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The process of developing a serious game for nurse education

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Abstract

Future nursing education is challenged to develop innovative and effective programs that align with current changes in health care and to educate nurses with a high level of clinical reasoning skills, evidence-based knowledge, and professional autonomy.

Serious games (SGs) are computer-based simulations that combine knowledge and skills development with video game–playing aspects to enable active, experiential, situated, and problem-based learning.

In a PhD project, a video-based SG was developed to teach nursing students nursing care for patients with chronic obstructive pulmonary disease (COPD) in both a home health care and a hospital setting. This paper summarizes the process of the SG development and evaluation.

Introduction

Serious games (SGs) are proposed as a type of computer-based simulation that might provide nursing students with an opportunity to practice their clinical reasoning and decision-making skills in a realistic and safe environment (Cant & Cooper, 2014). Stuckless , Hogan, & Kapralos (2014, p. 146) defines a serious game as "an interactive computer application that (1) has a challenging goal, (2) is fun to play and/or engaging, (3) incorporates some concept of scoring, and (4) impacts to the user a skill, knowledge, or attitude that can be applied to the real world."

SGs should enable active, experiential, situated, and problem-based learning (Connolly, Boyle, MacArthur, Hainey, & Boyle, 2012). Thus, special efforts need to be made

in the design and development of SGs. Issues in usability of SG applications can drastically affect user experience and intended learning outcomes, yet research that addresses the development process of SGs in the domain of nursing education has been limited (Ricciardi & De Paolis, 2014). In addition, few studies have specifically addressed the domain of home health care (Popil & Dillard-Thompson, 2015; Stuckless et al., 2014).

Methods

During 2015, an SG to teach nursing students clinical reasoning and decision-making skills in health care for patients with chronic obstructive pulmonary disease (COPD) in a home health care and hospital setting was developed (Johnsen, Fossum, Vivekananda-Schmidt, Fruhling, & Slettebø, 2016). This paper aims to summarize the process when initiating and developing the SG.

Developer team

- A development team of experts/ professionals (Wattanasoontorn, Boada, García, & Sbert, 2013) consisted of a doctoral student, who was an intensive-care nurse with a master's degree in health informatics, and four undergraduate students in multimedia technology and design.
- Health care professionals from clinical practice was included in the development process to improve the match between nursing education and the realities of clinical practice. Two RNs, one from home health care and one from a local hospital, offered practical knowledge on caring for patients with COPD and contributed as actors in the SG scenarios. In addition, a person with COPD contributed as an actor in the SG scenarios.
- Agreement were made about roles, contributions, and funding.
- Meetings were held on a regular basis between the development team members and their supervisors to agree on design and discuss challenges in the design and development process.

Specifications of the game

Target users

The content and objectives of the game needed to fit the users' knowledge and experience (Olsen, Procci, & Bowers, 2011; Wattanasoontorn et al., 2013), as well as skills and competencies regarding information and communication technology (ICT). The target users of the SG were students in their second year of the Bachelor of Nursing program. The syllabus was examined to determine their current expected level of competencies in anatomy, physiology, and subjects in medical treatment and nursing.

Educational content

The following questions needed to be raised in the planning phase of the educational content for the SG to become a valuable educational tool that meets its objectives (Laamarti, Eid, & El Saddik, 2014; Petit dit Dariel, Raby, Ravaut, & Rothan-Tondeur, 2013; Wattanasoontorn et al., 2013):

- What should the SG be about (genre/story/context)?
- What should the learning objectives of the SG be?
- Should current evidence-based knowledge be required?
- Do the learning objectives and content fit the target user's knowledge and experience?
- Which theories/strategies can be employed that align with the learning objectives?
- Does the educational content comply with the faculty's learning and teaching strategy?

