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Real-time feedback in basic nursing education: Evaluation of basic life support training programs

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Abstract

Introduction: The level of BLS achievement at the end of basic education is not clear, so to develop a BLS training program using QCPR Learner® and to verify its effectiveness.

Methods: A quantitative descriptive study design was used. The developed BLS program was implemented for 81 fourth-year students at the school of nursing. The program consisted of 2 minutes of training per student and real-time feedback by QCPR Learner® as well as feedback among students and from faculty members and was conducted twice for each student. Evaluation was conducted from three aspects: learner response and program evaluation both using questionnaires, learning achievement of QCPR score.

Results: The mean values of learners' responses before and after the program were: attention, 4.32 before and 4.59 after; relevance, 4.48 before and 4.75 after; confidence, 2.32 before and 3.78 after; and satisfaction, 2.12 before and 3.41 after, which increased significantly after the program. The QCPR Learner® scores increased significantly from 74.08 for the first time to 86.76 for the second time. In the free response, some respondents stated that "visualisation of the procedure by the application improved my skills."

Conclusion: The results of the evaluation from three aspects showed that this program was effective in improving students' motivation to learn and skills.

Keywords: *Basic Life Support, Real-Time Feedback, Basic Nursing Education, Simulation Training, QCPR Learner*

Practice Highlights

- Real-time feedback application was effective in increasing motivation to learn and BLS skills.
- QCPR Learner® can be easily installed on the learner's device, making it suitable for self-learning.

I. INTRODUCTION

A “chain of life support” is necessary to save the lives of individuals in life-threatening situations such as cardiac arrest or asphyxiation, or in imminent danger of such situations, and to lead them back to society (Japan Resuscitation Council, 2020). When a person is unresponsive, it is important to immediately report suspected cardiac arrest and provide basic life support (BLS), which involves a series of procedures to support breathing and circulation including cardiopulmonary resuscitation (CPR) with chest compressions and artificial respiration and the use of an automated external defibrillator (AED). Prompt initiation of CPR by bystanders is essential to improve the survival rate of individuals in cardiac arrest and prompt BLS plays a major role in their reintegration into society. The international consensus on CPR has recently been revised after five years (Nolan et al., 2015), with the updated Japan Resuscitation Council Resuscitation Guidelines published in 2020 (Japan Resuscitation Council, 2020). This guideline includes detailed

guidance on compression depth and rhythm of cardiac massage, with improved quality of cardiac massage highlighted as particularly important in increasing survival following cardiac arrest. Effective education and training are important as quality CPR requires accurate compression depth, rhythm, and ventilation volume.

Studies of BLS simulations for nursing students have reported learning effects in students who had prior knowledge of BLS (Requena-Mullor et al, 2021). However, visual assessment is reported to be inaccurate in assessing quality of CPR (Brennan et al., 2016). Accordingly, the Resuscitation Guidelines 2020 include game-based learning, virtual reality, full mastery learning, iterative learning, and on-site simulation, which did not receive significant attention in the Resuscitation Guidelines 2015 (Japan Resuscitation Council, 2015). The new learning styles advocated by the revised Resuscitation Guidelines are expected to further promote the development and effectiveness of teaching materials. In educational settings, devices that can objectively evaluate CPR skills have been developed as a means of increasing educational effectiveness, with teaching materials that provide real-time feedback increasingly being used. In recent years, the use of feedback devices in BLS training for medical personnel has been shown to improve CPR skills (Abella et al., 2007; Lin et al., 2018; Otero-Agra et al., 2019; Semeraro et al., 2019); however, feedback devices for CPR have not previously been evaluated in prelicensure nursing students.

Accordingly, we focused on QCPR Little Anne, a cardiopulmonary resuscitation simulator that incorporates a feedback device into CPR training, and QCPR Learner®, a dedicated application that allows learners to check their performance. QCPR Learner® can be used in conjunction with QCPR Little Anne to obtain objective feedback on the quality of CPR from a smartphone or tablet PC. In the basic nursing curriculum, students are required to acquire BLS skills by the time they graduate from the program. The present study therefore aimed to develop a BLS training program with real-time feedback incorporating QCPR Little Anne and QCPR Learner® to enhance emergency response skills in a basic nursing education program. The BLS training program was evaluated according to three aspects: learner response including satisfaction, learning achievement, and overall program evaluation. QCPR is not a skill that can be experienced routinely in clinical practice. In addition, for nursing students, it is a skill that they may not always be able to experience during clinical practice. Objective feedback on the quality of QCPR would help students to further improve their skills through repeated self-leaning.

