# AI-Assisted Scoping for Multimodal Therapy: Establishing a Framework for Clinical Decision Support Systems




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- international cooperation
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- interdisciplinarity
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Web-based course and workshop in

## "Project Scoping with AI Assistance"

**(using conceptual case-study modeling)**

Univ. Gothenburg, Sweden

**8 April –13 May, 2025**

**This is to certify that**

***Tetiana Shestakevych***

**has completed this course involving conceptual modeling of complex systems and, importantly, applied this approach to a case study with focus on applied-science issues and decision support.**

The results were presented orally and as posters. PLATFORM website (https://kermitcooperation.wixsite.com/platform). Participants from several institutes have been involved and networking is also an important goal. Conceptual modeling was used as a tool for several important steps in project initiation, including: 1) Identification and Characterization of the "system" related to a case study, 2) System Structural Analysis of this system, and 3) Multi-Criteria Evaluation as a synthesis modeling tool for scenario predictions and applied interpretations. AI assistance involved testing ChatGPT in order to provide a more holistic perspective by complementing group diversity, making participants aware of related topics outside their own disciplines. An AI Workshop was also led by Jane Klepa (SET Univ., Kyiv) to help explore possibilities. The theory and case-study discussions and the presentations of this course involved 12 hours of scheduled webinars and considerably more time for individual and group development of case-study applications. The course has been presented in English. At Univ. Gothenburg participants would normally be registered for the course "Advanced Project in Earth Sciences" (GVN75A). Totally, the course activities are considered approximately equivalent to 5 ECTS credits.

22 May 2025

Course leader
Prof. emeritus Rodney Stevens, Dept. Earth Sciences
University of Gothenburg, Sweden

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Conferences > 2025 IEEE 13th International ...

## Multi-Criteria Analysis of a Web-Based Platform to Support Veterans' Reintegration

**Publisher: IEEE** Cite This PDF

Taras Cherna ; Tetiana Shestakevych All Authors

12 Full Text Views

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## Artificial Intelligence-Enhanced Learning in XR Technologies: Case Analysis of the "Technologies of Virtual Reality"

**Publisher: IEEE** Cite This PDF

Maksym Kryvoshyya ; Vasyl Andrunyk ; Oleh Papka ; Tetiana Shestakevych ; Roman Oliinyk All Authors

58 Full Text Views

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## Management of the International Educational Project on Teaching XR Technologies

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**Abstract**

Ukraine has successful experience in the implementation
such projects, European Union holds the Erasmus+ prog
With such support, Ukrainian academics can implement t

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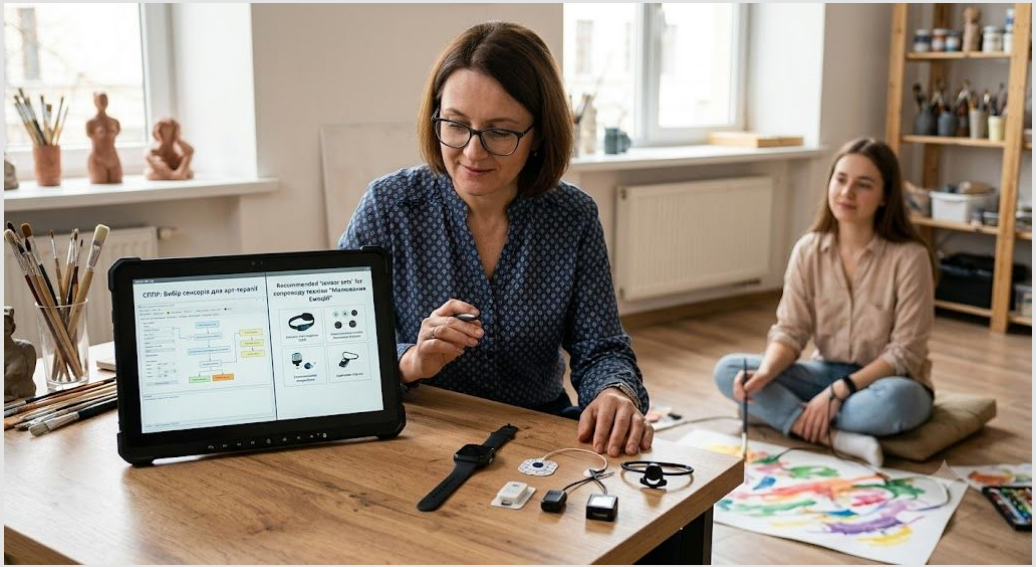
Comparison | 7 contributions Edit Share Actions

Analysis of the main characteristics of an educational project peculiarities

Created by Tetiana Shestakevych

July 2023 Published Education Systems and Educational Institutions Tetiana Shestakevych

# What we need



This study addresses the "black-box" challenge in technology-based rehabilitation for individuals with anxiety disorders by introducing a systematic AI-assisted scoping framework. The authors use a **hybrid methodology** that integrates **conceptual modeling**, **impact mapping**, and **multi-criteria evaluation**.

The results provide a blueprint for a clinical Decision Support System (DSS) that provides psychologists with transparent monitoring tools to enhance diagnostic quality in,as an example, VR art therapy




What if I had all the sensors possible?

**AI-Assisted Scoping**

# METHOD

## Conceptual Modeling

Establishing structural relationships between the technical parameters of the sensors and psychophysiological states

## Structural Analysis

Establishing parameters:

- Technical and Hardware,
- Methodological and Psychological,
- Economic and Operational,
- System Outcomes and Interdisciplinary Collaboration

## Impact Mapping

Using cause-effect graphs to identify the parameters with the strongest driving influence on the proposed decision support platform

## Multi-Criteria Evaluation

A multi-criteria evaluation demonstrates how different implementation strategies address different stakeholder needs

## Recommendations & Next Steps

Additional opportunities using Meta Quest 2 as an integrated sensing platform

# System sketch

## translator

between the language of human physiology and the language of emotions and computational models

## All sensors

database

## Stakeholders

- Psychologists
- Data scientists
- Hardware developers

## DSS

Decision Support System

# Conceptual System Architecture

01

## Capture Layer

**Data sources**: VR headsets, smart rings, fitness trackers, galvanic skin response patches, etc.
**Function**: Acquire physiological signals by continuously monitoring subtle changes in the patient's physiological state during psychotherapy sessions.

02

## Data Pipeline

**Components**: A local client running on a workstation or tablet.
**Function**: The data pipeline collects heterogeneous data streams from multiple sensors, synchronizes them using a common timeline, and performs signal preprocessing.

03

## Analytics Core

**Components**: Mathematical models, signal-processing algorithms, and machine learning classifiers.
**Function**: The analytics core transforms raw physiological signals into clinically meaningful psychological indicators.

04

## Presentation Layer

**Psychologists** have an clinical dashboard that summarizes complex physiological measurements as interpretable psychological indicators. Data scientists have an access to anonymized raw datasets.
**Hardware developers** can register new biometric devices, obtain standardized API specifications.

During the continuous use of the platform, **psychologists generate demand for new sensing technologies** while simultaneously providing expert annotations (ground truth) that improve the quality of analytical models. What **sensor set** I need to perform the technique?

**Data scientists** use these annotated datasets to **develop algorithms** for psychophysiological state assessment, whereas **hardware developers** identify **unmet technological needs** and design new, minimally invasive, open-hardware biometric devices.

This **continuous feedback loop** enables the platform to evolve as an integrated ecosystem that supports advances in digital psychotherapy, wearable sensing technologies, and artificial intelligence.

