



Patient Rescue Simulations Using XR, AI & Biosensors

Inside UAZ-Funded Scholarship

April 8, 2024

12:00pm – 1:00pm



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Land Acknowledgement



Rescue Simulations Using XR, AI & Biosensors



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Event Introduction



Guadalupe (Guada) Lozano

Director and Endowed Chair, CUES

Director, External Relations & Evaluation, School of Mathematical Sciences

Associate Research Professor of Mathematics

Speaker & Panelists



Janine Hinton

CUES Distinguished Fellow

Associate Clinical Professor, Nursing
Director, Steele Innovative Learning Center
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Shravan Aras

Assistant Director,
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Kamelia Sepanloo

Pd.D. Student
School of Industrial
Engineering;
Purdue University



Daniel Shevelev

Graduate Assistant,
Research; College of
Nursing

What will we share?

Project Purpose

- Gaps in nursing student preparation
 - Failure to Rescue
 - Social Determinants of Health
 - Diversity, Equity, Inclusion & Belonging
- Extended reality & clinical education
- Stress, workload, & situation awareness

Patients

- Digital patients x3
- Standardized patient

Pilot study

- Simulation map
- Measures
- Intelligent Simulation Environment
 - Conversational AI
 - AR & VR
 - Biosensors
- VR & 360 video
- Outcomes
- Next steps



What is the project purpose?



What are gaps in nursing student preparation?



Rescue Simulations Using XR, AI & Biosensors

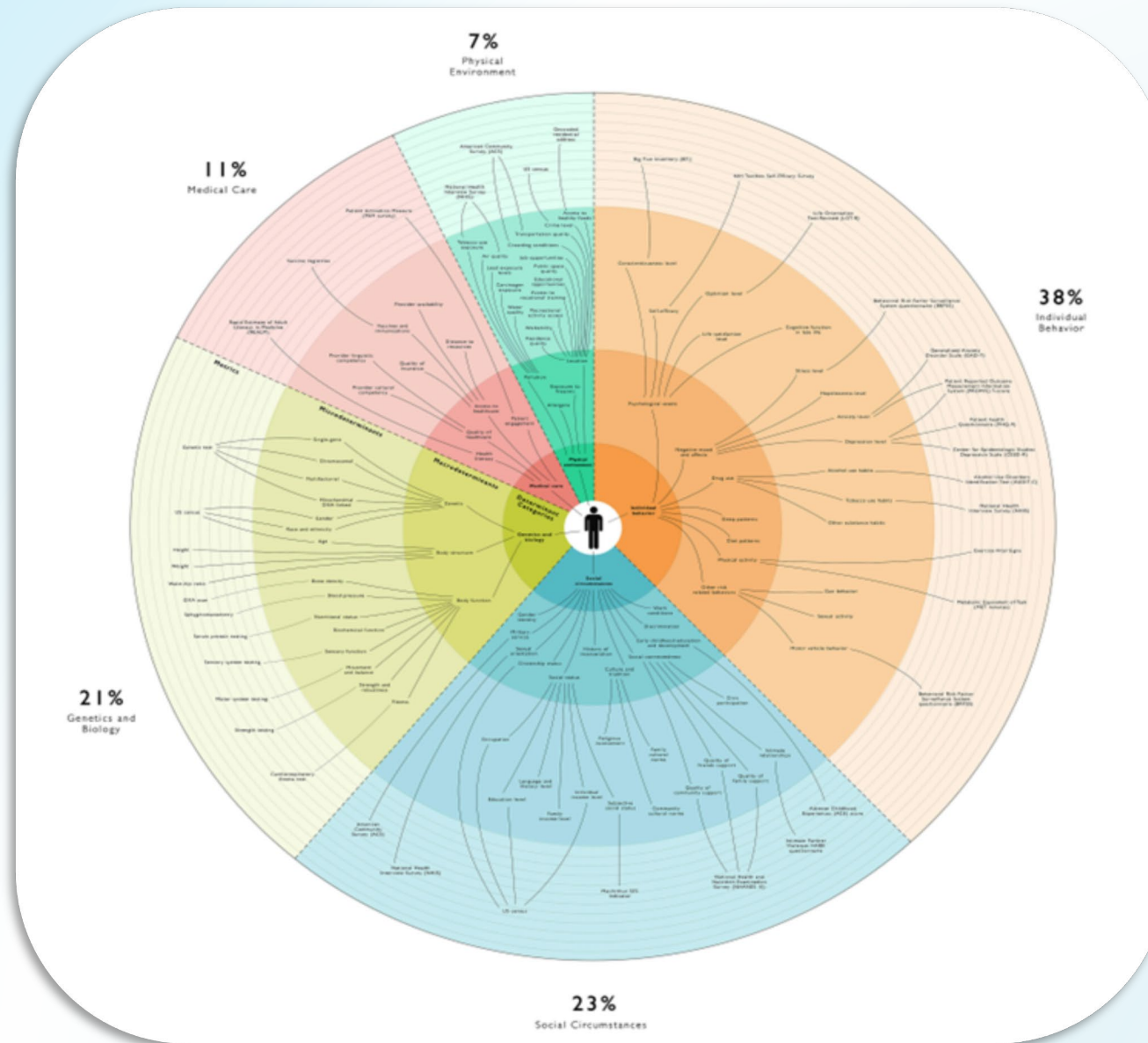
**What are gaps
in nursing
student
preparation?**

**Failure to
Rescue**



What are gaps in nursing student preparation?

Social Determinants of Health (SDOH)





**What are gaps
in nursing
student
preparation?**

**Diversity,
Equity,
Inclusion, &
Belonging
(DEIB)**

Why use Extended Reality (XR) for clinical education?



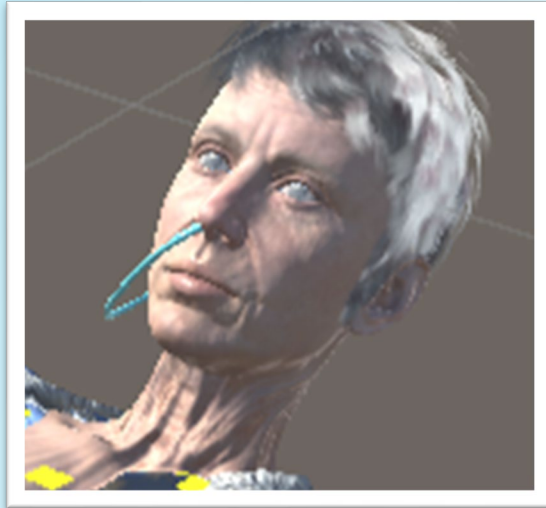
**How can we
optimize
stress,
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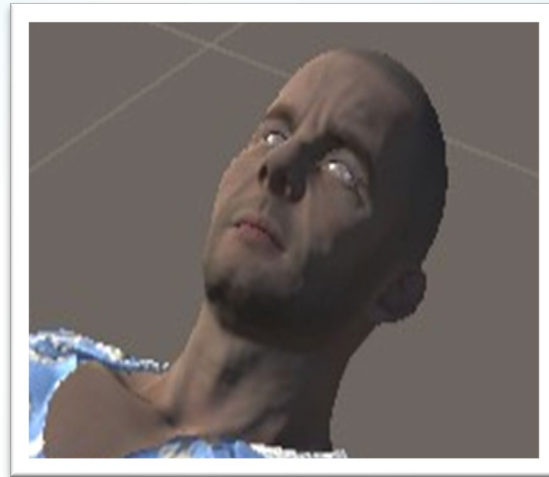
How can we optimize stress, workload, & situation awareness?



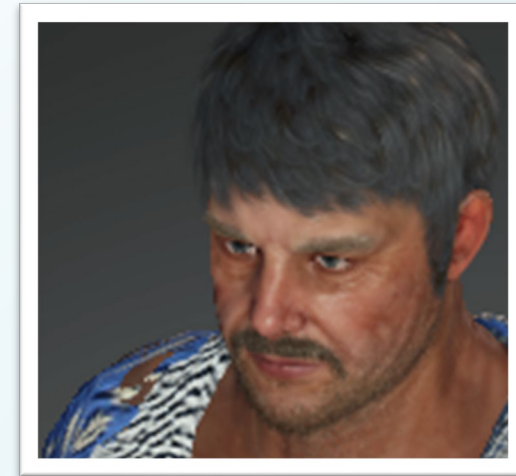
Who are our Digital Patients?



