnt, categorize solutions, and ideate them for further analysis.

3. **Implementation Phase:** Implement your crafted product into actual design practices and test the final product before real execution. See figure 1 for reference.

Keeping the affected people at the center of the Design process will guarantee the Success of the Designed Product.

Research Objectives

1. **Explore** how virtual reality technologies can enhance experiential learning for physically challenged students.

2. **Design and develop** a human-centered, VR-based educational product that addresses barriers to physical access in learning environments.

3. **Evaluate** the effectiveness and usability of the proposed VR solution in promoting adaptive and inclusive learning experiences.

4. **Investigate** how user personas and storytelling methods contribute to the iterative design of educational technologies.

5. **Contribute** to the body of knowledge on integrating HCD principles into the development of assistive educational technologies in the digital age.

Research Questions

1. How can virtual reality create immersive, inclusive, and engaging educational experiences for learners with physical disabilities?
2. What do physically limited students face the key challenges in accessing traditional experiential learning environments?
3. How can human-centered design processes be used to develop a VR headset that effectively addresses these challenges?
4. In what ways do iterative prototyping and persona-driven design improve the functionality and usability of educational VR products?
5. What implications does this VR product have for transforming experiential learning post-pandemic, especially in resource-constrained or physically inaccessible settings?

Frame the design challenge.

4. Keeping in view the product design process, we need to define a certain design challenge based on customer needs. For this purpose, a well-defined design problem is selected based on integrating technology in education, using Virtual reality headsets to enable physically limited persons to have maximum exposure. My design challenge is to make learning more adaptive and interactive in the contemporary digital age and post-pandemic situation, particularly for the physically challenged students. See figure 2 for reference.

Problem	Integrating technology in education is a complex issue taking many forms that differ in purpose. This can range from replicating existing educational practices through digital media with technology as tools, to transforming education to bring about new learning goals. Education is at the core of powerful and rapidly shifting educational, technological, and socio-economic and environmental forces that will shape the structure of educational systems across the globe for the rest of this century.
Design Challenge	To make learning more adaptive and interactive in contemporary digital age and post-pandemic situation.
Impact	It will aid to explore the diversity of digital learning experiences in contemporary times. It will Analyze the learners' experiences holistically, across the many technologies and learning opportunities they encounter and will break all physical and technological barriers. Furthermore, it will aid for easy workflow during pandemic situation.
Possible Solution	○ Explore VR & AR innovation in architecture ○ Document the monuments in 3D using photogrammetry drones that capture aerial images. By combining enough overlapping images of the same features, photogrammetry software can be used to generate photorealistic 3D representations of topographic surfaces. ○ Simple DSLR camera can also be used for the said purpose. ○ Digital resource center can be developed ○ Android applications can be developed to make the work flow more flexible.
Constraints	○ Availability of photogrammetry drones ○ Handling and processing of data ○ Management of digital resources

Figure 2: design challenge (source: Author)

Persona development (customer needs)

5. A persona represents the fictional yet realistic image of the actual user and is primarily utilized during the initial phases of the product development. The creation of persona development is crucial as it directly influences the design decisions by highlighting typical user requirements before the actual design phase commences. By clearly outlining user goals and abilities, personas establish a unified and precise understanding within the product development team. These personas are accurately crafted through wide-ranging research, analysis of

demographic statistics pertinent to the target area, and careful consideration of both explicit and implicit end-user requirements. Personas help to focus decisions surrounding site components by adding a layer of real-world design consideration. They also offer a swift and cost-effective way to test and arrange those features throughout the development process. See figure 3 for reference.

In addition, they can help:

- Stakeholders and leadership teams in effectively evaluating proposed site features
- Information architects in constructing well-informed wireframes, intuitive interface behaviors, and accurate labeling.
- Designers in developing a cohesive and appealing visual identity for the product.
- System engineers and developers choose suitable technological solutions aligned with user behavior patterns.
- Copywriters in tailoring content specifically crafted for targeted user groups, ensuring relevance and clarity.

