A Computer-based Clinical Simulation System Based on Constructivist Learning Environments for Undergraduate Nursing Students in the Field of Geriatric Emergencies

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Abstract

Background/Objectives: This study proposes to develop a computer-based clinical simulation learning system based on Constructivist Learning Environments (CLEs) to enhance nursing students' clinical reasoning skills for geriatric emergencies.

Methods/Statistical analysis: We designed the system to implement problem-based learning as a problem-solving process by providing nursing process through simulations. The system was piloted to 88 nursing students, which presented three emergency scenarios of the elderly in nursing facilities.
Findings: For this study, we developed a computer-based simulation system that can evaluate patients’ conditions in problem scenarios that can occur in real situations, according to the nursing process. And the pilot study result shows that upper-year students were more confident in using the system for learning compared with the lower-year counterparts, and they exhibited greater satisfaction using the system for learning.

Improvements/Applications: Applying the learning system equipped with information resources and cognitive tools from CLEs will improve students’ learning outcomes.

Key Words: Computer-based clinical simulation, Nursing education, Constructivist learning environments, Problem-based learning

1 INTRODUCTION

THE ELDERLY have become the core target population for public health and medical sectors as the elderly population increased worldwide (He, Goodkind, & Kowal, 2016). The number of elderly people using nursing facilities, alternative residential care places, or home care services was projected to increase from 15 million in 2000 to 27 million in 2050 (Center for Disease Control and Prevention, 2016). Such elderly people experience a decline in physical and mental functions, have multiple chronic illnesses, and are prone to emergency situations because of polypharmacy (Mortazavi et al., 2016). Frail and old residents in nursing facilities have a particularly poor prognosis if they do not rapidly receive appropriate treatment in emergencies, because nursing facilities have fewer physicians participating in direct care, with a shortage of medical personnel and equipment for diagnoses and treatment (Kim et al., 2015; Shanley et al., 2011). Under these circumstances, nurses are the main healthcare providers, and their quality crucially affects the level of care for the elderly in the facilities. Therefore, nursing education for geriatric care has been recognized as critical (Spilsbury et al., 2011), and Berman et al. (2005) suggested that it be implemented of the undergraduate curriculum. Such curriculum should integrate classroom knowledge and apply it to actual clinical settings. A clinical reasoning skill, a dynamic cognitive process, is
essential for identifying a patient’s problem, interpreting and analyzing information, and coping with a patient’s status. Therefore, education for nursing skills and knowledge improvement that can improve clinical reasoning skills is necessary (Lapkin et al., 2010).

Clinical simulation education is known to be effective in an educational setting as it does not harm actual subjects while allowing the learner to integrate theory and practice by utilizing multimedia data, patient simulators and computer simulations. Previous studies reported that simulation education used in a clinical practice entails improvement in the following areas: practical skills, knowledge, self-competence, and communication ability (Centrella-Nigro et al., 2016; Gotwals and Scholtz, 2016; Bambini, 2009). Research on clinical simulation education has recently been implemented using computers, which have no spatial and temporal limitations and can apply numerous learning strategies and individualized learning factors, in addition to inducing student interest (Cook et al., 2012). Specifically, adopting computer simulations strategically has the advantage of reducing the number of required personnel for training, as well as enhancing the ability to self-update information and retain techniques (Cook et al., 2012).

Problem-Based Learning (PBL) is another useful learning strategy that increases students’ perceived learning effectiveness and satisfaction, problem solving ability, critical thinking ability, and clinical reasoning ability through group discussions and self-directed learning (Dolmans et al., 2016). Because the problem situation presented by the PBL provides authentic case, it can provide effective education when combined with simulation training (Kim and Choi, 2008). The recent development of information and communication technology has yielded web-based PBL, which is computer based and provides realistic scenarios and extremely fast access to diverse information, and has provided an environment where PBL can be implemented easily (Dolmans et al., 2016; Spinello and Fischbach, 2008). Therefore, the purpose of this study was to develop and pilot a computer-based PBL learning system using the simulation system to improve the clinical reasoning skills of the nursing students in the field of geriatric emergencies, who may not have practical experience. We have developed a computer-based simulation system that can evaluate patients’ condition according to the nursing process by gathering and analyzing the information needed
2 MATERIALS AND METHODS

This study was composed of two parts: the development of computer-based clinical simulation education and its evaluation for possible application in nursing curricula.

