Blended Learning Improves Physical Assessment by Nursing Students

Machiko Saeki Yagi
School of Nursing
Jichi Medical University
Shimotsuke, Japan
email: mati-s@umin.ac.jp

Shigeki Tsuzuku
Research Center for Instructional Systems
Kumamoto University
Kumamoto, Japan
email: tsuzuku@kumamoto-u.ac.jp

Natsuko Miura
School of Nursing
Iwate Prefectural University
Takizawa, Japan
email: natsuko@iwate-pu.ac.jp

Alan Kawarai Lefor
School of Medicine
Jichi Medical University
Shimotsuke, Japan
email: alefor@jichi.ac.jp

Abstract—**The ability to perform accurate physical assessment is an essential skill, which also contributes to developing the nursing process, and providing appropriate care. However, patient safety initiatives in some institutions limit opportunities for nursing students to receive adequate training. A blended learning system combining e-learning with simulation may provide the necessary training. However, learning outcomes for these methods have not yet been reported. We undertook this study to explore learning outcomes using a blended system to improve physical assessment skills of nursing students in Japan. The contribution of e-learning to improved physical assessment skills was evaluated in depth, as well as outcomes after training and the influence of blended learning on the desire to learn. From 82 junior nursing students who had completed physical assessment training, we recruited 46 students for this study. Each was assigned to one of two groups: a blended learning group or a simulation-only group. Objective assessment and subjective evaluation of the e-learning experience was performed during the study including a checklist by a proctor, and assessment at skill stations. All participants were able to greet the patient upon entering room and exit the room after a polite goodbye. All participants in the blended learning group were able to measure the patients' vital signs and interpret the results. Scores of those in the simulation-only testing the ability to perform skills for assessment of side-effects of chemotherapy and excretion condition were lower than the blended group (88% vs 17% and 74% vs 17%). Participants in the blended group were more likely to make recommendations around "lack of balanced nutrition" and "risk for infection", as "consultation can help ensure that a diet plan is enacted", "Proposal to have an antiemetic administered", " Initiate hand washing", "Wearing mask", and " Initiate mouth washing ", while those in the simulation-only group were more likely to make recommendations regarding "Anxiety" and "follow-up examination". These results suggest that e-learning improves the ability of nursing students to evaluate vital signs and information gathering skills. Simulation training was effective because e-learning stimulated participants' imagination of the simulation content. However, e-learning itself had no significant learning effect and simulation training enabled participants to perform the actual skills. Blended learning helped participants recognize the relevance of learning content to their professional practice. E-learning is effective in the study of assessment skills but must be combined with simulation to improve actual physical assessment, as a blended learning program.**

Keywords- nursing students; physical assessment; nurse education.

I. INTRODUCTION

Nurses are increasingly expected to advance their skills of patient assessment, particularly the ability to provide advanced and accurate physical assessment [1][2]. This change is prompted in part by changes in the healthcare environment, such as advancements in medical technology, increased age and disease severity of patients, shortening of the average length of hospital stay, and an increasing transition to home care. Thus, nurses must begin physical assessment training that is suitably adapted to clinical practice (e.g., simulation education using simulators, and simulated patients) as early as possible, ideally in their basic nursing education. However, simulation and clinical practice require more practice materials, more instructors, and extra time which increases instructor hours per student [3]. 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 these skills is challenging [4]. Optimal methods for teaching integrative content to large groups of people need to be examined to improve physical assessment education.

E-learning may be effective to ensure optimal learning for each individual in group learning situations. In the context of continuing education for physicians, e-learning has been demonstrated to be as effective as conventional teacher-led education [5].

E-learning appears to be an effective method of instruction, which is not limited by the learning environment or time for learning, at least for knowledge-level content. We hypothesized that e-learning would be appropriate for

teaching physical assessment skills, and in particular the knowledge-level component of such skills, to nurses.