# System Development Stages

## Stage 1. Development of a Global Sensor Dataset

### 1.1. Classification of Biometric Sensors

To ensure efficient data organization for both psychologists and data scientists, biometric sensors are classified into four primary categories according to their sensing mechanisms:

1. **Contact Physiological Sensors** – Sensors that require direct attachment to the human body and measure electrical, chemical, thermal, or other physiological signals.
2. **Contact Kinematic Sensors** – Devices that capture body movements, limb dynamics, muscle activity, force, posture, or other biomechanical characteristics.
3. **Remote (Contactless) Sensors** – Sensors that monitor physiological or behavioral responses remotely using cameras, radar, microphones, or other ambient sensing technologies without requiring physical contact with the patient.
4. **Integrated Wearable Devices** – Commercial multi-sensor platforms, such as smartwatches, smart rings, VR headsets, or other wearable devices that combine several sensing modalities within a single product.

# Stage 1. Development of a Global Sensor Dataset

### 1.2. Device Characterization

Each sensor included in the knowledge base is described using a standardized profile consisting of four groups of characteristics:

- **Physical characteristics:** weight, dimensions, and attachment type (e.g., chest strap, wristband, clip, glasses, or contactless configuration).
- **Ergonomic characteristics:** wired or wireless connectivity (Bluetooth/Wi-Fi), battery life, and invasiveness level reflecting the degree of interference with the patient's comfort.
- **Technical characteristics:** sampling frequency, output data format (raw API data or processed metrics), computational requirements, including memory and processor demands.
- **Economic characteristics:** estimated market price and commercial availability.

# System Development Stages

## Stage 2. Translating Technical Measurements into Psychological Knowledge

### 2.1. Mapping Physiological Data to Psychological States

A fundamental component of the proposed platform is the semantic mapping between measurable physiological signals and clinically meaningful psychological constructs. Examples include:

- **Galvanic Skin Response (GSR)** → autonomic arousal level, emotional activation, and trigger detection.
- **Hand movements in VR** (movement amplitude and velocity) → anxiety level, motor inhibition, defensive behavior, or avoidance responses.
- **Eye-tracking** (pupil diameter and gaze fixation) → attentional focus, cognitive workload, and visual avoidance during trauma processing.

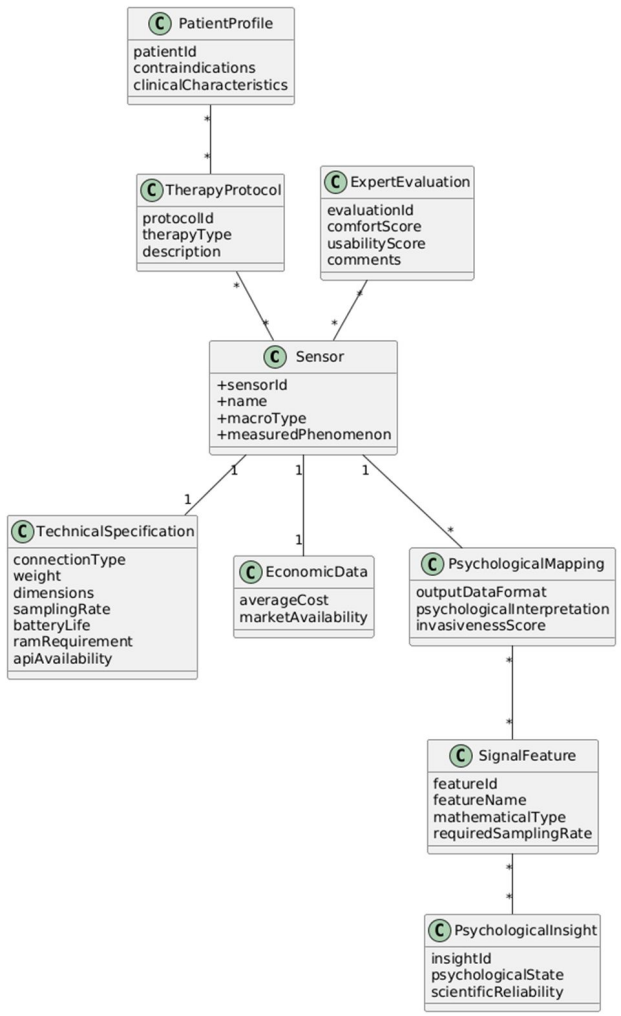
# System Development Stages

## Stage 2. Translating Technical Measurements into Psychological Knowledge

### 2.2. Classification of Psychotherapeutic Scenarios

The platform supports multiple psychotherapeutic approaches by linking sensing technologies with specific therapeutic contexts, including:

- **Eye Movement Desensitization and Reprocessing (EMDR);**
- **Virtual Reality Exposure Therapy (VRET)** for phobias and post-traumatic stress disorder (PTSD);
- **Body-oriented psychotherapy;**
- **Cognitive Behavioral Therapy (CBT)** with continuous stress monitoring during therapeutic sessions.




# Comprehensive Taxonomy of Human Monitoring Sensors

**To support sensor selection for digital psychotherapy, the platform incorporates a comprehensive taxonomy of currently available sensing technologies, ranging from established medical devices to emerging wearable and ambient sensing solutions.**

## 1. Contact Physiological Sensors

These sensors require direct contact with the patient's body and measure physiological processes.

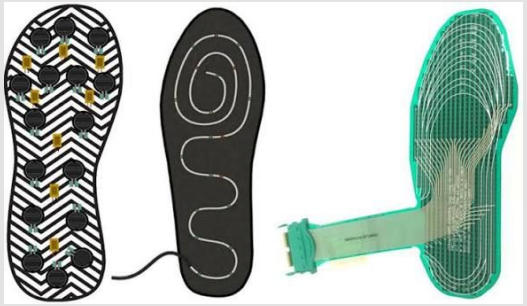
- **Galvanic Skin Response (GSR) / Electrodermal Activity (EDA):**
- **Continuous Blood Pressure Sensors:**
- **Biochemical Wearable Sensors:**
- **Electroencephalography (EEG):**
- **Photoplethysmography (PPG):**
- **Electrocardiography (ECG):**
- **Electromyography (EMG):**
- **Skin Temperature Sensors:**
- **Respiratory Belt Sensors:**



## 2. Contact Behavioral and Biomechanical Sensors

These devices capture body movement, posture, and physical interaction with the environment.

- **Accelerometers and Gyroscopes (Inertial Measurement Units, IMUs):**
- **Force and Pressure Sensors:**
- **Smart Insoles (Podometric Sensors):**



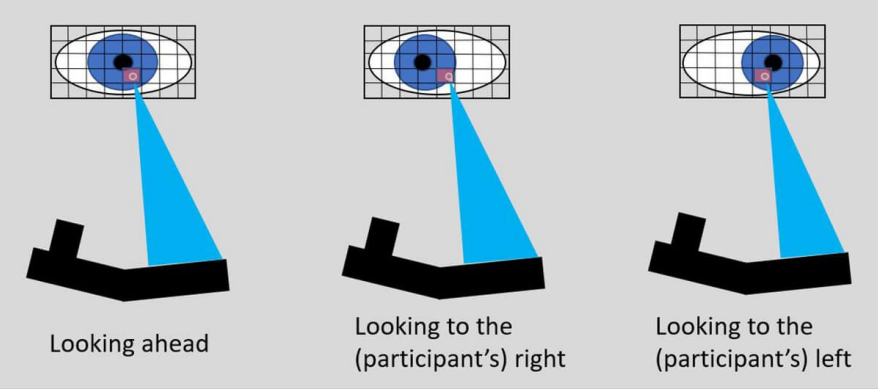





## 3. Contactless Remote Sensors

These technologies monitor psychophysiological responses without requiring physical contact.