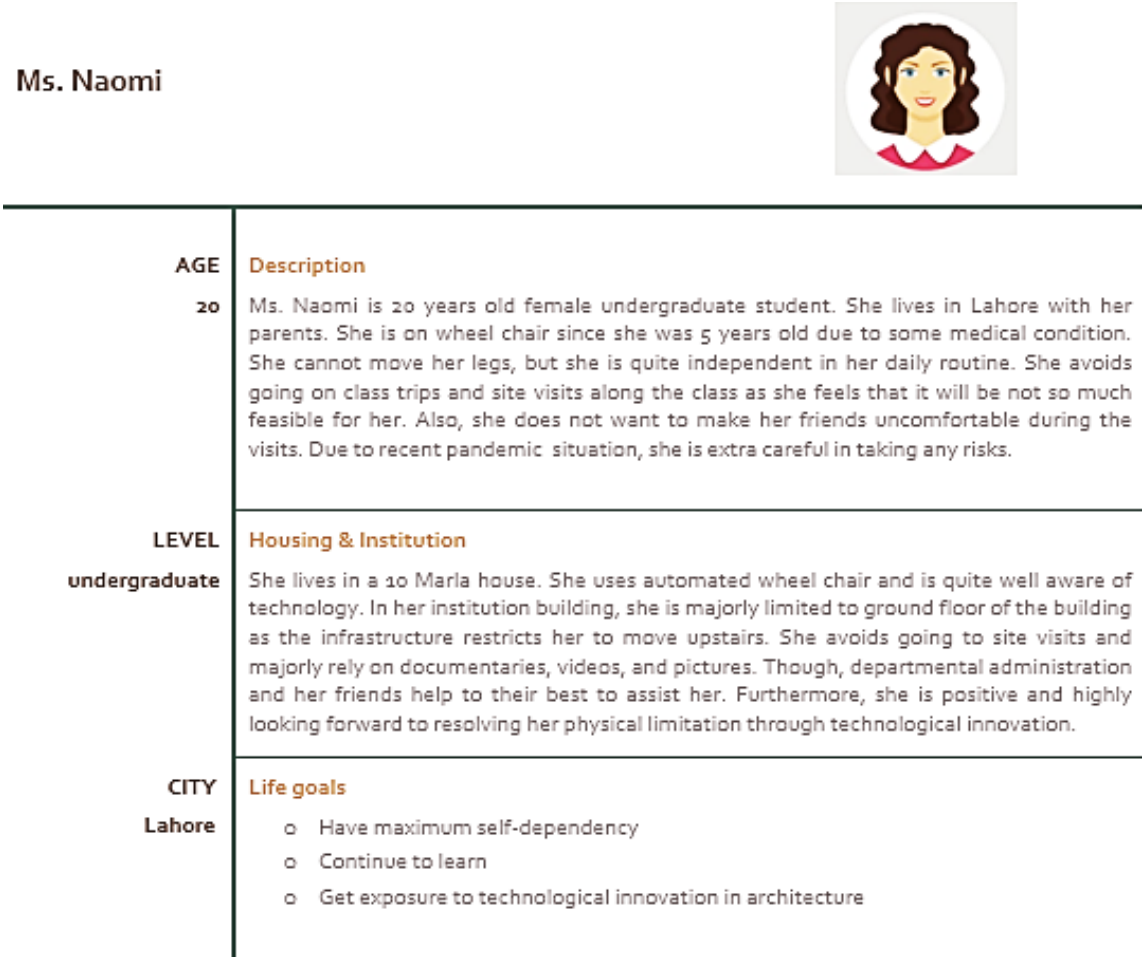

Figure 3: Persona development (source: Author)

Story beats

Designers increasingly rely on storytelling as a powerful tool to understand users, communicate ideas, and create a more meaningful user experience. It serves as a bridge between data and emotions by providing depth to the user's needs and behaviors. One of the most effective ways is to use story beats to format it structured way and represent it through

turning points and key moments that can help the designer in making final decisions for the product. To make storytelling more relatable and structured, designers often create fictional but research-based characters that represent typical users. Here, in this particular research, a fictional character is crafted using various aspects based on the interview conducted with an original character. It has incorporated various aspects involving her real-life challenges and her strengths that make her more adaptive to the contemporary world. This will help to decide the final product that is needed to make her life more flexible and interactive.