In recent years, the utilization of e-learning in medical education has been expanding, marking a shift from passive knowledge transmission to active, self-motivated (i.e., lifelong) learning [6]. Self-motivated learning using e-learning tools has become a critical feature of nursing education. Learning which effectively utilizes information and communication technology needs to be implemented at the early stages of nursing education. Students receiving basic nursing education are considered "digital natives". They are from a generation for whom the internet has existed since birth [7], indicating that their information literacy is higher than that of past generations. They have a high likelihood of readily embracing e-learning in their education.

Although e-learning affords numerous benefits to learners, it also presents a number of challenges. First, e-learning relies on a learners' ability to self-manage the learning process, and second, e-learning methods must possess features to maintain the desire to learn [8]. For example, massive open online courses (MOOCs) [9] can theoretically provide instruction to an extremely large number of participants, but they do not encourage learners to self-manage learning, and students tend to drop out of these programs due to diminished motivation. A strategy proposed to resolve these problems in MOOCs is "blended learning," which combines face-to-face and e-learning methods. We hypothesized that a blended learning approach may help overcome the challenges of e-learning. This aim of this study is to investigate the effects and influence on motivation of a blended learning system to improve physical assessment skills by nursing students. The remainder of this paper is organized as follows. Section II presents the methods. Section III provides an overview of the results. Section IV discusses implications and limitations. Finally, conclusions and future work are detailed in Section V.

II. METHODS

A. Participants and Data Collection

From 82 junior nursing students who had already completed physical assessment training, we recruited 46 students who consented to participate (45 females and 1 male aged 20 to 22 years). Each participant was assigned to one of two groups: a blended learning group or a simulation-only group (Figure 1). Preliminary evaluation of participants' computer literacy revealed that they were able to connect to the Internet and could effectively use mobile devices (e.g., laptop, smartphones), but had no previous e-learning experience. Additionally, they either did not have any experience with simulation training or had undergone it only once or twice. Data collection was conducted through objective assessment (i.e., correct answer rate on an e-learning pre-test, a checklist evaluating simulation results, correct answer rate on an e-learning post-test) and subjective evaluation of the e-learning experience (questionnaire and interview). Training was conducted from September to October 2013.

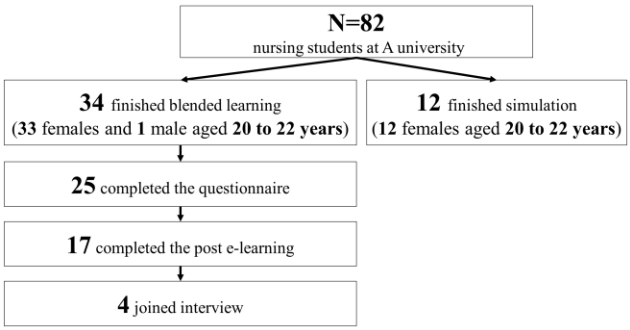

Figure 1. Study Flow

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

Learning Objectives: The objective of physical assessment training was to be "able to visit the patient's bedside and assess their condition." We created a checklist of skills that participants should be able to perform at the end of the training, including visual inspection, performing a medical interview, measuring vital signs, and performing auscultation and palpation. We created a simulation scenario wherein they conducted physical assessment of a patient with breast cancer receiving chemotherapy. This blended learning scenario was designed to create suitable educational materials to help nursing students understand 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 assessment, clinical reasoning, patient safety, and communications.

E-learning Design: The open-source learning management system, Moodle [8], was used to design the e-learning system (Figure 2). To eliminate differences according to usage environment, the e-learning system presented learning materials in a text format and images using Japanese manga comics only (i.e., no video) so that the system could run smoothly on PCs as well as mobile devices such as smartphones and tablets. The purpose of using manga in this study is to help participants imagine the patient's condition and the situation in a simulated hospital room. Participants were tested first to evaluate their baseline ability. The e-learning system presented a simulated patient, and the participant was expected to perform a physical assessment using the displayed data. The system also included a test on content related to the medical interview, physical assessment, and communication about findings, interventions, and patients' status to a supervising nurse. The test was conducted before simulation training to confirm if they possessed the knowledge necessary to take part in the simulation. As in previous research [11], the structure of the e-learning system involved solving problems in a format similar to the simulation, thus serving as an introduction to

the simulation environment. The e-learning covered the entire nurse-patient interaction including entry to the patient's room, conduct of physical assessment, and exit from the room. It was configured such that participants answered 14 multiple choice questions and two short-answer questions, for a total of 16 questions (Figure 3 and Table I). Patients' vital signs in the e-learning post-test were different from the pre-test to discourage learning vital signs by rote.