II. METHODS

A. Program Overview

In the BLS training program, participants were required to study until they achieved a score of 100 on a test of items related to BLS in the online educational tool Nursing Skills as a prerequisite for program participation. This is because in simulation education, it is important to learn practically based on an understanding of knowledge. Those who fulfilled the conditions for participation participated in the program, and a pretest and simulation training assignments were conducted.

B. Study Participants

The present study comprised fourth-year undergraduate nursing students in the School of Nursing at Nagoya City University in Japan. All students consented to participation in the present study.

C. Training Program Development

The development process of the program used in the present study is described below. CPR is one of the essential skills for both nursing students and health care providers. In clinical settings, BLS training has been shown to be effective in allowing trainees to respond quickly in situations requiring BLS (Kuyt et al., 2021; Shin et al., 2015). However, the effectiveness of BLS education in basic nursing curricula has not been adequately examined despite BLS being a requirement for graduation. In recent years, teaching materials have been developed that allow real-time visualisation of performance using cardiopulmonary resuscitation simulators that incorporate feedback devices. As BLS education is required by nursing students before graduation, visualisation of skills through real-time feedback may represent a useful addition to BLS training.

The following learning objectives for the program were set with reference to the skills required of nursing students at graduation (Ministry of Health, Labor and Welfare, 2021) and the BLS provider course conducted by the ACLS Association of Japan (American Heart Association, 2016). Goal 1: Be able to perform an initial assessment of an injured or unwell individual following a witnessed collapse. Goal 2: Be able to request support from the emergency response system. Goal 3: Be able to immediately perform CPR. Goal 4: Be able to promptly use an automated external defibrillator (AED). The program focused on how to respond as a bystander following a witnessed collapse of a patient and included BLS training for in-hospital cardiac arrest as an algorithmic simulation that assumes an actual situation. During the program design, interviews were conducted with nurses with extensive BLS teaching experience and experts in simulation education to confirm the

appropriateness and validity of the content. In addition, a pilot test was conducted by researchers and nursing faculty with experience in BLS education for nursing students.

The specific program flow was as follows. An orientation and pre-test were given to participants who met the prerequisites. The simulation used one QCPR Little Anne per group of three to four participants. Each facilitator was assigned one or two groups. After a 10-minute briefing, the participants were divided into groups. Group members took turns and each person performed two 5-minute simulations. Each simulation consisted of preparation, practical (two minutes), and feedback. QCPR Learner® real-time feedback consisted of overall score, compression depth, and ventilation rate (Laerdal, 2022). Performers were also advised of the observations of the group members and facilitators. A 20-minute debriefing was held after all participants had completed the simulation. The evaluation was conducted from three aspects: learner response including satisfaction and program evaluation, as Level 1 response of Kirkpatrick's four-level evaluation method (Gagne et al., 2005), and learning achievement, as Level 2 learning.

D. Data Collection

1) Survey Contents:

As a pre-test, a test consisting of five questions was evaluated the learners' knowledge before the program. The pre-test was created based on a test of items related to BLS in the online educational tool Nursing Skills, with correct answer scoring one point. Learner responses were assessed before and after the program using a self-administered, anonymous learner response sheet. The response sheet consisted of questions regarding attention, relevance, confidence, and satisfaction on a 5-point Likert scale with reference to previous research (Hirakawa et al., 2018) on the Kirkpatrick's Four-Level Training Evaluation Model (Alzahrani, 2016) was originally developed. Participants were also given the opportunity to provide free-response statements. As a measure of learning achievement, the overall score for each applicant was used in the study analysis. A Class Evaluation Scale for Nursing Skills Practice (Mochizuki & Nagano, 1999) was administered after the program to allow evaluation of the overall program. The class evaluation scale is a scale consisting of 39 questions on six subscales.

2) Survey Method:

Prior to the start of the exercise, the pre-tasks were reviewed, and a pre-test and response sheet were administered. After the program, response sheets and class evaluation scales were distributed to all participants. The response sheets and class evaluation scales were collected anonymously. Data collection was conducted in September 2020.

