A Computer-Supported Personalized and Collaborative Learning to Improve Professional Learners' Performance in Advanced Cardiac Life Support Training

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Abstract: The Advanced Cardiac Life Support (ACLS) training was organized to help professional learners establish basic competence in the comprehension of electrocardiograms. However, learners usually have difficulty memorizing the meanings of different electrocardiogram waveforms, which could represent clinical symptoms or even the feeling of dying, via traditional instruction. Some severe problems could lead to death if the professional staff does not make correct judgments and provide timely treatment. Thus, this paper reports an exploratory study on the effects of a computer-supported personalized and collaborative learning approach on professional learners' ACLS learning achievement. A 2-week experiment was conducted to compare the learning achievement of the following: professional learners who learned with the ACLS situation-based computer-supported personalized and collaborative learning approach, and those who learned with the ACLS traditional approach. The experimental results show that the professional staff who learned the proposed method had a better learning performance than those who learned the ACLS traditional approach.

Keywords: Decision making, computer-supported personalized learning, collaborative learning, mobile applications

1. Introduction

For the sake of medical quality and patient safety, clinicians in medical institutions around the world are required to take an Advanced Cardiac Life Support (ACLS) training course, as shown in Figures 1, which includes educational programs for basic life support, acute coronary syndrome (ACS), and electrocardiograms (EKG or ECG), to check for signs of heart disease (Chang, Chang, Hwang, & Kuo, 2019). Among these programs, EKG is an especially required course for medical staff to comprehend heart rhythm and rate, arrhythmia, atrial enlargement, ventricular hypertrophy, myocardial hypoxia, and myocardial injury from a wave chart depicting cardiac electrical conduction activity. Medical staff must have adequate expertise and skills to interpret EKGs when assessing patients' heart function (Amini et al., 2022). Basic waveforms of EKG can be categorized into critical cardiac arrhythmias (17 rhythms included) and cardiac arrest (4 rhythms included). Moreover, symptomatic bradycardia or tachycardia rhythms and the diagnosis of additional heart rhythms, such as ACS, acute pulmonary oedema, hypotension, shock, and cerebral infarct, may lead to an abnormal heart rhythm (Hu, Kao, et al., 2016). It is important for professional staff to enhance their EKG interpretative ability as it may facilitate their clinical work of monitoring patient safety, assessing disease progression, and evaluating more effective therapeutic outcomes (Hu, Kao, et al., 2016). In traditional EKG training courses, based on the philosophy of the American Heart Association, the instructors of ACLS training are able to guide medical learners in practical exercises to determine the best treatment in real time in the clinical practice aid, and to provide patients with the best care in a timely manner for their survival (Hu, Kao, et al., 2016). According to a comprehensive literature review, professional staff usually have difficulty memorizing the meanings of different EKG waveforms, which could represent clinical symptoms or even the feeling of dying, with traditional instruction (Chang et al., 2019).

