Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Design and implementation of an information and communication technology-supported first aid training intervention aimed at undergraduate students

E. Esteban-Valverde

eestebanva@gmail.com

Universitat de Vic - Universitat Central de Catalunya

L. Llauger-García

Universitat de Vic - Universitat Central de Catalunya

A. Esteban-Valverde

Public Education Center of Aragon

G. Gonzalez-Caminal

Research Group in Transformative Innovation and Simulation

Research Article

Keywords: (MeSH): first aid, mobile applications, simulation training

Posted Date: March 23rd, 2026

DOI: https://doi.org/10.21203/rs.3.rs-8817527/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: No competing interests reported.

Design and implementation of an information and communication technology-supported first aid training intervention aimed at undergraduate students

Author: E. Esteban-Valverde[1], L. Llauger-García[1,2], A. Esteban-Valverde[3], G. Gonzalez-Caminal[4]

[1] Universitat de Vic - Universitat Central de Catalunya, Spain. https://orcid.org/0009-0009-3004-4606
[2] Althaia Xarxa Assistencial Universitària de Manresa, Spain. https://orcid.org/0000-0002-0660-2526
[3] Public Education Center of Aragon Government, Spain.https://orcid.org/0009-0000-5558-7433
[4] Research Group in Transformative Innovation and Simulation, Spain. https://orcid.org/0000-0002-7697-0623

Contact: Eva Esteban-Valverde. Mail: eestebanva@gmail.com
Universitat de Vic - Universitat Central de Catalunya, Spain

1. ABSTRACT

Background: First aid is the initial care provided in response to acute illness or injury, with objectives to preserve life, alleviate suffering, prevent deterioration, and promote recovery. Our hypothesis is that incorporating a mobile application into a first aid training intervention for undergraduate students will enhance their knowledge acquisition in these situations.
The objectives of the study are to design and assess the performance of a first aid training program supported by information and communication technology tools that combines self-learning and practice with simulation for undergraduate students.
Methods: The learning content comprises three topics: seizure crises, basic life support with automated defibrillation, and airway obstruction. The methodology was a hybrid format, with online theoretical material complemented by synchronous training sessions through simulation. To evaluate the intervention, multiple choice tests were implemented before and after the training and performance checklist during simulations.
Results: Performance outcomes during simulation obtain the required items to guarantee the competence. The participants rated the application positively and gained confidence in responding to an emergency.
Conclusion: Use of IT devices can be an alternative to traditional face-to-face teaching. Simulation is an indispensable tool in first aid education that promotes the automation of actions and participant satisfaction.

Keywords (MeSH): *first aid, mobile applications, simulation training.*

Practice points:

- Educating the community is an essential method to increase the provision of first aid by bystanders and improve survival chances.
- Clinical simulation allows acquiring first aid skills without posing any risk to patients.
- Teaching through mobile or IT app and devices decreases students' cognitive load and enhances the learning process.

2. BACKGROUND

First aid is the initial care provided in the event of an acute illness or injury. Its goals include preserving life, alleviating suffering, preventing progression, and promoting recovery [1,2] of the detected situation.

Out-of-hospital cardiac arrest (OHCA) is a severe global public health issue. In Spain, It is estimated that 30.000 people experience a OHCA annually, and only 5 to 10% of individuals fully recover [3], representing an estimated 2.250 deaths annually or an average of 6 deaths per day. In Europe, 400.000 OHCA occurs annually, and less than 10% survive [4].

Intervening within the first 3-4 minutes can increase survival rates to over 50% [3,4]. Bystander initiation of cardiopulmonary resuscitation (CPR) remains suboptimal in some countries (average 50%; range 13-83%) [5]. The factors correlated with up to 50% survival rates and reduced neurological complications include early initiation of CPR, performing high-quality CPR, early defibrillation, and epinephrine administration [6].

Victims who received an electric shock from a bystander were significantly more likely to survive discharge compared to whose initial shock was performed by emergency services (66.5% vs. 43.0%) and were discharged with a favorable functional outcome (57.1% vs. 32.7%) [7].