E. Data Analysis

For quantitative data, the correspondence t-test was used to compare test scores and an independent t-test was used to compare data from learner response sheets. Descriptive statistics were used for program evaluations. For qualitative data, free-response statements and class evaluation scores were categorised to maintain semantic content. Codes, subcategories, and categories were checked between researchers to enhance the veracity of the analysis. Quantitative data were analysed using SPSS ver. 28.0.

III. RESULTS

A. Overview of Study Participants

A total of 81 students participated in the present study after provided informed consent. Valid responses were obtained from 78 students (96.2%) for the first response sheet, from 80 students (98.8%) for the second response sheet, and from 78 students (96.2%) for the overall class evaluation form. The mean score on pre-test was 4.57 ± 0.67.

B. Learner Reactions

Comparisons of scores from the pre- and post-program response sheets are shown in Table 1 (Masuda, 2023). Significantly increases in all four assessed areas were observed after the program: interest ($t = -2.74$; $P = 0.01$), relevance ($t = -2.926$; $P = 0.00$), confidence ($t = -10.45$; $P = 0.00$), and satisfaction ($t = -8.12$; $p = 0.00$). The four items on the response sheets were strongly and positively correlated with interest and satisfaction (pre: $r = 0.51$; post: $r = 0.58$) and confidence and satisfaction (pre: $r = 0.87$; post: $r = 0.74$) before and after the program, respectively.

	Pre-program group (n=78)		Post-Program group (n=80)		*t*	*p*
	M	SD	M	SD		
Attention to learning BLS	4.32	.69	4.59	.52	-2.73	.01
Are relevance to learning BLS	4.48	.66	4.75	.49	-2.92	.00
I am confident in my BLS skills	2.32	1.02	3.78	.71	-10.45	.00
I am satisfied with my current BLS skills	2.12	1.08	3.41	.92	-8.12	.00

Table 1. Learners' responses to BLS in the pre- and post-program

Independent t-test: M = mean, SD = standard deviation

The free-response statements were summarised resulting in 116 codes, 17 subcategories, and four categories. Responses related to subcategories and "categories" are shown below (Table 2: Masuda, 2023). The most frequent positive responses were those related to the effectiveness of QCPR Learner. Examples of statements representative of categories and subcategories are provided below.

Visualisation of the appropriateness of the technique clarified my issues, I can improve by checking my current level with the application and "Visualisation of the technique with the application improved my skills". Comments related to the effectiveness of QCPR Learner informed the "I improved my skills through repetitive practice training" category consisting of subcategory statements such as I improved my skills through repetitive training, and my skills improved through practical training. The category "Learned the elements of techniques necessary for QCPR" consisted of statements informing subcategories such as using the back mask was difficult and I was able to learn a series of BLS techniques. The category "I realised that the effectiveness of BLS is enhanced through group cooperation" included the subcategory "I was able to enhance my skills with my group members, including encouragement and feedback from members". Statements informing the "Increased motivation to learn" category included I enjoyed improving my skills, I am glad I participated, I gained confidence, and if something happens, I will be able to implement BLS.

Subcategory	**Category**
Visualising the appropriateness of the technique helped clarify issues	Skills improved through visualisation of techniques by application
Enjoyed learning while improving the accuracy of skills	
The use of the app increased my motivation	
The application allowed me to see my current level of skill so that I can improve	
Practical training improved my skills	Skills improved through repetitive practice training
The content was designed for practical use	
I was able to acquire skills through repetitive training	
Skills improved through repetitive training	
Correct use of BM is difficult	Learned the elements of techniques required for QCPR
Learned how to use the back mask	
I was able to learn a series of BLS techniques	
Realised that BLS requires physical strength	
I was able to perform high-quality CPR by working together as a group.	Realised that BLS is more effective when working in a group
I was able to enhance my skills with my group members	
I learned that BLS is more effective when we work together as a group	
I was able to improve my skills in a fun way	Increased motivation to learn
If something happened, I would be able to perform it.	
If something happens, I will be confused, but I will be able to cooperate with others	
I gained confidence	
I am glad to have participated	

Table 2. Categories related to learner response

C. Learning Achievement

The second test scores on QCPR Learner were significantly higher than the first test scores (t = −4.78; P = 0.00) (Table3).

