Differentiating the design principles of virtual simulations and serious games to enhance nurses' clinical reasoning

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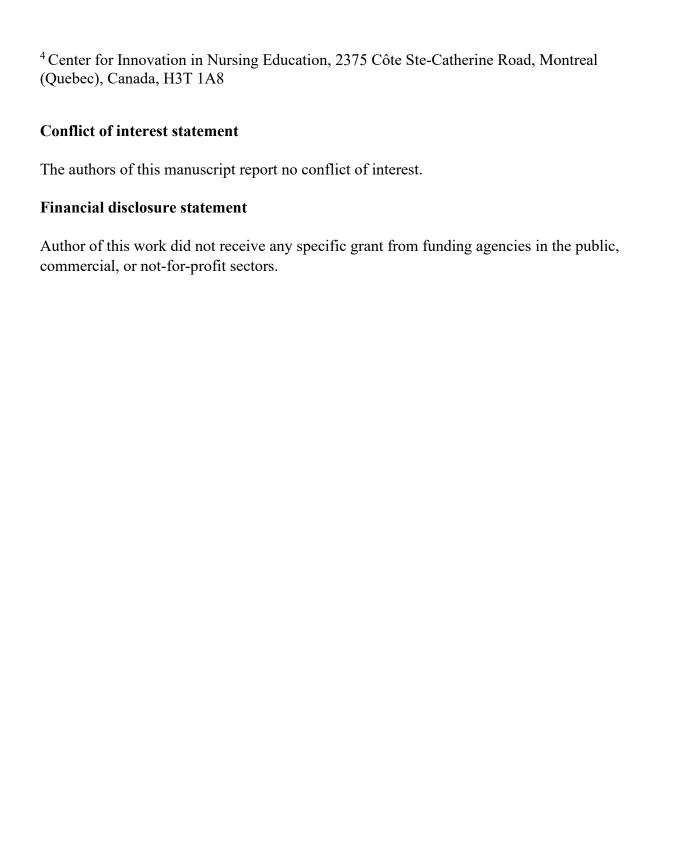
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Abstract

Virtual simulation (VSs) and serious games (SGs) are e-learning interventions with the potential to enhance nurses' clinical reasoning. However, distinctions in the design principles of each intervention remain ambiguous. Clarifications are needed to distinguish both interventions and ease the articulation between their design principles and the development of clinical reasoning. In this paper, we examine the overlapping and unique design principles of VSs and SGs.

Keywords: Simulation, gaming, experiential learning, problem-based learning, instructional design, nursing, decision-making

Key Points

- Distinctions between virtual simulation and serious games are ambiguous;
- Design principles of each intervention are defined;
- Each intervention should be designated based on their design principles.

Introduction

Clinical reasoning encompasses the complex cognitive process of collecting and interpreting clinical data to formulate a judgment about a patient's health-related clinical situation (Holder, 2018). Nurses' clinical reasoning is crucial for the detection and recognition of patients' problems, such as clinical deteriorations. Thus, it is imperative to support the development and promotion of nurses' clinical reasoning through a variety of learning interventions (Orique & Phillips, 2018).

Serious games (SGs) and virtual simulations (VSs) are two examples of e-learning interventions that have emerged in the last decade to improve nurses' clinical reasoning (Duff, Miller, & Bruce, 2016; Koivisto et al., 2018). The use of both SGs and VSs has increased recently: 60% of all trials evaluating SGs in healthcare education have been published after 2015 (Maheu-Cadotte et al., 2018) and, over the next decade, VSs are expected to replace—or at least complement—simulations with human patient manikins (Cant, Cooper, Sussex, & Bogossian, 2019).

Considering that SGs and VSs are both e-learning interventions that appear similar at first glance due to their appealing visual rendering and high level of interactivity, it can be difficult to distinguish their unique characteristics. The use of phrases such as "game-like simulation" or "simulation game" to describe both interventions can be seen as a reflection of their commonality (Koivisto et al., 2018). Both SGs and VSs build on experiential and problem-based learning approaches to foster the development of nurses' clinical reasoning (Barrows, 1996; Kolb, 2015). As such, authors usually refer to design principles, or learning conditions (e.g., unsettledness, feedback), found in experiential and problem-based learning when designing SGs and VSs to foster the development of clinical reasoning (Koivisto et al., 2018). While SGs and VSs are both based on these learning approaches, they differ in a few ways. SGs are video games designed to be fun while allowing nurses to achieve specific learning objectives (Agence for Healthare Research and Quality, 2020). VSs are designed to digitally recreate authentic clinical situations for nurses to experiment safely (Cant et al., 2019).

