

## Evaluating System Usability, Workload Suitability, and User Experience of Game-Based Virtual Reality in Spaceflight Education and Training

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# Evaluating System Usability, Workload Suitability, and User Experience of **Game-Based Virtual Reality** in Spaceflight Education and Training



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## CHALLENGE:

- Space mission complexity poses a challenge in spaceflight education and training
- Orbiting spacecraft or satellites are elusive and difficult for a trainee to visualize
- Ground console streaming telemetry requires a steep learning curve

## PROPOSED SOLUTION:

- Game-Based Virtual Reality (GBVR)
- **Game-based** instruction - enhanced learner **motivation**
- **Virtual reality** scenarios - prolonged **cognitive engagement**

## TEST METHOD:

- Experimental study conducted in a university laboratory
- Three validated scales measured user perception of the GBVR training environment

## TEST RESULTS:

- Results were satisfactory for all scales

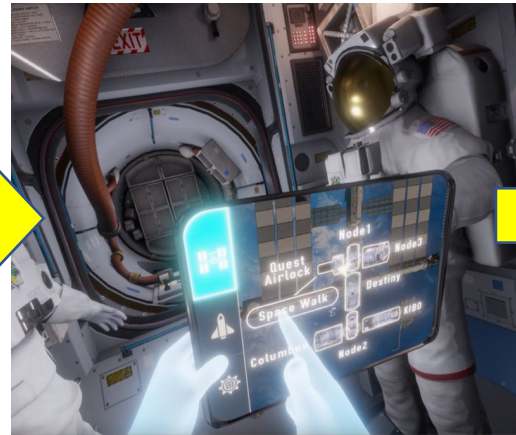


# EXPERIMENTAL DESIGN

- 10 Participants (9 males and 1 female)
- Senior level college students enrolled in Spaceflight Operations
- Average age of participants was 23.4 years (SD = 2.7)
- Three 75-minute lectures (two weeks)
- 10-15 minute ground console simulation (Python, Microsoft office)
- 10-15 minute GBVR simulation (Mission ISS software, Valve Index VR Kit)
- 48 item questionnaire

```
MAIN MENU:  
Press 1 to Gather Telemetry  
Press 0 to EXIT the Program  
1  
What time would you like to view the telemetry (min 1 - min 20): 4  
-----  
9 deg   = Solar Panel Angle  
97 deg C = Radiator Temperature  
48 deg   = Radiator Angle  
154 volts = Solar Panel Voltage  
-----  
***ERROR***  
***The Radiators are above the acceptable temperature of 90 deg celsius***  
Press 1 to reduce the temperature by 5 deg celsius  
Press 2 to reduce the temperature by 10 deg celsius  
|
```

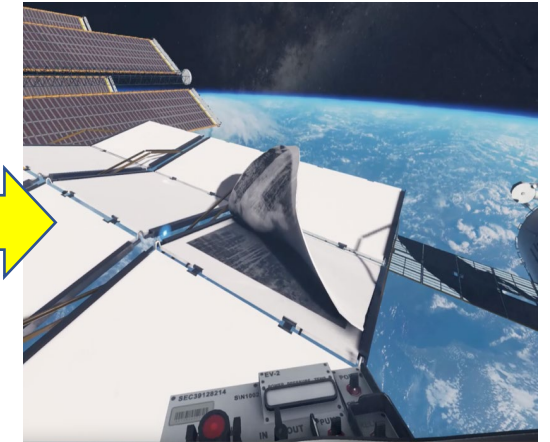
Ground Console Telemetry Readout



Spacewalk Decision Menu



Handrail Navigation to Site



Visual Inspection of Anomaly

# VALIDATED SCALES

## System Usability Scale (SUS):

- Developed in 1986 (Usability.gov)
- Used to evaluate user perception of hardware devices and software applications

## NASA Task Load Index (TLX):

- Developed in 1980s (NASA Ames Research Center)
- Subjective measurement of operator workload of human-machine interface

## Game User Experience Satisfaction Scale (GUESS-18):

- Developed in 2020 (Keebler et al.)
- Derived from the GUESS-55 of 2016 (Phan et al.)
- Used to measure user satisfaction and enjoyment during gameplay



**Table 1**

*Validated Scale Results and Accepted Benchmarks*

Scale	<i>N</i>	Min	Max	Mean	<i>SD</i>	Accepted Benchmarks
SUS	10	67.5	90.0	81.8	7.6	68.0 = average score
GUESS-18	10	73.0	98.4	82.1	8.3	78.7 = popular game score <sup>a</sup>
NASA TLX	10	22.0	60.0	40.5	12.3	42.0 = mean score

*Note.* <sup>a</sup> An average GUESS-24 score of  $M = 78.7$  resulted when examining six popular video games (Shelstad et al., 2019).





### Research Summary:

- The integration and evaluation of GBVR in the classroom revealed satisfactory results
- Learner enjoyment and satisfaction were amplified, likely leading to increased motivation, prolonged cognitive engagement, and enhanced learning

### Attributes for success:

- Proper laboratory setup – High system usability and suitable workload attributed to proven VR software and hardware setup
- Effective game mechanics - Overall user satisfaction ranked among six popular video games through proper in-game goal setting, reward, and immediate feedback

### Future Research:

- A follow-up experiment will be performed with a larger sample size
- Develop knowledge test to measure skill retention with & without GBVR

# CONCLUSION

Slide 5 of 8

# Thank you for your attention!

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