Review

Simulation in the Internet age: The place of Web-based simulation in nursing education. An integrative review

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SUMMARY

Objective: The objective of this article was to review the literature on utilisation and place of Web-based simulation within nursing education. Web-based simulation combines electronic multimedia options with a central video or virtual world to produce interactive learning activities mediated by the learner.
Design: An integrative review.
Data sources: A search was conducted of healthcare databases between 2000 and 2014 and of Internet sources for hosted simulation programs in nursing. Eighteen primary programs were identified for inclusion.
Review methods: A strategy for integrative review was adopted in which studies were identified, filtered, classified, analysed and compared.
Results and discussion: Of 18 programs, two game-based programs were identified which represented a 'virtual world' in which students could simultaneously or individually immerse themselves in a character role-play. However, most programs ($n = 10$) taught an aspect of procedural patient care using multimedia (e.g. video, audio, graphics, quiz, text, memo). Time-limited sequences, feedback and reflective activities were often incorporated. Other studies ($n = 8$) taught interpersonal communication skills or technical skills for equipment use. Descriptive study outcomes indicated ease of program use, strong satisfaction with learning and appreciation of program accessibility. Additionally, four studies reported significant improvements in knowledge post-intervention.
Conclusion: Web-based simulation is highly acceptable to students and appears to provide learning benefits that align with other simulation approaches and it augments face-to-face teaching. Web-based simulation is likely to have a major place in nursing curricula in the next decade, yet further research is necessary to objectively evaluate learner outcomes and to justify its use.

Introduction

E-simulation is an emerging technology that can be used to broaden the teaching strategies used in health science education. E-simulation involves goal-based digital simulations that take place via a computer screen (Australian Learning and Teaching Council, 2010). For decades, simulation has been in use as an integral part of nursing education to 'model' real situations in order that students can gain practice experience and develop problem-solving skills (Moule et al., 2008). Such experiential learning, usually played out face-to-face in a skills laboratory, has been shown to facilitate learning and enhance nursing students' knowledge and skills (Lapkin et al., 2009). More recently, advances in technology, faster internet speeds, lower costs, and more sophisticated technologies (Byrne et al., 2010) have enabled simulation approaches to move from the classroom to a virtual Internet classroom. This follows the trend in electronic communications for teaching and learning and students' strong acceptance of online learning (Sun et al., 2008). Simulation-based e-learning delivers computer-based simulation that immerses students in realistic contexts relying upon programs that are accessed directly from the Internet, downloaded as an application, or viewed on a DVD (Deakin University, 2013). Such practical applications facilitate the transfer of knowledge and enhance learning outcomes (Decker et al., 2008).

As a new and relatively uncommon form of simulation that has been utilised within the last decade, Web-based simulation is worthy of exploration. This paper presents an integrative review of the utilisation and place of Web-based simulation within contemporary nursing education.

Methodology

An integrative review combines experimental and non-experimental research to explore and describe the state of the evidence (Whittemore

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and Knafl, 2005). In this study we searched electronic databases in healthcare for publications in English between 2000 and 2014: Ovid Medline, Cinahl Plus, Scopus, PubMed, and the search engine Google Scholar. Keyword combinations included, for example 'simulation based e-learning', 'e-simulation', 'Web-based simulation', 'virtual clinical simulation', 'computer-based simulation'; 'experiential learning', 'nursing', and 'Internet'. All designs that explored interactive Web-based simulation programs in nursing were included. Any studies using Web-based materials without active learning approaches were omitted (Wong et al., 2010) (e.g. discussion boards, blogs, podcasts, videos and video-conferencing) as were studies based upon stand-alone computer applications. Additional ancestral papers were sourced as background for the narrative. The Whittemore and Knafl (2005) strategy for conduct of an integrative review was adopted as it was suitable for a focused examination of diverse Web-hosted simulation programs, aiming to identify program authenticity and educational outcomes. Abstracts of all the identified studies were read and 18 primary program studies were selected for inclusion. Only three programs were publicly available and thus the analysis was dependent upon published descriptions. Published reports were read in entirety, classified, analysed and compared, with the outcomes then being synthesised to describe e-simulation in the nursing context.