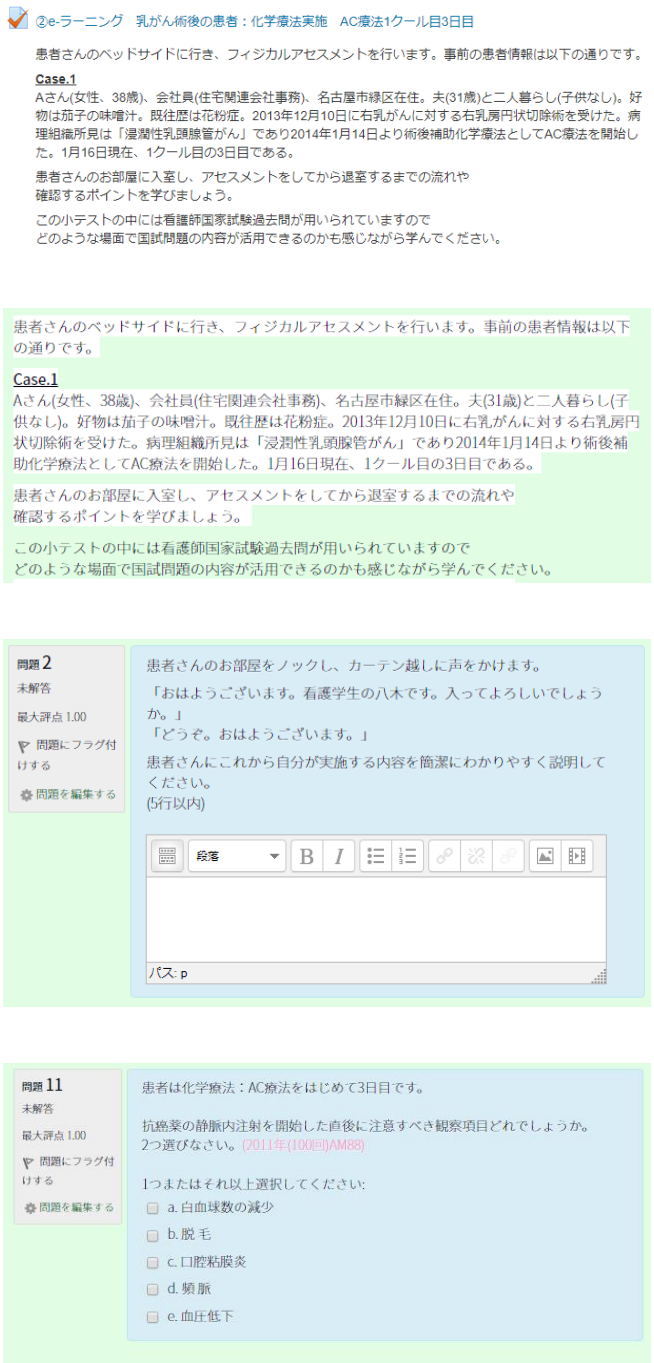

Figure 2. (a,b,c,d) e-learning interface (Japanese)

TABLE I. E-LEARNING TEST CONTENTS

Number	Contents	Methods
1	The rule of entering a hospital room	Multiple choice question
2	Explaination of implementation	Free coments
3	Correct site of measurment of body temperature	Multiple choice question
4	Nomal range of body temperature	Multiple choice question
5	Correct site of measurment of pulse	Multiple choice question
6	Nomal range of pluse rate	Multiple choice question
7	Correct position for post-ope patient about breast cancer	Multiple choice question
8	Measurement methods of blood pressure	Multiple choice question
9	Nomal range of blood pressure	Multiple choice question
10	Nomal range of respiratory rate	Multiple choice question
11	Side effect of chemotherapy	Multiple choice question
12	Communication with patient feels vomiting	Multiple choice question
13	Check point for patient during chemotherapy	Multiple choice question
14	Communication with constipation patient	Multiple choice question
15	Physical examination about abdomen	Multiple choice question
16	Explaination about physical findngs and diagnostics releted to patient condition	Free coments

