Nursing Education Research Conference 2018 (NERC18)

Exploring Evidence for the Use of Immersive Virtual Reality Simulation With Undergraduate Nursing Students

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Background: The purpose of the study was to assess learning outcomes of participants trained with two types of Virtual Reality Simulation (VRS) in the disaster skill of decontamination. The study was framed by the NLN/Jeffries Simulation Theory. Based on the theory, participant outcomes were measured that included the participants experience/satisfaction, cognitive knowledge, and performance. In addition, participant characteristics were evaluated for correlation to outcomes. Two types of VRS with varying levels of immersive capability were evaluated: head-mounted display and mouse and keyboard. Outcomes of VRS were compared to traditional teaching methods (written instructions).

Procedures: This mixed method study used a quasi-experimental design with repeated measures; the study was qualitatively informed by focus groups. *Subjects*: Following IRB approval from all participating institutions, subjects were recruited from a convenience sample of senior baccalaureate degree nursing students from four different campuses in the Midwest over two academic years. Participants were primarily Caucasian (89%), 18-25 years of age (73%), and female (88%). Most had no disaster training or experience, although many students virtual reality or gaming experience. Subjects were consented and then randomly assigned to one of three groups. Pretreatment each group completed a written cognitive exam and demographic questionnaire followed by a web-based module on decontamination training. *Treatment*: Following web-training, the control group received traditional written instructions ("Just in Time Training") for decontamination (Group C). The intervention groups completed a virtual reality simulation training using either an immersive head-mounted display (Group A) or a less immersive computerized mouse and keyboard version/less immersive option (Group B). *Post treatment Assessments*: Cognitive knowledge and performance outcomes were measured immediately post training and 5-6 months following intervention. Performance was measured based on time to complete task and score using a 17-item checklist developed by the researchers based on the literature. Pilot testing of the checklist indicated a Content Validity Index for the overall instrument score of 0.94, Internal consistency coefficient (KR-20) of 0.607, and Inter-rater reliability (Intra-class correlation) of 0.9114. Higher scores based on the checklist indicated higher levels of performance; shorter times indicated a faster performance. Cognitive knowledge was measured using a 20 question multiple choice test based upon a Federal Emergency Management Association (FEMA) exam. A pilot study indicated acceptable values of reliability and validity. Satisfaction and student experiences were examined via focus group interviews with groups of students across all four campuses after the initial VRS training. Focus group questions were based on literature related to VRS and the researchers' experience using VRS. *Analysis*: Demographic characteristics were analyzed and descriptive statistics were used to characterize the sample. A two sample t test was used to check the differences between any two treatments (A vs B, A vs C or B vs C). The detected differences between any two treatments was further used to estimate the required sample size to satisfy 80% power and 0.05 type I error rate in the power analysis. An ANOVA was used to analyze whether there were any differences among 3 treatments (A, B, and C). Finally, the generalized linear model was applied to analyze the impacts of 8 covariates (gender, race, age, ethnicity, actual disaster experience, participation in a previous disaster exercise, virtual reality, and gaming) on 3 outcomes (cognitive test, performance scores and time seconds).

Results: For the post-test and overall results, there were significant differences in performance scores between B (keyboard and mouse) and C (control group; p=.0004, p= 0.0135). The results indicate that treatment group B performs better than C. For time of decontamination in seconds at six months post, there was a significant difference between groups A (head-mounted display) and B (keyboard and mouse; p=0.0471). In the overall comparison of time using both the post and 6 month post results, B

(keyboard and mouse) group was faster in completing decontamination when compared to C (control group; p=0.0486). For the cognitive test, there were no differences among three treatments and time points.

When exploring the effects of participant characteristics on outcomes, it was found that older participants spent significantly longer time performing decontamination, compared to younger participants(t=2.48, p=0.014). In addition, female participants were significantly faster than males in the decontamination performance (t=-2.99, p=.003).

Qualitative analysis of focus group interviews indicated that students were satisfied with both types of VRS, but found the immersive version was significantly more interactive and encouraged muscle memory by providing movement during the simulation. Three themes that emerged were simulation learning experience, simulation design, and participant outcomes. There was a preference for the simulation over traditional learning methods.

Limitations: This study was limited by use of a convenience sample of students. While 4 different sites were used, they were all from the midwest and showed similar demographic characteristics that may not be representative of students across all settings. In addition, only one skill was evaluated in this study--that of the disaster skill of decontamination. Evaluation of performance was conducted in a laboratory setting and not in an actual disaster.

Conclusions/Implications: This study identified that the use of a less immersive VRS lead to similar outcomes and student satisfaction as a more complex and immersive VRS for the skill of decontamination. The outcomes were equivalent to traditional methods with high levels of satisfaction. Given the need to develop knowledge, skills, and attitudes for safe practice in new nurses, nurse educators must understand how to select among the numerous technological approaches for facilitating learning and which approaches best support learning outcomes. This is particularly important for a skill, like decontamination of a contaminated patient, that must be done both accurately and quickly to promote safety of both the patient and the nurse. With the cost of VRS becoming affordable and the opportunities for students to access this technology increasing, nurse educators must understand how to incorporate VRS based on best practice standards and simulation theory.

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Keywords:
Serious games, Virtual reality and nursing education

References:

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Abstract Summary:
The NLN/Jeffries Simulation Theory was used to frame a mixed method, multi-site study examining two varying levels of virtual reality (VR) to teach decontamination. Satisfaction, cognitive knowledge, and performance were measured as outcomes. Findings indicate VR training is as effective as traditional methods and that participant characteristics influence performance.

Content Outline:

1. **Introduction**

1. Brief Overview of history of Virtual Reality (VR)
2. Review of Scientific literature VR training

II. Body

A. Description of methods

1. Setting/Sample/Theoretical Underpinning

a) Sample

b) Setting

c) The NLN/Jeffries Simulation Theory

2. Procedure

a) Mixed methods

b) Repeated measures across multiple sites

c) Instruments

B. Findings

1. Repeated Measure ANOVA

1. Within/Between Subject Effects

2. General Linear Model

1. NLN/Jeffries Simulation Theory variables
2. Covariates

3. Focus Group Data

1. Themes
2. Triangulation

III. Conclusions

1. Implications for nursing education

B. Next steps

C. Limitations

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