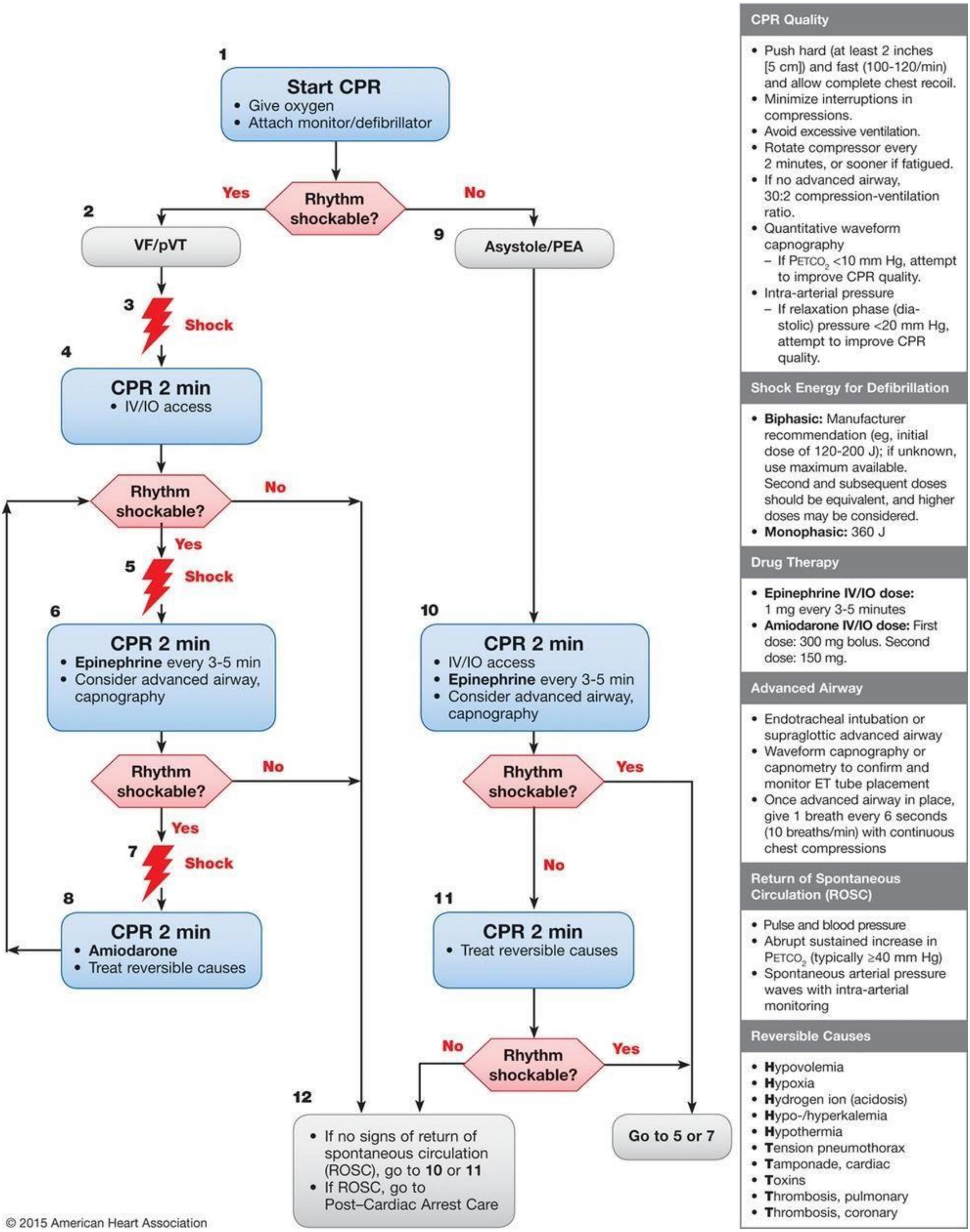

Figure 1. the ACLS process (Link et al., 2015).

Thus, this paper reports an exploratory study on the effects of the computer-supported personalized and collaborative learning approach on professional staff's ACLS learning achievement. Incorporating the computer-supported personalized and collaborative learning approach into professional learners' courses and combining situated learning strategies with digital learning systems to guide learners in reflective and deep thinking has become a new learning approach in recent years. Consequently, this study proposes a learning approach combining computer-supported personalized and collaborative learning with the situated learning strategy in an ACLS training course, which we call the ACLS situation-based computer-supported personalized and collaborative learning approach. To examine the effectiveness of the proposed approach, the following research issues are addressed:

(1) Does the ACLS situation-based computer-supported personalized and collaborative learning approach improve professional staff's learning achievement more than the ACLS traditional approach does?
(2) Does the ACLS situation-based computer-supported personalized and collaborative learning approach enhance professional staff's critical thinking regarding ACLS more than the ACLS traditional approach does?

2. Quasi experimental design

2.1 Participants

A total of 60 nursing staff with an average age of 27 years, from an academic teaching hospital in northern Taiwan were randomly assigned to two groups. The experimental group included 30 participants who adopted the ACLS situation-based computer-supported personalized and collaborative learning approach, while the remaining 30 who adopted the ACLS traditional approach were assigned to the control group. The two groups were taught by the same instructor.

