Effects of a Blended Learning System on Improving the Physical Assessment Ability of Nursing Students

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***Abstract*—This study assessed the effects of a blended learning system—combining e-learning with simulation training—on improving the physical assessment ability of nursing students in Japan. Specifically, we evaluated how e-learning improved physical assessment knowledge and its application in simulation training. We also reviewed their evaluations of the blended learning system, comprising e-learning and simulation training, after they experienced the system and the influence of blended learning on their desire to learn. We used an interventional study design with a questionnaire survey. The results indicated that e-learning improved participants' ability of checking vital signs and information gathering skills. However, e-learning as regards conducting auscultation, and palpation showed no significant learning effects and simulation training helped to do auscultation and palpation. Additionally, e-learning helped participants recognize the relevance of learning content to their professional practice. In conclusion, using e-learning to study some physical assessment skills was effective and it's necessary to combine e-learning and simulation to improve physical assessment ability as blended learning.**

Keywords-e-learning; nursing students; physical assessment; nurse education.

I. INTRODUCTION

Nurses are increasingly expected to obtain skills related to grasping their patients' situations, particularly the ability to provide advanced and accurate physical assessments [1]. Thus, nurses must begin physical assessment training that is suitably adapted to clinical practice (e.g., simulation education) as early as possible, ideally in their basic nursing education. As physical assessment relies on nurses appropriately integrating knowledge and technique, such as conducting an accurate physical examination and judging a situation based on available information, learning to perform it is challenging [2]. Optimal methods for teaching integrative content to large groups of people thereby need to be examined to improve physical assessment education.

One potentially effective method of ensuring optimal learning for each individual in group learning situations is e-learning. In the context of continuing education for physicians, e-learning has been demonstrated to be as effective as conventional teacher-led education [3]. In other words, e-learning appears to be an effective method of instruction, as it does not limit the learning environment or time for learning, at least for knowledge-level content. In recent years, the breadth of the utilization of e-learning in medical education has been expanding, marking a shift from mere passive knowledge transmission to active, self-motivated learning [4]. Indeed, self-motivated learning using e-learning tools has become a critical feature of nursing education. Hence, learning that effectively utilizes ICT needs to be implemented from early on in nurses' education. Current students receiving basic nursing education are known as "digital natives"; they are from a generation for whom the Internet has existed since birth [5], indicating that their information literacy is higher than that of past generations. Thus, they have a high likelihood of readily taking to e-learning methods in their education.

Although e-learning affords numerous benefits to learners, it also presents a number of challenges. First, e-learning relies on learners' ability to self-manage their learning process, and second, e-learning methods must possess features that help maintain the desire to learn [6]. For example, massive open online courses (MOOCs) [7] can theoretically provide instruction to an extremely large number of participants, but they do not allow learners to self-manage their learning, and students tend to drop out of these programs owing to diminished motivation to learn. One strategy that has been proposed to resolve these problems in MOOCs is "blended learning," which combines face-to-face and e-learning methods. We thus hypothesize that such blended learning training may help overcome the challenges of e-learning. This study aimed to investigate the effects and influence on motivation of a blended learning system to improve physical assessment ability. The remainder of this paper is organized as follows. Section II presents the methods. Section III provides an overview of our results. Section IV discusses implications and limitations. Finally, conclusions and future work are detailed in Section V.

II. METHODS

A. Participants and Data Collection Methods

Of the 82 junior nursing students who had already completed physical assessment training at A university, we recruited the 34 students who consented to participate (33 females and 1 male aged 20 to 22 years). A preliminary testing of the participants' computer literacy revealed that they were able to connect to the Internet and could

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effectively use mobile devices (e.g., laptop, smartphones), but had not had previous e-learning experience. Additionally, they either did not have any experience with simulation training or had undergone it once or twice. Data collection was conducted through objective assessment (i.e., correct answer rate on an e-learning test, and a checklist evaluating simulation results) and subjective evaluation of the e-learning experience (questionnaire). The investigation period was from September to October 2012.

