Online-Journals.org

iJOE International Journal of Online and Biomedical Engineering

iJOE | eISSN: 2626-8493 | Vol. 20 No. 13 (2024) | OPEN ACCESS

https://doi.org/10.3991/ijoe.v20i13.50335

PAPER

The Impact of a Blended Cardiopulmonary Resuscitation Training Program on CPR Knowledge and Attitude to Perform It: The Case of Non-Medical Undergraduate

Aseel O. Ajlouni[1](✉), Reem M. Abuabbas[2], Hatem A. Shlool[3]

[1]The University of Jordan, Amman, Jordan

[2]Jordan University Hospital, Amman, Jordan

[3]Al-Ahliyya Amman University, Amman, Jordan

a.ajlouni@ju.edu.jo

ABSTRACT

Blended learning (BL) has recently been extensively utilized as an effective instructional method in the educational field. Despite its benefits, few studies investigate its impact on cardiopulmonary resuscitation (CPR) training programs for non-medical students and staff. The importance of CPR training lies in its contribution to achieving the third sustainable development goal (SDG) by enhancing survival rates. Nevertheless, some obstacles have hindered university students from participating in these courses. This study aims to identify the impact of blended learning, which integrates asynchronous online learning with face-to-face instruction, on CPR knowledge and attitudes among non-medical undergraduates. Using a true experimental design, the experimental group (n = 41) received the BL CPR training program while the control group (n = 40) received the convolutional CPR training program. Data were collected using a developed CPR knowledge test and an attitude measure toward performing CPR before and after the program. The analysis of covariance (ANCOVA) analysis at the 5% significance level ($p < 0.05$) revealed a significant positive influence of the BL method on enhancing students' CPR knowledge and their attitudes toward performing it. These results recommend that decision-makers employ BL programs to enhance students' CPR knowledge and attitudes toward performing it.

KEYWORDS

cardiopulmonary resuscitation (CPR), cardiopulmonary resuscitation knowledge, attitude, blended learning (BL), training program, instruction

1 INTRODUCTION

All countries strive to achieve the sustainable development goals (SDGs), where nations are particularly focused on leveraging technological advancements to drive progress. SDG 4 stands out as a key priority, where the aim is to assure global access

Ajlouni, A.O., Abuabbas, R.M., Shlool, H.A. (2024). The Impact of a Blended Cardiopulmonary Resuscitation Training Program on CPR Knowledge and Attitude to Perform It: The Case of Non-Medical Undergraduate. *International Journal of Online and Biomedical Engineering (iJOE)*, 20(13), pp. 118–137. https://doi.org/10.3991/ijoe.v20i13.50335

Article submitted 2024-05-30. Revision uploaded 2024-08-03. Final acceptance 2024-08-04.

to high-quality education and to provide lifelong learning opportunities for all [1]. In recent years, technology has played a central role in advancing this objective, as it facilitates widespread access to educational resources and enhances learning experiences. Moreover, by promoting education and empowering individuals, technology contributes to SDG 3, which intends to improve health and well-being worldwide by improving access to quality healthcare services for all. Despite health and preservation of human life being primary objectives for societies and nations, the number of deaths compared to survivors of cardiac arrests remains alarmingly high [2–3]. Cardiac arrests embody a serious medical emergency characterized by the sudden stop of the heart's pumping function. Without immediate intervention, cardiac arrests can quickly result in death [4]. The importance of cardiopulmonary resuscitation (CPR) increases the chances of survival for individuals experiencing cardiac arrest [5]. This underscores the importance of providing CPR training and awareness programs to all segments of society, not just limiting them to the medical sector, as emphasized by numerous previous studies [6–8]. In light of this, organizations and associations in some countries have taken significant steps to raise public awareness about CPR. Such as conducting training sessions and incorporating courses into relevant curricula related to CPR [6, 9]. Despite these, several studies have confirmed that there is a lack of CPR knowledge, skills, and awareness among people around the world [10–13].

Former studies have proved the positive role of CPR training courses in increasing knowledge and awareness of CPR among the mature population and improving outcomes in cardiac arrest cases [14–15]. It is essential to keep nurses' knowledge and practical approaches updated with current CPR guidelines [16–17]. However, these courses and training face challenges and barriers, including a lack of time, funds, and instructors [18–19]. Furthermore, there is currently insufficient data on the optimal training methods for CPR [20]. However, having knowledge does not ensure that individuals will act accordingly; the behavior is influenced by their attitude and perception of their ability to carry out the behavior [21]. The ABC Model, one of the attitude theories, provides a theoretical base for understanding how attitudes lead to specific behaviors [22]. individuals to perform actions and administer this life-saving service to those in need.