- **RGB Computer Vision Cameras:**
  - Facial expression analysis;
  - Remote photoplethysmography (rPPG).
- **Remote Eye-Tracking Systems:**
- **Thermal Imaging Cameras:**
- **Acoustic Voice Analysis Systems:**
- **Radio Frequency and Radar Sensors.**



## 4. Integrated Wearable Platforms

Commercial multi-sensor devices combine several sensing modalities within a single platform.

- **Smart Glasses:**
- **Smart Rings:**
- **VR/AR Headsets:**
- **Smartwatches.**



# Sensor Dataset for Art Therapy

## Drawing pressure and movement amplitude

Motion sensors attached to the wrists, as well as smart styluses or digital pens, can record drawing pressure and movement dynamics throughout the creative process.

## Fine motor kinematics

The velocity, acceleration, and smoothness of brush or pencil strokes provide valuable behavioral indicators.

## Autonomic physiological response

Wearable devices such as smart rings worn on the non-dominant hand continuously monitor electrodermal activity (EDA/GSR) and heart rate.

## Visual attention

Eye-tracking glasses or remote eye-tracking cameras record gaze behavior throughout the session. These measurements reveal which elements of the artwork attract sustained visual attention and which objects, colors, or regions are consistently avoided, providing additional insights into attentional focus, emotional processing, and possible avoidance behaviors.

# Use Cases: Data Analytics and Data Science Module

01

## Sensor Bottleneck Detection

The platform analyzes psychologists' requests and identifies psychophysiological markers that are **frequently required** but **insufficiently supported** by existing commercial sensing technologies.

02

## Sensor Redundancy Analysis

When multiple sensors are selected for the same therapeutic protocol, the platform evaluates the **degree** of **information overlap** among their output signals.

03

## Signal-to-Noise Simulation

Using sensor specifications stored in the knowledge base, including sampling frequency and signal characteristics, the platform **estimates** the **expected signal quality** under realistic operating conditions.

04

## Automatic Technical Specification Generation for Data Scientists

The platform automatically generates formal analytical requirements for interdisciplinary research teams. Instead of providing only psychological objectives, it translates clinical requirements into precise computational tasks.

# Use Cases: Expert and Methodological Support Module

01

## Patient Profiling and Contraindication Analysis

The platform automatically evaluates the compatibility of sensing technologies with an individual patient's clinical and psychological profile.

02

## Reverse Sensor Selection

The platform supports inverse problem solving by allowing psychologists to define a target psychological construct rather than selecting sensors directly.

03

## Expert Consensus Engine

The platform enables psychologists and clinical experts to evaluate biometric devices based on their practical experience, assigning scores for criteria such as patient comfort, usability, and clinical suitability.

04

## Study Protocol Generator

Once a psychologist selects and approves a recommended sensor configuration for a particular therapeutic approach (e.g., Eye Movement Desensitization and Reprocessing (EMDR)), the platform automatically generates a structured technical appendix for a research protocol or scientific publication.

# Use Cases:
# Integration and Hardware Development Module

01

## Automatic API Schema Generation

The platform automatically generates standardized interface specifications for newly developed biometric devices. Rather than providing only textual integration guidelines, it produces structured data schemas describing the information that a sensor must transmit to ensure compatibility with the platform's analytics engine and psychological decision-support modules.

02

## Virtual Sensor Prototyping

The platform enables developers to evaluate **hypothetical sensing devices** before physical implementation. The system estimates the number of recommended sensor configurations in which the new device could be incorporated and evaluates its expected ranking according to criteria such as cost, patient comfort, and clinical utility. This virtual prototyping capability provides an effective decision-support tool for **assessing** the **technological feasibility** and **commercial potential** of novel biometric devices before prototype development.

# Use Cases: Self-Evolving Knowledge Base

01

## Dynamic Benchmarking

Each newly registered biometric sensor automatically triggers a complete re-evaluation of the existing recommendation database. The platform recalculates thousands of potential sensor combinations using the multi-criteria decision model and updates their rankings according to technical performance, clinical utility, patient comfort, and economic factors.

# Use Cases: Interdisciplinary Collaboration Support

01

## Automatic Generation of Engineering Requirements

Based on a psychologist's research objectives, the platform formulates technical specifications for the development of new sensing devices. For example, the system may identify the need for a next-generation smart art therapy tool, such as a smart brush or smart pencil holder, incorporating miniature force sensors to measure grip strength and drawing pressure together with an integrated galvanic skin response (GSR) sensor positioned beneath the thumb.

02

## Generation of Data Science Requirements

The platform automatically formulates analytical tasks for data scientists. For the proposed smart art therapy device, the system may require the development of software capable of synchronizing physiological signals (e.g., GSR and heart rate) with a time-stamped video recording of the drawing process. As a result, psychologists receive an enriched visualization in which moments of significant physiological activation are automatically highlighted.

# Connecting clinical practice, data science, and biomedical engineering

## Psychologists

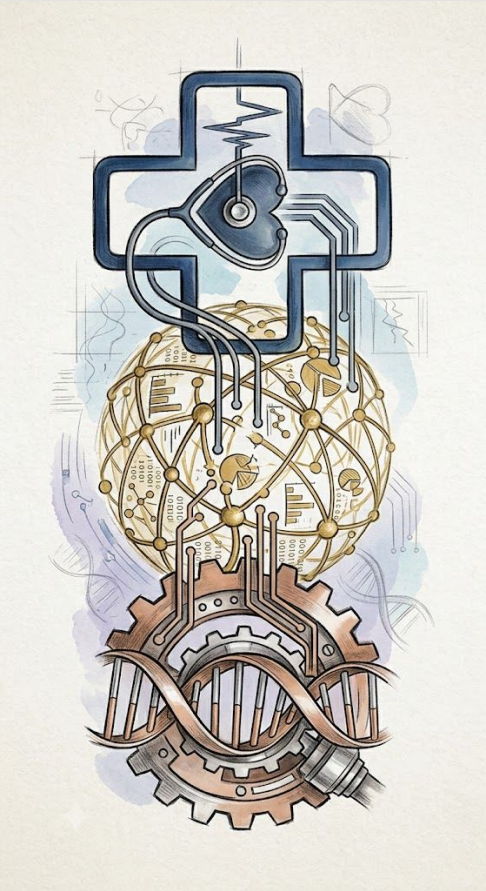
receive evidence-based decision support for selecting the most appropriate and least invasive sensor configurations tailored to specific therapeutic scenarios.

## Data scientists

gain access to standardized mathematical models, multimodal signal representations, and high-quality annotated datasets for developing and validating advanced machine learning algorithms

## Hardware developers

obtain clearly defined market-driven design requirements, enabling the development of next-generation open, minimally invasive biometric sensing devices that address real clinical needs identified by psychologists and researchers






# System Structure Analysis

To analyze the proposed decision support system, a set of **key parameters** describing its technological, methodological, economic, and operational characteristics was identified. These parameters constitute the basis for the subsequent structural analysis and the construction of the **interdependency matrix**.

# 1. Technical and Hardware Parameters

- **P1. Database Completeness:** The completeness and diversity of the sensor knowledge base, including the number of registered devices and semantic relationships between sensors and psychological indicators.
- **P2. Sensor Invasiveness Level:** The degree of physical interference caused by sensing devices, including weight, dimensions, attachment mechanisms, wired or wireless operation, and overall patient comfort.
- **P3. API Openness:** The availability of raw physiological data and open application programming interfaces (APIs) provided by sensor manufacturers.
- **P4. Sampling Rate and Measurement Accuracy:** The capability of sensing devices to capture subtle physiological changes with sufficient temporal resolution and accuracy.
- **P5. Response Time:** The ability of the sensing platform and processing infrastructure to acquire, synchronize, and analyze multimodal data streams in real time.