The persona presented here is attached to a physical mobility barrier. She cannot move independently and must get help from an assistant for movement. She cannot move upstairs as the institution does not have an elevator, so she has to attend classes while sitting downstairs after the class with the teacher. So, she loses the precious class participation phase of her career. For the same reason, she cannot go on class visits. The virtual reality headset may help her to largely overcome her mobility barrier.

6. See figures 4 and 5 for reference.

Aspect 1	Ms. Naomi does not go to site visits and class tours as she feels that it can be a hazard for her and can make her fellows uncomfortable. She takes help from her friends to get pictures and videos and watch online documentaries to understand the project and site. Through digital documentations, 3D environment can be created using VR & AR that can contribute towards learning the people with physical restriction to actually feel the real time experience.
Aspect 2	Ms. Naomi is well versed with digital tools and softwares as she believes that technology is the way forward for her. she often takes assistance form them. Android application can help Ms. Naomi to learn on her own and give her self-dependency
Aspect 3	Her parents and siblings sometimes find themselves helpless as to how to assist her in her studies. Digital documentations of sites and important monuments can aid her to overcome this issue. Additionally, it can assist her during pandemic closure of the institutions and many other sites as well.
Aspect 4	Besides, digital documentation of built heritage can be a useful tool for conservation process as well and it can make the process of learning more flexible and approachable.

Figure 4: Story beats (source: Author)

Figure 5: sketches based on story beats (Source: Author)

What is generally available in the market?

Generally, in the market, VR headsets are without head covers. They just provide covering from the back side that transfers the load to the back side only. Color schemes are generally white and black or dark blue, which gives them a sophisticated look.

See figure 6 for reference.

Figure 6: Headsets available in the market (source: online resources)

What do we need in the headset? (Based on Story Beats / Aspects)

As mentioned earlier, a headset is needed for a female student who has physical limitations. The features I need based on story beats are:

- Professional look
- Female student customized
- Should provide a head cover to transfer the load
- Ear protection
- Provided with microphones & camera
- good resolution
- Portable
- data storage
- Can be attached to a wheelchair
- Lightweight
- Simple & sophisticated

Concepts

A product concept serves a foundation for the proposed solution offering preliminary yet structured configuration of the product's key features including

its core technology, operational principles, and its physical formation.it encapsulated the core idea behind the product, highlighting its intends to behind the product as per required by the end user or market demands. At the initial phase, the concept helps to serve as a guiding principle, synthesizes the technical feasibility with user user-centered design approach. (Ulrich & Eppinger, 2016).

7. By providing a clear and physical representation of the design intent, a well-developed product concept plays a key role in aligning the stakeholders, governing the prototype design, and serving as a major reference point for iterative development throughout the design process. Here, the product concept is derived from the persona of the student or customer's needs. That has defined the overall form development process. Various formations and sketches have been tried to achieve the final format. See figure 7 for reference.