B. *Design of the Physical Assessment Training Using E-learning and Simulation*

1) *Learning Objective*

The learning objective of the physical assessment training was "able to visit the patient's bedside and comprehend their condition." Accordingly, we created a checklist of the skills that participants should be able to perform at the end of the training, including visual inspection, performing a medical interview, measurement of vital signs, and performing auscultation and palpation. We created a simulation scenario wherein they carried out a physical assessment of a breast cancer patient during chemotherapy. This blended learning was designed to create suitable educational materials to help nursing students learn real-world clinical situations, by using stories to help them better anticipate the realities of clinical practice. The characteristic points of the materials were the use of Japan's national nursing examination, modified using scenarios and actual clinical cases, and story-type e-learning that included learning opportunities for assessments, clinical thinking, patient safety, and communication.

2) *E-learning Design*

An open-source learning management system, Moodle [8], was used to design the e-learning system. Specifically, the e-learning system presented patients on a screen, on which participants were supposed to perform a physical assessment using the displayed data (Fig 1). The system also included a test on content related to physical assessment. The test was conducted before the simulation training to confirm if the participants possessed the knowledge necessary to take part in the simulation. As in previous research [9], the structure of the e-learning system involved solving test problems within the same account as the simulation, thus serving as an introduction to the simulation. The e-learning covered the period of the student's entry to the hospital room, conduct of the physical assessment, and exit from the room. It was configured such that participants answered 14 multiple choice questions and 2 short-answer questions, for a total of 16 questions.

3) *Simulation Design*

The simulation was conducted in a simulated hospital room (Fig 2). An advanced simulator that enables the measurement of patients' blood pressure, pulse, and respiratory rate was used. During the simulation, learning achievement was evaluated using the simulation checklist mentioned previously. In the medical interview, the patient's vocal responses were produced by an instructor with a microphone.

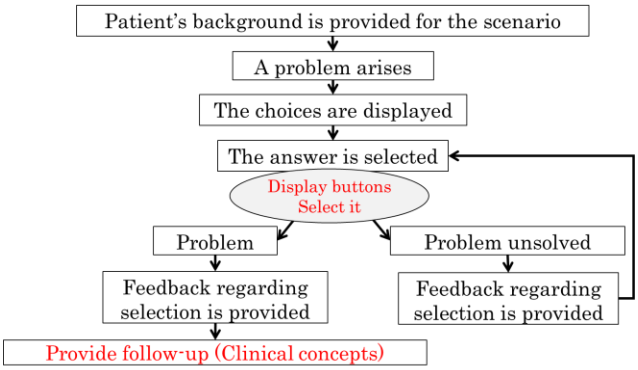

Figure 1. Flow of e-learning

C. *Questionnaire Creation*

The questionnaire assessed participants' opinions of the e-learning system (including amount of learning material, difficulty of questions, visibility, and ease of operation) and its effect on their desire to learn using a five-point Likert scale (extremely dissatisfied, slightly unsatisfied, neither satisfied nor dissatisfied, slightly satisfied, and extremely satisfied) and a free-comment section.

Desire to learn and the influencing factors for the successful implementation of learning were assessed using the four-subscale Instructional Materials Motivation Survey (IMMS), which was created based on the ARCS model [10]. This model contains four components: attention, relevance, confidence, and satisfaction. The IMMS, comprising 36 items, was designed to measure individuals' reactions to self-driven teaching materials, such as e-learning. A five-point Likert scale was used to rate each item, with higher scores indicating a more positive opinion. The IMMS includes items expressed negatively, which are reverse scored. In other words, before adding these answers to the total score, items given a rating of 5 were converted to have a rating of 1, with 4 being converted to 2, 3 remaining the same, 2 to 4, and 1 to 5.

After completing the entire training sequence, participants who gave their consent were interviewed to explore their thoughts on the e-learning and simulation, and to determine the influence of the simulation training on learning effectiveness and desire to learn.

D. *Statistical evaluation*

For the e-learning, test scores, times, and times of simulation are expressed as means ± standard deviations. For the questionnaire, scores are expressed as means and median values (quartile range). The free-response descriptions were

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listed as written by participants. All statistical analyses were performed using IBM SPSS Statistics 22 (IBM Corp., Armonk, NY). A significance level of 5% was used in the analysis.

E. Ethical Considerations

This study was conducted with the approval of the medical ethics committees of Nagoya University, Japan; the survey was approved in June 2013 (No. 2013-0049).