## 2. Methodological and Psychological Parameters

- **P6. Patient Trust:** The extent to which sensing technologies are perceived as comfortable, non-intrusive, and acceptable during psychotherapy.
- **P7. Behavioral Spontaneity:** The degree to which patients maintain natural behavior while wearing biometric sensing devices, particularly during expressive therapies such as art therapy.
- **P8. Scientific Reliability:** The level of scientific evidence supporting the relationships between physiological biomarkers and psychological states represented in the knowledge base.
- **P9. Expert Consensus:** The degree of agreement among psychologists when evaluating sensors and assigning expert ratings within the platform.
- **P10. Therapy Adaptability:** The flexibility of the platform to recommend sensor configurations for diverse psychotherapeutic approaches, including EMDR, art therapy, cognitive behavioral therapy (CBT), and virtual reality-based interventions.

# 3. Economic and Operational Parameters

- **P11. Sensor Cost:** The affordability of biometric sensing devices for psychologists, researchers, and healthcare institutions.
- **P12. Research and Development Cost:** The financial resources required to design and manufacture new sensing technologies identified as necessary by the platform.
- **P13. Market Availability:** The availability of sensors as commercial products rather than specialized laboratory or medical equipment.
- **P14. Setup Complexity:** The time, effort, and technical expertise required to install, configure, and calibrate sensor configurations before a therapy session.
- **P15. Certification and Regulatory Compliance:** The extent to which sensing devices satisfy legal, ethical, and medical certification requirements for clinical use.

# 4. System Outcomes and Interdisciplinary Collaboration

- **P16. User Satisfaction:** The usefulness and practical relevance of the recommendations provided to psychologists during clinical practice.
- **P17. Hardware Developer Engagement:** The willingness of hardware developers to adopt the platform's engineering specifications and develop new biometric sensing devices.
- **P18. Data Analytics Quality:** The effectiveness of data processing algorithms in filtering noise, extracting meaningful features, and generating reliable psychophysiological indicators.
- **P19. Number of Interdisciplinary Projects:** The number of collaborative research and development initiatives initiated through the interaction of psychologists, data scientists, and hardware developers.
- **P20. System Scalability:** The ability of the platform to support increasing numbers of users, sensors, therapeutic scenarios, and integrated hardware technologies.

| Parameter code and name | P1: Database Completeness | P2:Invasiveness Level | P3: API Openness | P4: Sampling Rate & Accuracy | P5: Response Time | P6: Patient Trust | P7: Behavioral Spontaneity | P8 |
|---|---|---|---|---|---|---|---|---|
| P1: Database Completeness | X | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| P2:Invasiveness Level | 0 | X | 0 | 0 | 0 | 3 | 3 | 0 |
| P3: API Openness | 1 | 0 | X | 0 | 1 | 0 | 0 | 0 |
| P4: Sampling Rate & Accuracy | 1 | 1 | 0 | X | 2 | 0 | 0 | 1 |
| P5: Response Time | 0 | 0 | 0 | 0 | X | 1 | 1 | 0 |
| P6: Patient Trust | 0 | 0 | 0 | 0 | 0 | X | 3 | 0 |
| P7: Behavioral Spontaneity | 0 | 0 | 0 | 0 | 0 | 2 | X | 0 |
| P8: Scientific Reliability | 1 | 0 | 0 | 0 | 0 | 1 | 0 | X |

# Analysis of Critical Interaction Cases

**High-Impact Relationships (Impact Score = 3)**

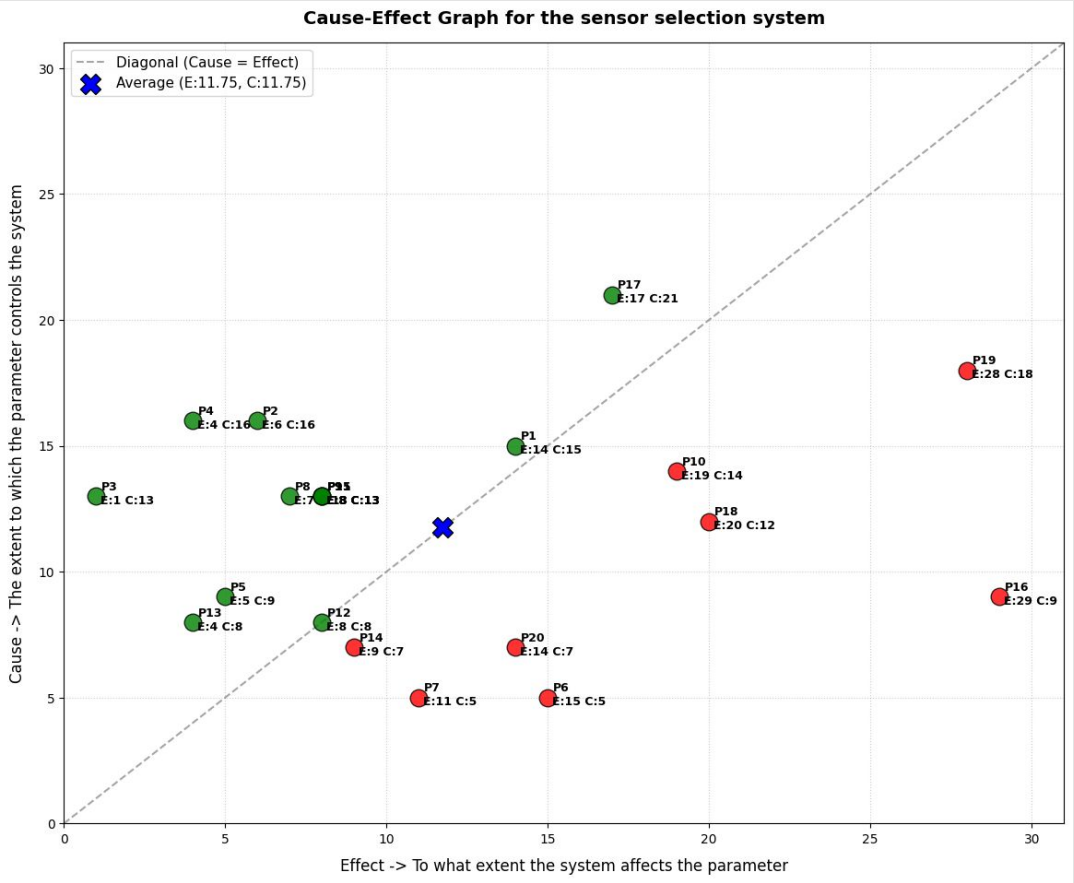
- **P1 (Database Completeness) → P10 (Therapy Adaptability): Impact = 3.** The platform's ability to recommend sensor configurations for specific therapeutic approaches depends directly on the completeness and diversity of its knowledge base. A limited sensor database significantly restricts the capability to generate customized solutions for therapies such as art therapy or Eye Movement Desensitization and Reprocessing (EMDR).
- **P1 (Database Completeness) → P17 (Hardware Developer Engagement): Impact = 3.** A comprehensive and well-structured sensor repository enables hardware developers to identify unmet clinical needs and technological gaps. Consequently, the platform becomes a source of innovation opportunities and stimulates the development of new sensing technologies.
- **P2 (Sensor Invasiveness) → P6 (Patient Trust): Impact = 3.** Patient trust is strongly influenced by the physical characteristics of sensing devices. Heavy, wired, or cumbersome equipment may increase discomfort and negatively affect patients' willingness to participate in therapy, whereas lightweight and minimally invasive devices contribute to a more comfortable therapeutic environment.
- **P2 (Sensor Invasiveness) → P7 (Behavioral Spontaneity): Impact = 3.** Minimally invasive sensing technologies are essential for preserving natural patient behavior during therapy. This factor is particularly important in movement-based interventions, including art therapy and body-oriented psychotherapy, where unrestricted movement directly affects therapeutic outcomes.