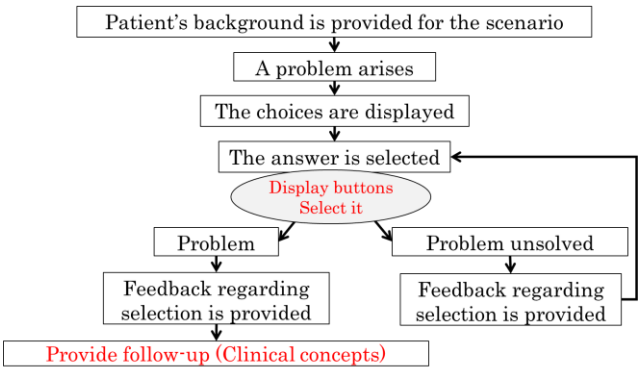

Figure 3. E-learning Flow

Simulation Design: The simulation was conducted in a simulated hospital room (Figure 4). An advanced simulator that enables the measurement of patients' blood pressure, pulse, respiratory rate, pupil size as well as auscultation of lung and bowel sounds was used (ALS Simulator, Laerdal Medical Japan Co., Ltd.). The simulator included skin moulage consistent with the appearance of a patient who underwent breast-conserving surgery. In the medical interview, the patient's verbal responses were produced by an instructor with a microphone and the voice came from a

loudspeaker built into the simulator in order to impart a feeling of realism, as if the subject was speaking with the simulator directly. The procedure for the simulation was explained beforehand and an orientation was conducted, wherein subjects touched the simulator, measured its blood pressure, etc. in the simulated hospital room to eliminate unnecessary stress due to lack of familiarity with the simulation process [12]. Simulation training was conducted for 10 minutes per person. Participants then used the simulation training to assess the patients' condition and reported using the SBAR (situation, background, assessment, and recommendation) method to the instructor. [13]. During the simulation, performance was evaluated using the simulation checklist. Feedback was given to participants and participants took an e-learning post-test to assess their knowledge after the program (Figure 5).

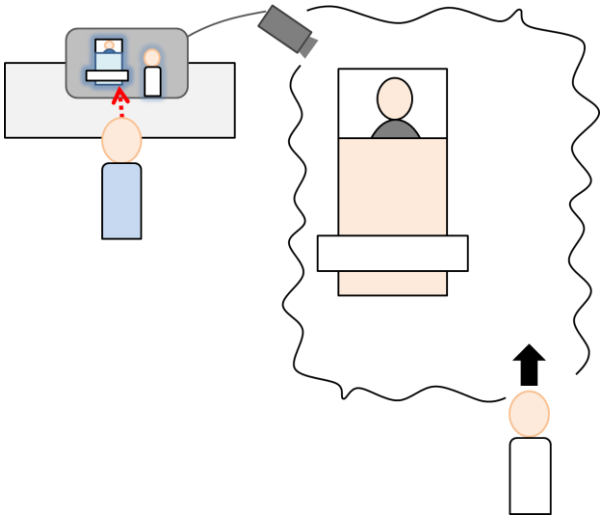

Figure 4. (a) The instructor watches participants' performance via video to ensure a safe learning environment (b)Simulated hospital room

Figure 5. Simulation training flow. (a)Explanation of the simulated hospital room and instructor. (b,c) Participant observes the simluated patient to assess their condition. (10min/person) (d) Report patient condition using SBAR to the instructor (3-5min/person)

C. Survey tool

The survey tool 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 factors influencing the successful implementation of learning were assessed using the four-subscale Instructional Materials Motivation Survey (IMMS), which was created based on the ARCS model [14]. 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 consent were interviewed to express their thoughts regarding e-learning and simulation, and to determine the influence of simulation training on learning effectiveness and the desire to learn. All participants were given feedback about their performance after the simulation.