2.2 Measuring tools

The measuring tools adopted in the study used a 5-point Likert rating scheme and had acceptable Cronbach's α values, ranging from .79 to .88. The questionnaires employed included the 6-item learning motivation scale developed by Wang and Chen (2010), the 7-item learning attitude scale developed by Hwang, Yang, and Wang (2013), the 9-item learning satisfaction scale constructed by Chu, Hwang, Tsai, and Tseng (2010), and the 6-item critical thinking disposition scale constructed by Chai, Deng, Tsai, Koh, and Tsai (2015). The ACLS assessment items were constructed by two nursing instructors certified by the Nursing Association in Taiwan. They consist of 20 multiple-choice items related to common EKG waveforms in the clinic, giving a perfect score of 100. The online ACLS course was established for the computer-supported personalized and collaborative learning approach, and learners were allowed to learn using their mobile devices.

2.3 Experimental procedure

First, to determine the professional staff's initial ability, both groups took the 2-day ACLS training course and completed the pre-test of prior knowledge and the pre-questionnaires, as shown in Figure 2. In the pre-class activity, learners in the experimental group were given the ACLS textbooks and were asked to preview the ACLS online multimedia material (combining videos, photos, and text) to establish basic ACLS knowledge and skills in advance. During this session, the learners did first-aid simulation exercises, such as rhythm tests, airway procedures, cardiopulmonary resuscitation (CPR), and automated external defibrillator (AED) use, as shown in Figures 3 and 4. In such a learning situation, not only could the preliminary ACLS knowledge and skills be learned, but questions about the specific operations steps of ACLS in different situations could also be proposed before the in-class activities. Therefore, the learners were able to pay more attention to the educator's explanation of the process and to self-address their questions.