# Analysis of Critical Interaction Cases

**Zero-Impact Relationships (Impact Score = 0)**

- **P1 (Database Completeness) → P2 (Sensor Invasiveness): Impact = 0.** The number of sensors included in the knowledge base does not influence the physical characteristics of commercially available devices, such as their weight, dimensions, attachment mechanism, or wired/wireless design.
- **P2 (Sensor Invasiveness) → P3 (API Openness): Impact = 0.** The physical design and ergonomics of a sensing device are independent of the manufacturer's software policy regarding access to raw physiological data or application programming interfaces (APIs).
- **P3 (API Openness) → P6 (Patient Trust): Impact = 0.** Patients do not directly interact with data transmission protocols or software interfaces. Their level of trust is determined primarily by the physical characteristics and usability of sensing devices rather than by the underlying data communication format.
- **P5 (Response Time) → P11 (Sensor Cost): Impact = 0.** The computational performance of the analytical platform or cloud infrastructure does not affect the commercial price of biometric sensing devices.

# Impact Matrix: Cause-Effect Graph for Veteran support IT system



Cause-Effect analysis can be performed as in the following Table

| Parameter code and name | Effect | Cause | Role in a system |
|---|---|---|---|
| P1: Database Completeness | 14 | 15 | CAUSE (Driving force of the system / Active) |
| P2: Invasiveness Level | 6 | 16 | CAUSE (Driving force of the system / Active) |
| P3: API Openness | 1 | 13 | CAUSE (Driving force of the system / Active) |
| P4: Sampling Rate & Accuracy | 4 | 16 | CAUSE (Driving force of the system / Active) |
| P5: Response Time | 5 | 9 | CAUSE (Driving force of the system / Active) |
| P6: Patient Trust | 15 | 5 | EFFECT (Indicator of change / Symptom / Passive) |
| P7: Behavioral Spontaneity | 11 | 5 | EFFECT (Indicator of change / Symptom / Passive) |
| P8: Scientific Reliability | 7 | 13 | CAUSE (Driving force of the system / Active) |
| P9: Expert Consensus | 8 | 13 | CAUSE (Driving force of the system / Active) |
| P10: Therapy Adaptability | 19 | 14 | EFFECT (Indicator of change / Symptom / Passive) |
| P11: Sensors Cost | 8 | 13 | CAUSE (Driving force of the system / Active) |

# Key Driving Factors (Cause Variables)

- **P17. Hardware Developer Engagement (Cause = 21, Effect = 17).** Active participation of hardware developers continuously expands the knowledge base, **stimulates the development of new sensing technologies**, and directly promotes interdisciplinary research and innovation projects.
- **P2. Sensor Invasiveness Level (Cause = 16, Effect = 6)** and **P4. Sampling Rate and Measurement Accuracy (Cause = 16, Effect = 4).** Sensor invasiveness strongly influences **patient trust** and the **naturalness of patient behavior** during therapy, whereas sampling rate and measurement accuracy determine the quality of physiological data available for subsequent analytical processing.
- **P1. Database Completeness (Cause = 15, Effect = 14).** A comprehensive knowledge base enables **more accurate sensor recommendations** and broader therapeutic adaptation, while its continued growth depends on contributions from hardware developers and researchers.
- **P3. API Openness (Cause = 13, Effect = 1).** It is influenced by very few other variables but has a substantial impact on the quality of data analytics by **providing access to raw physiological signals** required for advanced signal processing, feature extraction, and machine learning model development.

# Key Outcome Variables (Effect Variables)

- **P16. User Satisfaction (Effect = 29, Cause = 9).** User satisfaction depends on multiple upstream factors, including sensor accuracy, access to raw physiological data, ease of system configuration, and the quality of analytical algorithms.
- **P19. Number of Interdisciplinary Projects (Effect = 28, Cause = 18).** By connecting psychologists, data scientists, and hardware developers through shared technical and clinical requirements, the platform facilitates the initiation of collaborative research and development projects, thereby functioning as an effective interdisciplinary collaboration hub.
- **P18. Data Analytics Quality (Effect = 20, Cause = 12).** As these supporting factors improve, the reliability of psychophysiological analysis increases accordingly.
- **P10. Therapy Adaptability (Effect = 19, Cause = 14).** As additional sensing technologies and therapeutic scenarios are incorporated, the platform becomes increasingly flexible and applicable across a wider range of clinical contexts.

# Multi-Criteria Evaluation

## Scenario A:

### Psychological MVP Knowledge Base

This scenario prioritizes the needs of psychologists by initially developing the **information and decision-support components** of the platform. At this stage, no real-time data acquisition infrastructure or hardware integration is implemented.

## Scenario B:

### Technology Core and Analytics Infrastructure

This scenario focuses on developing the **technical infrastructure** required for multimodal physiological data acquisition and analysis. Rather than emphasizing end-user functionality, the initial implementation concentrates on building a scalable analytical backend.

# Scenario A: Psychological MVP Knowledge Base (User-Centric Approach)

1. **Sensor Knowledge Base and Psychological Mapping.** A comprehensive repository of commercially available biometric sensing devices is established, incorporating technical specifications together with psychological characteristics such as invasiveness (P2), usability, and cost (P11). The database also includes mappings between physiological measurements and psychological indicators.
2. **Web-Based Decision Support Interface.** A simple web application enables psychologists to specify the characteristics of a therapeutic session and receive evidence-based recommendations regarding suitable sensing devices and compatible software tools.
3. **Knowledge Base for Data Interpretation.** A structured repository of methodological guidelines assists psychologists in interpreting physiological indicators obtained from external sensing platforms and commercial devices.

This scenario provides an early decision-support tool with relatively low implementation complexity while creating the foundation for subsequent platform expansion.

# Scenario B: Technology Core and Analytics Infrastructure (Technology-Centric Approach)

1. **Data Ingestion and Synchronization Engine.** Development of a software module capable of acquiring multimodal physiological signals from heterogeneous sensing devices, synchronizing data streams in real time, and reducing motion artifacts prior to analysis (P18).
2. **Open API and Software Development Kit (SDK).** Development of standardized APIs and SDKs that enable hardware developers to integrate commercial devices as well as custom prototypes (e.g., Arduino- or Raspberry Pi-based sensors) into the platform (P3, P17).
3. **Analytical Sandbox Environment.** A dedicated environment that allows data scientists to develop, test, and validate signal processing algorithms, feature extraction methods, and machine learning models using synchronized physiological datasets.

This scenario establishes the technological foundation required for future expansion of the platform while encouraging collaboration with hardware developers and data scientists from the earliest stages of implementation.

# Criteria Prioritization

## Tier 1

### Critical Analytical Requirements

P3. API Openness.
P4. Sampling Rate and Measurement Accuracy.
P8. Scientific Reliability.
P9. Expert Consensus.
P18. Data Analytics Quality.

## Tier 2

### Infrastructure and Scalability

P1. Database Completeness.
P5. Response Time.
P20. System Scalability.
P10. Therapy Adaptability.