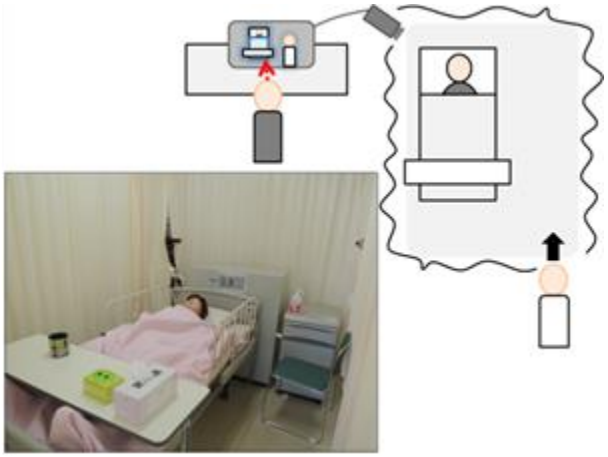

Figure 2. Simulated hospital room: The instructor watches participants' performance via video to ensure a safe learning environment.

III. RESULTS

A. Research Participation

Of the participants, 34 finished the e-learning and simulation, whereas 25 completed the questionnaire. Interview data were obtained from four participants; most of the participants had to attend clinical training.

B. E-learning

The correct answer rate on the test was 91.1% ± 8.5%: that for the measuring site of temperature and pulse, and the side effect of chemotherapy were for each 73.8%, 68.5%, 73.8%, less than 75%. Regarding the time taken to complete the test, the participants had a mean time of 21 min 49 s ± 9 min 15.

C. Simulation

According to the checklist analysis results, all 25 participants were able to greet the patient upon entering room; measure the patient's pulse, blood pressure, respiratory rate, and temperature, and then interpret the measured values; and exit the room after a polite goodbye. Confirmation of food intake, sleeping condition, excretion condition, and side effect of chemotherapy was carried out by 28, 21, 25, and 30 individuals, respectively; only two participants used information obtained from touching, such as auscultation and palpation. The mean completion time of the simulation was 10 min 32 s ± 2 min 12. After the feedback about simulation from the instructor, all participants understand the needs of auscultation and palpation and tried to examine by auscultation and palpation once again.

D. Questionnaire and Interview Results

1) Evaluation of E-learning and Simulation

The results of the questionnaire assessing the e-learning characteristics are shown in Table 1. The participants chose item 3 in the scale as their response for all of the questionnaire items. From the free-response answers, one participant reported that the number of questions and difficulty of the e-learning was "exactly the right number and difficulty." Another reported that it was "a little too much to do in my spare time." Regarding visibility and operability, which had the most free-response answers, participants listed various concrete problems, such as "difficult to see," "difficult to use on a cellphone," "froze mid-answer," and "difficult to enter sentences on a smart phone."

According to the interviews, participants reported the following on the simulation: "It was interesting, so I would like to use this method in classes as well"; "Because it was done in the e-learning, I could imagine it"; and "Because I knew what was going to be implemented beforehand [owing to the e-learning], I was able to do it." One participant reported, "Although I understood the content, I became nervous and forgot it [during the simulation]." Additionally, participants reported contrasting views, such as "I was able to reconfirm my knowledge with the test" and "It was unnecessary because I was able to understand from the feedback during the simulation."

TABLE I. THE RESULTS OF THE QUESTIONNAIRE ASSESSING THE E-LEARNING CHARACTERISTICS

Contents	Mean, Median; Quartile range
Number of questions	2.9, 3; 3-3
Time taken	2.9, 3; 3-3
Difficulty	2.8, 3; 3-3
Readability	3.3, 3; 3-4
Character size	3.4, 3; 3-4
Screen design	3.7, 3; 3-3
Operability	3.0, 3; 3-3

2) Influence on Desire to Learn

Table 2 shows an IMMS item. Items 1 "When I first looked at this lesson, I had the impression that it would be easy for me" and 9 "There were stories, pictures, or examples that showed me how this material could be important to some people" (included in the Confidence and Relevance subscale), had a low median (3 points). According to the free-response answers, a number of participants expressed wanting more developmental content included in the e-learning. The participants' comments