Beatrice



James

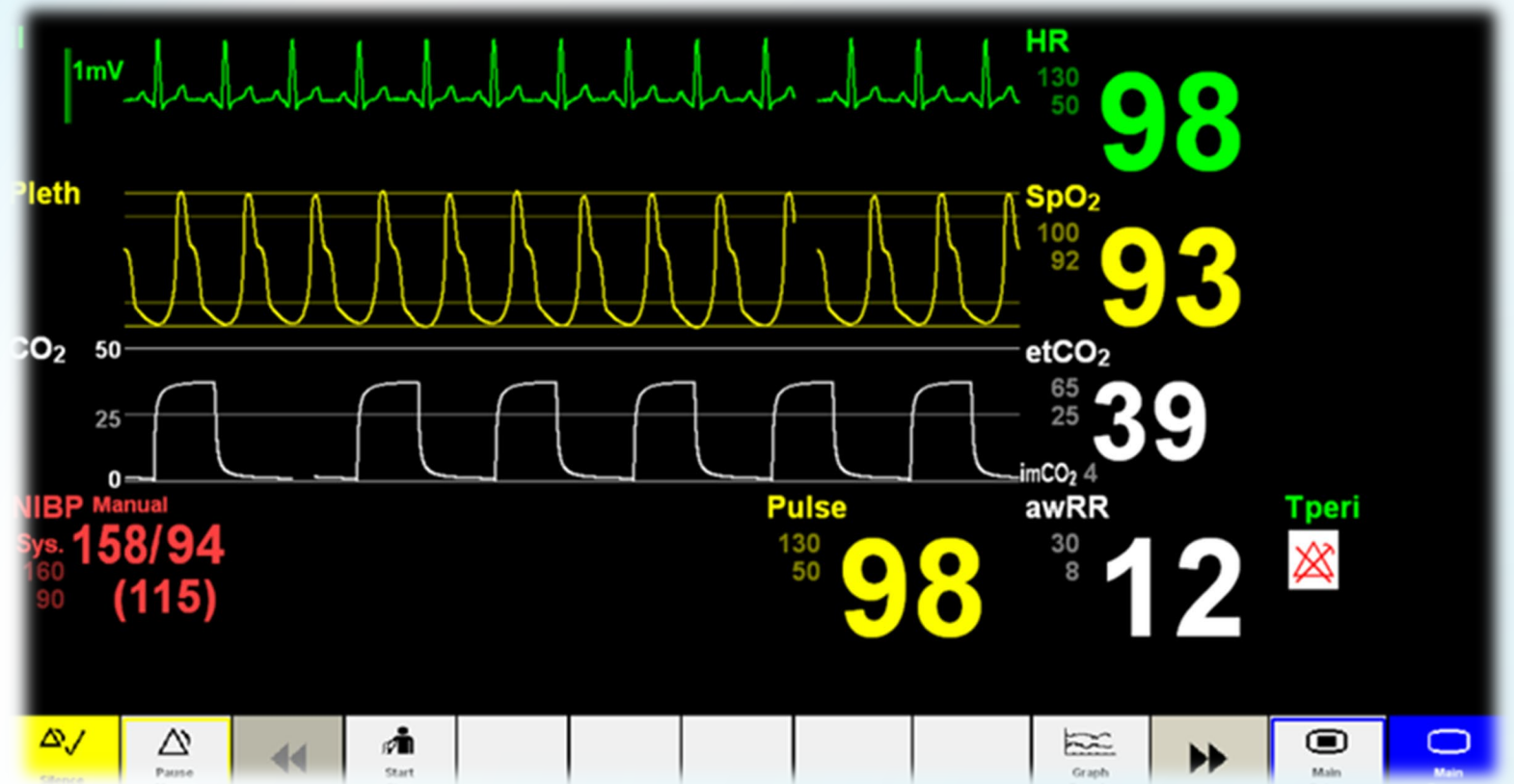


Miguel

Who is our Standardized Patient?

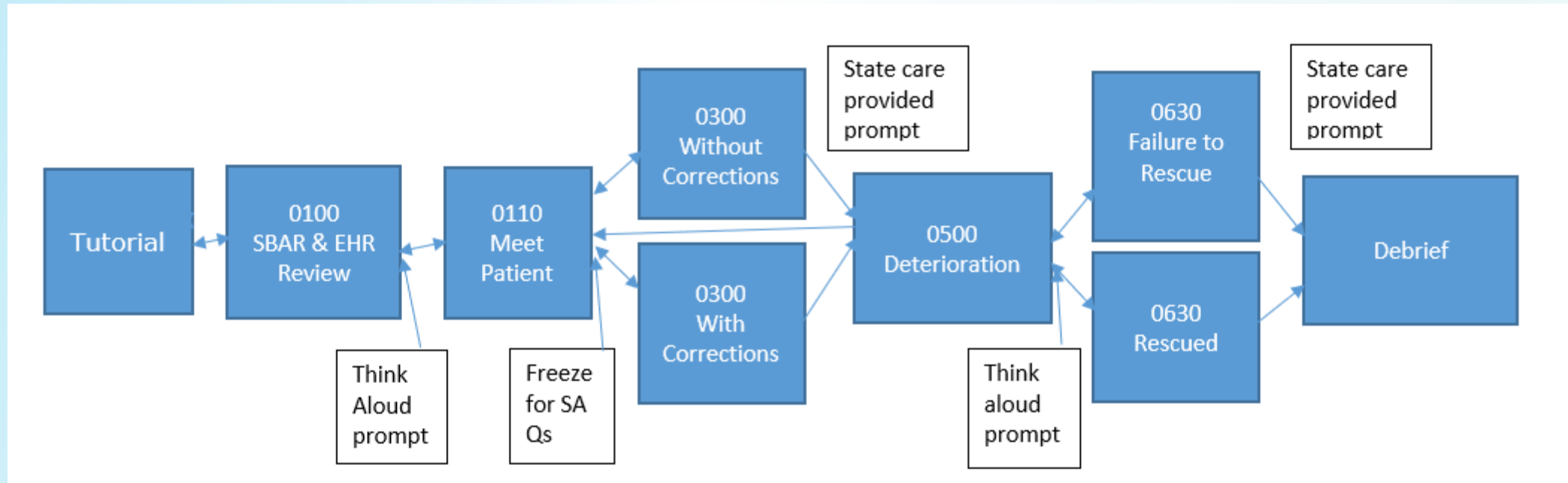


John



How are we developing & testing sim-time travel mixed reality simulations?

Pilot Study



How are we developing & testing sim-time travel mixed reality simulations?

Measures



Qualitative

- 1) Think-aloud pauses
- 2) Stated interventions
- 3) Open ended debrief questions

Quantitative

- 1) Situation Awareness Global Assessment Technique (SAGAT) (Endsley & Garland 2000)
- 2) Nursing Performance Profile 5-Factor instrument (Hinton, et al., 2020)
- 3) NASA task load index (Hart 2006)
- 4) Mixed Reality Experience survey
- 5) Event log

System Overview

➤ Software:

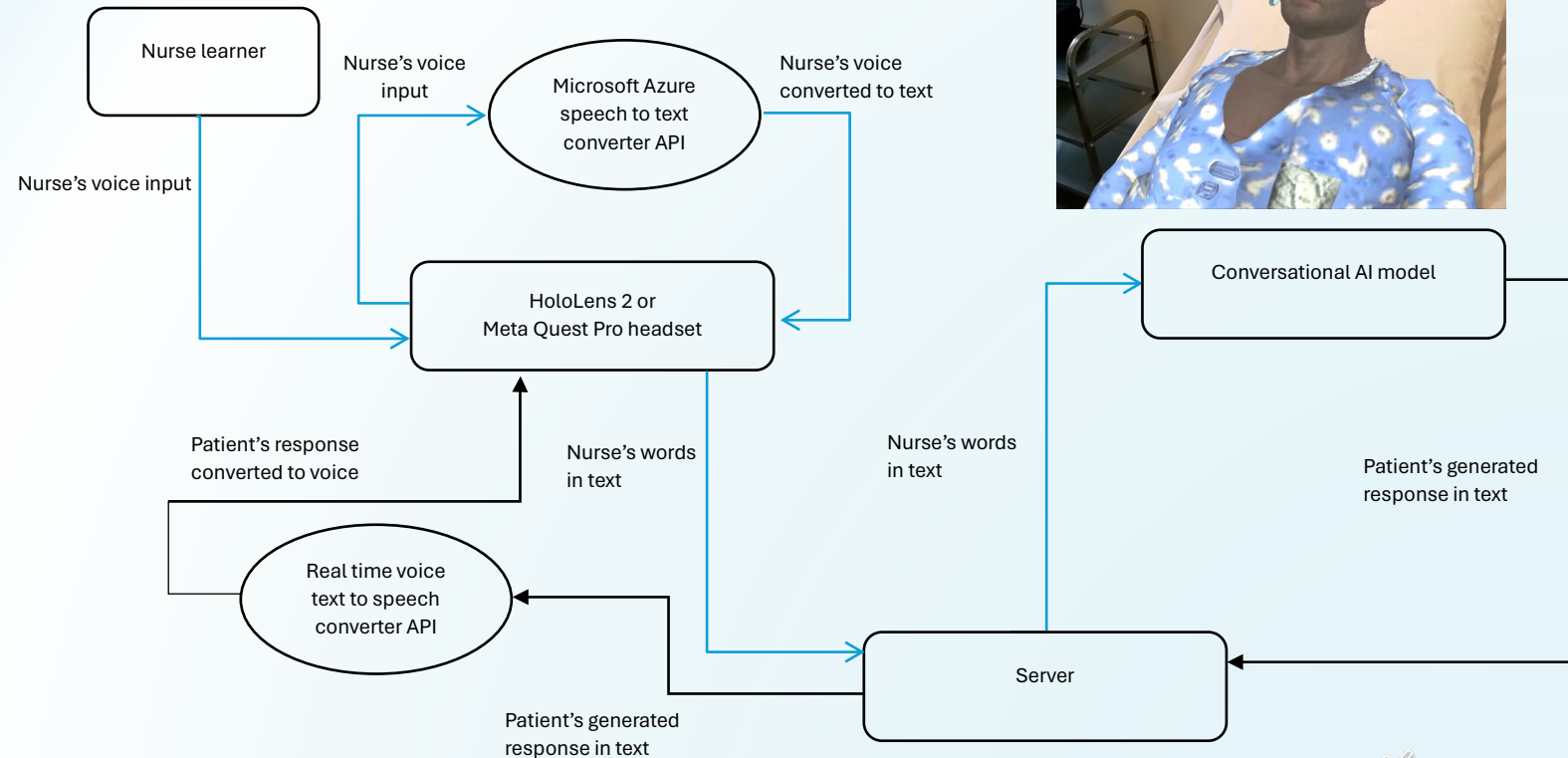
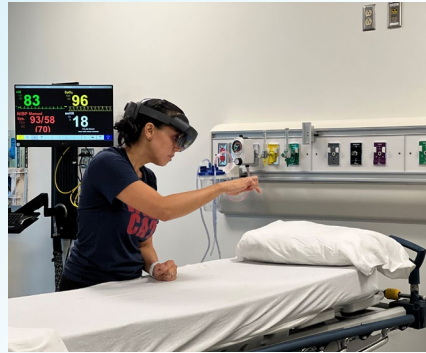
- MindMeld platform for **conversational AI**
- Reallusion character creator for **digital patient model**
- Unity 3D for **digital equipment** and **scenario** development