D. Study Design

Participants were divided into two groups by random assignment. The first group was simulation-only. After undergoing a brief orientation, participants completed a simulated patient visit according to the plan above. The clinical interaction was recorded on videotape and the video reviewed and scored according to a checklist.

Participants in the blended learning group, started with a pre-test to evaluate their approach to clinical evaluation of a patient. The pre-test was conducted as an integral part of the e-learning program using Moodle. Following the e-learning component, blended learning group then did the simulation, in the same manner as the simulation group. Following simulation training, participants in blended learning group completed a post-test using Moodle.

E. Statistical analysis

Test scores, times, and times of simulation are expressed as means ± standard deviations. The Wilcoxon signed rank test was used to assess differences in test scores before simulation and after. Differences in test scores were evaluated using the Mann-Whitney U test. For the questionnaire, scores are expressed as means and median values (quartile range). The free-response descriptions are listed as written by participants. All statistical analyses were performed using IBM SPSS Statistics 22 (IBM Corp., Armonk, NY). Analysis p-value<.05 is considered significant.

F. Ethical Considerations

This study was conducted with the approval of the medical ethics committee of Nagoya University, Japan. The survey was approved in June 2013 (No. 2013-0049). Subjects' freedom to withdraw from the study and protection of anonymity were explained both verbally and in writing. Written informed consent for this study was obtained from each participants.

III. RESULTS

A. Research Participation

A total of 46 junior nursing students participated in the study. Of these, 34 completed blended learning, e-learning and simulation, and 25 completed the questionnaire. The e-learning post-test was completed by 17. Interviews were completed for four participants. Simulation training only was completed by 12 participants who lacked the time to complete the e-learning.

B. E-learning

Correct answers on the e-learning pre-test were given by was 91% ± 8.5%. The correct answer rate for the measuring site of temperature and pulse, and the side effects of chemotherapy were 74%, 69%, and 74%, respectively. Participants took a mean of 22 ± 9 min to complete the e-learning.

Among the post-test participation group (n=17), the correct answer rate on the e-learning post-test was 99% ± 1.2%, which is significantly higher than the correct answer rate on the e-learning pre-test (87%±5.2%, p<.05), and reflects the effectiveness of e-learning. Participants who wrote 'free-form' comments often said that the e-learning was more likely to contain lists of words or wrong answers. In the e-learning post-test, the comments typically reflected the main points to be learned and described specific content, such as physical findings and diagnostic tests. Assessment of the patients' condition was also mentioned, in addition to recommendations about implementation of interventions based on patient care needs and priorities, and relevant patient education and teaching. The time needed for the e-learning post-test was 14 ± 4 min, significantly shorter than the time needed for the pre-test. The patients' vital signs in the e-learning post-test were different from those in the pre-test (Table II). The correct answer rates according to content are shown in Table III. Participants answered almost questions correctly and the answer rates are higher than on the pre-test.

TABLE II. PRE- AND POST-TEST ANSWER RATE AND TIME (N=17)

Contents	Pre-test	Post-test
Correct answers (mean ± standard deviation)	87% ± 5.2%	99% ± 1.2%
Time (min) (mean ± standard deviation)	24 ± 6	14± 4

TABLE III. RESULTS OF E-LEARNING PRE-TEST (N=17)

Number	Contents	Pre-test	Post test
1	The rules for entering a hospital room	100%	100%
2	Explanation of implementation	92%	100%
3	Correct site to measure temperature	74%	100%
4	Nomal range of body temperature	97%	100%
5	Correct site to measure pulse	69%	94%
6	Nomal range of pluse rate	95%	100%
7	Correct position for measurement of blood pressure for post- breast cancer operation patient	74%	97%
8	Methods for blood pressure measurement	92%	100%
9	Nomal range of blood pressure	92%	100%
10	Nomal range of respiratory rate	97%	97%
11	Side effects of chemotherapy	74%	74%
12	Communication with a vomiting patient	92%	100%
13	Check points for patient receiving chemotherapy	74%	100%
14	Communication with a constipated patient	92%	100%
15	Physical examination of the abdomen	92%	100%
16	Explaination of findngs releted to the patient's condition	91%	97%