Positive attitudes toward performing CPR are essential, playing a significant and crucial role in the readiness and execution of CPR for individuals facing life-threatening cardiac arrest situations. As per the theory of planned behavior, an individual's positive attitude strongly influences their behavioral response [23]. Previous research underscores the prevalent lack of positive attitudes towards performing CPR among many individuals, which encompasses various fears, including disease transmission, visible blood, perceived danger, legal liability, causing harm to the victim, and risks to personal safety while administering CPR, in addition to insufficient knowledge and practical skills of CPR [11, 24–25]. These barriers to performing CPR are often rooted in misinformation regarding it. They include misconceptions about disease transmission, insufficient understanding of preventive measures, incorrect CPR delivery techniques, and the serious importance of providing timely CPR to save lives. Therefore, a demanding need arises for training initiatives aimed at fostering positive attitudes among individuals, empowering them to deliver CPR interventions effectively when the situation demands it.

In alignment with contemporary educational methodologies, blended learning (BL), with its versatile pedagogical features [26], BL could be a promising approach for delivering comprehensive CPR training. By integrating theoretical knowledge with practical skills, BL offers a flexible solution that caters to the diverse needs

and schedules of learners [27]. Thus, this study assumes significance in addressing the existing gap in educational literature pertaining to integrated CPR training programs for non-healthcare sector students and evaluating their efficacy in enhancing knowledge acquisition and cultivating positive attitudes towards CPR. Consequently, the study endeavors to address the following two pivotal questions:

Q1: Are there significant differences in the student's CPR knowledge attributable to the instructional method (BL vs. conventional) at the significance level ($\alpha < 0.05$)?
Q2: Are there significant differences in the development of students' attitudes toward performing CPR attributable to the instructional method (BL vs. conventional) at the significance level ($\alpha < 0.05$)?

2 LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1 Blended learning

Blended learning is a modern instructional approach that creates a dynamic and interactive learning experience. Several definitions of interpretations for BL have existed within scholarly works [27]. Some of these definitions describe it as combining online (asynchronous and/or synchronous) and offline (convolutional or classroom) methods to create a comprehensive learning experience for students in a course or subject [28–31]. In higher education, BL offers opportunities to develop transformative learning environments that foster critical, creative, and complex thinking skills. The success of this approach relies on teachers selecting the appropriate technology [32]. Further, [29, 33] outlines that BL is a grouping of convolutional instructional methods and online learning experiences, or computer-mediated instruction. Consequently, it can be deduced that there exists a consensus emphasizing that the essential components of BL encompass convolutional and web-based instruction or learning. The aim of BL is not to replace either of these methods but rather to combine their merits, constructing an enhanced and more efficient learning encounter for students [34].

Blended learning efficiently combines the advantages of web-based learning and traditional classroom methodologies [35–36]. This innovative instructional approach has gained growing popularity across educational institutions. Moreover, the COVID-19 pandemic highlighted the vital role of BL and web-based learning in addressing the challenges of traditional teaching methods [37–38]. Numerous studies have investigated the educational advantages of BL for students, including the development of self-directed learning skills, 21st-century skills, and competencies; increased motivation and engagement; enhanced learning outcomes; efficient time utilization; prompt access to feedback; multiple opportunities for fostering connections; promoting collaboration; and driving changes in pedagogical practices [39–40]. Furthermore, it suggests several advantages to educational institutions, workplaces, and learners, such as supporting self-directed learning, convenience, effective experience, and reducing costs [41–42]. Additionally, it enables substantial cost savings [43].

Despite the pedagogical advantages offered by BL, there is a noticeable absence of literature that specifically investigates the implementation and design of effective BL approaches [44]. A recent study in 2024 reported various challenges that impact the successful implementation of a BL strategy and highlighted a need to investigate

more study [45]. Furthermore, there is a pressing need for an increase in experimental and quasi-experimental studies that investigate the effectiveness of BL in higher education. Recent findings from a systematic review conducted by [46] that analyzed evidence from 59 experimental studies conducted in HEI have revealed deficiencies in BL research. This review has highlighted the necessity for more comprehensive descriptions of face-to-face activities within BL, as these descriptions can aid in developing precise interventions and offering practical guidance. Further, [47] emphasized the need for additional research to investigate BL as a promising educational trend for the future.