## Tier 3

### Data Quality and Clinical Reliability

P2. Sensor Invasiveness Level.
P7. Behavioral Spontaneity.
P14. Setup Complexity.
P6. Patient Trust. P15. Certification and Regulatory Compliance.

## Tier 4

### Economic and Deployment Factors

P17. Hardware Developer Engagement.
P19. Number of Interdisciplinary Projects.
P16. User Satisfaction.
P11. Sensor Cost.
P13. Market Availability.
P12. Research and Development Cost.

PRIORITIES CALCULATED

$$Weighted\ Utility = \sum_{i=1}^{20} \left( \frac{W_i}{100} \cdot Utility_i \right)$$

| Parameter code and name | Priority, % |
|---|---|
| P1: Database Completeness | 7 |
| P2: Invasiveness Level | 4,5 |
| P3: API Openness | 12 |
| P4: Sampling Rate & Accuracy | 10,5 |
| P5: Response Time | 6 |
| P6: Patient Trust | 3 |
| P7: Behavioral Spontaneity | 4 |
| P8: Scientific Reliability | 8,5 |
| P9: Expert Consensus | 8 |
| P10: Therapy Adaptability | 5 |
| P11: Sensors Cost | 1,5 |
| P12: R&D Cost | 1 |
| P13: Market Availability | 1,5 |
| P14: Setup Complexity | 3,5 |
| P15: Certification & Compliance | 3 |
| P16: User Satisfaction | 2 |
| P17: Hardware Developers Engagement | 2,5 |
| P18: Data Analytics Quality | 7,5 |
| P19: Collaborative Projects Count | 2 |
| P20: System Scalability | 5,5 |

# SCENARIOS EVALUATION

Scenario A: Psychological MVP Knowledge Base (User-Centric Approach)

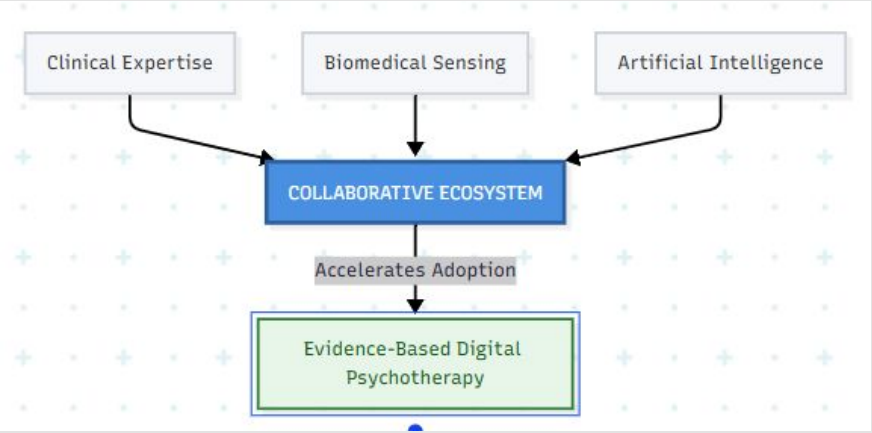
Scenario B: Technology Core and Analytics Infrastructure (Technology-Centric Approach)

| Parameter | Priority (Wi, %) | Utility (S1) | Utility (S2) | Total utility (S1) | Total utility (S2) |
|---|---|---|---|---|---|
| P1: Database Completeness | 7 | 9 | 5 | 63 | 45 |
| P2: Invasiveness Level | 4,5 | 9 | 5 | 40,5 | 45 |
| P3: API Openness | 12 | 1 | 9 | 12 | 9 |
| P4: Sampling Rate & Accuracy | 10,5 | 1 | 9 | 10,5 | 9 |
| P5: Response Time | 6 | 1 | 9 | 6 | 9 |
| P6: Patient Trust | 3 | 9 | 1 | 27 | 9 |
| P7: Behavioral Spontaneity | 4 | 9 | 1 | 36 | 9 |
| P8: Scientific Reliability | 8,5 | 9 | 5 | 76,5 | 45 |
| P9: Expert Consensus | 8 | 9 | 1 | 72 | 9 |
| P10: Therapy Adaptability | 5 | 9 | 5 | 45 | 45 |
| P11: Sensors Cost | 1,5 | 9 | 5 | 13,5 | 45 |
| P12: R&D Cost | 1 | 1 | 9 | 1 | 9 |
| P13: Market Availability | 1,5 | 9 | 5 | 13,5 | 45 |
| P14: Setup Complexity | 3,5 | 9 | 1 | 31,5 | 9 |
| P15: Certification & Compliance | 3 | 5 | 5 | 15 | 25 |
| P16: User Satisfaction | 2 | 9 | 1 | 18 | 9 |
| P17: Hardware Developers Engagement | 2,5 | 1 | 9 | 2,5 | 9 |
| P18: Data Analytics Quality | 7,5 | 1 | 9 | 7,5 | 9 |
| P19: Collaborative Projects Count | 2 | 1 | 9 | 2 | 9 |
| P20: System Scalability | 5,5 | 5 | 9 | 27,5 | 45 |
| | | | Sum | 457,5 | 403 |

# CONCLUSIONS

The proposed platform has the potential to become a **collaborative ecosystem** that accelerates the adoption of evidence-based digital psychotherapy by connecting clinical expertise, biomedical sensing technologies, and artificial intelligence.

By facilitating standardized data collection, improving interoperability between sensing devices, and supporting the development of clinically validated analytical models, the platform may contribute to the design of more **objective, personalized, and minimally invasive psychophysiological assessment systems**.



# METHOD

## Conceptual Modeling

Establishing structural relationships between the technical parameters of the sensors and psychophysiological states

## Structural Analysis

Establishing parameters:

- Technical and Hardware,
- Methodological and Psychological,
- Economic and Operational,
- System Outcomes and Interdisciplinary Collaboration

## Impact Mapping

Using cause-effect graphs to identify the parameters with the strongest driving influence on the proposed decision support platform

## Multi-Criteria Evaluation

A multi-criteria evaluation demonstrates how different implementation strategies address different stakeholder needs

## Recommendations & Next Steps

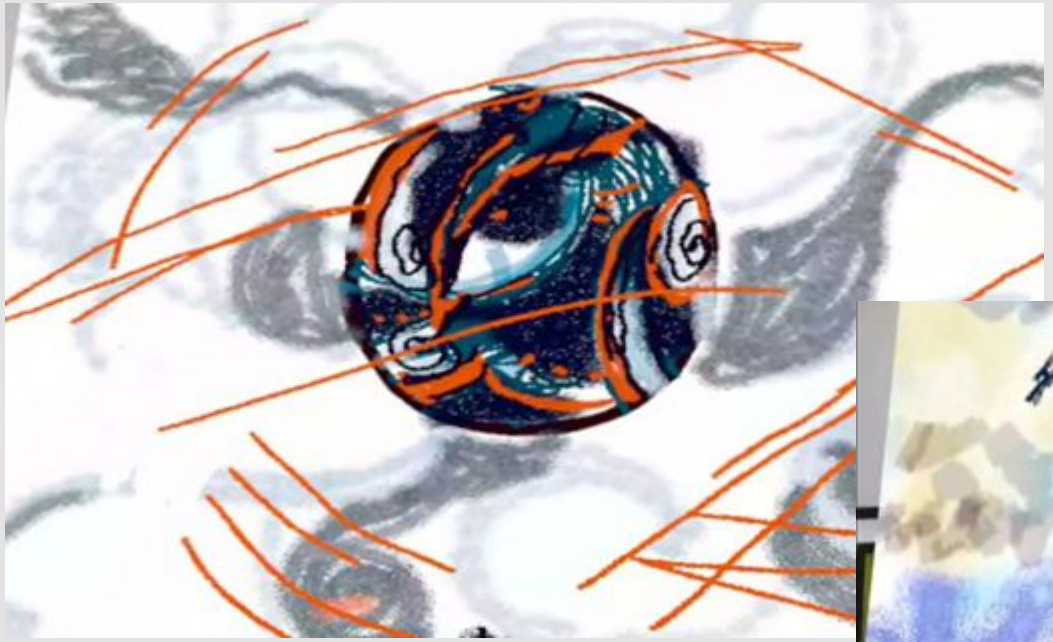
**Additional opportunities using Meta Quest 2 as an integrated sensing platform**