Based on the theoretical literature on the design of SGs and VSs to foster the development of nurses' clinical reasoning, we argue that SGs and VSs are distinct e-learning

interventions based on overlapping and unique design principles. Specifically, this paper aims to: 1) identify the overlapping and unique design principles of SGs and VSs; and 2) describe the theoretical links between design principles and the development of nurses' clinical reasoning. This is of prime importance for educators and researchers interested in the development of theory-based and conceptually coherent technology-based interventions to foster the development of clinical reasoning.

Overlapping design principles of virtual simulation programs and serious games

To enhance nurses' clinical reasoning, both SGs and VSs build on design principles found in experiential and problem-based learning approaches (Kolb, 2015). According to experiential learning, reflection on experience leads to learning. In problem-based learning, exploring real-world clinical problems by formulating questions, seeking answers, and applying existing or newly acquired knowledge to solve clinical problems would promote learning (Barrows, 1996).

Design principles from both approaches include unsettledness, authenticity, scaffolding, and feedback. Unsettledness refers to the rise of cognitive conflicts as one tries to accommodate new information into an existing cognitive framework. Unsettledness can occur by offering clinical experience and problems that do not make sense on their own and whose evolution cannot be anticipated entirely (Kolb, 2015). Authenticity means that the experience or the problem should reflect nurses' clinical practice as they perceive it. Authenticity is believed to be essential for nurses to link a learning experience to real-world clinical practice (Weeks et al., 2019). Scaffolding means that the complexity of a clinical experience or problem is tailored to a nurse's perceived mastery level. Scaffolding could result in a greater improvement of clinical reasoning as nurses exert a progressively greater cognitive effort to make sense of the clinical situation (Barrows, 1996). The provision of feedback in both e-learning interventions should favor nurses' reflection on their experience and their experimentation in solving the problems offered to them (Holder, 2018).

Designing virtual simulations

Virtual simulations aim to recreate clinical situations perceived as authentic by nurses and in which problems are embedded. Thus, VSs are usually built around detailed and complex

clinical situations in which nurses are required to interact with a patient as they would in real-life clinical practice (Orique & Phillips, 2018). Rarely seen or critical clinical situations, such as rapidly deteriorating patients due to cardiac, respiratory or unknown causes, can be simulated to favor unsettledness (Borg Sapiano, Sammut, & Trapani, 2018). As authenticity is a major design principle of VSs, these clinical situations are expected to mimic the ones found in real-life in terms of how nurses can intervene and how patients respond to nursing interventions (Duff et al., 2016). In VSs, scaffolding can be achieved, for example, by including different clinical situations so that patients' conditions can range from stable to unstable. For instances, patients could exhibit states of shock or signs and symptoms less commonly identified in practice by nurses. Feedback regarding nurses' interventions can be programmed for them to reflect on, for example, the accuracy of their evaluation (e.g., did they identify all critical changes to a patient's clinical condition, what they missed, why it is important for them to identify these changes).

Designing serious games

Definitions of SGs refer to a playful learning approach—as evidenced by terms such as "entertainment" and "enjoyment"—and to a fantasy design principle, through the use of the term "artificial" (Agence for Healthare Research and Quality, 2020; Tobail & Arisha, 2017). Entertainment and enjoyment refer to the hedonic sensation of fun and serve to specify the autotelic nature, or the intrinsically motivating nature, of SGs. Thus, the use of SGs would be primarily motivated by fun (Alexiou & Schippers, 2018). Authors conceptualize fun as a driver to the learning experience (Tobail & Arisha, 2017). Fun should promote nurses' cognitive engagement and their persistence in SGs, which in turn should favor the development of their clinical reasoning (Perski, Blandford, West, & Michie, 2017). Two of the main challenges in designing SGs are then to identify design elements to promote fun and to consider how these elements align with the overarching aim of learning to enhance clinical reasoning. Authors suggest four major interrelated emotional states that can lead to fun in SGs, which are feelings of accomplishment, competition, control, and curiosity (Malone, 1980; Shi & Shih, 2015); these emotional states and related design elements are defined in Table 1.

Table 1. Design elements to improve the sensation of fun in serious games.