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TABLE II. THE RESULTS OF INSTRUCTIONAL MATERIALS MOTIVATION SURVEY

Items	Contents	ARCS	reverse	Mean, Median; Quartile
2	There was something interesting at the beginning of this lesson that got my attention.	A		3.5, 4; 4-4
8	These materials are eye-catching.	A		3.7, 3; 3-5
11	The quality of the writing helped to hold my attention.	A		3.5, 3; 3-4
12	This lesson is so abstract that it was hard to keep my attention on it.	A	○	4.2, 4; 4-5
15	The pages of this lesson look dry and unappealing.	A	○	4.5, 5; 5-5
17	The way the information is arranged on the pages helped keep my attention.	A		3.7, 3; 3-4
20	This lesson has things that stimulated my curiosity.	A		4.1, 4; 4-5
22	The amount of repetition in this lesson caused me to get bored sometimes.	A	○	4.1, 4; 4-5
24	I learned some things that were surprising or unexpected.	A		3.6, 4; 4-4
28	The variety of reading passages, exercises, illustrations, etc., helped keep my attention on the lesson.	A		3.6, 4; 4-4
29	The style of writing is boring.	A	○	4.1, 4; 4-5
31	There are so many words on each page that it is irritating.	A	○	4.4, 5; 5-5
6	It is clear to me how the content of this material is related to things I already know.	R		3.9, 4; 4-4
9	There were stories, pictures, or examples that showed me how this material could be important to some people.	R		2.9, 3; 3-3
10	Completing this lesson successfully was important to me.	R		4.3, 4; 4-5
16	The content of this material is relevant to my interests.	R		4.0, 4; 4-4
18	There are explanations or examples of how people use the knowledge in this lesson.	R		4.1, 4; 4-5
23	The content and style of writing in this lesson convey the impression that its content is worth knowing.	R		3.6, 4; 4-4
26	This lesson was not relevant to my needs because I already knew most of it.	R	○	4.2, 4; 4-5
30	I could relate the content of this lesson to things I have seen, done, or thought about in my own life.	R		4.1, 4; 4-5
33	The content of this lesson will be useful to me.	R		4.6, 5; 5-5
1	When I first looked at this lesson, I had the impression that it would be easy for me.	C		2.8, 3; 3-3
3	This material was more difficult to understand than I would like for it to be.	C	○	4.1, 4; 4-5
4	After reading the introductory information, I felt confident that I knew what I was supposed to learn from this lesson.	C		3.4, 3; 3-4
7	Many of the pages had so much information that it was hard to pick out and remember the important points.	C	○	4.1, 4; 4-5
13	As I worked on this lesson, I was confident that I could learn the content.	C		3.3, 3; 3-4
19	The exercises in this lesson were too difficult.	C	○	3.3, 3; 3-4
25	After working on this lesson for awhile, I was confident that I would be able to pass a test on it.	C		3.3, 3; 3-4
34	I could not really understand quite a bit of the material in this lesson.	C	○	4.6, 5; 5-5
35	The good organization of the content helped me be confident that I would learn this material.	C		4.0, 4; 4-4
5	Completing the exercises in this lesson gave me a satisfying feeling of accomplish¬ment.	S		4.0, 4; 4-4
14	I enjoyed this lesson so much that I would like to know more about this topic.	S		3.8, 4; 4-4
21	I really enjoyed studying this lesson.	S		3.9, 4; 4-4
27	The wording of feedback after the exercises, or of other comments in this lesson, helped me feel rewarded for my effort.	S		3.9, 4; 4-4
32	It felt good to successfully complete this lesson.	S	○	4.0, 4; 4-4
36	It was a pleasure to work on such a well-designed lesson.	S		4.1, 4; 4-5

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suggested a desire to use the e-learning system in the future, such as "In practice, I felt like I would be able to use it"; "I want to do normal exercises as well as e-learning and simulation"; and "As long as you know how it works, I think you could practice simulation similar to this with a classmate."

IV. DISCUSSION

A. Effects of Blended Learning

Although simulation is an effective learning method and typically provides a greater sense of understanding, it often causes students to experience significant mental strain, thus making them require learning support. We developed a pre-simulation e-learning system to provide such support. The results showed that, after using the e-learning system, all of the participants performed the greeting, vitals measurement, and complete physical assessment based on the gathered measurements, even if it was their first experience with the simulation. This success can be attributed to participants' completion of the skill building and mock training exercises via e-learning system before the simulation. In other words, the e-learning program enabled them to imagine the content of the simulation and thus integrate relevant knowledge and skills into their simulation experience.

However, participants did not completely learn to perform auscultation and palpation, according to information obtained from medical interviews [11]. Therefore, the e-learning items related to this content may need to be modified. Specifically, the e-learning system can be modified such that, when repeatedly used, items that have been completely learned are excluded, thereby enabling users to focus on items that were not completely learned. Such a modification would allow for the delivery of deliberate and effective training aligned with the learning objectives of nurse education, referred to as deliberate practice [12][13].

