# RESEARCH TRIAL PROTOCOL

## 1. General Information

- **Protocol Title:** The Efficacy of Extended Reality Based Virtual Training for Enhancing Vocational Skills Among the Hearing Impaired: A Study on Boosting Employability
- **Principal Investigator:** [**Abdellah Ibrahim Mohammed Elfeky**]
- **Affiliation:** [*King Salman Center for Disability Research, Riyadh 11614, Saudi Arabia*]
- **Trial Sponsor/Approval Body:** Directorate of Special Education, Ministry of Education, Jeddah, Saudi Arabia.
- **IRB Approval Reference:** JED-SE-2025-ETH-094
- **Trial Registration Identifier:**
- **Protocol Version & Date:** Version 1.2 – June 2026.

## 2. Project Summary and Objectives

The purpose of this behavioral intervention trial is to empirically examine the efficacy of an interactive, Extended Reality (XR) based virtual training environment—specifically utilizing 360-degree Virtual Reality (360-VR) interactive simulations—against conventional classroom experiential methods.

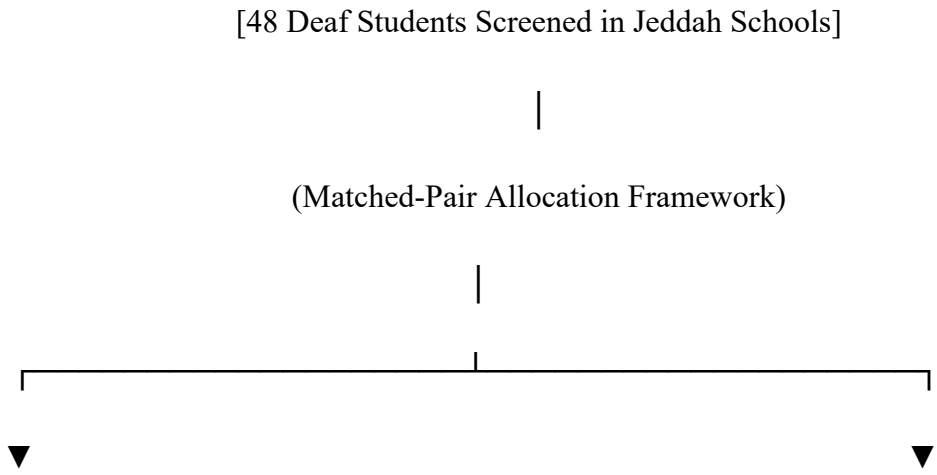
**The primary objectives are defined as follows:**

- To evaluate whether integrating synchronized visual scaffolding (Saudi Sign Language [SSL] video loops paired with concise text hotspots) can systematically enhance the multi-dimensional constructs of **Vocational Skills** (Housekeeping and Culinary Arts) for deaf and hard-of-hearing (DHH) students.
- To investigate the longitudinal impact of immersive simulation on optimizing visual working memory and expanding the psychological horizons of **Employability Readiness** (Self-efficacy and Workplace Anxiety Mitigation) during the critical school-to-work transition phase.

## 3. Study Design and Methodology

### 3.1 Trial Design

This investigation is structured as a **Quasi-Experimental Pretest-Posttest Control Group Design**. Due to strict administrative regulations enforced by the Ministry of Education in Jeddah and the ethical necessity of maintaining intact classroom ecological validity, a traditional randomized controlled trial (RCT) layout was modified to a **Matched-Pair Allocation Framework** to balance baseline participant parameters.




### 3.2 Participant Recruitment and Selection

- **Setting:** Specialized resource rooms and multi-activity zones within certified Al-Amal Secondary Schools for the Deaf in Jeddah, Saudi Arabia.
- **Target Sample Size:** ($N$ = 48) participants ($n$ = 24) Experimental Group; ($n$ = 24) Control Group), verified via a prospective power analysis (G*Power) assuming a large effect size (($f$ = 0.40), type-I error rate ($\alpha = 0.05$), and a statistical power ($1-\beta$) = 0.85).

**Inclusion Criteria:**

1. Chronological age formally documented between 17.0 and 20.0 years (transition-ready youth).
2. Documented medical diagnosis of profound bilateral sensorineural hearing loss exceeding **(70*dB*)**, verified by the Saudi Commission for Health Specialties.
3. Fluency in **Saudi Sign Language (SSL)** as the primary linguistic modality.
4. Formally enrolled in the senior vocational track under the Saudi special education framework.