➤ Hardware:

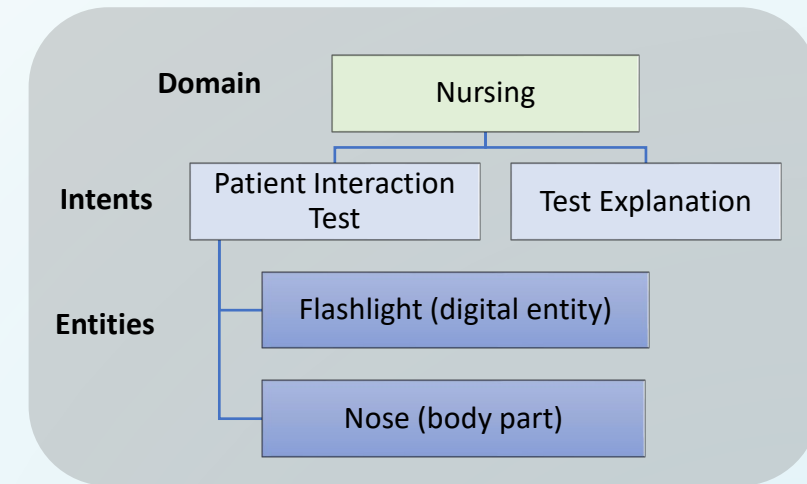
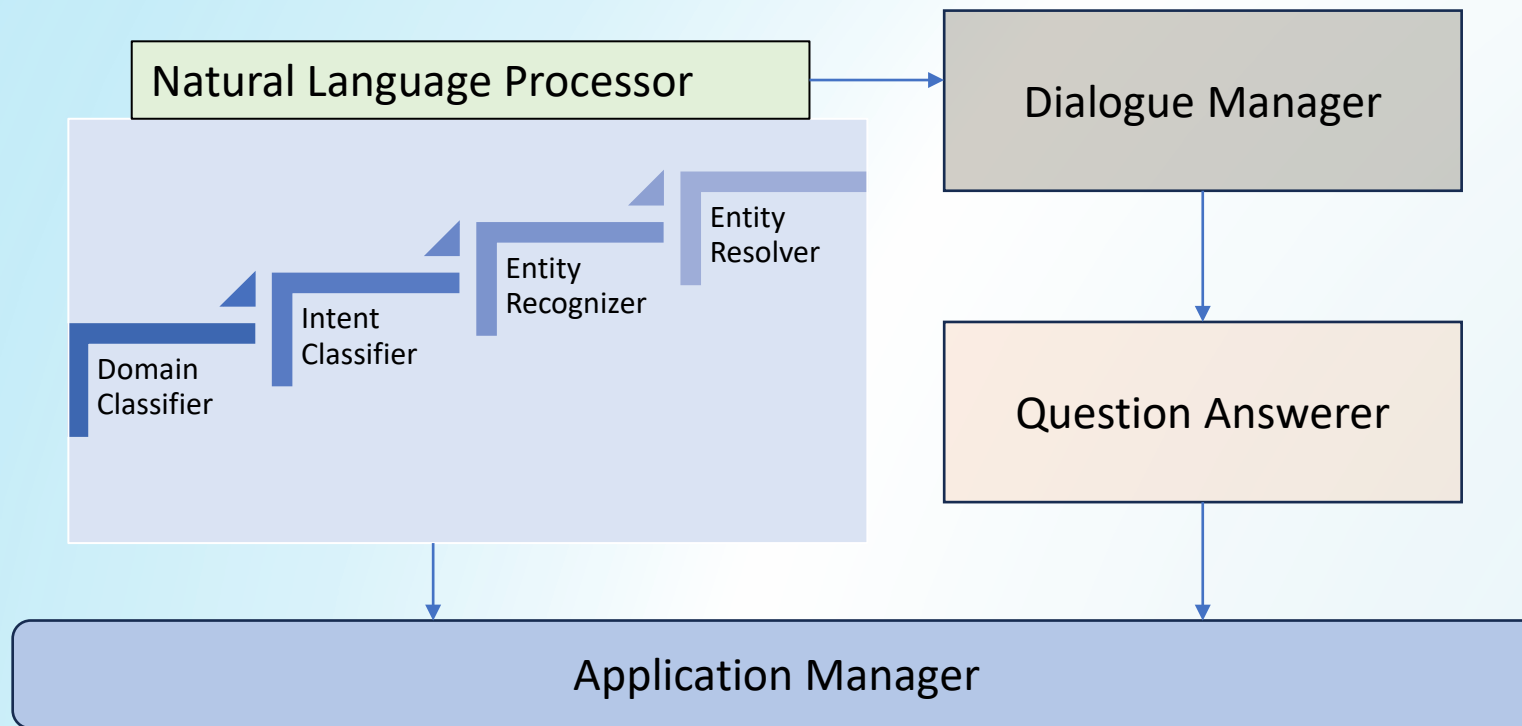
- Microsoft HoloLens 2.0 for **mixed-reality**
- Meta Quest Pro for **virtual-reality**
- Empatica E4 wristband as **sensor**
- Movisens chest strap as **sensor**

➤ Environment:

- Simulated hospital room



How is our Conversational AI model developed?