Learning self-management has been identified as a key factor for continued education via e-learning [6]. To succeed in remote self-learning, participants may need to receive adequate explanation on the necessity of post-training tests in acquiring knowledge related to medical interviews, auscultation, and palpation, which were areas that remained challenging after the simulation training.

B. Effects of E-learning and Training on Motivation to Learn

The ARCS model is a method of organizing the factors that influence motivation to learn [14], described by Suzuki as follows: "A) First, attention is captured. 'This looks interesting—there's something to this.' R) Next, one realizes the relationship to themselves; knowing the learning task and realizing that 'it looks rewarding and it is related to my values.' Not only is the future value of the task significant, but also enjoying the learning process is valued. However, even if one finds significance in their learning, one can lose motivation when one recognizes that there is low possibility to accomplish the learning goal. C) On the contrary, if one has successful experiences in the first learning stages and can associate the experience with the endeavor, leading to the perception that 'I can manage it,' confidence is facilitated. S) If one can feel fulfillment after looking back on the learning process and its accomplishment, it then leads to motivation to learn." In the present study, the participants recognized e-learning as "having an important relationship to themselves," and they utilized this recognition as motivation to learn. To improve learners' confidence, we propose the following strategies: 1) Share evaluation criteria and allow learners to tackle tasks with a prediction of their possibility for success in mind; 2) adjust the difficulty of the system so that they can have a meaningful and successful experience; and 3) provide opportunities and feedback that regulate learning, thus encouraging them to be aware that they can achieve their goal by themselves [15]. A number of participants commented that the training could feasibly be implemented as peer training and skill review. Repetitive practice through sharing stories with peers and skill review has been shown to help learners acquire self-confidence [16]. Further consideration of task difficulty will also facilitate continuous learning in this context.

C. Determinants of Successful E-learning

As described above, e-learning relies on independent learning, which means that it has an inherent risk of dropout. We thus set learning objectives to help foster learning motivation and created teaching materials relevant to real-world clinical settings. In this study, the item "The content of this lesson will be useful to me" was rated 4.6, 5; 5-5 point, indicating that blended learning sustained participants' motivation. Additionally, the item "I could not really understand quite a bit of the material in this lesson" was reverse scored, also totaling 4.6, 5; 5-5 point. The difficulty of blended learning and acquisition of confidence through simulation may be factors that influenced their motivation. In this respect, the structure of the blended learning needs to be improved such that it can help participants gain confidence in their ability to perform the learning exercises and promote their self-learning through repetitive practice and detailed explanations for items identified as their weakness.

Operability is another factor that may have influenced participation. We expected this tendency in designing the system, and had tested the teaching material on smartphones prior to the survey. However, our interview results showed that when smartphones were used, the participants reported longer working time and poorer operability. This finding coincides with previous reports that the physical environment for online learning, such as Internet and terminal devices, influences compliance with e-learning [17].

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For example, poor video teaching materials can reduce the motivation to learn [18]. Future research is needed to investigate additional factors related to operability, the differential effects of computers and smartphones, and the effects of the tendency to use smartphones for mobile learning, which is common among nursing students.

Recently, an interactive digital simulator for problem solving and clinical reasoning, both of which require physical assessment skills, was developed in Europe [19]. The digital simulator was developed for medical students and clinicians and uses virtual patients. Problem solving and clinical reasoning are needed in clinical nursing practice [20]. Future studies are needed to develop learning materials for nurses to acquire these required competencies immediately.

V. CONCLUSION

The results of the present study demonstrate that the e-learning system we developed was partially effective for improving physical assessment ability like checking vital signs and information gathering skills. However, our results show that e-learning is insufficient for augmenting the ability of auscultation and palpation, suggesting that teaching materials related to these skills must be improved using simulation training. Additionally, e-learning helped participants recognize the relevance of learning content to their professional practice. In conclusion, it's necessary to combine e-learning and simulation to improve physical assessment ability as blended learning.

The advancement of remote education provides students with the opportunity to learn anywhere as opposed to strictly in classrooms. E-learning systems allow individuals attempting to learn medical practice to learn effectively and efficiently in their own environment. Thus, we aim to continue improving the current e-learning system, by making it more operable, to ensure that it sustains motivation to learn, as such, encourages continuous learning.

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