In the realm of training programs, BL presents advantages in terms of cost reduction and minimizing time away from the workplace [48]. The combination of theoretical online material with practical hands-on experience or mentor-directed instruction offers an effective and economically feasible approach to delivering workforce training. Consequently, several workforce sectors have adopted BL models [49]. Despite the growing discourse surrounding BL in various research studies, there is a noticeable gap in the exploration of BL for CPR training [50–52]. Additionally, there have been no studies conducted among non-medical staff and students in this context.

2.2 Cardiopulmonary resuscitation education

Cardiopulmonary resuscitation is a vital lifesaving method, and its effectiveness affects the survival rates of individuals experiencing cardiac arrest [4]. This technique involves thoracic and rescue breathing [53], and it's intended to sustain blood flow and oxygen delivery to organs until professional medical care arrives. The significance of widespread CPR knowledge and training has been acknowledged as a vital influence in enhancing the outcomes of sudden cardiac incidents [54]. Out-of-hospital cardiac arrest (OHCA) continues to be a principal cause of death worldwide, with its survival rate still low [2, 3, 10, 55].

One of the strategies to improve OHCA survival rates is to ensure passable CPR, increasing CPR awareness and knowledge within the community [2]. Hence, the European Resuscitation Council guidelines advocate for cardiac awareness campaigns to involve a wider community. Further, the ERC 2021 guidelines encourage CPR training for all pupils, who should routinely receive CPR training each year through campaigns such as WRAH, as it can enhance resuscitation rates in untrained people [56].

Studies revealed that bystander CPR is mostly performed by individuals with a medical or health background [21, 53]. Providing comprehensive CPR training can enhance survival rates [57]. As a solution, CPR programs for the community have been established [58]. Nevertheless, despite the increased focus on educating people about CPR, there are still barriers to effective course delivery [57]. This highlights the importance of conducting studies accompanied by appropriate structural interventions to overcome these barriers.

2.3 Attitude to perform cardiopulmonary resuscitation

The study of attitude is becoming increasingly important due to its significant influence on individual behavior as well as its ability to predict and explain such behavior [59]. Attitude refers to the favorable or unfavorable mental predispositions

towards an object [60]. Numerous studies explain attitudes, with the ABC model being one of the most valuable and cited [61–64]. The ABC model posits that attitude consists of three components: affect, behavior, and cognition. Affect refers to the emotional response to an attitude object; behavior indicates the actions or intentions directed toward the attitude object; and cognition encompasses the beliefs and thoughts an individual holds about the attitude object [60]. In the context of the ABC model, attitude toward performing CPR encompasses: a) affect: emotional responses such as confidence or anxiety about performing CPR. b) behavior: actual or intended actions to perform CPR during emergencies. c) cognition: knowledge and beliefs about the importance and effectiveness of CPR. Together, these components shape an individual's overall attitude toward performing cardiopulmonary resuscitation.

As per Ajzen's theory in the context of behavior [59], an individual's inclination to perform CPR is influenced by their attitude, which encompasses both behavioral intention and actual behavior [21]. Despite the significance of fostering a positive attitude towards CPR, studies have identified examples of negative attitudes towards CPR and its performance [21, 65]. These negative attitudes serve as barriers to future learning and the execution of resuscitation efforts [66].

Previous studies discovered the connection between training backgrounds and attitudes, emphasizing the advantages of receiving CPR education early. These benefits manifest in attitudes toward assisting others, increased confidence in resuscitation outcomes, and an inner drive to help those in distress [67–70]. On the other hand, it has been observed that enhancing behavior change can have a significantly greater impact when accompanied by appropriate structural interventions, such as educational programs and awareness campaigns, which are particularly relevant in the field of public health [18]. In the context of CPR, self-training in CPR can enhance positive attitudes, thereby increasing the probability of individuals taking action during emergencies. Research conducted by [14] suggests that CPR training enhances children's CPR knowledge, boosts their willingness, and improves their attitudes and intentions toward assisting others. even though recent studies discovered a negative attitude among individuals [71] that underscores the urgent need for procedures that enhance individual attitudes toward performing cardiopulmonary resuscitation.