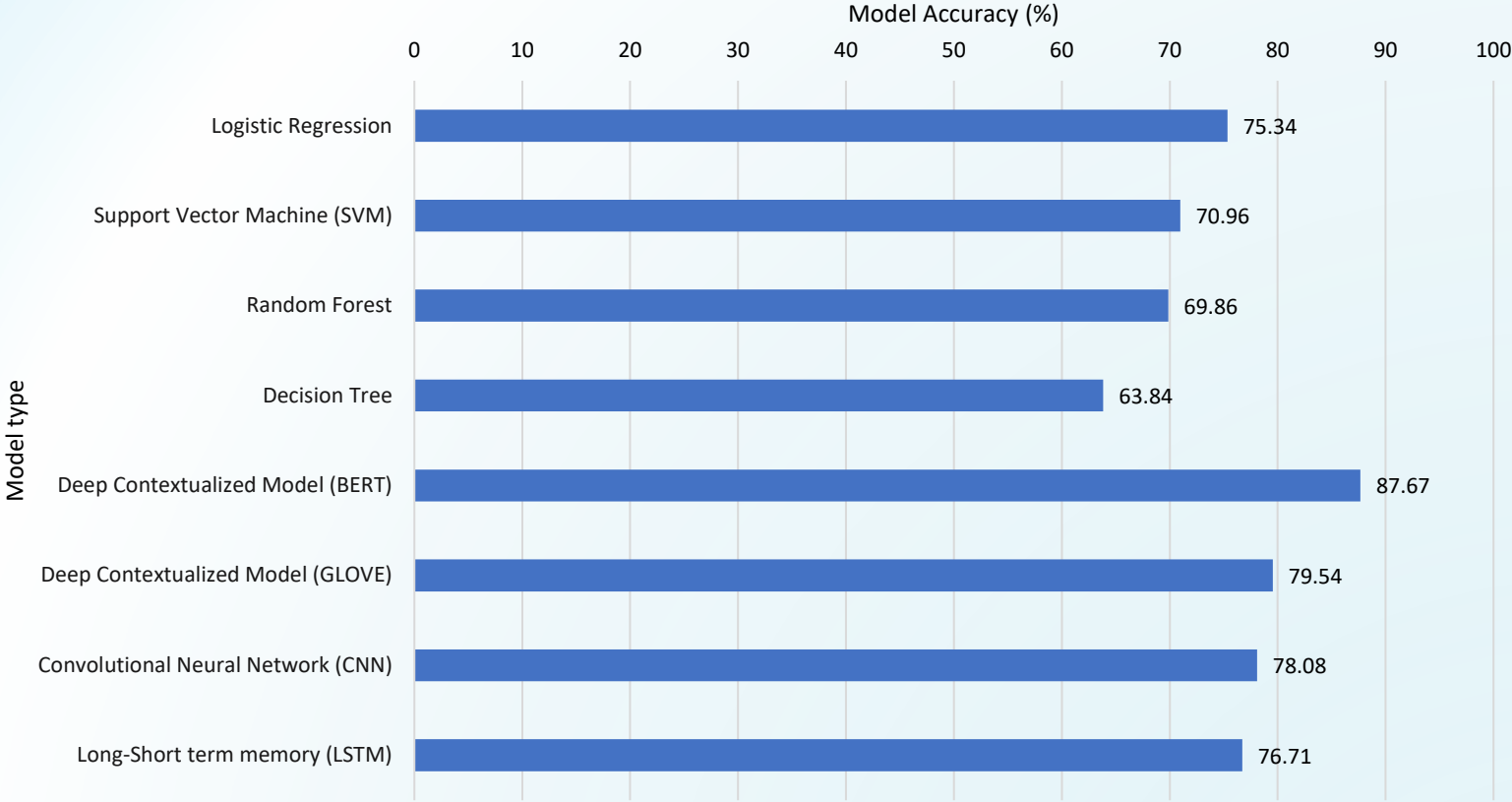


Example: Can you follow the flashlight towards your nose so that I can check your vision??

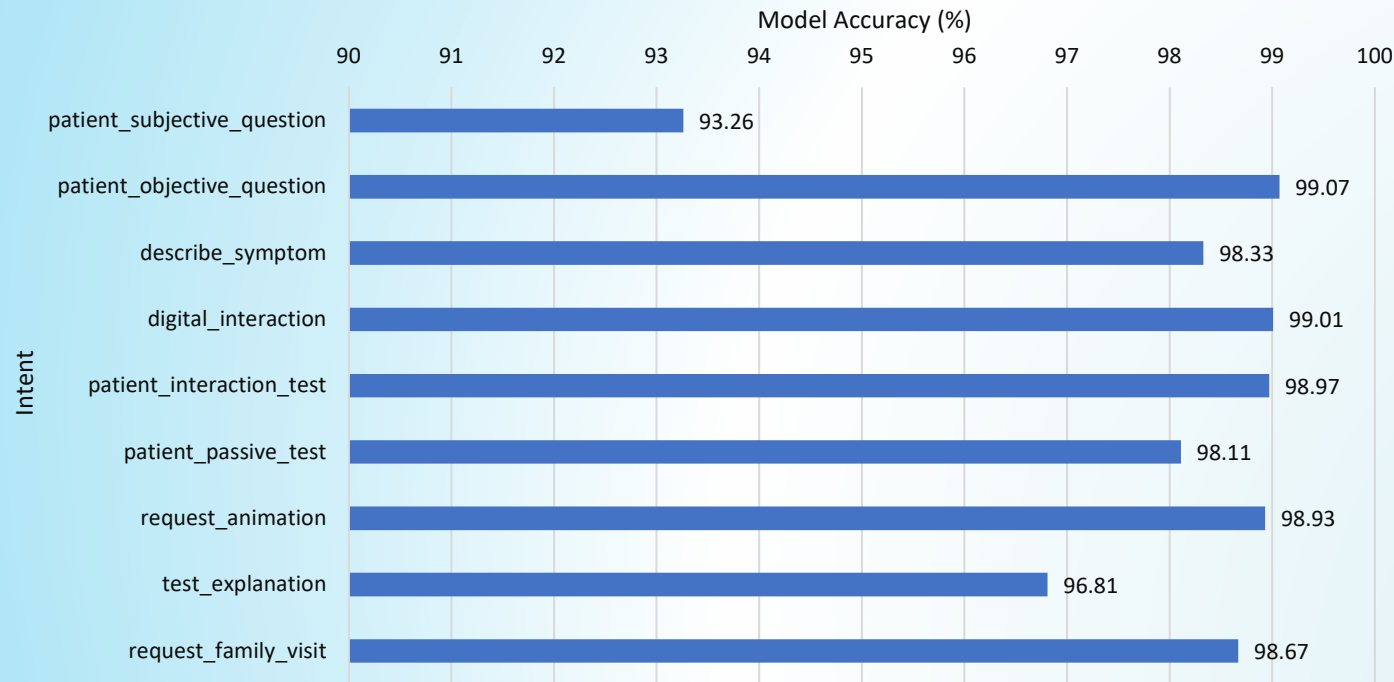


How well is the intent classifier model performing?

Intent Classifier



How well is the entity recognition model performing?



➤ Model Type:

Tagger (generates a part-of-speech tag for each token in a sequence)

➤ Model Settings:

Maximum Entropy Markov Model (**MEMM**)



Why did we develop our own AI model?

TS I want you to act as a patient and I am a nurse who is checking your status. Your name is Beatrice B Sander, an 88-year-old female patient. Your tentative diagnosis is small bowel obstruction secondary to adhesions. Your medical background includes colon cancer and a colectomy 5 years ago. You have been complaining of nausea, abdominal pain, and bloating for the past week. You take ibuprofen for mild joint pain. You have allergies to sulfa drugs. As far as your assessment, your last vital signs 2 hours ago were Temp: 97.8 F (36.5 C), BP: 96/60 while sitting up. Pulse: 87, ECG: sinus. RR: 18, O2 Sat: 94% on room air. You are oriented to person, place, and situation. You have mild abdominal pain 3/10 and that is tolerable for you. Your lungs with crackles in lower bases, no cough. Your hypoactive bowel sounds. I will ask you some questions and you will provide the reply

Yes, that is correct. My name is Beatrice B Sander and I am an 88-year-old female patient. I have been experiencing nausea, abdominal pain, and bloating for the past week. My medical background includes colon cancer and a colectomy 5 years ago. I take ibuprofen for mild joint pain and have allergies to sulfa drugs. I am oriented to person, place, and situation and have mild abdominal pain at a level of 3/10 which is tolerable for me. My lungs have crackles in the lower bases but no cough, and my bowel sounds are hypoactive.

TS Hi, Mrs. Beatrice, how are you today

I am not doing well today. I have been experiencing nausea, abdominal pain, and bloating for the past week and it is causing discomfort. I am glad you are here to check on me.

TS I am sorry to hear that. I am going to put my gloves and then check your conditions.

That's okay, thank you for understanding. I understand the need for precautions and I appreciate your care.

Regenerate response

TS Ok, I know your pain is level 3/10, as 0 is the comfortable level, can you describe the reasonable level of pain for you?

I would say that a level of 5/10 would be the most reasonable level of pain for me. At that level, I am still able to function and carry out my daily activities with some discomfort, but it is manageable. Levels higher than that would be difficult for me to tolerate and would likely require medication or other forms of pain management.

How are we using biomarkers to understand learner stress?

Physiological biomarkers for stress using Empatica device

Goal → Use HRV to quantify changes in stress during simulation.



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How →

- Ultra short term HRV windows (<60s) to calculate time domain metrics.
- RMSSD corresponds to PNS, SDNN corresponds to SNS+PNS.
- Study relative changes in SDNN & RMSSD with / without stressor events per individual.



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What sensor →

- Raw BVP values coming from wrist worn Empatica E4 device.
- Sampling frequency of 64 Hz.



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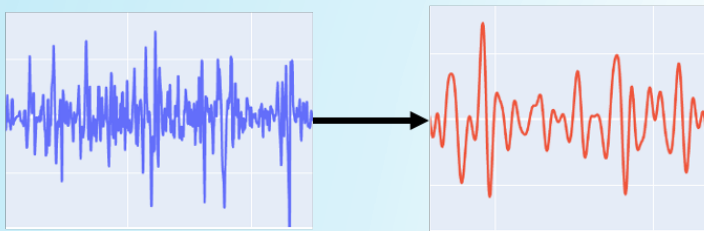
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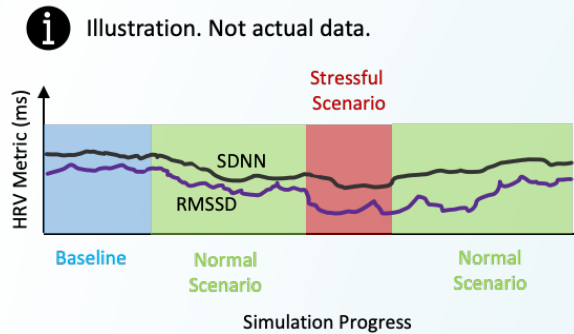
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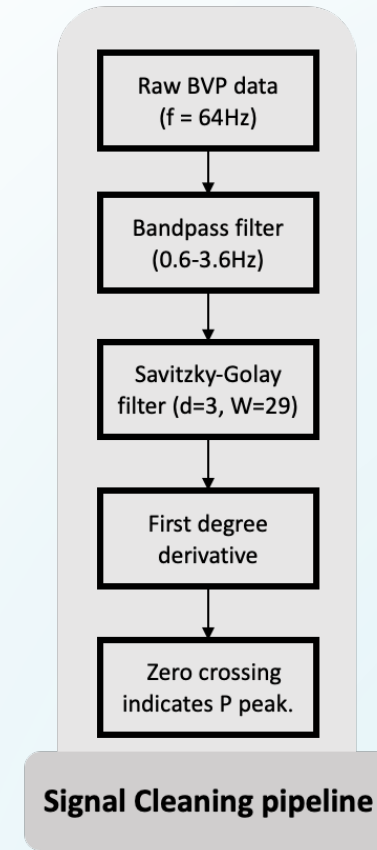
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After cleaning and filtering.