A. Stage 1: Development of a computer-based clinical simulation system based on CLEs

1. Concepts for learning system (Constructivist Learning Environments)

The proposed system is based on Constructivist Learning Environments (CLEs), environments required for effective constructions in learning. A learner acquires knowledge through the interaction with the external world (environment) and constructs a meaning or knowledge for oneself (Yldz-Feyziolu et al., 2013). As shown in [Figure 1], the goal of the learning system in this study was to provide information resource and cognitive tools from the CLEs. The Information resources provides the information expected to be required during the problem-solving process and are prepared so that the learner can learn effectively. They are essential elements in self-directed learning such as textbooks, encyclopedias, and online resources. The web-links provides definitions to the medical terminology presented in the system, which are linked to Medical Library Engine as information resource. The Cognitive tools help learners effectively support cognitive processes to gain meaningful experiences in the process of building their own knowledge. In this study, the system provides feedback during a problem-solving process while comparing it to the expert rule as cognitive tools.
2. System design
The proposed learning system is designed to perform PBL by reconstructing the nursing process in the system as a problem-solving process. As shown in Figure 1, the computer-based clinical simulation system is composed of clinical problem scenarios, which present background information of an emergency and a patient’s condition; the problem-solving process, which provides questions that require decision-makings; and feedback, which helps the learner solve the problems autonomously by comparing the learner’s decision making with the expert rules in the system. The expert rules were based on the management principles for the elderly with chest pain, suggested by Kim et al (2017). The expert rules were verified by 15 experts consisting of (i.e., emergency medicine, neurology, and geriatrician specialists), six were nursing professors, and six were staff members in geriatric nursing facilities.

B. Stage 2: An evaluation of computer-based clinical simulation education based on CLEs for possible application in nursing curriculum

1. Participants
The participants in our study consisted of 88 college students in a 4-year nursing college in South Korea (28 first-year, 35 second-
year, 13 third-year, and 12 fourth-year students). We were approved by the Institutional Review Board (KU-IRB-10-15-A-2) of Korea University for developing expert rule based algorithm, which is the main part of the proposed learning system. However, Korea University does not require an IRB for a pilot test, so instead, a consent letter was received from all of the students.

2. Procedures

The system background, purpose and method of using the system were explained to the participants of each grade prior to the test, followed by a guidebook and the contact information of the responsible researchers. Each student was allowed to access the system through the Internet whenever they were personally available, and the average time required for problem-solving was 30 minutes. The students were required to solve three problem scenarios related to chest pain, a frequently occurring emergency in nursing facilities. All medical terms were linked to the medical search engine so that the user could check the unfamiliar words by clicks. Feedback was provided during the problem-solving process. The final feedback was provided to confirm the answers upon completing the problem-solving. Finally, the system was evaluated through a survey.

3 RESULTS AND DISCUSSION

A. Stage 1: Development of a computer-based clinical simulation system based on CLEs

For this study, we developed a computer-based simulation system that can evaluate patients’ conditions in problem scenarios that can occur in real situations, according to the nursing process. [Figure 2] shows the system composition suggested in this study.
The problem scenario is presented on the upper-left side of the system, the diagnosis list on the bottom-left side, and problem-solving progress on the right, with the answer and explanation revealed upon solving the problem.

1. Presenting a problem scenario
   The problem scenario presents information on the emergency background and the patient’s current condition. Problem-solving begins in the problem scenario after the learner presses the “start” button.

2. Problem-solving according to nursing process
   The problem-solving step presents the learner decisions made from expert rules in the simulation system’s nursing process in the
form of a questionnaire for the proposed learning system. The problem-solving step consists of four nursing processes: assessment, diagnosis, intervention, and evaluation; each process presents with three to four problems. The three types of content presented to the learner for decision making during the problem-solving step are as follows:

First, in the assessment step, learners select, from 101 appearances in nine categories, all the visible symptoms of the patient for a given scenario in the problem-solving process. Afterward, learners will select the most probable diagnosis from 15 symptoms and diseases (including chest pain) that occur frequently in nursing facilities. The third step involves general decision making for nursing intervention. This section is presented as multiple-choice and yes-or-no questions.

3. Problem explanation feedback

Problem explanation feedback is provided if the comparison between the choice (decision) of the learner and that of the expert rules in the simulation system reveals different answers. In the feedback section, a section of the scenario that the learner must focus on is underlined, and additional information required for problem solving is provided.