Emotional states interrelated with fun	Design elements
Accomplishment Learners' feeling when their self-esteem is increased by the achievement of a significant goal. These design elements serve as reminders to learners of their satisfactory level of knowledge and skills based on their achievement of in-game goals and help them reflect on their progression.	**Badges for achievement** A visual representation that symbolizes the learner's successful take on a problem. **Content unlocking** Access to new aspects of the serious game when certain aspects of a problem have been solved successfully. **Points** Points are awarded or subtracted depending on the learner's performance and progression. **Virtual goods** Virtual assets awarded to learners that have a certain in-game value.
Competition Learners' feeling when a goal is reachable only through a sufficient demonstration of knowledge and skills. Goals should be numerous, be made explicit, restrict learners' progress inside the SG until they have been reached, and allow for different strategies.	**Challenges** Problems that are attached to specific proximal and distal goals that are to be achieved by learners. **Leaderboard** A table or a graph that ranks learners according to their success on specific criteria. **Performance tables or graphs** A table or a graph that provides information to the learners about the progression or their performance over time. **Teams** Learners working collaboratively with each other to achieve a common goal, or competitively to determine a winner. **Time pressure**

Emotional states interrelated with fun	Design elements
	A time limit allocated for the learner to achieve a specific problem, e.g., a countdown timer that indicates the time remaining.
Control	**Difficulty adaptation**
Learners' feeling that they are masters of their success and that they have a certain degree of freedom to reach their goals.	The difficulty level of problems can be adjusted by the learner, or individually adapted to the learner's performance.
	Hints
All design elements offer an optional cognitive support to help learners reach a goal.	A suggestion or an indication to help the learner solve a problem. Learners may choose to receive a hint, or the serious game can give hints based on their performance.
Curiosity	**Plot**
Learners' feeling when they wish to obtain information that is not immediately accessible to them, that is surprising, or that does not make sense to them.	A narrative discourse that serves to organize the events of a story in a logical or temporal order; goes beyond contextualization.
	A plot allows for the integration of individual problems to be solved and goals to achieve into a greater, coherent, and meaningful whole.

Note. Adapted from Maheu-Cadotte et al. (2018)

Regarding the fantasy principle, the very nature of games is that they operate on a set of rules that are distinct from the rules that govern the real world and distinguish what is possible from what is not. Games reside inside spatiotemporal barriers, forming what is sometimes labeled as a "magic circle"; they propose their own world and their own set of rules (Malone, 1980). Contrarily to VSs, SGs are not bound by authenticity and can incorporate rules that modify what is possible for nurses to do or how patients would respond to real nursing interventions. Fantasy should not be confused or reduced to the surreal; fantasy primarily allows SG developers to create a virtual world that can be more or less representative of everyday life. However, the knowledge and skills targeted by SGs should remain representative of the ones nurses need in clinical practice (Alexiou & Schippers, 2018). For example, a SG could require nurses to quickly identify the greatest number of clinical deterioration signs in a high number of patients and these patients could suddenly deteriorate if nurses incorrectly evaluated them. In this

case, nurses are expected to develop the knowledge and skills required to identify real signs of deterioration, but patients do not respond in a realistic manner.

Recommendations and conclusion

The design principles of SGs and VSs are outlined in this work and also synthesized in Table 2. Educators and researchers interested in the development of VSs can refer to them to improve nurses' clinical reasoning. Conceptual clarity should also favor the review and synthesis of studies' findings about these interventions.

Table 2. Design principles of virtual simulations and of serious games

Design principles		Virtual Simulations	Serious Games
Authenticity		X	X
Fun	Accomplishment		X
	Competition		X
	Control		X
	Curiosity		X
Fantasy			X
Feedback		X	X
Scaffolding		X	X
Unsettledness		X	X

Future studies should be conducted to compare SGs and VSs with design variations (e.g., through factorial experiments) to identify aspects of their designs that can support the learning experience. These could inform, for example, areas of these interventions that should remain authentic, to favor the transfer of learning outcomes to nurses' clinical practice, and areas that could adopt a more fantasist approach, to help sustain nurses' intrinsic motivation during these interventions.

In the same vein, such studies could inform the optimal ways to operationalize and articulate each design principle to enhance nurses' clinical reasoning. For instance, when feedback should be given to nurses (e.g., immediate, delayed) to best support their reasoning process while without overloading them with information or putting them in a passive state for too long (Custers, 2019). Or, in SGs, what is the impact of integrating or subtracting design

elements such as a plot on nurses' intrinsic motivation and their achievement of the learning objectives?

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