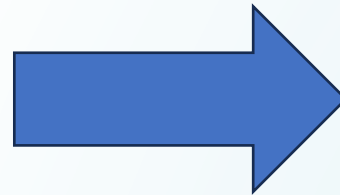


Note – Because we use BVP instead of ECG, we refer to the R peak as P which signifies the systolic peak.



What is Presence?

“Presence” refers to the sensation or feeling of being present in a virtual environment, despite physically being elsewhere.



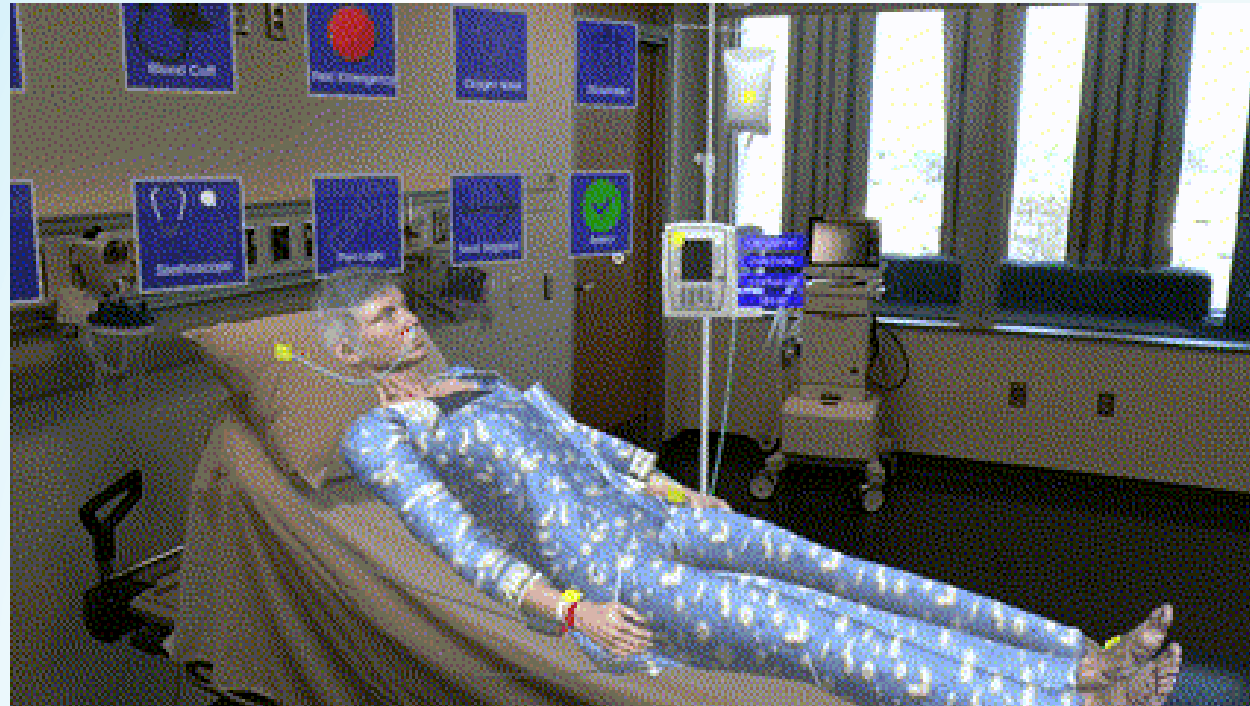
How is VR effective for students?

Virtual Reality (VR) is a computer-generated simulation of an immersive, interactive environment that can be explored and experienced by users through specialized hardware.



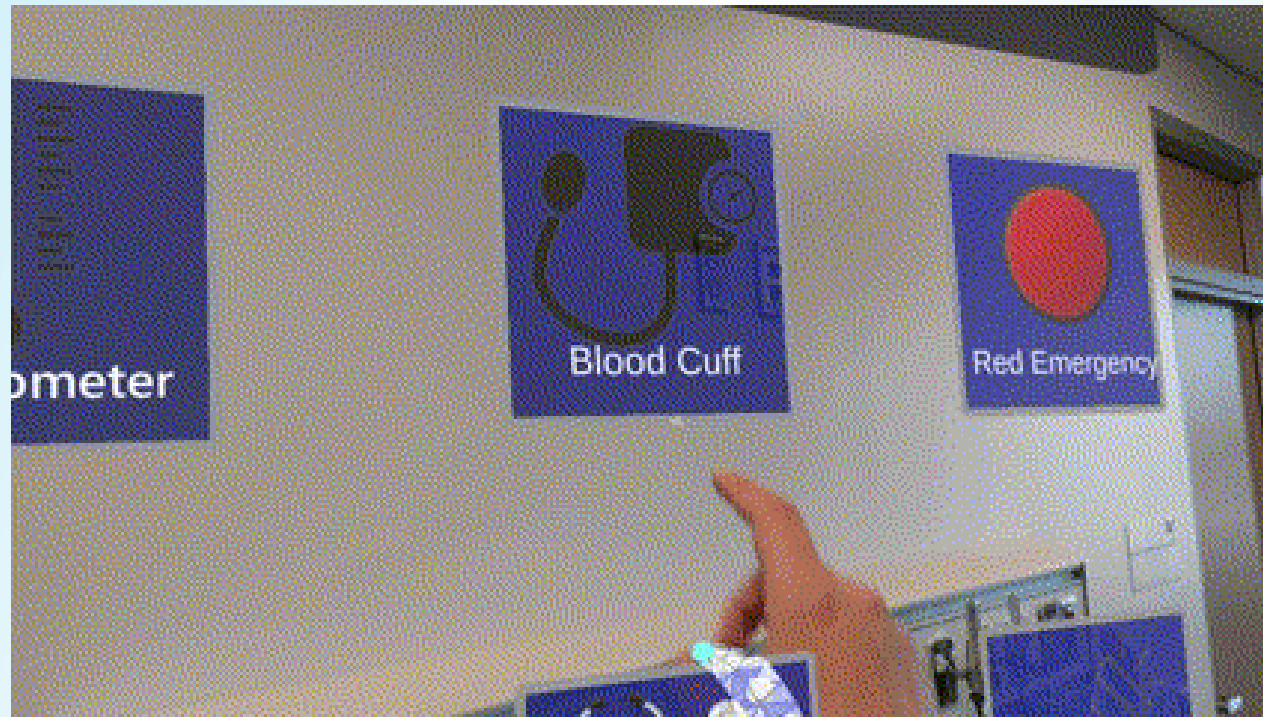
How is AR effective for learning?

Augmented Reality (AR) is a technology that overlays digital information such as images, videos, or 3D models onto the real world, enhancing the user's perception and interaction.



How do we incorporate Mixed Reality?