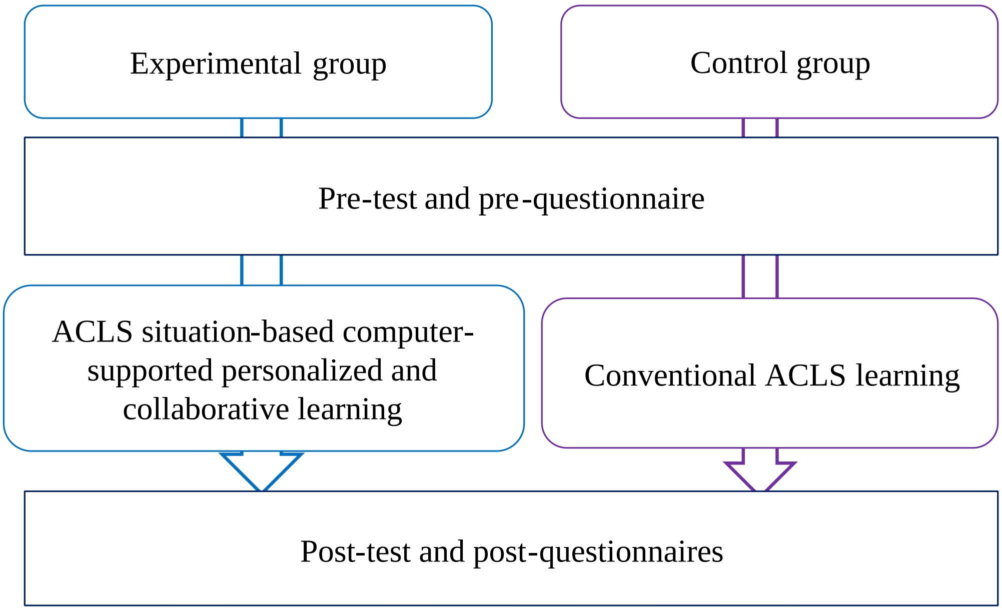

Figure 2. Experimental procedure

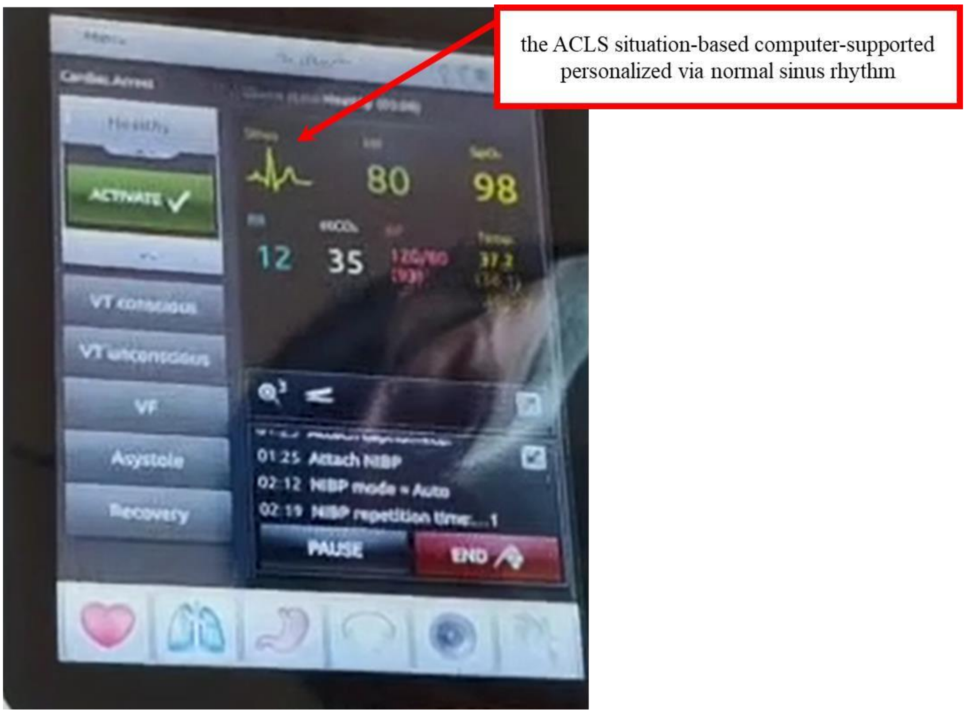

Figure 3. Screenshot of the ACLS situation-based computer-supported personalized via normal sinus rhythm.

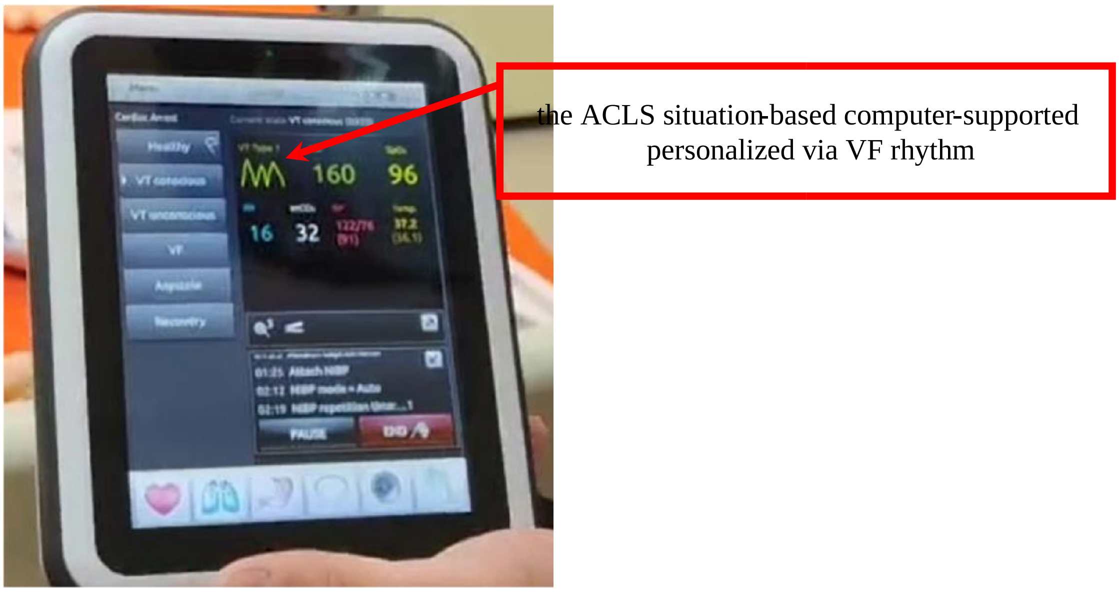

Figure 4. Screenshot of the ACLS situation-based computer-supported personalized via VF rhythm.

