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Review article

A review of the design and development processes of simulation for training in healthcare – A technology-centered versus a human-centered perspective

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ABSTRACT

This article reviews literature about simulation systems for training in healthcare regarding the prevalence of *human-centered* approaches in the design and development of these systems, motivated by a tradition in this field of working technology-centered. The results show that the focus on human needs and context of use is limited. It is argued that a reduction of the focus on technical advancements in favor of the needs of the users and the healthcare community, underpinned by human factors and ergonomics theory, is favorable. Due to the low number of identified articles describing or discussing human-centered approaches it is furthermore concluded that the publication culture promotes technical descriptions and summative evaluations rather than descriptions and reflections regarding the design and development processes. Shifting the focus from a technology-centered approach to a human-centered one can aid in the process of creating simulation systems for training in healthcare that are: 1) relevant to the learning objectives, 2) adapted to the needs of users, context and task, and 3) not selected based on technical or fidelity criteria.

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1. Introduction

The use of simulation methods is now widespread in the field of healthcare as an effect of changing conditions for bedside training and higher demands on patient safety, thus decreasing the opportunities for practice in actual contexts (Qureshi and Maxwell, 2012). This development has provided opportunities to produce technically advanced simulation systems, to build simulation centers and to develop curricula for integrating simulation into medical education and continuing professional development. Simulations can be designed in many forms, ranging from full-scale team simulations involving instrumented patient-like mannequins, to virtual reality-based systems with patient-specific three dimensional models and haptic interaction, to computer-based desktop scenarios and serious games; and be classified according to a number of different dimensions (Gaba, 2004).

Numerous studies support the use of simulation as a method for bridging theory and practice, in healthcare and other areas, see for example Hart et al. (2006) and Stirling et al. (2014). And with a healthcare agenda that more explicitly focuses on patient safety aspects, the use of simulation for training has received much attention as a means to meet those demands by for example shortening the learning curve, providing a foundation for adopting safe practices and reducing patient harm (Aggarwal et al., 2010; Ziv et al., 2000).

In this rapid development and integration of simulation systems for training in healthcare it is necessary to ensure that the resources are invested where they will add most value. Technical development has promoted a focus on more technically advanced systems that are not always grounded in the underlying training needs nor are they based on a comprehensive knowledge of the users' needs, tasks and context of use. This concern is something that has recently been emphasized by for example Winters in the *Handbook of Design in Educational Technology (*Winters, 2013, *p.301)*:

> "… in order to make appropriate use of learning technologies in medical training, a more significant focus needs to be placed on learning design and design methodologies."

This reasoning triggers thoughts about how the use of simulator systems actually affect patient safety and can be approached by looking at how the integration of human factors and ergonomics (HFE) aspects are suggested as a means to improve patient safety (Gurses et al., 2011). HFE deals with the interactions among humans and other elements of a system in order to strive for an optimal fit of the system to the human. There are several knowledge gaps and under-exploited areas related to healthcare and patient safety in which HFE principles and methods can fill a function (Waterson and Catchpole, 2015). A framework to systematically evaluate and change the healthcare setting is obtained by adopting the three fundamental characteristics of HFE; taking a systems approach, being design-driven, and focusing on the two related outcomes of performance and well-being, (Dul et al., 2012). HFE could in this sense work as a bridge between human behavior and the technology. Letting this theoretical framework underpin also the area of simulation systems for healthcare training would allow for a holistic view of the setting of the system (including the implications of the training for learning outcome and patient safety) to guide the development rather than the technical possibilities.

A practical implementation of working in a HFE approach for developing a system of some sort can be found in the ISO standard 9241-210, 2010, *Ergonomics of human-system interaction – Part 210: Human-centered design for interactive systems*, where human-centered design relates to any process that "aims to make systems usable and useful by focusing on the users, their needs and requirements, and by applying human factors/ergonomics, and usability knowledge and techniques." (ISO 9241-210, 2010, p. viii). According to this standard a human-centered approach ensures that: (a) the design is based on an explicit understanding of the users, tasks and environments, (b) users are involved throughout the design and development, (c) the design is driven and refined by user-centered evaluation, (d) the process is iterative, (e) the design addresses the whole user experience, and (f) the design team includes multidisciplinary skills and perspectives (ISO 9241-210, 2010, p. 5).

The aim of this review is to examine the process that precedes the implementation and evaluation of simulation systems for training in healthcare by reviewing healthcare simulation publications with an emphasis on the discussion about the design process and in what way a *human-centered design* approach has been adopted.

2. Method

2.1. Study questions

The study questions investigated in this review are: 1) In what way is a human-centered approach adopted in the design and development process for simulation training systems in healthcare, including information about training needs, learning objectives, users' needs, tasks and use context? 2) To what extent is the knowledge and experience from these processes shared and discussed in the literature?

2.2. Search strategy

These study questions are multidisciplinary in nature, relating to healthcare, technology and pedagogy. This multidisciplinary perspective presented a challenge in identifying the correct search terms to use, since the relevant terminology can differ between disciplines. Librarians with expertise in database searching were consulted for advice on where to start the search. Appropriate literature reviews were also examined to see what databases were used in the search processes. *Google Scholar* was furthermore used to retrieve publications of interest to identify additional databases that could be included in the search. This iterative process moving between formulating search terms, identifying relevant articles and evaluating databases resulted in the following four search themes:

1. *Simulation* – All types of simulation were of interest. This meant that a number of terms representing these systems were used: *simulation, visualization, "virtual reality", "virtual environment", mannequin, "desktop simulation", "computer-based scenarios", "simulated patients", "virtual patients", "online worlds", game.*