C. Simulation

According to the checklists, all participants in the blended learning group were able to greet the patient upon entering the room, measure the patient's pulse, blood pressure, respiratory rate, and temperature, interpret the measured values, and exit the room after a polite goodbye. Confirmation of oral intake, sleeping condition, excretion condition, and side effects of chemotherapy were performed by 28, 21, 25, and 30 participants (n=34), respectively. Only two participants used information obtained from actually touching the patient, such as auscultation and palpation. Comparatively, participants in the simulation group were able to greet the patient upon entering room and exit the room after a polite goodbye. However, performance of other skills such as the side effects of chemotherapy and excretion condition were lower than for participants in the blended learning group. No participant in this group performed auscultation or palpation (Table IV). After feedback about simulation from the instructor, all participants understand the importance of physical examination such as auscultation and palpation, and included these modalities after the feedback.

The results of SBAR communication were different between the two groups. Participants in the blended learning group were more likely to make recommendations regarding "lack of balanced nutrition" and "risk for infection", as "consultation can help ensure that a diet plan is enacted", "proposal to have an antiemetic administered", " Initiate hand washing", "Wearing mask", and " Initiate mouth washing ", while participants in the simulation group were more likely to suggest issues such as "Anxiety" and "follow-up examination".

TABLE IV. SIMULATION CHECK LIST RESULTS

Contents	Number (%)	
	Blended learning group (n=34)	Simulation group (n=12)
-Greet the patient upon entering the room	n=34(100%)	n=12(100%)
-Measure the patient's pulse, blood pressure, respiratory rate, and temperature, and then interpret the measured values	n=34(100%)	n=7(58%)
-Exit the room after a polite goodbye	n=34(100%)	n=12(100%)
-Side effects of chemotherapy	n=30 (88%)	n=2 (17%)
-Confirmation of oral intake	n=28 (82%)	n=3 (25%)
-Excretion condition	n=25 (74%)	n=2 (17%)
-Sleeping condition	n=21 (62%)	n=3 (25%)
-Auscultation and palpation.	n=2 (5.9%)	n=0 (0.0%)

D. Questionnaire and Interview Results

Evaluation of e-learning and simulation: The results of the questionnaire assessing the e-learning characteristics are shown in Table V. Participants scored a value of 3 for all questionnaire items. In 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."

In 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.

Influence on the desire to learn: Table VI shows the results for responses to all IMMS items. Item 15, "The pages of this lesson look dry and unappealing (reverse)", 33 "The content of this lesson will be useful to me" and 34 "I could not really understand quite a bit of the material in this lesson" (included in the Attention, Relevance and Confidence components), were scored at more than 4.5 points. In contrast, 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 components), had a low median score (3 points). In the free-response answers, a number of participants expressed wanting more developmental content included in the e-learning. The participants' comments 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."

TABLE V. QUESTIONNAIRE ASSESSING E-LEARNING CHARACTERISTICS (N=34)

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

IV. DISCUSSION

A. Effects of Blended Learning

Although simulation is an effective learning method and typically provides a greater sense of understanding, it can cause significant mental strain, which requires learning support. We developed a pre-simulation e-learning system to provide such support. The results showed that all participants performed the greeting, even if it was their first experience with simulation. Compared to the results of the simulation only group, using the e-learning system helped participants to assess vital signs, and complete physical assessment based on clinical data. This success can be attributed to participants' completion of the skill building and mock training exercises via e-learning system before the simulation. The e-learning program enabled participants to imagine the content of the simulation and thus integrate relevant knowledge and skills into their simulation experience.

However, participants did not completely master auscultation and palpation, according to information obtained from the interviews [15]. 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, enabling users to focus on items that were not completely mastered. Such a modification allows for the delivery of deliberate and effective training aligned with the learning objectives of nurse education, referred to as deliberate practice [16] [17]. In this study, students' ability to explain the side effects of chemotherapy did not increase the correct answer rate. Thus, the contents should be revised to be more effective. Learning self-management has been identified as a key factor for continued education via e-learning [7]. To succeed in remote self-learning, participants may need to receive explanations of the necessity of post-training tests in acquiring knowledge related to medical interviews, auscultation, and palpation, which are areas that remained challenging after the simulation training.