2.4 Blended learning in the context of cardiopulmonary resuscitation education

E-learning and BL methods are becoming increasingly popular in emergency medicine education. However, there is limited data on how these methods affect procedural learning and skill acquisition compared to traditional approaches [72]. Despite the advantages of BL, few studies have examined its impact on healthcare training programs, such as basic life support (BLS) or CPR training [73]. For example, [73] conducted a systematic review of BLS training with virtual reality (VR) for adult laypersons, revealing that BLS training with VR may enhance the chest compression skills as compared to convolutional BLS training. Further, previous research indicated that an exclusively online, or BL, approach for remote BLS CPR training was equally effective as convolutional training, although it generally required more time to achieve the same level of proficiency [74].

[75] conducted a quasi-experiment study that revealed supplementing face-to-face CPR training with an e-learning course significantly improved knowledge retention, suggesting using e-learning alongside traditional training. In Egypt, also, [20]

conducted a quasi-experimental study that found CPR video-based online learning significantly enhanced practical skills among physical education students. As well as [76] conducted a quasi-experimental study that revealed electronic learning package applications for post-CPR enhanced CPR knowledge and skills among nurse students, Also, [13] conducted an experimental study among marathon runners that found that the e-learning system for CPR knowledge significantly improved participants' skills, leading to increased confidence in handling emergencies. Most of the participants are willing to recommend the eLearning CPR system. Further, [26] revealed that the CPR BL method with virtual simulation enhanced self-directed learning abilities and CPR skills among nurse students. A study by [77] revealed that a BL CPR program that integrated videos and face-to-face lectures improved CPR knowledge and attitudes towards it among nurse students. Similarly, [50] conducted a systematic review, which confirmed augmenting their competencies, understanding, perspectives, self-confidence, and readiness to administer resuscitation among nurse students. Likewise, [78] announced that blended BLS training improves nurse students' knowledge of cardiac arrest first aid.

Research that examined the effect of BL in the context of attitude toward performing CPR was limited but confirmed its positive effect. For example, the study by [79] concluded that a BL with VR for primary and secondary students enhanced students' comprehension of BLS procedures and their readiness to respond in cardiac arrest scenarios. Also, the study by [80] revealed that CPR multimedia learning enhances nursing students' willingness to perform CPR. As well [81], research results indicated that the majority of medical students expressed satisfaction with the BL BLS module they engaged in. And conclude that the BL appears to be an efficient method for delivering the course.

Based on the extensive literature review, studies confirmed a lack of CPR knowledge and a positive attitude toward conducting CPR among individuals worldwide [6, 8, 10–11, 65, 82–84], including Jordan [12–13]. Additionally, there is a noticeable absence of previous studies with robust designs focusing on university students from non-health-related disciplines. Most of the existing studies with experimental design were conducted on nursing students [76–78, 80] and featured weak designs, such as single-group studies [80], lack of random assignment, pre-experimental or static group designs [74, 78], or groups with fewer than 30 participants [74–76]. The results of previous studies examining BL CPR, predominantly targeting medical and health students, consistently affirm its positive impact on knowledge and attitudes toward CPR. It focused on the medical health sector and students. Despite the critical significance of CPR awareness across all societal segments, a notable void exists in the educational literature concerning BL CPR among non-medical university students. This underscores the importance of the present study in bridging this crucial gap and addressing the educational needs of a broader student demographic. This study is conducted on university students from non-medical fields, using a true experimental design that includes two groups with random assignment and at least 40 participants in each group.

3 METHODOLOGY

3.1 Study design, participants, and procedures

The study employed a true experimental design incorporating a control group with pretest and posttest measures. The study design is based on randomized controlled

trials to ensure reliable evidence. This design is commonly used in psychology and education, where two groups are measured before and after an intervention, such as a training program [85]. Analysis of covariance (ANCOVA) was used to determine the treatment effect by comparing differences between the treated group and the untreated group on a quantitative outcome measured before and after treatment [86], providing greater statistical power [87].

The study sample comprised 81 students from Al-Ahliyya Amman University (AAU) in Jordan. It is the highest-ranked private university in Jordan and holds the third position among all Jordanian universities in the 2024 global Top 1000 list. Before conducting the study, official approval from the administration of the AAU was obtained. The approval number for the study is KMT-S-NRA-192. All participants voluntarily agreed to join the study and completed the consent form.

The required data analysis to investigate the effectiveness of instructional methods on the independent variables was performed using the SPSS software version 26.