**Exclusion Criteria:**

1. Co-occurring neurodevelopmental or cognitive conditions (e.g., intellectual disabilities or profound Autism Spectrum Disorder).
2. Medical history of photosensitive epilepsy, severe visual comorbidities, or chronic vestibulo-ocular reflex disorders.
3. Absence of basic functional Arabic text reading comprehension.

## 4. Intervention and Execution Plan

### 4.1 The Experimental Arm (XR Group)

Participants in the experimental group will engage with the interactive 360-VR learning platform. The environment captures authentic 5-star hotel luxury suites and commercial kitchens via 8K spherical cameras (maximizing **ecological validity**). The intervention spans **6 weeks**, consisting of two 20-minute individual sessions per week (12 sessions total).

**The Multimedia Scaffolding Loop:**

The software runs an interactive state machine containing sequential visual prompts. When a DHH student activates a designated icon (**Hotspot**) via gazing or hand controllers, the engine triggers:

1. **Visual Pruning:** Fading secondary background assets to minimize the spatial split-attention effect.
2. **Synchronized Overlays:** Launching a transparent window featuring a native SSL interpreter executing standardized hospitality steps, paired with hyper-short text descriptions to optimize the student's Visual Working Memory (VWM) capacity and shield their cognitive load.

### 4.2 The Control Arm (Conventional Technology Group)

Participants in the control group will target identical vocational learning competencies (room ventilation, bed-making corners, knife safety, board color codes) using traditional special education workshops. The instructional dosage (40 minutes weekly for 6 weeks) and environmental configurations (quiet resource rooms in Jeddah) will be strictly matched with the experimental group. Instruction relies on real-time teacher demonstrations, static 2D image pamphlets, and physical practice, completely isolating the immersive technology treatment effect.

## 5. Ethical Considerations and Safety Monitoring

### 5.1 Informed Consent and Assent

- Written formal **Informed Consent** will be secured directly from the parents/legal guardians of the minor participants before baseline measurement.
- Visual and verbal **Assent** will be obtained from the DHH students using simplified pictographic cards and professional sign language interpreters.
- Explicit parent/guardian consent will be secured for publishing any illustrative software interaction graphics in open-access formats (fully de-identified to protect anonymity).

### 5.2 Safety and Trial Discontinuation Protocols

The standalone VR headsets (Meta Quest) will be strictly sanitized with medical-grade UV-C and isopropyl wipes after each user. The resource room will feature a pre-cleared, cushioned physical boundary of **(3 × 3 meters)** (Virtual Guardian Boundary).

If a student displays physical markers of tech-distress (e.g., hand tremors, continuous eye blinking, attempts to remove the headset, or frantic signing), the system will immediately be shut down, the student will be unmasked, and the session terminated by the counselor. Participants retain the absolute right to voluntarily withdraw at any juncture without any academic or social penalties.

## 6. Data Management and Statistical Analysis

### 6.1 Assessment Instruments

The trial relies on a triad of psychometrically validated tools administered pre- and post-intervention:

1. **Cognitive Achievement Test (CAT):** A 30-item, hyper-visualized, low-text Multiple-Choice Question (MCQ) instrument designed to evaluate theoretical safety and operational hospitality knowledge (KR)-20 reliability = 0.85).
2. **Psychomotor Performance Rubric (PPR):** A 15-item behavior observation checklist scored on a 3-point Likert configuration (**2: Fully Mastered, 1: Partially Mastered, 0: Not Mastered**) assessed by two blind independent vocational instructors simultaneously (Inter-rater reliability target: Cohen's ($\kappa \leq 0.82$).
3. **Saudi Employability Readiness Scale (SERS):** A 12-item psychometric scale translated into synchronized SSL videos, measuring Vocational Self-Efficacy, Workplace Adaptation Awareness, and Communication Confidence (Cronbach's ($\alpha = 0.88$).

### 6.2 Analysis Plan

Data analysis will be performed using IBM SPSS Statistics (v.29). A **one-way Analysis of Covariance (ANCOVA)** will evaluate posttest scores between the groups, using the pretest baseline scores as the continuous covariate to isolate treatment variance and remove pre-existing individual variances. **Partial Eta Squared ($\eta 2$)** will quantify the practical effect size. Within-group longitudinal performance alterations in system telemetry will be analyzed via Paired-Sample (t)-tests or non-parametric Wilcoxon Signed-Rank tests depending on Shapiro-Wilk normality profiles.