The results of SBAR communication were different in the two groups, and suggest that participants using e-learning decided on a recommendation based on information gathered from reading the patient's expressions and other situational and specific factors, while participants in the simulation group made their decisions based on general information.

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

The ARCS model is a method of organizing factors that influence the motivation to learn [18], described by Suzuki as follows: A) 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) Satisfaction: 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, 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;

TABLE VI. RESULTS OF THE INSTRUCTIONAL MATERIALS MOTIVATION SURVEY (N=34)

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

and 3) provide opportunities and feedback that regulate learning, thus encouraging them to be aware that they can achieve their goal by themselves [19]. A number of participants commented that the training could be implemented as peer training and skill review. Repetitive practice through sharing stories with peers and skill review have been shown to help learners acquire self-confidence [20]. Further consideration of task difficulty will also facilitate continuous learning in this context.

C. Determinants of Successful E-learning

E-learning relies on independent learning, which means that there is an inherent risk of dropouts. Learning objectives were designed 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 rrated by a mean of 4.6 points, 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 a mean of 4.6 points. The difficulty of blended learning and acquisition of confidence through simulation may be factors that influenced participants' motivation. 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 self-learning through repetitive practice and detailed explanations for items identified as weaknesses.

1) 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, the 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 [21]. For example, poor video teaching materials can reduce the motivation to learn [22]. 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.

2) An interactive digital simulator for problem solving and clinical reasoning, both of which require physical assessment skills, was developed in Europe [23]. 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 [24]. Future studies are needed to develop learning materials for nurses to acquire these required competencies.

V. CONCLUSION

These results show that e-learning was partially effective to improving physical assessment by nursing students. Additionally, e-learning helped participants recognize the relevance of learning content to their professional practice. It is necessary to combine e-learning and simulation to improve physical assessment ability in a blended learning program. However, the results also suggest that e-learning is insufficient for augmenting skills of auscultation and palpation, suggesting that teaching materials related to these skills must be improved using simulation training. Further development of e-learning, to make it more functional and to ensure that it sustains motivation to learn will be necessary, and requires continued study and evaluation.

ACKNOWLEDGMENT

Part of this research was supported by Grant-in-Aid for Young Scientists (B), 25862108, from Japan Society for the Promotion of Science (JSPS), JAPAN.

REFERENCES

[1] M.S. Yagi, N. Miura, and S. Tsuzuku, "Effects of a Blended Learning System on Improving the Physical Assessment Ability of Nursing Students," in Proc. eTELEMED 2017, Nice, France.

[2] J. K. Hayden, R. A. Smiley, M. Alexander, S. Kardong-Edgren, and P. R. Jeffries, "The NCSBN National Simulation Study: A longitudinal, randomized, controlled study replacing clinical hours with simulation in prelicensure nursing education," J. Nurs. Regul., vol. 5, no. 2, pp. S1–S64, 2014.

[3] P. Moreno-Ger, J. Torrente, J. Bustamante, C. Fernández-Galaz, B. Fernández-Manjón, and M. D. Comas-Rengifo, "Application of a low-cost web-based simulation to improve students' practical skills in medical education, " International Journal of Medical Informatics, vol. 79, no. 6, pp. 459-467, 2010.

[4] L. Bickley and P. G. Szilagyi, Bates' guide to physical examination and history-taking. Philadelphia, Pennsylvania: Lippincott Williams & Wilkins, 2012.

[5] M. Fordis, J. E. King, C. M. Ballantyne, P. H. Jones, K. H. Schneider, S. J. Spann, et al., "Comparison of the instructional efficacy of Internet-based CME with live interactive CME workshops: a randomized controlled trial," JAMA, vol. 294, no. 9, pp. 1043‑1051, 2005.

[6] J. G. Ruiz, M. J. Mintzer, and R. M. Leipzig, "The impact of e-learning in medical education," Acad. Med., vol. 81, no. 3, pp. 207–212, 2006.