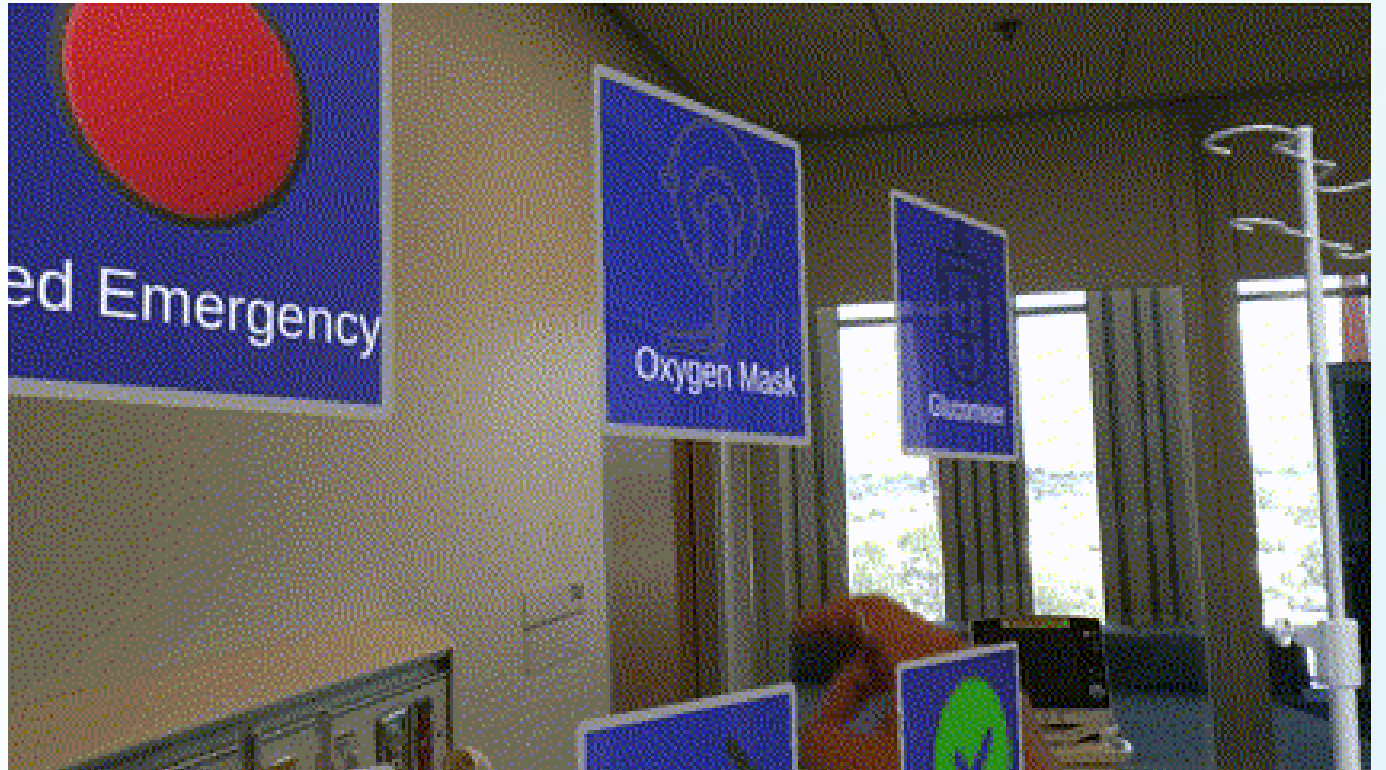
Mixed Reality (MR) is a type of augmented reality where the digital objects interact with the real world.



Why even use MR?

Mixed Reality when used effectively can greatly increase a user's presence.

Users have complete freedom over their movement.



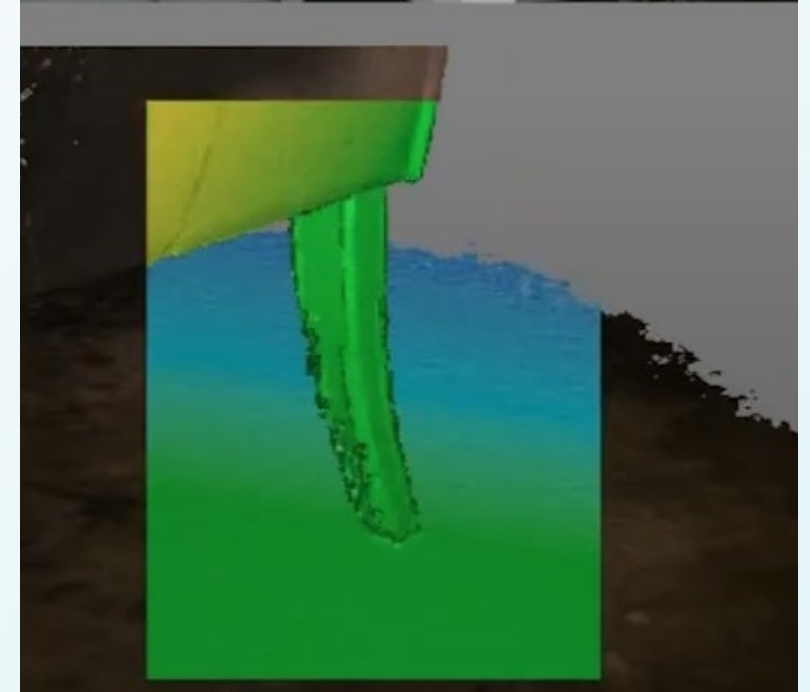
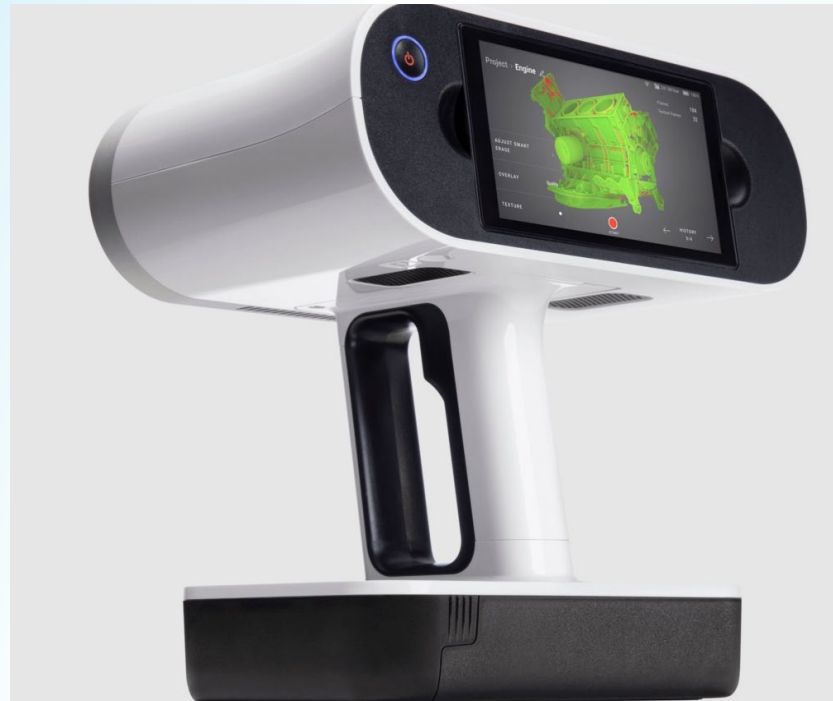
What is the difference between AR and VR?

Virtual Reality transports learners into immersive virtual environments, while Augmented Reality enhances real-world learning experiences.



What tools did we use to build the scene?

- **3D scanning**
- LiDAR Scanning
- 3D modeling
- AI Generation



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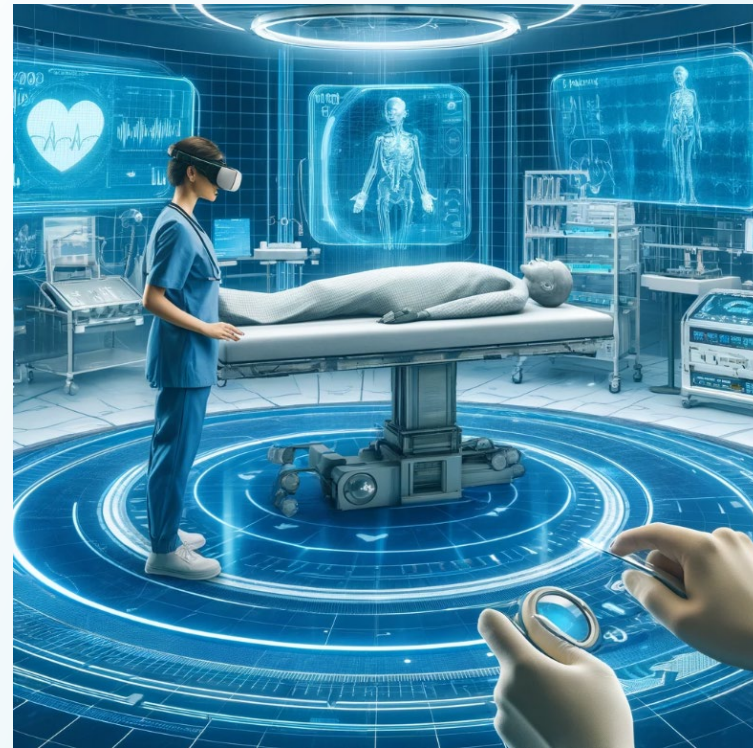
- 3D scanning
- LiDAR Scanning
- 3D modeling
- **AI Generation**



What does the future look like for our development?

Constantly looks for way to better improve interaction between user and digital objects.

Create easy and fast way to add more patients with varying problems.



How are we using virtual reality to train nurses to rescue patients from deterioration due to opioids?