A study evaluated that during an OHCA chest compressions were not delivered half of the time and most compressions were too shallow [8], emphasizing the importance of the dissemination and implementation of these life-saving skills.

In cases of OHCA, CRP by a trained bystander multiplies the chances of survival between 2 to 4 times [6]. Training of the population, therefore, is considered an important way to increase the first aid provided by passers and the possibilities of survival [4].

Epilepsy affects around 50 million people worldwide [9]. Epilepsy and functional neurological disorders are common, can cause alterations in consciousness and/or seizures, and are therefore both associated with significant disability and psychological distress [10].
Almost 10% of people experience at least one seizure in their lifetime. Most of the seizures are self-limiting events but some may develop cardiac arrest [11]. Although seizures are common, they require careful evaluation and management [12].

The airway obstruction due to foreign bodies is an important health problem causing 250 deaths in the United Kingdom and 5,200 deaths in the United States per year. Early removal of foreign-body airway obstruction (FBAO) by bystanders was associated with improved neurological survival [13].

In general, first aid skills are needed to deal with all these common emergencies [2].

The goal of saving more lives depends not only on sound, high-quality science but also on effective education. The European Resuscitation Council (ERC) urges the provision of CPR training within higher education institutions [5] including also non health sciences profiles. Promoting the acquisition of first aid knowledge defends two fundamental rights; education and health protection. Both are included in articles 14, 34 and 35, respectively, of the "Charter of Fundamental Rights of the European Union", 2012/C 326/02 and in articles 27 and 43, respectively, of the Spanish Constitution from December 1978.

Clinical simulation recreates real-life scenarios to practice safely, making it essential for learning first aid without causing harm to patients. The World Health Organization recommends simulation as a methodology for training healthcare professionals [14]. The Simzone framework aids in implementing simulation scenarios, ensuring the quality of activities. It permits simulation development with specific learning needs, aiming to prevent organizational issues and ensure effective learning [15,16]. Simulation stands out as experiential learning that encourages students to participate and act in front of a multiplicity of scenarios, from basic to complex analyzing them [17].

Studies have shown that self-learning supported with IT devices, especially with mobile phones, reduces students' cognitive load and facilitates learning. Its advantages are the convenience, efficiency, organization, and flexibility [18,19]. The ERC recommends its use for pre-course e-learning for all levels of CPR courses [20]. Because of their ubiquity, smartphone applications are an ideal device to disseminate education and guidance on CPR [6]. Mobile learning can stimulate interest in training and is likely to play an increasingly important role in clinical education [17,19].

Therefore, different articles reference a lack of basic knowledge about first aid [3,5], and others have highlighted the benefit of simulation training [15,16] and mobile learning [18,19] to cover the topic.

Hypothesis: the combination of self-learning with IT devices and simulation in hybrid theoretical-practical training for undergraduate students improves the acquisition of competence about first aid.

2.1.1. General objectives

1. Design and evaluate a training on first aid combining self-learning thought out IT devices and simulation for undergraduate students.
2. Know the impact of including a self-learning support method on a first aid training for undergraduate students.

2.1.2. Specific objectives

1. Design a first aid hybrid training course combining self-learning theoretical content and simulation covering three prevalent topics on first aid for undergraduate students.
2. Evaluate performance during a critical situation through simulation.
3. Assess the self-efficacy of the training process of the participants.
4. Validate the suitability and usability of the app tool as an easy and intuitive training complement for students.

3. METHODOLOGY

3.1. Study design

This analytic study used a pre-post assessment for a first aid training intervention. The material designed and used for the study previously published [21]

3.2. Population, sampling and recruitment

The target population consisted of undergraduate students from the UVic-UCC, campus Vic, Spain. Inclusion criteria were enrollment in any undergraduate faculty at UVIC-UCC, completion of the registration form, and download and access to the mobile application.