The study sample was randomly selected from students enrolled in the School of Educational Science who registered for courses during the spring term of the 2022–2023 academic year. Participants were randomly assigned into control groups (n = 40) that taught the CPR training program using convolutional (face-to-face) methods and an experimental group (n = 41) that taught the same CPR training program using BL (face-to-face and asynchronous online learning). The developed attitude towards performing the CPR scale and the CPR knowledge test was administered to the study participants pre- and post-instruction in the CPR program. The study participants received instruction from the same CPR specialist for four hours during a single week.

The BL environment for this study was designed based on the five stages of ADDIE model design [88] using the Moodle learning management system (LMS), which is a suitable open-source LMS for conducting blended learning.

The BL approach comprised three hours of asynchronous online learning, facilitating self-paced learning where students can use instructional materials uploaded on the Moodle platform. This was complemented by a one-hour face-to-face practical session conducted on campus, ensuring a well-rounded educational experience.

The training of the instructional material was carefully designed to encompass content in a manner that ensures the achievement of the predefined objectives of the BL CPR training in light of the guidelines provided by the American Heart Association (AHA) and referencing relevant previous studies on CPR [89–91]. The digital interactive content was designed in accordance with the Cognitive Theory of Multimedia Learning [92], Mayer's Principles of Multimedia Learning [93], and SCORM standards [94]. The digital instructional material for the training was redesigned by researchers using Articulate Story Line software, which includes interactive videos, quizzes, and activities. These materials were uploaded to the Moodle platform. They encompass all essential materials (i.e., prerequisite resources) to cater to the diverse needs and capabilities of all students. Students in the experimental group can log in to Moodle at any time and place and complete the BL training in their self-paced learning (3 H). and then they join the practical session (1 H) in the classroom. In the experimental group, the instructor's role was confined to facilitating the learning process and offering feedback; in contrast, students in the control group were taught the same topic covering the same goals through conventional learning methods (face-to-face). The instructor conducted classroom sessions to meet the students' requirements during the training, which amounted to 4 hours per week. Students utilized paper worksheets, PowerPoints, and the AHA handbook as part of their learning materials.

3.2 Study instruments

Two instruments were used to collect the study data, which are the developed CPR test and the attitude toward performing cardiopulmonary resuscitation.

The attitude performing cardiopulmonary resuscitation (ATCPR): The ATCPR scale was developed based on the ABC model of attitudes, literature related to attitudes performing CPR, and relevant attitude scales [60, 77], [95–97]. It consisted of 10 items that assessed the students' attitude towards performing CPR, distributed over three domains: affective (three items), cognitive (three items), and behavioral (four items). This was an adaptation of the five-Likert scale. The total score of ATCPR ranged between five and 50. Higher scores indicate more positive attitudes toward performing cardiopulmonary resuscitation.

The content validity of ATCPR was confirmed by 10 experts specializing in academic physicians specializing in anesthesia, intensive care, emergency medicine, and educational psychology. To ensure the spectrometric properties of the ATCPR administered to a pilot study (n = 35), Table 1 shows the correlation between each item of ATCPR and the overall ATCPR score, which were all significant at $p < 0.005$ and varied between 0.679 and 0.885. Cronbach's alpha was extracted and was 0.93. These findings confirmed the validity and reliability of the *attitude performing* cardiopulmonary resuscitation.

Table 1. The Pearson correlation coefficients for *attitude performing* cardiopulmonary resuscitation

Item	Statement	r with a TS
1	I hesitate to perform rescue breaths on an injured person due to concerns regarding the transmission of diseases. (Behavioral)	0.867*
2	I hesitate to perform chest compressions on an injured person. (Behavioral)	0.770*
3	I hesitate to administer an electric shock to an injured person using an automated external defibrillator (AED). (Behavioral)	0.862*
4	I will feel satisfied with myself when performing CPR on an injured person. (Affective)	0.749*
5	I will feel anxious when performing CPR in real-life emergencies. (Affective)	0.875*
6	I believe that having CPR skills is important and increases the chances of saving the lives of injured people. (Cognitive)	0.885*
7	I want to learn advanced CPR skills. (Affective)	0.679*
8	I believe that attending a CPR course is necessary for everyone. (Cognitive)	0.875*
9	I believe that CPR should be part of the curriculum. (Cognitive)	0.771*
10	I will not hesitate to perform CPR on any injured person. (Behavioral)	0.867*

Notes: *r: person correlation coefficient, TS: total score, significant at $p < 0.05$.