D. Program Evaluation

Regarding the class evaluation scale administered after the program, the subscale "Time allocation and difficulty of content" scored 59.49 ± 6.12, "Delivery and guidance/advice" scored 33.77± 2.21, "Use and innovation of teaching materials" scored 9.27 ± 1.02, "Demonstration" scored 26.21 ± 4.71, "Interaction among students" scored 9.64 ± 0.84, and "Attitude and response to students and exercises" scored 43.29 ± 3.30 (Table 4).

n=78

	1st QCPR		2nd QCPR		*t*	*P*
	M	SD	M	SD		
QCPR score	74.08	23.53	86.76	14.29	-4.78	0.00

Table 3. Pre- and post-QCPR score changes

Paired-samples t-test: M = mean, SD = standard deviation

n=79

	M	SD
Time allocation and difficulty of the content	59.49	6.12
Delivery and guidance/advice	33.77	2.21
Use and innovation of teaching materials	9.27	1.02
Demonstration	26.21	4.71
Interaction among students	9.64	.84
Attitude and response to students and exercises	43.29	3.30

Table 4. Evaluation of a class evaluation scale for nursing skills practice

Subjects were asked to respond to an open-ended question regarding their evaluation of the program, resulting in 29 codes, 10 subcategories, and six categories. Responses related to subcategories and "categories" are shown below (Table 5). Statements related to evaluation of the program content and facilitators informed the category "The facilitator's involvement was good" consisting of statements representative of the subcategories the entire program was clear and concise, and the facilitator created an easygoing atmosphere. The category "The program time and content were just right" consisted of subcategories informed by statements such as the time of the program was just right, and the amount of the program was just right. There were a few opinions regarding the content of the program and the instructors such as there were some problems with the application, more specific explanations would have been better, and there were too many hours spent on the exercise.

Subcategory	Category
The entire program was clear and concise The Facilitators created an easygoing atmosphere	The facilitators involvement was good
The time of the program was just right The amount of program was just right	The program time and content were just right
There were some problems with the application	There was a glitch in the application
More specific explanations would have been better There were too many hours spent on the exercise	More specific explanations would have been better
The time commitment was too much	The time commitment was too much

Table 5. Categories related to evaluation of the program

IV. DISCUSSION

A. Evaluating Programs from the Perspective of Learner Responses

The results of the response sheets administered before and after the program demonstrated a significant increase in all items. BLS skills are technical items in the nursing education curriculum designated by the Ministry of Health, Labor and Welfare (Ministry of Health, Labor and Welfare, 2021) that may be required in clinical practice. The implementation of simulations of potential future scenarios promotes student motivation (Hae-Kyoung, 2021). and simulations are known to be an effective learning method for putting theoretical knowledge into practice and reducing fear before encountering real situations (Carrero- Planells et al, 2021). The students were highly satisfied with the simulation in the present study as they had completed their clinical training, had an image of the clinical

situation, and recognised that it was a necessary skill for post-graduates.

In addition, a correlation was observed between interest in BLS and satisfaction with BLS, and between confidence and satisfaction with BLS. The findings indicate that it is necessary to select subjects that are already interested in BLS and likely to have greater satisfaction with BLS training and to structure BLS programs in a way that leads to confidence and satisfaction with BLS skills.

Many participants in the present study gave positive evaluations of the program, such as "Visualisation of the technique by the application helped me improve my skills." The effectiveness of visual feedback has been shown to be effective in improving skills in previous studies in other fields (Unell et al., 2021; Yamamoto et al., 2019). The QCPR Learner® used in this study also make it clear at a glance whether the current skill of the self is appropriate, due to is visualised the CPR situation in real time.-For example, by following the application parameters while performing chest compressions, the learner was able to learn how to utilise his/her own body functions accurately while performing the CPR. Thus, we believe that the real-time visual feedback was a challenge for the learners and helped them to improve their skills.