The sample was calculated with GRANMO for repeated paired measures in a group, accepting an alpha risk of 0.05 and a beta risk of 0.2 in a bilateral contrast, 40 subjects were required to detect a difference equal to or greater than 0.5 units. A standard deviation of 1 was assumed. A loss to follow-up rate of 20% had been estimated.

To recruit, an announcement was broadcast via WhatsApp, including a descriptive message and the URL of the Microsoft Forms® registration form. Additionally, A3-size posters and A5-size flyers of the same design were distributed throughout the campus.

3.3. Instruments

Sociodemographic information was collected using the registration form. Two adhoc questionnaires (Annex 1 on supplementary file) consisting of 30 multiple choice (true/false) were validated [21]. A pedagogical guide with ad hoc checklist (Annex 2 on supplementary file) was also design and implemented to assess performance during simulation. A satisfaction survey was designed following the Learning-Transfer Evaluation Model [22, 23] and a self perception form assessing degree of understanding, ability to explain, recognize, and act in an emergency.

3.4. Intervention

The Moodle application was chosen as suitable and accessible for all university members. The data generated was securely stored and protected within the institution's server space. The application enabled offline access to content, maintained activity records, recorded grades for each student, and facilitated communication with participants through notifications.

Once participants registered, they took a pre-test to assess baseline knowledge of the topics. Then participants followed the course, to be completed in 4 weeks and enrolled in a simulation session. Following the simulation standards, participants were grouped into 7-8 participants to

create subgroups for the simulation. There were 6 subgroups that were randomly divided according to the availability of participants.

The practical part of the course consisted of three simulation stations. The Faculty of Health Sciences of the UVic-UCC provided the required material, a classroom, 4 mannequins, and 2 DEA for each training day.

3.5. Statistical analysis

Due to the pre-post study, a paired data analysis was applied. Demographic variables such as university degree, gender, previous training, academic year, and age, as well as study variables including global simulation, PCR, FBAO, seizure scores, and questionnaire responses, were analyzed.

Descriptive analysis was performed for demographic variables, and group comparisons were conducted using chi-square or Fisher's exact tests for nominal variables and the Kruskal-Wallis test for ordinal and continuous variables. Continuous variables were evaluated for normality with appropriate parametric or non-parametric tests applied based on the results. A significance level of $p<0.05$ was set for all statistical tests. Inferential statistics included linear regression analysis and paired samples t-tests to compare pre- and post-intervention.

MS Excel® was used for collecting primary data and IBM SPSS Statistics® 29.0.2.0 and RStudio® 4.3.3 for statistical analyses.

4. RESULTS

4.1. Flow-chart

A flowchart (**Figure 1**) was created. The STROBE (STrengthening the Reporting of OBservational studies in Epidemiology) guidelines to ensure clarity and quality in the reporting of the observational study was followed [24].