In contrast to the experimental group, the learners in the control group were only given the ACLS textbooks and were not asked to preview the ACLS online multimedia. During the in-class activities, the two groups were taught the same learning activities and course discussion on first aid for emergency situations. Instructors in this session addressed the professional staffs' problems with the assignments and used dummy simulations to conduct first-aid training for any emergency; these included the respiratory arrest, post-resuscitation care, CPR, ACS/acute myocardial infarction, hypotension/shock/pulmonary edema, and megacode. Learners in both groups could propose any clinical emergency problems for discussion in this session. After the in-class activity, the learners were all required to complete the post-test of learning achievement and the post-questionnaires. The multimedia material mainly introduced the key points of the on-site learning activities conducted by the teachers. The videos also presented the actual group exercises, including rhythm tests, airway procedures, CPR with AED, and megacode. The experimental group learners were able to practice the learning tasks repeatedly in the pre-class stage, thus producing the prerequisite knowledge, skills, and questions in advance of the in-class stage, as shown in Figure 5 and Figure 6.

Figure 5. Screenshot of the ACLS situation-based computer-supported personalized and collaborative learning process.

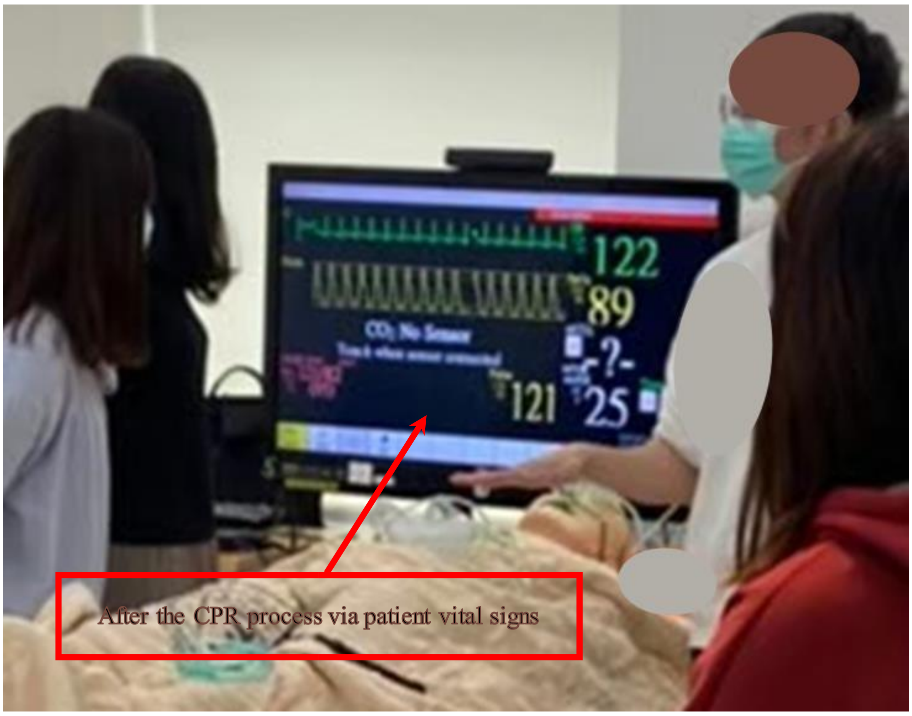

Figure 6. Debriefing for the ACLS situation-based computer-supported personalized and collaborative learning.

2.4 Experimental Results

Analysis of covariance (ANCOVA) was employed by using the pre-test scores of learning achievement as the covariate, while the post-test scores of learning achievement were the dependent variable. After verifying that the assumption of homogeneity of regression was not violated with $F = 3.57$ ($p > 0.05$), the post-test scores of both groups were analysed using the ANCOVA method. As shown in Table 1, it was found that there was a significant difference between both groups ($F = 60.34$, $p < 0.001$). That is, the ACLS situation-based computer-supported personalized and collaborative learning approach had significantly better effects (mean = 89.53; standard deviation [SD] = 5.94) on professional staffs' learning achievement than did the ACLS traditional classroom (mean = 80.87; SD = 5.14). The adjusted means of the experimental group and the control group were 89.72 and 80.68, respectively. This implies that the ACLS situation-based computer-supported personalized and collaborative learning approach could enhance the professional staff's learning achievement more than the ACLS traditional classroom could. In addition, the correlation coefficient ($\eta2 = 0.514$) was higher than 0.138, implying that the ACLS situation-based computer-supported personalized and collaborative learning approach highly affects professional staff's learning achievement.