# Additional opportunities using Meta Quest 2 as an integrated sensing platform

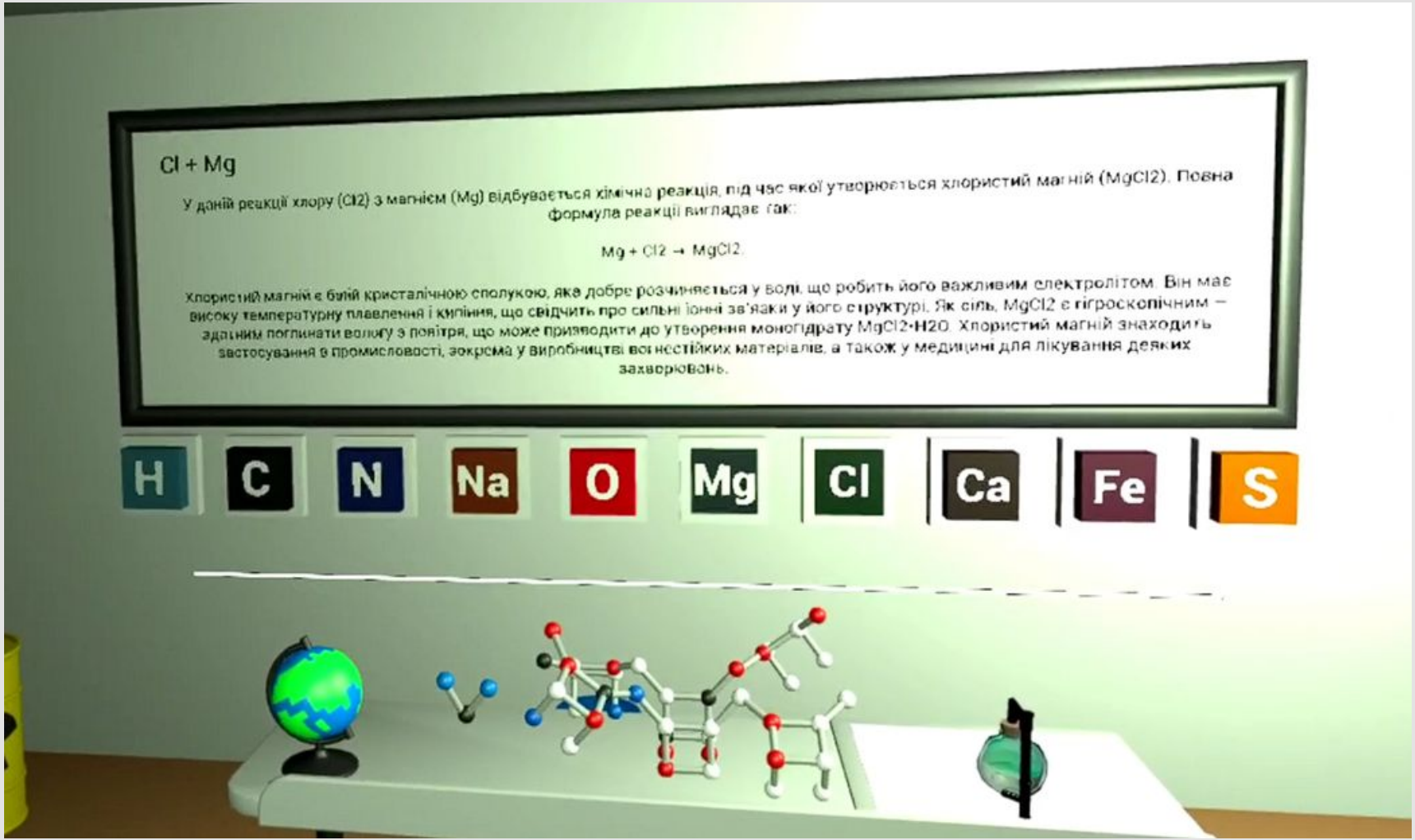
**Native capabilities of Meta Quest 2 and Touch controllers as a primary data source**

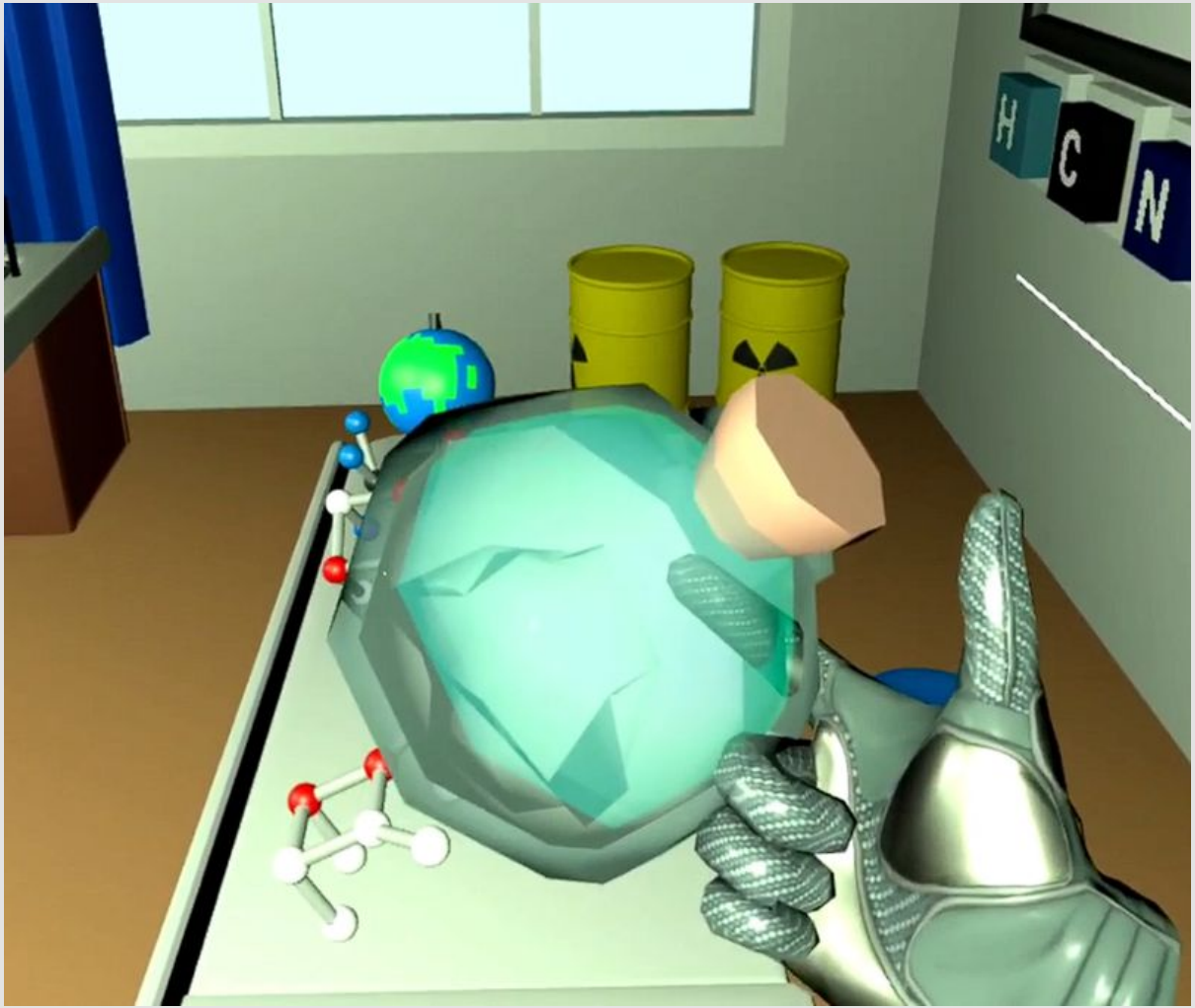
- **3D hand trajectory and movement kinematics:** Meta Quest 2 controllers integrate high-precision inertial sensors (accelerometers and gyroscopes) with six degrees of freedom (6DoF) tracking. During VR art-therapy sessions, the system can continuously record hand trajectories, movement velocity, stroke amplitude, tremor characteristics, and fine motor behavior. These measurements provide valuable indicators of psychomotor activity and emotional expression.
- **Grip dynamics and trigger interaction:** The analog trigger buttons capture continuous variations in finger pressure rather than simple binary clicks. These data can be used to estimate grip intensity, pressure modulation during drawing or sculpting tasks, and involuntary changes associated with stress, hesitation, or emotional arousal.
- **Head movement and body positioning:** The headset continuously tracks head position and orientation in three-dimensional space. Analysis of head movements allows therapists to identify avoidance behavior, increased engagement, withdrawal from virtual objects, or excessive immersion during therapeutic activities.