The cardiopulmonary resuscitation knowledge (CPRN) test: The CPRN test was developed by researchers based on the related literature on the CPR knowledge test [98–100]. The test consists of 20 multiple-choice items, with each item having four options, one of which is correct and assesses the student's CPR knowledge, and each correct answer receives one score. The total score of the CPRN test ranged between 0 and 20, with higher scores representing higher students' CPR knowledge. The CPRN test was reviewed by 10 academic physicians specializing in anesthesia, intensive care, emergency medicine, educational psychology,

measurement, and evaluation to ensure the test's content validity. Then CPRN tests were administered in a pilot study to confirm their spectrometric properties. Cronbach's alpha equation calculated an internal consistency of 0.87. Based on these results, the CPRN test has an adequate level of reliability for this study.

For the CRPN items, difficulty and discrimination were measured using data that was collected from the pilot sample. The range of values for 20 items for the difficulty index was between 0.70 and 0.22, and the discrimination index was all positive and greater than 0.20. Based on these findings, the reliability and validity of the CPRN test were confirmed.

3.3 Data analysis

Descriptive statistics and ANCOVA analysis were conducted using SPSS to evaluate the impact of the blended CPR training program on both CPR knowledge and attitudes toward performing CPR. Additionally, eta square values were calculated to determine the effect size of the instructional method on the CPR knowledge and attitudes towards performing CPR. Before the ANCOVA, researchers confirmed that the assumptions of the analysis were met.

4 RESULTS AND DISCUSSION

Effectiveness of a blended cardiopulmonary resuscitation training program on cardiopulmonary resuscitation knowledge: To address the initial research question, denoted as Q1: "Are there significant differences in the CPR knowledge among undergraduates attributable to the instructional method (BL vs. conventional) at the significance level ($\alpha < 0.05$)?" the researchers obtained descriptive statistics, including means (M) and standard deviations (SD) of both groups' CPRN test scores before and after the instruction CPR training program. These findings are delineated in Table 2.

Table 2. The statistics of the cardiopulmonary resuscitation knowledge test

Group	Pre_Instruction	Post_Instruction
	M ± Sd	M ± Sd
Experimental	6.78 ± 2.66	16.95 ± 1.34
Control	6.75 ± 2.16	14.00 ± 2.48

The data presented in Table 2 suggests that before receiving instruction from the training program, both groups of students exhibited comparable levels of CPR knowledge, with the control group's total CPRN test score at 6.75, closely resembling that of the experimental group at approximately the same value. However, noticeable disparities in CPRN test scores between the study groups appeared post-instruction. Specifically, the experimental group, utilizing BL, demonstrated a higher mean score of 16.95, in contrast to the control group's mean score of 14, which experienced conventional instruction. An ANCOVA was conducted to determine the statistical significance of the differences in mean scores between the study groups, and the findings are shown in Table 3.

Table 3. Analysis of covariance analysis results

Source of Variation	Sum Square	Df	Mean Square	F	Sig	(η2)
Pre-Instruction	32.867	1	32867	9.187	0.003	0.105
Instructional Method	175.370	1	175.370	49.022	0.000	0.386
Error	279.036	78	3.577			
Adjusted Total	488.247	80				

Notes: Sig: significant, Df: degrees of freedom, F: F-test, and η2: eta square.

The ANCOVA results indicated a significant difference in the mean CPRN scores among the study groups after the training program (F = 49.022, P = 0.000), demonstrating that instructional methods have an impact on students' CPR knowledge levels. As presented in Table 4, the eta square value reached 0.386, signifying that 39% of the variance in CPR knowledge among the study groups can be attributed to the instructional method. To identify the most effective instructional method, the adjusted means (AM) and standard errors (SE) of the study groups' CPRN scores after instruction were calculated and are displayed in Table 4.

Table 4. Adjusted means and standard errors for SP scale

Group	AM	SE
Experimental	16.95	0.30
Control	14.00	0.30

The adjusted mean CPRN score following instruction was higher for students in the experimental group (16.95) compared to those in the control group (14.00). This implies that students in the experimental group, who were taught using BL, attained a greater level of CPR knowledge. Thus, the findings suggest that BL positively impacts the enhancement of students' CPR knowledge.

The positive influence is credited by the researcher to various factors, mainly the active technological learning environment provided by instruction-based BL. This environment supports self-regulated learning, stimulating students to acquire CPR knowledge according to their individual needs and abilities. Interactive videos and instructional materials offer nonlinear navigation, enabling students to move through learning content according to their level of understanding [101].