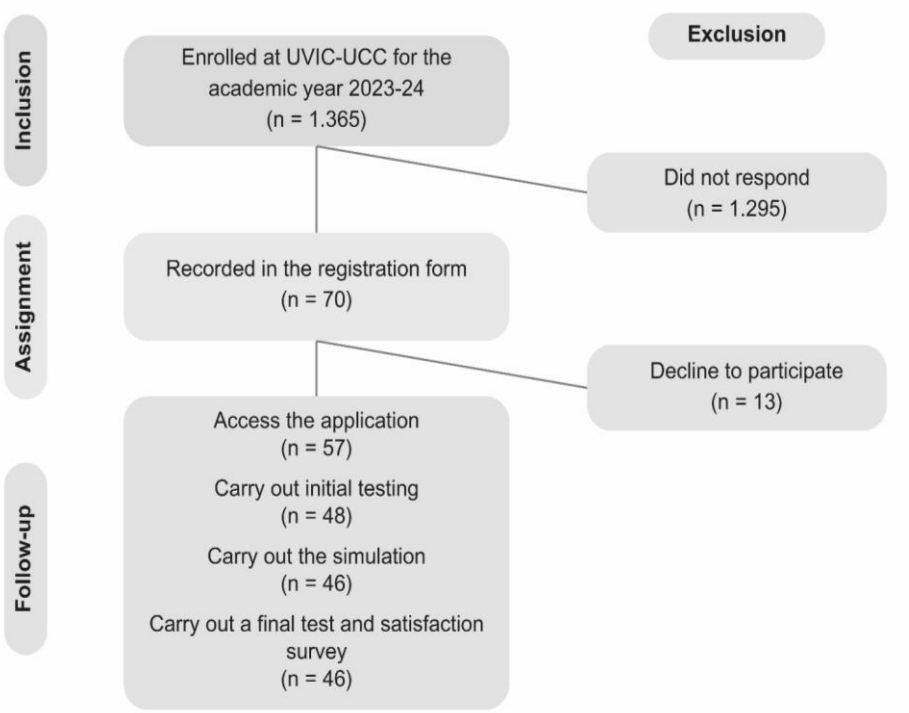


Figure 1: *Flow-chart*

4.2. Recruitment and preparation

The course was designed from June to October 2023. Ethics committee approval was obtained on 19th December 2023 with approval reference ID 295/2023. Registration opened during January and February 2024. The intervention, access to the mobile app and simulation training were from February to April 2024.

4.3. Baseline data

To analyse results, participants were segmented into either medicine students or students of other degrees to mitigate potential biases.The gender variable did not significantly differentiate between both groups and was not considered a dividing factor. Health sciences group came from a Medicine degree (n=31, 100%). Among other university degrees, participants belonged to Physical Activity and Sport Sciences with a Primary Education Teaching (n=6; 40.0%), Early Childhood Education and Primary Education Teacher (n=4; 26.7%), Biomedicine (n=3; 20.0%), Dentistry (n=1; 6.67%), and Psychology (n=1; 6.67%). **Table 1** shows sociodemographic characteristics by groups, medical students, or from other careers.

	Medicine ***N=31***	**Other careers** ***N=15***	**p-value**
Age	20.6 [19.5;22.3]	19.6 [18.9;21.2]	0.101
Gender			0.723
Woman	22 (71.0%)	12 (80.0%)	
Academic year			0.516
First	11 (35.5%)	5 (33.3%)	
Second	11 (35.5%)	7 (46.7%)	
Third	0 (0.00%)	1 (6.67%)	
Fourth	8 (25.8%)	2 (13.3%)	
Fifth	1 (3.23%)	0 (0.00%)	
Previous training in first-aid			0.078
Yes	7 (22.6%)	0 (0.00%)	

Shown: the median [25th percentile – 75th percentile], absolute number (percentage)