4. Answer, Explanations and Web link

Learners study by using the PBL format and moving back and forth between the problem-solving step and the feedback process in the learning system. Answers and explanations provide explanations with a suggestions page, which is offered in the problem-solving step. If the learner selects the correct answer, he or she is able to view the contents of the suggestions page, which are unavailable during the problem-solving process, and the learner can review the entire problem-solving process.

The proposed learning system provides information on jargon that is necessary during problem solving by providing hyperlinks for problem situations and scenarios, the problem-solving step, and during the feedback process. [Figure 3] shows the Medical Library Engine, an information resource provided by the system in this study.
B. Stage 2: An evaluation of computer-based clinical simulation education based on CLEs for possible application in nursing curriculum

For this study, we conducted the following survey to investigate whether the evidence-based simulation learning system was useful during the process of autonomously building techniques and knowledge required by learners for geriatric nursing. The questionnaire comprised sections of self-efficiency, satisfaction of system usage, effectiveness in learning, and usability, which presents questions on the ease of use [Table 1]. The average scores were not high, with an average of 3.55 for self-efficiency, 3.45 for satisfaction, 3.59 for effectiveness, and 3.66 for usability. This indicates that the user is unfamiliar with PBL, which provides a comparison in the diagnosis between the learner and an expert.

**TABLE I**

<table>
<thead>
<tr>
<th>Section</th>
<th>No.</th>
<th>Question</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-efficacy</td>
<td>Q1</td>
<td>I was interested to learn using this system</td>
<td>3.42</td>
<td>1.10</td>
</tr>
<tr>
<td>M=3.55</td>
<td>Q2</td>
<td>I was eager to learn using this system</td>
<td>4.01</td>
<td>0.75</td>
</tr>
<tr>
<td>SD=0.73</td>
<td>Q3</td>
<td>I am confident that I can learn using this system</td>
<td>3.21</td>
<td>0.89</td>
</tr>
<tr>
<td>Satisfaction</td>
<td>Q4</td>
<td>I want to learn using this system again</td>
<td>3.12</td>
<td>0.99</td>
</tr>
<tr>
<td>M=3.45</td>
<td>Q5</td>
<td>I am satisfied with learning through this system</td>
<td>3.25</td>
<td>0.66</td>
</tr>
<tr>
<td>SD=0.72</td>
<td></td>
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</table>
[Figure 4] shows the analysis results of each category. The analysis of each category revealed that the average scores generally increased with each grade, from the first to the fourth. The following is the result of a detailed analysis of the survey on self-efficiency, satisfaction, effectiveness, and usability, and shows that for self-efficiency, first-year students scored the lowest (3.32), while fourth-year students scored the highest (3.83). For satisfaction, first-year students scored the lowest (3.19), while fourth-year students scored the highest (3.77). The effectiveness score, the purpose of which is to determine the degree of helpfulness, shows that first-year students obtained the lowest average score (3.40), while fourth-year students had the highest average score (3.80).
Subjective comments included, “the web-links and feedback provided by the system was helpful for solving the problems” and “the scenario-based problem-solving process of the system was helpful for enhancing clinical reasoning skills and geriatric emergency management.”

The pilot study result shows that upper-year students were more confident in using the system for learning compared with the lower-year counterparts, and they exhibited greater satisfaction using the system for learning. Subjective comments by upper-year students suggested that the problem-solving process based on a scenario was helpful for learning geriatric emergency management. This finding may be because they have more substantive theoretical background and practical experience, which is in line with a previous study result showing that those with more knowledge in the relevant area can utilize the system with greater confidence (Grbz and Birgin, 2012; Reed et al., 2010).

There are several limitations in this study. This study was based on data from one institution with small and unequally sized subgroups that the findings may not be generalizable. Ideally, a larger sample would be desirable for comprehensive data that can be generalized. Moreover, the conducted survey includes students’ perceived improvement of clinical reasoning skills after using the sys-
tem. Further research would need to include both pre- and post-test data of using the system that shows statistical significance to learn if developed learning system has any increase on the overall student knowledge base and clinical reasoning skills.

4 CONCLUSION

In this study, the learning system was developed with the goal of enabling learners to solve problems autonomously by providing CLE information resources and cognitive tools. The students’ responses demonstrated that the proposed learning system (web-links and feedback) provided by the system was helpful for learning. Applying the learning system equipped with information resources and cognitive tools from CLEs will improve students’ learning outcomes and the quality of students’ educational experience.

References