Additionally, the multimedia approach, designed following Mayer's principles, presents information through multiple sensory channels, minimizing cognitive load and enhancing learning effectiveness [102]. By incorporating simulations of CPR procedures and abstract concepts, multimedia aids non-medical and health students in comprehending and internalizing complex concepts. Verbal reinforcement techniques within multimedia elements and assessments motivate students to persist in their learning journey, further enriching their CPR knowledge.

Furthermore, the BL method with appropriate instructional material design affords students numerous choices and flexible learning opportunities, supporting self-paced learning and accommodating various learning styles. They provide multiple representations of content, alternative elements, additional links, and diverse navigation methods, empowering students to select content representations aligned with their preferred learning styles and schedules. This flexibility allows students to learn at their convenience and location of choice, while the availability of diverse

content encourages active engagement in self-directed learning [35–36, 39–40, 44]. Overall, the BL approach offers students access to a wide range of educational resources online, facilitating continuous access to information and fostering a deep understanding of cardiopulmonary resuscitation.

The findings of this study are in accordance with the results of former studies [26, 50, 73, 75–78] that found the use of BL in CPR or BLS enhanced CPR or BLS knowledge and retention among students. Furthermore, this outcome aligns with the discoveries made by [26], who found that utilizing virtual simulation can facilitate the transition from theory to practice in medical education.

The effectiveness of a blended cardiopulmonary resuscitation training program and the attitude to perform it among undergraduate students: To explore the second question identified as "Q2: Are there significant differences in the development of students' attitudes toward performing CPR attributable to the instructional method (BL vs. conventional) at the significance level ($\alpha < 0.05$)?" The researchers obtained descriptive statistics (i.e., M, SD) of both groups' ATCPR test scores before and after the CPR training program. These statistics are presented in Table 5.

Table 5. The statistics for the attitude performing cardiopulmonary resuscitation scale

Group	Pre_Instruction	Post_Instruction
	M ± Sd	M ± Sd
Experimental	2.41 ± 0.32	3.68 ± 0.41
Control	2.42 ± 0.29	3.04 ± 0.36

The data shown in Table 5 suggests that prior to instruction, students' attitudes toward performing CPR were relatively similar across both groups, with the mean score for the control group on the ATCPR scale being at 2.42, closely resembling that of the experimental group at 2.41. However, noticeable differences in mean ATCPR scores between the study groups appeared post-instruction. Specifically, the mean score for the experimental group, which utilized the BL method, was 3.68, surpassing the mean score for the control group, which received conventional instruction, at 3.04. An ANCOVA was conducted to determine the statistical significance of the differences in mean scores between the study groups, and the findings are shown in Table 6.

Table 6. Analysis of covariance results for attitude performing cardiopulmonary resuscitation scale

Source of Variation	Sum Square	Df	Mean Square	F	Sig	(η2)
Pre-Instruction	0.076	1	0.076	0.499	0.482	0.006
Instructional Method	8.461	1	8.461	55.647	0.000	0.416
Error	11.860	78	0.152			
Adjusted Total	20.371	80				

The ANCOVA findings indicated a notable distinction in the mean ATCPR scores among the study groups post-instruction (F = 55.647, P = 0.000), indicating that instructional methods significantly influenced attitudes towards performing CPR. As indicated in Table 6, the eta square value reached 0.416. This indicates that the instructional method accounts for 42% of the variability in attitudes toward

performing CPR among the study groups. To identify the most effective instructional method, the AM and SE of the study groups' ATCPR scores post-instruction was extracted and shown in Table 7.

Table 7. The Adjusted means and standard errors for the attitude performing cardiopulmonary resuscitation scale

Group	AM	SE
Experimental	3.68	0.06
Control	3.03	0.06

After instruction, the adjusted mean ATCPR score was higher for students in the experimental group than for those in the control group, with values of 3.68 and 3.03, respectively. This implies that students in the experimental group, who received instruction through BL, showed a more favorable attitude toward performing

This significant positive emotional attitude toward CPR among the control group after instruction can be explained in light of the ABC model, in which the attitude compromises affect, behavior, and cognition components [62]. The affect components represent the student's emotional response to performing CPR. The behavior components indicate the actions or intentions directed towards performing CPR, and the cognition represents the beliefs and thoughts an individual holds regarding performing cardiopulmonary resuscitation.

