Design of a Human Centered Computing (HCC) based Virtual Reality Simulator to train First Responders Involved in the COVID-19 pandemic

Sam Kauffman, OSU, Center for Cyber Physical Systems, Computer Science, OSU
Research Advisor: Professor J. Cecil

1. Background

PROBLEM STATEMENT
- This COVID-19 virus pandemic has put an overwhelming strain on the Nation's ability to treat patients;
- the number of patients who need to be tested continues to rise
- Currently, there is an urgent need to train first responders in performing screening/testing activities in a methodical, safe and efficient manner.

PROJECT OBJECTIVES
- To develop and assess the effectiveness of a Virtual Learning Environment (VLE) focused on training first responders in proper COVID-19 pandemic procedures. Specifically:
  - Donning sequence of Personal Protective Gear (PPE)
  - Administration of nasopharyngeal swabbing for COVID sample collection
  - Doffing sequence of PPE after interacting with potential COVID positive patient

2. Methods

- **Role of Participatory Design and eEML model**
  - Focuses on the involvement of experts in the medical domain.
  - Through the participatory discussion with the expert, a better understanding of the domain and the process is obtained.
  - This understanding results in the creation of information-centric model.
  - Such models become the foundation of the design, building, and assessment of the framework

Pre-Swab procedure
Sam Kauffman
Last update: 2/5/21
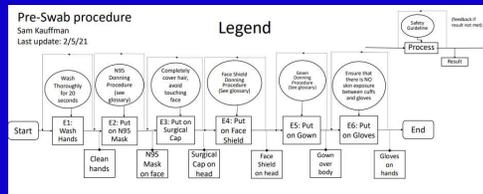
- **Role of HCI based Design Approach**
  - HCI based design approach is proposed involving attributes such as affordance, cognitive load, and visual density.
  - Functional Process Affordance, Dynamic Visual Density and their relationship to scene's comprehension and understanding have been explored.
  - Variations on affordance included distracting sounds/visuals to represent those present in an actual hospital setting
  - Designing these HCC elements was also done using the same participatory design approach, since nurses are more familiar with an average hospital environment.

3. Virtual Learning Environments

- Three training environments developed:
  - pre-swab activities
  - swab activities
  - post-swab activities
- Each VLE contains:
  - text/audio/animation cues (see right)
  - challenge scenarios

## 4. Interaction with Nurses and Doctors in Hospitals

- Coordinated through regular meetings with Vern McKinney, Nurse Manager at Yavapai Regional Medical Center in Prescott Valley, AZ
- Developed elided eEML models to illustrate the proper sequence of PPE gear usage and nasopharyngeal swabbing
- The VR environments were developed based on such eEML models
- After the creation of the VR environments, the content was validated and modified based on nurses'/doctors' feedback
- Student nurses from Dignity Health, Yavapai Regional Medical Center West surveyed
- After experiencing the VLE, participating nurses also gave feedback on possible improvements to realism and functional affordance

5. Assessment and Results

Assessment was conducted at Yavapai Regional Medical Center.
A group of 29 nurses interacted with the assessments:
- Affordance studies - defined as function of comprehension of a scene by a user inside a virtual 3D environment moving along a specific path P
- Knowledge assessment - Both groups were tested on their knowledge of COVID-19 Pre, Post, and Swabbing procedures
  - Compared to a survey of 4 inexperienced OSU undergraduate students, all of which had improved scores by 68%
  - Nurses were given a challenge scenario, where the nurse would show their understanding of each procedure within the VLE by interacting with virtual models of patients and PPE gear.
  - Both groups showed improved scores after interacting with the VLE.
  - Groups with no distractions showed greater improvement and a higher overall average

Test Scores Pre and Post Interaction
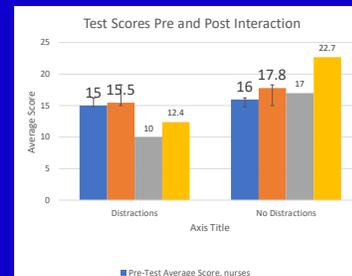
5. Assessment and Results (contd.)

- In scenes designed to measure Functional Process Affordance, participants scored higher on comprehensive tests with fewer distractions.

Average Score
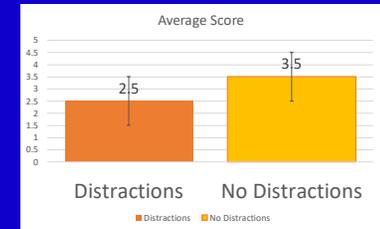
Conclusions

- Virtual Learning Environments have the potential to be effective in improving comprehension of COVID-19 procedures
- The use of audio and visual distractions such as loud noises and moving objects has an adverse effect on affordance in the learning environment
- VR can convey important information and skills in a manner that medical professionals with little understanding of VR can acquire

References

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