The objective of the SG was to increase nursing students' clinical reasoning and decision-making skills and aimed to increase nursing students' perception and confidence in clinical situations related to health care for patients with COPD. Further, to promote systematic assessment of COPD patients, and improve the recognition of and manage concrete manifestations of patient deterioration (exacerbation). The SG provides four video-based,

simulated scenarios from clinical practice: two from a home health care setting and two from a hospital setting. Users take part in a nurse's visits to a patient with COPD in different stages of his disease. In the first scenario, he has recently been diagnosed with COPD, and in the fourth he is hospitalized with an infectious exacerbation of his severe COPD.

During the scenarios, the users need to solve different quiz-based tasks and questions. The different questions were based on the six cognitive process-categories of Bloom's taxonomy (Whei Ming & Osisek, 2011): remember, understand, apply, analyze, evaluate, and create. Questions were formulated to motivate the students to analyze information provided in the scenarios and transfer learned knowledge to the specific situations related to the patient in the scenarios.

User–computer interaction design

Usability is defined as "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use" (Zhang & Walji, 2011, p. 1052). Therefore, different elements concerning user–computer interaction design needed to be considered (Annetta, 2010; Laamarti et al., 2014; Wattanasoontorn et al., 2013). We developed a single-player SG. Users interact with the SG by watching video-based scenarios (visual/audio) and by using a mouse or touchpad (physical). Users need to answer questions or complete tasks presented during the scenarios before they can continue (in-game assessment). Through their answer(s), users dictate the action(s) of the nurse character in the scenario. Users receive points for each correct answer. The SG contains different types of questions (single- or multiple-answer and drag-and-drop questions) to increase immersion. When the students submit their answer(s), they receive feedback from the nurse character in the scenario through a demonstration of the proper things to do or say. In addition, the correct answer can be viewed in writing by using a link at

the bottom of the screen. When users have finished a scenario, learning objectives for the SG are summarized and a final score is provided.

Technology

Usability of an SG will also require selected technical solutions. Hence, decisions had to be made about the following components (Petit dit Dariel et al., 2013; Wattanasoontorn et al., 2013):

- Game engine
- Database
- Design of software applications that fit with planned features in the SG
- Platform (touch-tablet, laptop, personal computer (PC), phone)
- Compatibility with a Learning and Management System (LMS)?
- Special equipment needed? (i.e., video cameras and microphones)

Adobe Captivate 8, Adobe Premiere Pro CC, and Adobe Photoshop CS6 were chosen as development software. HTML5 was chosen for uploading to an Internet address. The SG was made available for use on PCs, laptops, and the newest tablets.

Storyboarding

A storyboard was drafted based on a fictitious story about a patient with COPD. The storyboard contained a detailed description of content and sequences in the SG (Olsen et al., 2011), and numbered descriptions of each video clip and its tasks and questions.

Location and recording of video-based scenarios

The two scenarios for home health care were video recorded in an apartment at a nursing home facility, and the two scenarios from the hospital settings were recorded in the simulation laboratory at the university (Figures 1 and 2).

Fig. 1. The location for recording the scenarios in the home health care setting

Fig. 2. Picture from the location for recording the scenarios in the hospital setting

Development of a prototype

The multimedia-technology and design students designed and developed a prototype from the first scenario in home health care by putting the video clips and questions together and adding necessary information and instructions. The SG prototype was developed based on usability design principles (Olsen et al., 2011) and usability heuristics (Zhang & Walji, 2011). Figure 3 shows a screenshot from the SG prototype.

Fig. 3. Screenshot from scenario 2, when the patient develops an exacerbation and needs to be hospitalized.

Usability evaluation of the prototype

Usability testing is a key step in the process of designing SGs (Lazar, Feng, & Hochheiser, 2010; Olsen et al., 2011). In-house testing of the pilot version was conducted by the development team with six participants in a computer laboratory before an evaluation of the final prototype was conducted by potential users.

Further development

Issues from the usability evaluation was addressed and a final version of the SG was prepared. New in-house testing was conducted to ensure that all issues had been addressed and that the final version was free of any defects (Olsen et al., 2011). This version made the basis for further development of the last three scenarios. Each of the four scenarios in the final version was repeatedly tested by the development team and the doctoral student for language editing, conciseness, and technical flaws before implementation.