[7] C. Jones, R. Ramanau, S. Cross, and G. Healing, "Net generation or Digital Natives: Is there a distinct new generation entering university?," Comput. Educ., vol. 54, no. 3, pp. 722–732, 2010.

[8] J. Keller and K. Suzuki, "Learner motivation and e-learning design: A multinationally validated process," J. Educ. Media., vol. 29, no. 3, pp. 229–239, 2004.

[9] J. Daniel, "Making sense of MOOCs: Musings in a maze of myth, paradox and possibility," J. Interac. Media Educ., vol. 2012, no. 3, 2012.

[10] M. Dougiamas and P. Taylor, “Moodle: Using learning communities to create an open source course management system,” World Conference on Educational Media and Technology, vol. 1, pp. 171–178, 2003.

[11] M. S. Yagi, K. Ikegami, Y. Shibata, S. Shiba, and M. Miyoshi, “The design of the story-based learning materials to imagine realistic clinical practice using goal-based scenario theory,” Japan Journal of Health Professional Development, vol. 3, no. 2, pp. 69–76, 2015.

[12] C. Arthur, T. Levett-Jones, A. Kable, "Quality indicators for the design and implementation of simulation experiences: a Delphi study," Nurse Education Today vol. 33, no.11, pp.1357-1361, 2013.

[13] M. Leonard, S. Graham, D. Bonacum, "The human factor: the critical importance of effective teamwork and communication in providing safe care," Quality and Safety in Health Care, vol. 13, suppl 1, pp. i85-i90, 2004.

[14] J. M. Keller, Motivational design for learning and performance: The ARCS model approach. New York City: Springer Science & Business Media, 2009.

[15] J. H. Barsuk, W. C.McGaghie, E. R.Cohen, K. J.O’Leary, and D. B. Wayne, “Simulation-based mastery learning reduces complications during central venous catheter insertion in a medical intensive care unit,” Crit. Care Med., vol. 37, no. 10, pp. 2697–2701, 2009.

[16] K. A. Ericsson, K. Nandagopal, and R. W. Roring, “Toward a science of exceptional achievement,” Annals of the New York Academy of Sciences, vol. 1172, no. 1, pp. 199–217, 2009.

[17] M. H. Oermann, S. Kardong-Edgren, T. Odom-Maryon, B. F Hallmark, D. Hurd, N. Rogers, et al., “Deliberate practice of motor skills in nursing education: CPR as exemplar,” Nurs. Educ. Perspec., vol. 32, no. 5, pp. 311–315, 2011.

[18] J. M. Keller, Motivational design for learning and performance: The ARCS model approach. New York City: Springer Science & Business Media, 2009.

[19] K. Suzuki, “On the Framework of Designing and Developing ‘appealing instruction’: The ARCS Motivation Model,” The Japan Association for Educational Media Study, vol. 1, no. 1, pp. 50–61, 1995.

[20] K. M. Lundberg, “Promoting self-confidence in clinical nursing students,” Nurse Educ., vol. 33, no. 2, pp. 86–89, 2008.

[21] C. Power, H. Petrie, V. Sakharov, and D. Swallow, “Virtual learning environments: another barrier to blended and e-learning,” in International Conference on Computers for Handicapped Persons, Berlin and Heidelberg: Springer, pp. 519–526, 2010.

[22] M. S. Yagi, N. Kumagai, C. Funakoshi, and M. Masuda, “Development of e-learning material for sophomore nursing students to simulate clinical practice,” The Association for Medical Education in Europe, 270, #4JJ16 (126905), 2016.

[23] Body Interact. http://bodyinteract.com/ [retrieved: February, 2017]

[24] P. E. Benner, P. L. Hooper-Kyriakidis, and D. Stannard, Clinical wisdom and interventions in acute and critical care: A thinking-in-action approach. New York City: Springer Publishing Company, pp. 10–11, 2011G. Eason, B. Noble, and I. N. Sneddon, “On certain integrals of Lipschitz-Hankel type involving products of Bessel functions,” Phil. Trans. Roy. Soc. London, vol. A247, pp. 529–551, April 1955.