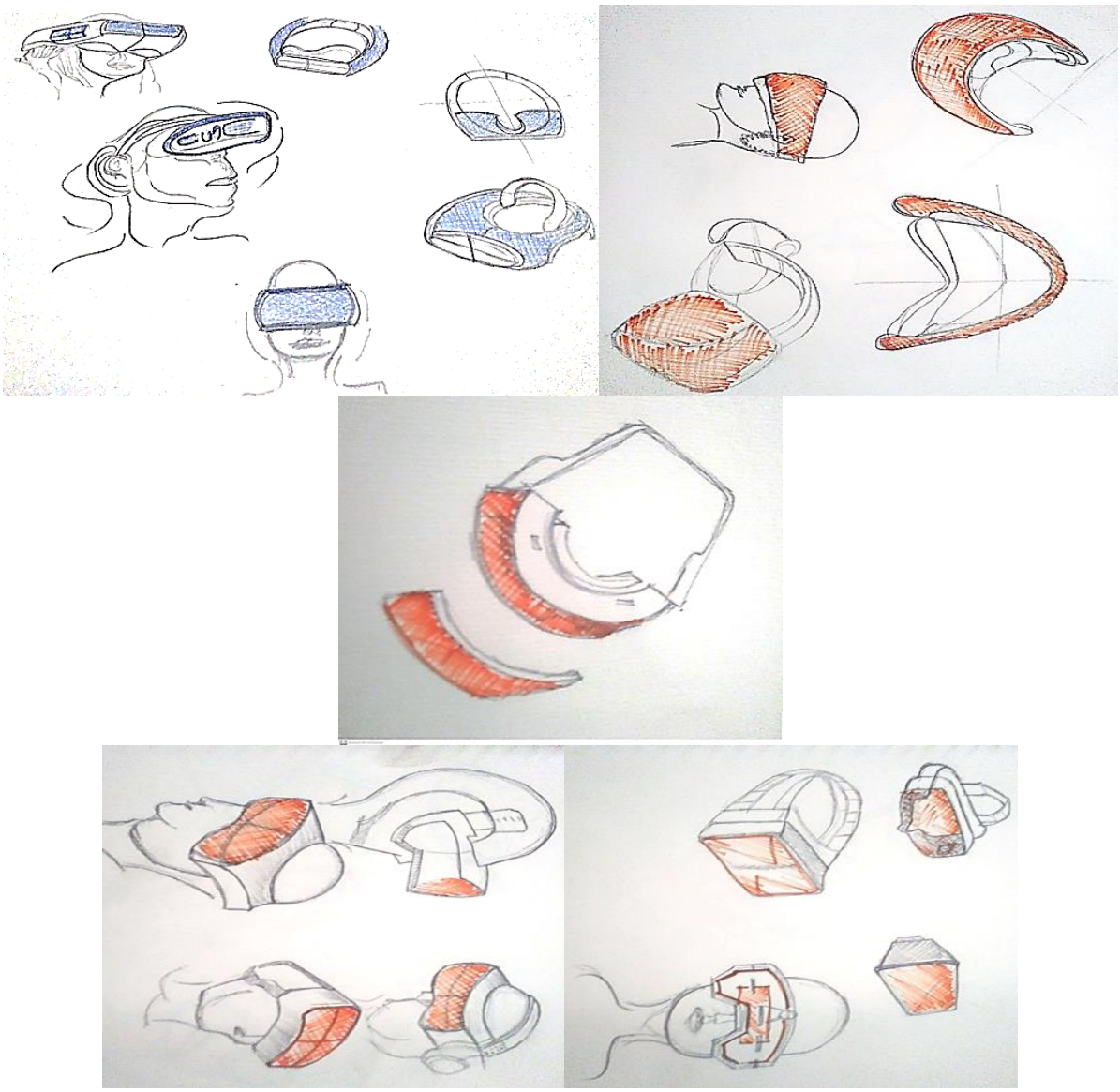

Figure 7: Conceptual sketches (source: author)

Parameters used

Emotional	Portability	storage
Color scheme	Easily attached to the wheelchair.	Can store all the data of the visits for future reference
shape	Attached with a camera and microphones	Data can be transferred to other devices
Professional attachment	Light weight	Extra memory can be added

Table 1: Parameters used for the final product

3D Modelling & experimentation

Figure 8: analytical modelling (source: author)

Working Drawings

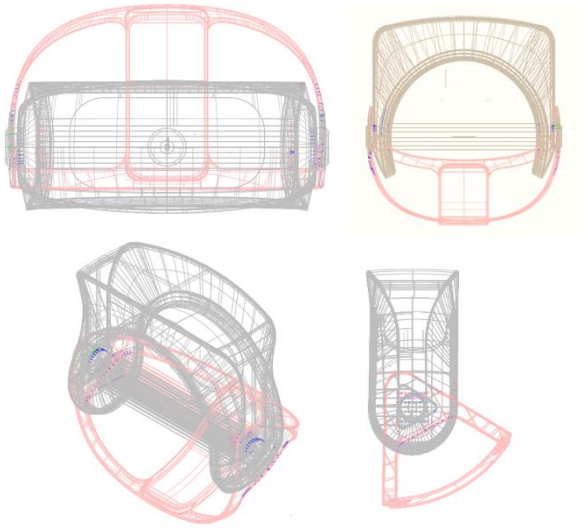

Figure 9: AutoCAD Drawing (source: author)