- **Integration of Technologies**

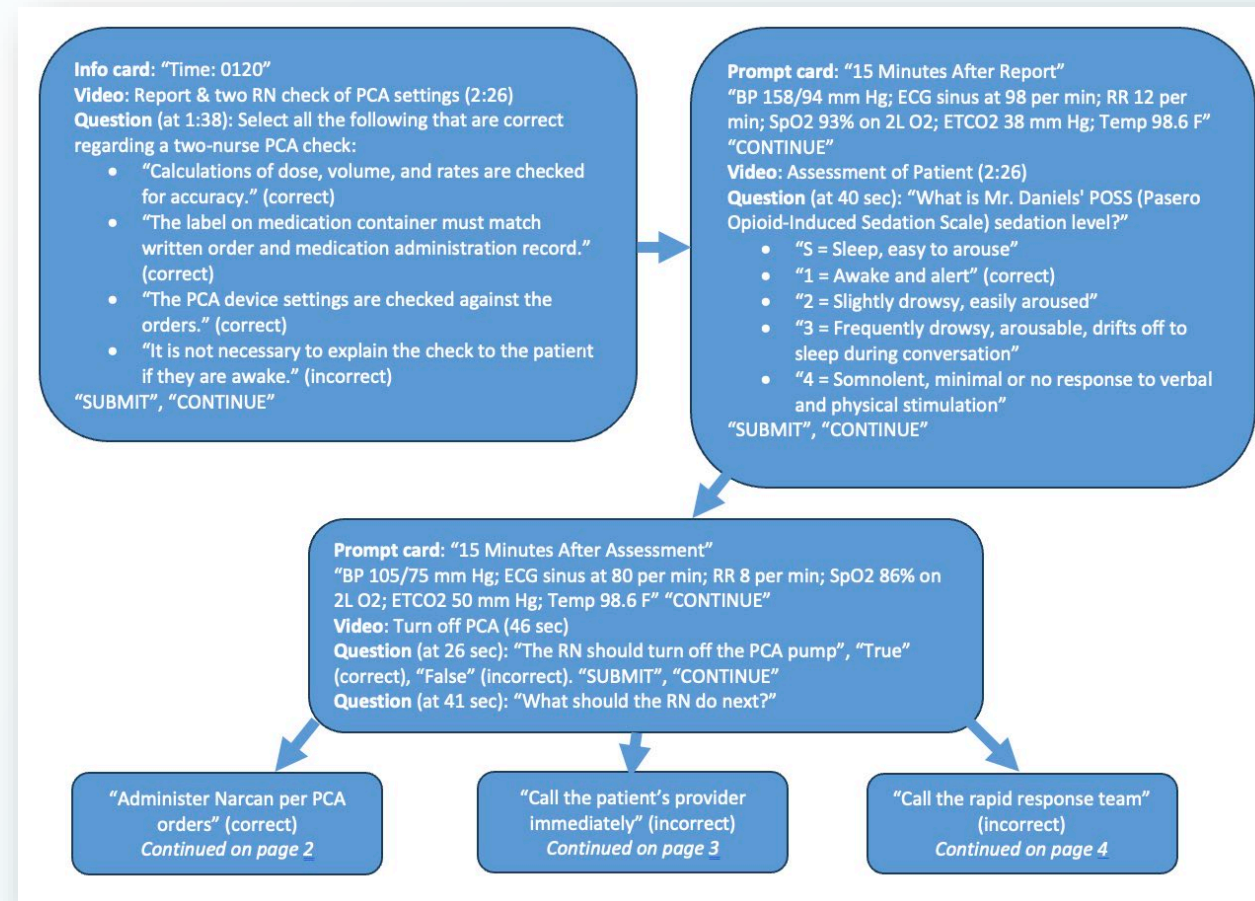
- D2L
- 360° video capture
- OrchestrateVR



How did we design the immersive learning experience?

• Simulation Development Process

- Branching logic design
- 360° video capture and editing
- Scene creation
- Logic mapping



How are we maximizing the learner's experience?

- **Simulation Development Process**

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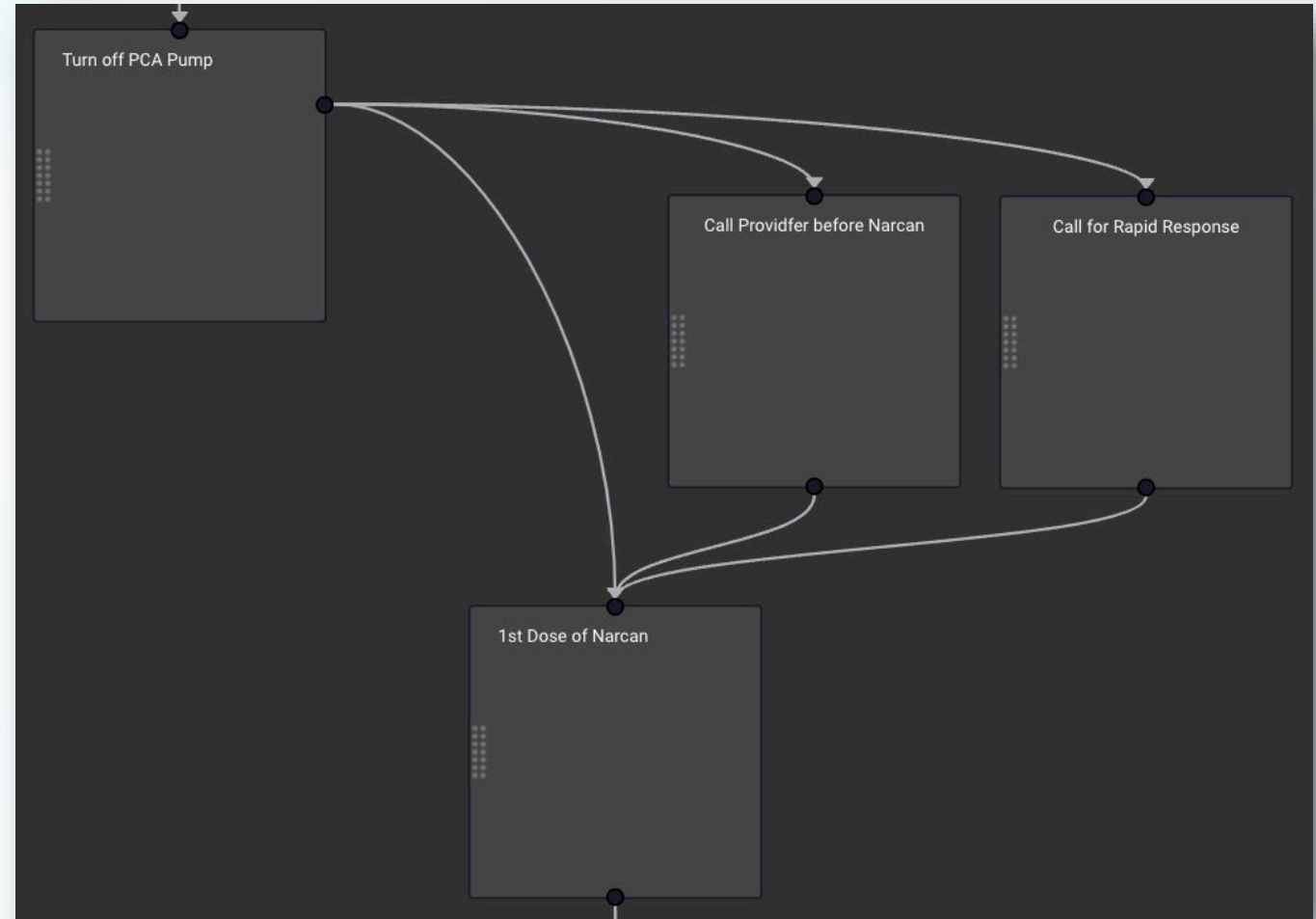
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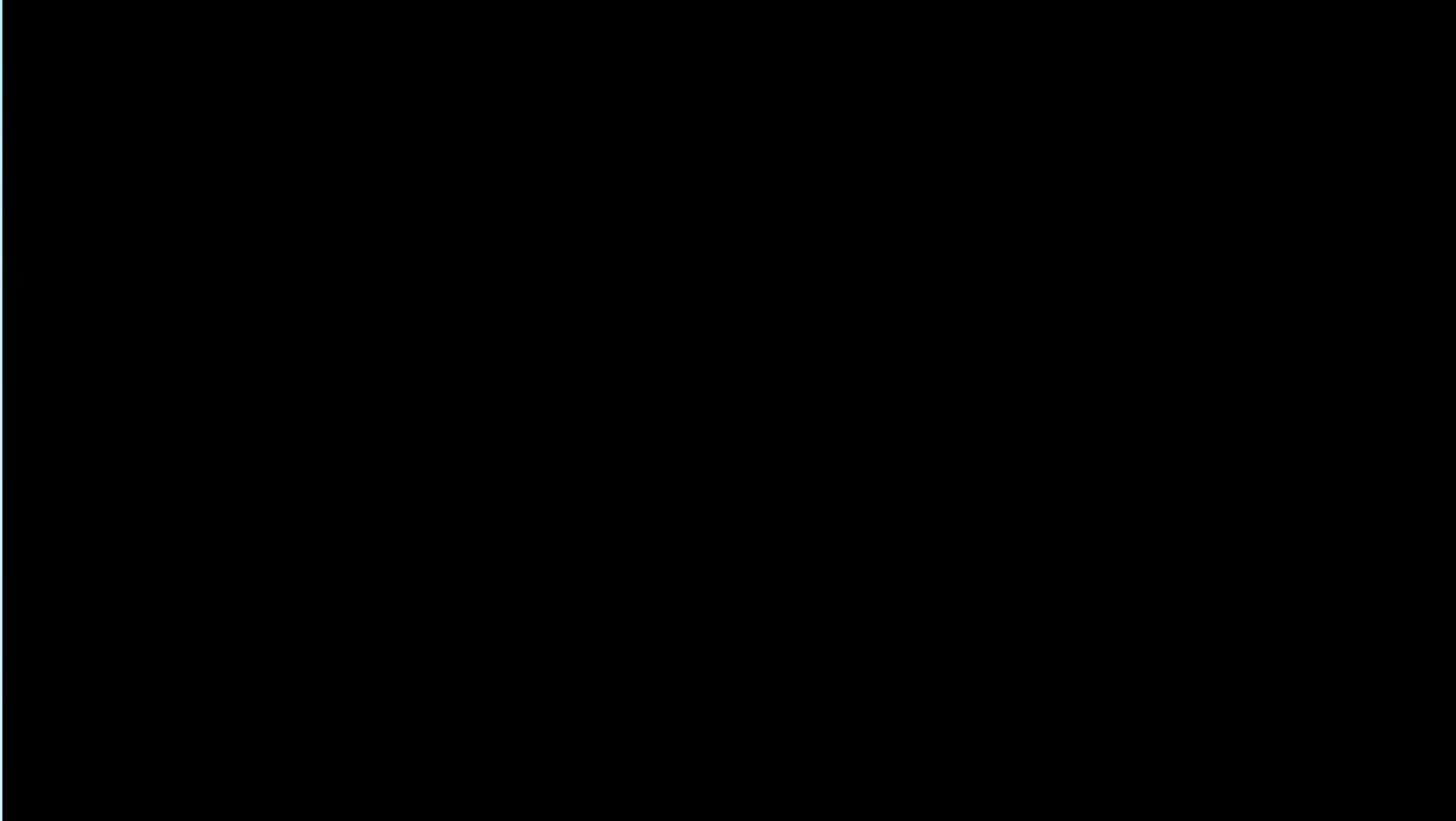
How are we maximizing the learner's experience?