The learners also realised that visualisation and repetitive training using the QCPR Learner® helped them learn the elements of the technique necessary for high-quality CPR and that the effectiveness of BLS was enhanced through group cooperation. Furthermore, this may have led to increased motivation to learn. The ARCS model (Keller, 2010), a model for improving motivation to learn proposed by John Keller in 1983 (Keller, 1987), describes the following actions that educators should take to improve and maintain learner motivation: attention, relevance, confidence, and satisfaction. From the components of the "Increased motivation to learn" category identified in the present study, the following subcategories were developed: *I enjoyed improving my skills*, *if something happens, I will be able to implement BLS*, *I gained confidence*, and *I am glad I participated*.

Considering the four aspects of the ARCS model, "Enjoyed" corresponds to attention, "Will be able to implement" to relevance, "Gained confidence" to confidence, and "Glad to have participated" to satisfaction. A key finding of the present study was the importance of simulating all four aspects of the ARCS model, as evidenced by the increased motivation to learn among participating nursing students.

B. Learning Effectiveness in terms of Learning Attainment

Our program used QCPR Little Anne and QCPR Learner® to improve BLS skills, with feedback given according to the application score after the first implementation. As a result, significantly higher scores were obtained in the second session. Previous studies have reported that visual feedback enables students to perform challenging procedures such as ensuring the correct depth of chest compressions (Baldi et al., 2017). In our program, students were able to visually perceive them own BLS skills as numerical values indicating weaknesses and areas for improvement, thereby leading to improved BLS skills.

C. Program Evaluation

Program feedback, time allocation and difficulty level of the content, communication of significance and objectives, guidance and advice, use and innovation of teaching materials, demonstration, interaction among students, and attitude and response to students and exercises were all highly evaluated in the present study. The program was conducted in small groups after the students watched a demonstration video with clearly stated objectives and goals. We believe this approach increased student motivation to learn BLS skills. The program also received positive feedback from the facilitators and group members during individual training and the facilitators provided timely advice, which led to skill improvement. These results indicate that the program provided appropriate conditions for the acquisition of BLS skills.

In the results of the free description, most of the participants were positive about the facilitator's involvement and the duration and content of the program. On the other hand, some participants felt that the program was too time-consuming, albeit only slightly. This may be attributable to the extra time required to change clothes due to coronavirus precautions. In addition, some participants expressed a desire for more practice. The QCPR Learner® used in this program can be easily installed on the learner's own device. We therefore believe that methods that allow self-study at any time may satisfy the desire to learn and lead to skill improvement. Regarding the device, one participant stated "There was a problem with the application"; however, this was expected and could be avoided as a spare device had been prepared in advance. We were able to confirm once again that preparing in advance for anticipated problems and responses to them is an important factor for success when using such devices.

V. CONCLUSION

The results of the present study demonstrate that visualisation of skill improvement using an application that provides real-time feedback was effective in increasing motivation to learn and improving BLS skills. This led some of the learners to request further training. Although it is possible to increase the training time per person by increasing the program duration or the number of simulations, this is limited by cost and manpower. Accordingly, it is necessary to establish a self-learning system that enables learning at any time.

Notes on Contributors

Mitsumi Masuda, Naomi Kimura, and Akemi Nakagaki contributed to all process of this research and read and approved the final manuscript.

Dr. Mitsumi Masuda, PhD, RN, is an associate professor at the Graduate School of Nursing, Nagoya City University. She reviewed the literature, designed the study, performed data collection, data analysis and wrote the manuscript.

Dr. Naomi Kimura, PhD, RN, MW, is an assistant professor at the Graduate School of Nursing, Nagoya City University. She developed the methodological framework for the study, performed data collection, data analysis and gave critical feedback to the writing of the manuscript.

Dr. Akemi Nakagaki, PhD, RN, MW, is an associate professor at the Graduate School of Nursing, Nagoya City University. She performed data collection and data analysis. All the authors have read and approved the final manuscript.

Ethical Approval

The present study was conducted with the approval of the Research Ethics Review Committee of Nagoya City University (approval number: 20011-3). The research subjects were informed orally and in writing of the purpose, methods, protection of personal information, respect for their free will, that the submitted assignments would be processed for research after class evaluation so that individuals would not be identified, and that they would not be involved in any individual class evaluation.

Data Availability

Datasets generated and/or analysed during the current study are available from the following URL:

https://doi.org/10.6084/m9.figshare.21918864.v1

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Declaration of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interests.

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