Testing on potential users

Evaluation of an SG's educational value before implementation is central to determine its quality and ability to meet the target learning outcomes (Graafland et al., 2014). Other important features that will affect students' acceptance and intention to use an SG are an SG's usability, ability to engage/motivate, fit with personal needs and the nursing domain, social influence on other students, and facilitation of conditions such as access and user support (Venkatesh, Thong, & Xin, 2016). A pilot study was conducted, involving the implementation of the SG prototype as part of two simulation courses in nursing education. A survey was used to assess nursing students' perceptions of the SG in terms of face, content, and construct validity, specifically for degree of realism and authenticity, alignment of content and tasks with curricula, and the SG's ability to meet its learning objectives.

Ethics

To ensure that the research was conducted in an ethical manner and in accordance with general guidelines and principles for research ethics (Vivekananda-Schmidt, 2013), the following concerns were considered:

- Approval of the studies were obtained from the Norwegian Social Science Data Service (no. 38298).
- Oral and written information with the assurance of confidentiality was provided, and participants signed an informed consent.
- Ethical concerns with regard to patient–healthcare professional interaction and how the actors appear in the scenario were considered in design of the SG. For example, as being considered a potential role model, the RN in the scenario did not demonstrate any incorrect responses in the scenario.

Discussion

To increase the fidelity and realism in the SG, we employed video-based scenarios with RNs and a person with COPD. Our positive experience with use of a person with COPD as an actor corresponds with research on using standardized patients (Kowitlawakul, Chow, Salam, & Ignacio, 2015).

One of the greatest challenges in developing an SG for nursing education is that all the choices in the quiz-based tasks and questions needed to be predefined, and the user can choose only between the options available. For example, even if measuring the patient's blood pressure might not be the most important assessment at an earlier point during the game, it might be necessary data at a later point, depending on the patient's condition. This should be explained when users view the correct answer(s). Another challenge is whether the SG should provide the ability for users to choose the wrong answers deliberately and view the

consequences of their choice. Some SGs provide this ability (Kaczmarczyk, Davidson, Bryden, Haselden, & Vivekananda-Schmidt, 2015), whereas others argue against it (Laamarti et al., 2014). If developers decide to include the ability to choose different options, so that each option leads to another video, they should draft a decision tree to be used alongside a storyboard (Kaczmarczyk et al., 2015).

Debriefing has been shown to be an essential component in simulation (Dreifuerst, 2012). Hence, lack of ability to receive debriefing after finishing the SG scenario may represent a limitation of computer-based simulations compared to classroom simulations. Educators should consider offering the ability to debrief and/or have discussions as a supplement after students have played the SG.

As proposed by Wattanasoontorn et al. (2013), we saw that tools such as design software application are important features to consider when developing SGs. For example, the Adobe Captivate version used in this project had limitations in the number of answers that could be available on the screen. Furthermore, in questions with several correct answers, the software would only give a total score instead of giving a score for each correct answer. Due to these limitations in the design software, the developers needed to use scripts (workarounds). We experienced the following consequences of using scripts: The SG was not compatible with the university's LMS, registration of the performance of each user or communications with lecturers was not possible within the solution, and the SG could not provide feedback that addressed the performance of the player at the end of each scenario. Perceived limitations in design software show that it is important to choose design software applications that fit with planned features in the SG.

Showing the SG's educational value and user acceptance among these nursing students is important because this may justify the development and application of more SGs in nursing education. Further, nursing lecturers will be more likely to use an e-learning resource that

students perceived is educationally valuable (de Freitas & Oliver, 2006; Tait, Tait, Thornton, & Edwards, 2008).

Conclusion

In this paper, we have summarized the process of initiating and developing an SG. The SG in this project is an in-house product that does not have complex functions or graphics as in virtual-environment types of SGs. However, if considerations are taken concerning educational content and user–computer interaction design, even a simple and low-cost SG can be perceived as useful, usable, and well-liked by users. Thus, we hope this paper will motivate nurse educators to develop SGs that fit the needs in current education programs.

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