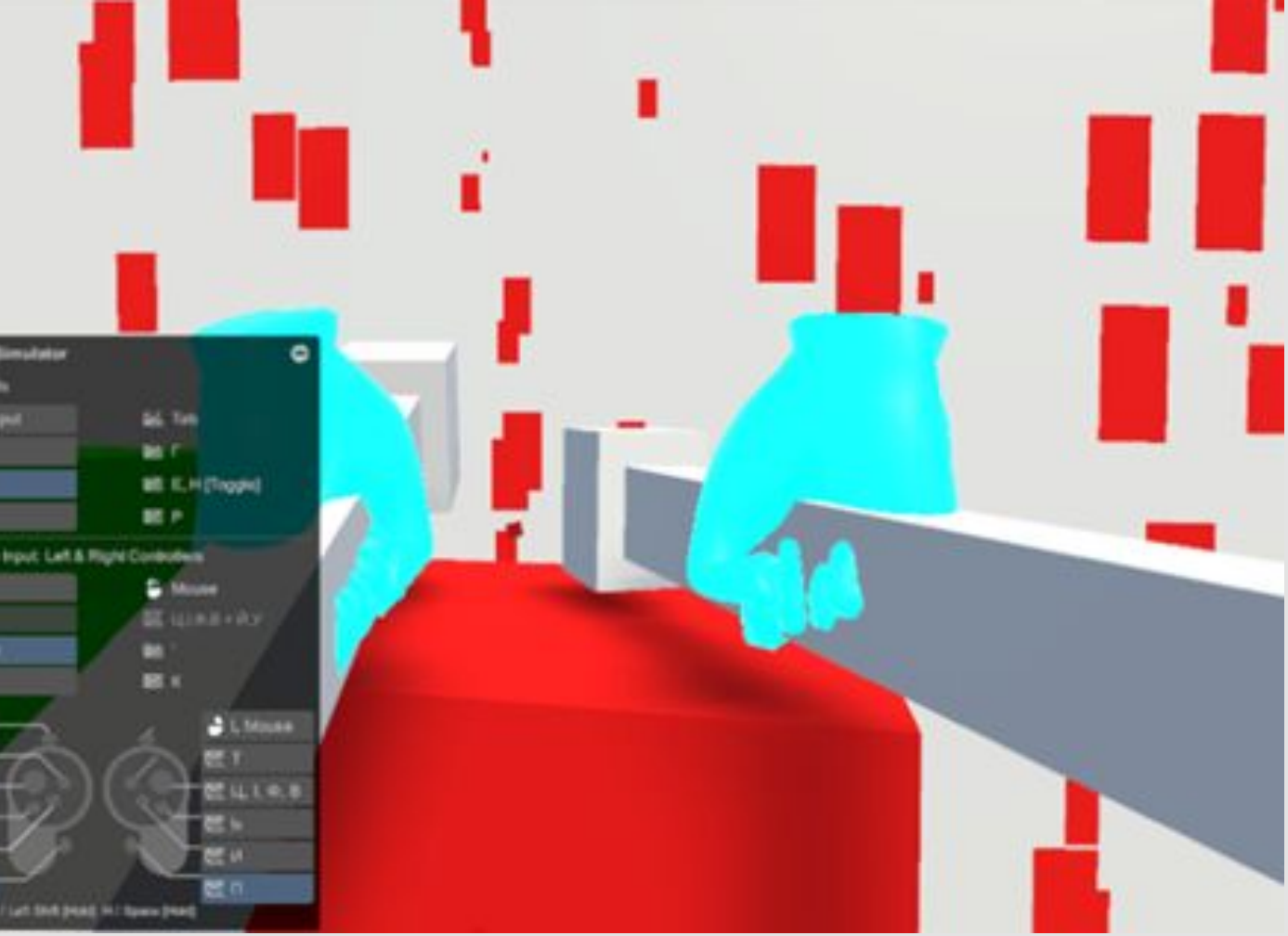

Cl + Mg
У даній реакції хлору (Cl2) з магнієм (Mg) відбувається хімічна реакція, під час якої утворюється хлористий магній (MgCl2). Повна формула реакції виглядає так:
Mg + Cl2 → MgCl2.
Хлористий магній є білий кристалічною сполукою, яка добре розчиняється у воді, що робить його важливим електролітом. Він має високу температурну плавлення і кипіння, що свідчить про сильні іонні зв'язки у його структурі. Як сіль, MgCl2 є гігроскопічним — здатним поглинати вологу з повітря, що може призводити до утворення моногідрату MgCl2·H2O. Хлористий магній знаходить застосування в промисловості, зокрема у виробництві вогнестійких матеріалів, а також у медицині для лікування деяких захворювань.
H
C
N
Na
O
Mg
Cl
Ca
Fe
S


H
C
N


DANGER!







instrument_data

| Total time spent playing: 89.55 sec | |
|---|---|
| | |
| **Instrument: Hihat** | |
| **Hit Count** | Applied Force |
| **1** | 0 |
| **2** | 1 |
| **3** | 1 |
| **4** | 0 |
| **5** | 0 |
| **6** | 1 |
| | |
| **Instrument: Drum** | |
| **Hit Count** | Applied Force |
| **1** | 0 |
| **2** | 1 |
| **3** | 0 |
| **4** | 0.7092436 |
| **5** | 0 |
| **6** | 1 |
| **7** | 0 |
| **8** | 0 |
| **9** | 1 |
| | |
| **Instrument: Snare** | |
| **Hit Count** | Applied Force |
| **1** | 0 |
| **2** | 0 |
| **3** | 0 |

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THANK YOU