Color coding

Colors are used in product design to attract the user, to create a sense of attachment, and to create a sophisticated meaning. Here, three colors have been combined to create an overall professional and personal impact. Grey creates an industrial and professional look. Pink is utilized for gender specification (although not specific). Off-White is employed to create a neutral and sophisticated impression.

Figure 10: color coding, Off-white, pink & grey (source author)

Prototyping & testing

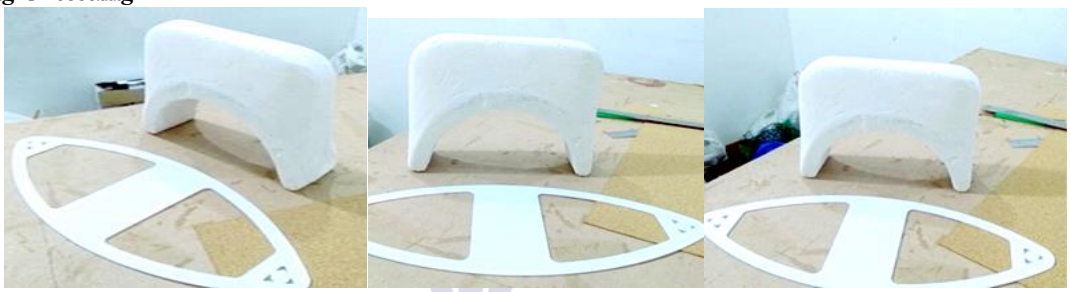

Figure 11: Physical model, making prototypes (source: author)

Figure 12: Adding color to the model (source: author)

Iteration

After the discussion and comments on the prototype, the model has undergone certain iterations and improvements to make it a more detailed and comprehensive version.

Following the main iteration that the model has gone through, the following changes have been made:

- Making it smart enough to adjust the functions inside
- The head carry should be movable and adjustable
- Face & nose holders should be provided
- Some major functions of the headset should be visible from the outside

The second prototype shows some of the iterations mentioned here.

Figure 13: Second prototype

Conclusions and discussion

In conclusion, rethinking experiential learning in the contemporary digital age of technological innovation through virtually experiencing the built environment significantly transforms educational methodologies, making it more adaptive, interactive, and inclusive. In this evolution process, the center design approach plays a pivotal role as it encapsulates the development process from problem validation to crafting, designing, testing, and delivering innovative solutions to the end user. As Erik Erikson emphasizes, product development is a complete process rather than merely aesthetic enhancement. By engaging human-centered design innovations, educational tools such as VR headsets become personalized specifically to user needs, improving interactivity and personalized engagement. It is particularly beneficial for people with physical limitations; these advanced VR solutions mitigate mobility barriers, facilitating participation in classes and lectures, and boosting diverse interactive learning experiences. Thus, integrating immersive technologies not only democratizes the learning environments but also significantly enriches the educational landscape in contemporary and future pedagogical frameworks.

The employment of virtual reality (VR) and immersive technologies presents novel potentials for experiential learning by reproducing real-world architectural and built environments in controlled, simulated spaces. This enables learners to engage in spatial cognition, environmental behavior analysis, and contextual decision-making without the constraints of physical presence. Integrating these technologies into education provokes constructive learning philosophies and makes learning more adaptive and sensitive to real-world problems and challenges. It allows the learners to gain knowledge through understanding, communication, and reflection. Virtual site visits, interactive walk-throughs, and simulated designed spaces, not only enhance the learner's understanding of spatial dynamics but also improve their critical thinking ability and problem-solving skills, vital for sensitive design approaches. The development of experiential learning, with the help of VR technologies, indicates a transformative alteration toward a more comprehensive, interactive, and impactful learning model.

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