The review

History of e-simulation

E-Learning or computer-based learning has grown exponentially as many education courses are offered online enabling students to learn at their own pace (Reeves and Reeves, 2008; Sun et al., 2008). In nursing, e-learning originally developed from the need to disseminate information widely and to incorporate textual discussion groups (Moule et al., 2008). Historically therefore, e-learning was limited to asynchronous communication, lacking the capacity for authentic experiential learning. With the development of faster Internet speeds, the mixed media dimensions of the classroom were transferable to e-learning, and included text, graphics, sound, vision, colour, animation and video. Such approaches offer a unique educational experience with significant resource benefits over other teaching modalities (Reeves and Reeves, 2008). Whilst many computer-mediated communication modes fit the e-learning label (e.g. self-directed learning modules, podcasts and video-enhanced programs) more technologically demanding *interactive* simulation-based e-learning modes are now possible.

Simulation-based e-learning

Simulation-based e-learning combines the pedagogy of face-to-face simulation with electronic multimedia options to produce activities that are both interactive and mediated by the learner. Programs can be hosted on the Internet and accessed via the Web using a choice of navigable software (Byrne et al., 2010; Medibiquitous Consortium, 2013). The learning objectives vary considerably from highly focused technical skills training (such as how to insert an intravenous line) to broader case-based patient scenarios that require critical thinking and clinical decision making. The learning activities should be authentic and ideally include problem solving, feedback and reflection (Buykx et al., 2011). Based on a central video (the simulation) and a set of on-screen options, action choices cascade or branch to another set of correct/incorrect options as students work through the program. Key points can be emphasised or enlarged upon using pop-up text, with user-directed navigation across media types. The programs aim to engage the learner in active processing of the subject matter, rather than merely acquiring knowledge (Deakin University, 2013), fostering deep learning through critically examining new facts and ideas, 'tying them into existing cognitive structures and making numerous links

between the ideas' (The Higher Education Academy Engineering Subject Centre, 2011, p.1.).

The development of e-simulation programs among various disciplines need to meet the challenges of skilled instructional design (Deakin University, 2013) bearing in mind that program participants can be single students learning independently or multiple learners individually collaborating on an online case-based scenario (Glasgow et al., 2005; Tait et al., 2008). A range of curriculum domains have been suggested including 'Procedural e-simulation' to inform a course of clinical action (such as cardiac resuscitation), 'Technical e-simulation' to highlight equipment use and 'Situational e-simulation' for a focus on communication and other non-technical skills. Virtual world games ('serious games') tend to incorporate many of these approaches with multiple focii (Bosman, 2002).

Byrne et al. (2010) describe in detail the options for architectural configuration for design of practical applications in this highly specialised field. For example, whether the simulation engine and application visualisation takes place at the interface of the remote server or on the client's-side in the application (in their computer). Programs generally require a background database to record user information, and the learner needs IT skills and access to high-speed Internet links. Table 1 illustrates the advantages and disadvantages of e-simulation which, although innovative, can be costly and requires a great expertise in development (Davids et al., 2011).

Synthesis

Primary studies of Web-based simulation programs in nursing that offered synchronous learner interactivity were few (Table 2). Of 18 included studies, three were randomised controlled trials; three were non-randomised case–control studies; six were quasi-experimental cross-sectional surveys, three were qualitative program evaluations and three were observational reports of Web-based simulation programs. Additional related reports and reviews of literature were used to support description and synthesis, although multiple studies reporting use of the same platform (e.g. Second Life) were selectively included.

There was confusion in terminology between studies as various models of delivery of computer-based simulation exist, with a lack of consensus about nomenclature. Some studies inferred that virtual simulation involved only animated human characters and not videoed standardised patients (human actors). For others, 'virtual' referred to the mode of presentation on a computer screen. Computer-based simulation was referred to as virtual patient simulation (Guise et al., 2011), virtual simulation (Sweigart et al., 2014), computerised virtual patients (Cook et al., 2010), virtual clinical simulation (Foronda et al., 2013), cybergogy (Foronda et al., 2013), e-simulation (Lamont and Brunero,

Table 1
Advantages and disadvantages of e-simulation for learning[a].

Advantages of e-simulation	Interactive, stimulating and enjoyable for learners
	Single-user or team interaction
	Provide realistic or real-world scenarios
	Enable controlled and predictable outcomes
	Promote trial-and-error learning in a risk-free setting
	Reduce face-to-face time and teaching resources
	Provide the basis for further discussion
	Controlled access (through passwords) with feedback
	Wide availability
Disadvantages of e-simulation	Can be expensive and time-consuming to build
	Often context and discipline specific
	May require extensive technical skills
	Potential for loss in speed through network traffic
	Vulnerable to security issues

[a] Extracted from Virtual Situated Learning Environments: Developing e-Simulations: module plan 002. Deakin University, Melbourne, (2013, [p.4]) and from Byrne et al. (2010).