Table 1. *learning result of learning achievement*

Variance	Group	*N*	Mean	*SD*	Adjusted mean	*Std. error.*	*F*	*η2*
Learning achievement	Experimental group	30	89.53	5.94	89.72	0.82	60.34^{***}	0.514
	Control group	30	80.87	5.14	80.68	0.82		

$^{***}p < .001$

After verifying that the assumption of homogeneity of regression was not violated with $F = 1.46$ ($p > 0.05$), the post-test scores of both groups were analysed via ANCOVA. As shown in Table 2, it was found that there was no significant difference between both groups ($F = 1.21$, $p < 0.01$). That is, the ACLS situation-based computer-supported personalized and collaborative learning approach did not have significant effects (mean = 4.22; SD = 0.38) on professional staffs' critical thinking in comparison with the ACLS traditional classroom (mean = 4.10; SD = 0.44). Additionally, the correlation coefficient (η2 = 0.21) was lower than 0.138, implying that the ACLS situation-based computer-supported personalized and collaborative learning approach has a lower correlation with professional staff's critical thinking. It can be inferred that the participants were all experienced professionals who originally had stable critical thinking abilities.

Table 2. *learning result of critical thinking*

Variance	Group	*N*	Mean	*SD*	Adjusted mean	*Std. error.*	*F*	*η2*
Critical thinking	Experimental group	30	4.22	0.38	4.22	0.08	1.21	0.021
	Control group	30	4.10	0.44	4.10	0.08		

3. Discussion and Conclusions

To enhance professional staff's in-clinic EKG interpretative ability, this study proposed an ACLS situation-based computer-supported personalized and collaborative learning method that integrated EKG scenes into the clinical learning settings. The multimedia materials mainly introduced the key points of the on-site learning activities conducted by the teacher. The students in the experimental group were able to practice the learning tasks repeatedly by watching the ACLS multimedia (combining videos, photos, and text) in the preclass stage and constructing the prerequisite knowledge, operation skills, and even concrete questions in advance of entering the in-class stage. Thus, in such a learning situation, the students in the experimental group could bring more concrete professional learners' concepts or questions into the in-class stage and interact with the teacher. On the contrary, the students in the control group who did not watch the ACLS multimedia prior to the in-class stage could not gain concrete prior knowledge or operation skills; thus, they had less interaction with the teacher in the in-class stage than the experimental group students did. That is, watching the ACLS multimedia in the pre-class stage could lead the students to understand the ACLS learning situations, and they could focus on the on-site learning situation based on the concrete questions that arose in the pre-class stage. Consequently, the research results show that the professional staff who learned with the ACLS situation-based computer-supported personalized and collaborative learning method gained better learning achievement than those who learned in the ACLS classroom.

This result reveals that professional staff in the experimental group more easily constructed concrete concepts and expertise for ACLS through a continued simulated manner in the pre-class and in-class activities than those who learned in the ACLS traditional classroom. That is, learners in the experimental group were provided with ACLS multimedia and simulation exercises in the pre-class stage. In such a learning situation, not only could the preliminary knowledge and nursing skills for ACLS be constructed, but they could also come up with questions about the specific operations for ACLS in different emergency situations in advance of the in-class activities. Therefore, learners were able to pay more attention to the educator's specific operations for ACLS in the class. Consequently, the proposed approach linking computer-supported personalized and collaborative learning and situated learning could promote learners' higher-order knowledge transition (Bdiwi, de Runz, Faiz, & Ali-Cherif, 2019) and enhance their mastery of ACLS skills before entering the clinic (Bowers et al., 2020). In contrast, those in the control group were not given the multimedia material and simulation exercises in the pre-class stage; thus, they may have brought abstract concepts of ACLS knowledge and skills into the in-class stage. In such a learning situation, it was difficult for the learners to identify their weaknesses and problems when learning ACLS in advance.

The main contribution of this article is that the innovation of the computer-supported personalized and collaborative teaching design course is worth promoting in other forms of education and training of professional staff and all medical staff in the future.

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