The researchers attributed the improvement in students' beliefs and thoughts to the pedagogical benefits of BL, which include well-designed instructional materials based on the cognitive theory of multimedia learning and Mayer's principles that support self-paced learning and regulated learning that enhance students' learning CPR knowledge and boost their awareness of the important role of performing early CPR in saving the life of an injured person in the correct procedure without being infected. This conclusion is consistent with the study by [76] that revealed the electronic learning package application for post-CPR enhanced CPR nurse students' knowledge as well as this instructional material that emphasized the significance of CPR in life-saving efforts and enhanced students affect component in having positive emotions towards performing CPR on people and assisting others.

Instructional material in BL and the nature of self-paced learning help students have positive emotions and knowledge of CPR that contribute to boosting the behavioral component. As noted by [18] in the field of public health, enhancing behavior change can be significantly more impactful when complemented by appropriate structural interventions, such as educational initiatives and awareness campaigns. In the context of CPR, this conclusion is consistent with the study by [76] that revealed the electronic learning package application for post-CPR enhanced CPR nurse students' knowledge as well as this instructional material that emphasized the significance of CPR in life-saving efforts and enhanced students affect component in having positive emotions towards performing CPR on people and assisting others.

Based on the ABC model of attitude, it can be explained that the engaging and flexible nature of BL enhances students' CPR knowledge, where the comprehensive and multimedia-rich content ensures a deep cognitive understanding of CPR techniques, reinforcing students' belief in their ability to perform CPR effectively and safely. The increase in knowledge observed in this study may have contributed to raising awareness of the importance of performing CPR in saving the injured. Consequently, it improved students' positive emotional response towards conducting CPR experiences for others, making it less stressful for them. Evidence by [26] revealed that

the CPR BL method with virtual simulation enhanced self-directed learning abilities among nurse students. Further, the repeated practice and hands-on simulations build confidence and readiness to perform CPR, translating into proactive behavior to conduct CPR. By addressing all three components of the ABC model, BL proves to be a highly effective method for improving attitudes toward CPR training among undergraduate students.

This finding coincides with the outcome of former studies [14, 50, 77, 79] that found BL in the context of CPR and BLS to be effective in improving attitudes regarding CPR. Also, the results support the finding's study [103] that found CPR training can positively impact attitude. Moreover, the outcomes of this study are supported by a research discovery [80] that found CPR multimedia learning enhanced nursing students' willingness to perform CPR.

5 CONCLUSIONS

The importance of this study lies in its contribution to achieving the third SDG, which relates to enhancing and providing health services, particularly in increasing the survival rate of cardiac arrest. This study addresses a gap in the educational literature regarding the implementation of BL in the context of CPR education among non-medical and health students.

The study's results indicate that the utilization of BL in CPR training programs has proven to be effective in enhancing the knowledge of CPR and the students' attitudes toward performing it. The study highlights the importance of adopting modern instructional strategies and approaches (i.e., BL) that combine theoretical and practical aspects to effectively design and implement CPR training. In addition, by employing suitable technology and multimedia in the educational process, individuals' understanding and attitudes towards performing CPR can be enhanced, thereby increasing their readiness and response in medical emergencies that align with the third SDG. Hence, the study focuses on the significance of investing in BL programs as an effective tool to promote awareness and vital rescue skills within communities, eventually leading to positive outcomes in survival rates during health emergencies.

The study's limitations stem from its relatively small sample size of 81 students from a single private university. This limitation restricts the generalizability of the findings to broader populations. Consequently, it's imperative to urge researchers within the domains of education and health to replicate this study across diverse and larger samples and to undertake additional research exploring the effects of employing BL in enhancing CPR skills.

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7 AUTHORS

Aseel O. Ajlouni is an Assistant Dean for Development, Academic Advising, and Community Service at the School of Educational Sciences, The University of Jordan. She has published several research papers on integrating technology in the classroom, online teaching and learning (E-mail: a.ajlouni@ju.edu.jo).

Reem M. Abuabbas works at Jordan University Hospital in the Anesthesia and Intensive Care Department. She holds a diploma in anesthesia and intensive care, a bachelor's degree in microbiology, and a higher diploma in instructional digital design.

Hatem A. Shlool is an Assistant Professor and the Head of the Physical and Health Education Department at Al-Ahliyya Amman University. He has published several papers on advancing physical and health education.