Featured Article

Using Game-Based Virtual Reality with Haptics for Skill Acquisition

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Abstract
Background: Nurse educators are challenged to find innovative methods to help nursing students develop and remember fundamental skills while ensuring patient safety. Virtual reality (VR) headgear and custom haptic technology combined with game-based learning principles may provide an innovative approach to promoting mastery learning and retention.
Method: This mixed methods pilot study explored the usability of, and user reaction to, a game-based VR system designed to practice urinary catheterization. Time on task and number of procedures completed in one hour were compared with subjects who practiced traditionally, using a task trainer with faculty oversight. Follow-up skill demonstration was compared two weeks after the practice session.
Results: Subjects (n = 20) rated usability of the VR system favorably; they also rated practicing catheter insertion this way as highly engaging and enjoyable. Subjects using the VR system spent more time practicing ($p = .001$) and completed more procedures in 1 hour than students who practiced traditionally ($p < .001$). Follow-up skill demonstration pass rates between groups were identical at 2 weeks.
Conclusion: Practicing nursing skills using game-based VR may be an effective way to promote mastery learning and retention.

Student nurses must function safely and effectively in a complex and constantly changing health care environment, yet they may have limited opportunity to practice procedures before performing them on patients. It has become apparent that current methods of learning procedural skills may not result in competence or retention of skill demonstration in practice (DeBourgh, 2011; Gonzalez &

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Sole, 2014; Kardong-Edgren & Mulcock, 2016; Oermann, Kardong-Edgren, & Maryon, 2011) and are not necessarily evidence based (Allan & Smith, 2010; Robinson & Dearmon, 2013). Procedural skill learning in nursing education typically relies heavily on memorization of steps from a criterion-based checklist that students use to demonstrate initial competency in the laboratory; students are then declared ready to perform the procedure on patients. However, because students may have limited opportunity to practice this procedure after initial checkoff, they may struggle to remember—and more importantly—perform safely what they initially learned.

Nurse educators have been called on to do a better job of preparing students for practice, regardless of the many challenges faculty may face (Benner, Sutphen, Leonard, & Day, 2010; Institute of Medicine, 2011; National League for Nursing, 2015). The use of varying levels of simulation fidelity in nursing education has grown significantly over the past decade in response to this challenge. The National Council of State Boards of Nursing study provided affirmation of the use of high-quality simulation as an effective teaching/learning strategy (Hayden, Smiley, Alexander, Kardong-Edgren, & Jeffries, 2014).

Simulation-based education (SBE) places learners in a realistic patient care environment where they can safely practice making decisions and providing care without causing any harm. Game-based learning shares several features of SBE, including clear learning goals, immediate feedback so learners can monitor their progress, increasing difficulty, and the opportunity for repetitive practice (Issenberg, McGaghie, Petrusa, Gordon, & Scalese, 2005). The VR system discussed in this study is another form of SBE, developed and tested as an educational tool that students can use to practice a basic procedural skill (urinary catheterization) repeatedly with immediate and consistent feedback.

Key Points

- Combining virtual reality (VR) with custom haptics and game-based learning elements provided nursing students an innovative and engaging way to practice urinary catheter insertion.
- Using a System Usability Survey, students rated the first iteration of the VR system favorably in the *acceptable* range with an average adjective rating of *good* to *excellent*.
- Recurring themes regarding user reaction to practicing in VR included fun, motivation, willingness to practice repeatedly, and engagement/focus while practicing.
- Follow-up pass rates for urinary catheterization two weeks after practicing in VR equaled those of students who practiced traditionally on partial manikins with faculty oversight.

Literature Review

Game-based learning is a way to capitalize on the characteristics that make game playing fun and use them for educational purposes (Bauman, 2013). Developments in VR technology have delivered computer and video games that, by their very nature, require students to be actively engaged in their own learning (Granic, Lobel, & Engels, 2014). A recent systematic review of games used for training health care professionals (Wang, DeMaria, Goldberg, & Katz, 2016) found that although the use of game-based learning for health professionals is on the rise, best practices are still being defined, stating that "serious games as a whole have yet to prove enhanced task performance in reality (i.e., improved patient care or outcomes)" (p. 48). Reporting more specifically on simulation-based mastery learning, Reed et al. (2016) found evidence that performance and retention of core clinical skills could be improved in senior medical students. Virtual reality (VR) has been used in various fields of study, including surgery (McCloy & Stone, 2001), construction management (Sacks, Perlman, & Barak, 2013), weld training (Stone, Watts, Zhong, & Wei, 2011), and military training (Bhagat, Lious, & Change, 2016) as a way to engage and motivate students, decrease time to achieve skill mastery, cut down on material usage, and improve final performance outcomes. The literature suggests that using VR and game-based learning to promote mastery learning in other fields has been effective; now this technology is available for use in nursing education.

Theoretical Framework

Deliberate practice theory is based on engaging motivated learners in focused practice that is based on a well-defined goal representative of a real-world task with immediately delivered informative feedback (Ericsson, Krampe, & Tesch-Romer, 1993). Using VR technology may assist students in acquiring individual practice time and experience to reach skill mastery. Although various studies have shown the benefits of deliberate practice for students in practice professions (Coughlan, Williams, McRobert, & Ford, 2014; Gunberg Ross, Bruderle, & Meakim, 2015; McGaghie, Issenberg, Cohen, Barsuk, & Wayne, 2011; Oermann et al., 2011), research remains quite limited in the nursing education literature regarding the effect of deliberate practice used to enhance student competence and retention of procedural skills (Gunberg Ross, 2012; Oermann et al., 2011; Whyte & Cormier, 2014). The VR system discussed in this study was developed as an educational tool to help nursing students engage in deliberate practice.