- **Simulation Development Process**

- Branching logic design
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What does the experience look like for learners?

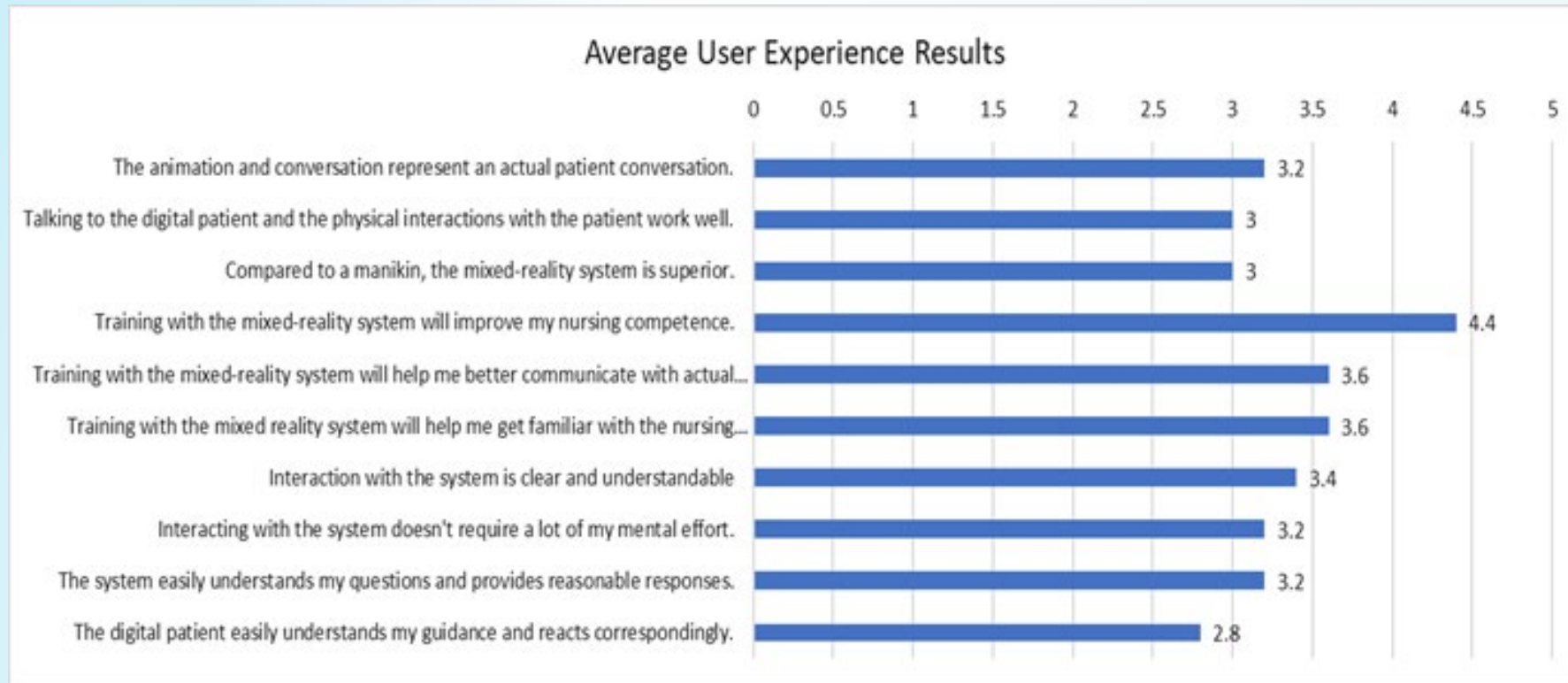


[Demo link](#)



What have we learned?

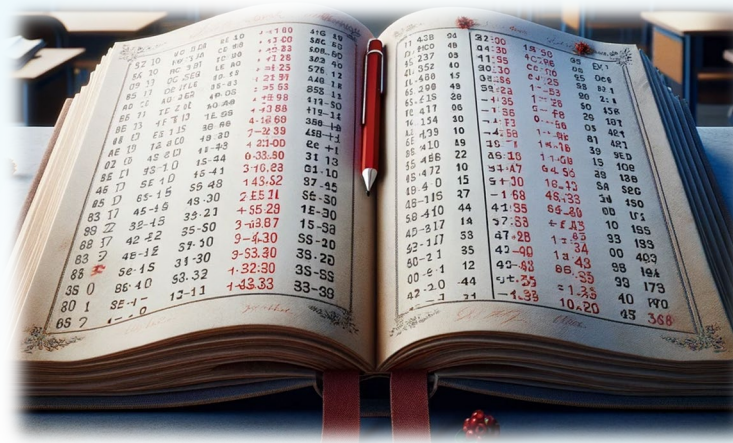
Outcomes



What have we learned?

Outcomes

Situation awareness scores ranged from 60 to 100% correct responses.



Nursing Performance Profile – 5 Factor scores ranged from 75.7 to 94.1% safe performance on rated items.

What have we learned?

NASA-TLX

- Subjective assessment of perceived mental workload.
- Learners rate their experience on a scale from 1 (low) to 21 (high).

Average Participant Responses (n=5):

- Low level of perceived physical demand (4.4)
- Temporal demand around the midrange (11),
- Efforts (12.8) and performance (13) within similar moderate levels



What have we learned?

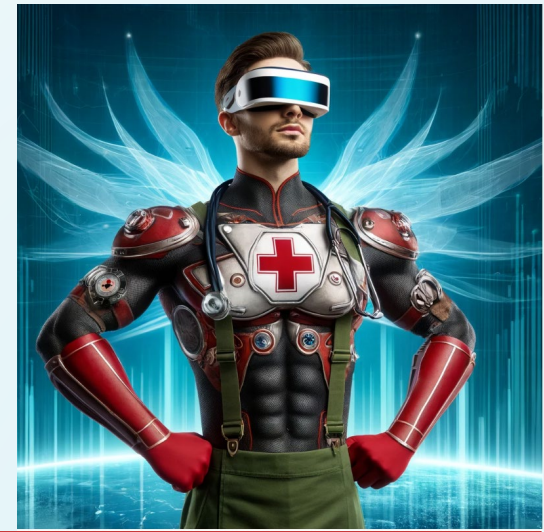
Every glitch made us smarter





What have we learned & What we can learn?

- **Enhanced Engagement**
- **Increased Preparedness for Real World Challenges**
- **Improved Clinical Competency**
- **Realism and Emotional Preparedness**
- **Adaptability to Complex Systems**
- **Promotion of Lifelong Learner**



What are the next steps?

Ongoing

- Intelligent Simulation Environment (ISE) & Precision Education Pilot Study
- ETCO2 Project
- Integrate Temi robot into ISE
- Explore how to include multiple learners from different healthcare professions in future versions of the simulations

June

- Submit podium presentation abstract for IMSH2025 (International Meeting on Simulation in Healthcare)

July

- Begin trial for ETCO2 Project with Banner RNs

August

- Submit at least one manuscript for publication in peer reviewed journal

Sept.

- Podium presentation, *Intelligent Simulation Environment for Building Competence: XR, AI, & Biosensors*. NLN (National League for Nursing) 2024 Summit, San Antonio, TX

Oct.

- Podium presentation, AZSimNet (Arizona Simulation Network) 2024 annual conference (abstract pending)

Nov.

- Submit collaborative (UA & Purdue) NSF grant proposal that includes metrics for promoting Cultural Humility, DEIB, and mitigating SDOH





Q&A Time



Rescue Simulations Using XR, AI & Biosensors



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