Table 1. Sociodemographic characteristics

4.4. Outcomes and estimation

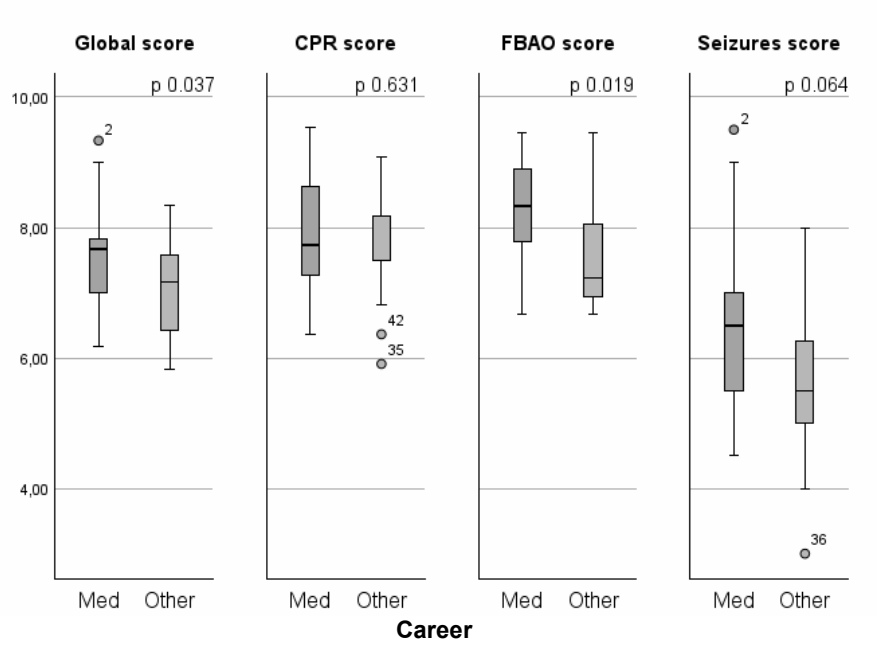
4.4.1. Simulation outcomes

The data used consisted of the score for each simulation block and the total score out of 10 (**Figure 2A**). Significant differences were found in the global simulation score and FBAO block. The box plot (**Figure 2B**) shows the median and interquartile range of each block divided by students of the two categories.

	All ***N = 46***	**Medicine** ***N = 31***	**Other careers** ***N = 15***	Difference of means	p-value
Global	7.33 (0.76)	7,49 (0,74)	7,00 (0,71)	0.495 (95% CI: 0.300-0.959)	0,037
CPR	7.88 (0.84)	7,92 (0,84)	7,79 (0,86)	0.130 (95% CI: 0.418-0.678)	0,631
FBAO	7.78 [7.22;8.89]	8,33 [7.78;8.89]	7.22 [6.94;8.06]	0.633 (95% CI: 0.113-1.154)	0,019

Seizures	6.12 (1.31)	6,37 (1,28)	5,6 (1,27)	0.770 (95% CI: 0.049-1.591)	0,064

A *Shown: the median [25th percentile – 75th percentile], absolute number (percentage)*



B

Figure 2. (A)*Table descriptive and* ***(B)*** *Boxplot of simulation scores by blocks*

The checklist (Annex 2 on supplementary file) was examined for each section. Results showed significant differences between groups in 5 items. In the CPR section, "open airway" (p 0.026) and "safe defibrillation" (p 0.010). In the FBAO block, "ask the victim if they can breathe" (p 0.042) and "recognize loss of consciousness" (p 0.014). Regarding seizure episodes, "communicate with a healthcare professional" (p 0.010).

Two linear regression models were carried out with the total score variable of the FBAO block and global simulation score. Equality of variances was accepted with non-statistically significant linear relationship ANOVA (FBAO p 0.065, Global p 0.360), a normal distribution of the standardized errors (FBAO p 0.189, Global p 0.200), independent errors by Durbin-Watson statistic (FBAO p 1.873, Global 1.335), homogeneity of variances and no extreme observations with substantial influence (Cook's distance).

Being a medical student was associated with 19% of the variability in FBAO block score (R-squared 0.1990). Not being a medical student corresponded to an average of -0.5 points less.

The linear regression prediction model was formulated as follows: FBAO score = 6.725 - 0.562 x Med_no + 0.060 x Age + 0.437 x Gender + 0.133 x Previous training.
Being a medical student was associated with a 9% variability in the overall simulation score (R-squared 0.095). The predictive model formula for global score was 6.725 - 0.527 x Med_no - 0.003 x Age - 0.083 x Gender + 0.099 x Previous training.

4.4.2. Training process

The data used consisted of the results of pre and post-course competence exams (Annex 1 on supplementary file) on first aid, use of the mobile application, and simulation.

The analysis of paired measures from the initial and final questionnaires yielded a p-value of < 0.01 for the entire sample and for the group of medical students, and a p-value of < 0.014 for the group of non-medical university students. The null hypothesis was rejected.

The initial questionnaire had an average score of 7.69. The final questionnaire had an average score of 8.92. Reveals differences by group in the final questionnaire (p < 0.006), but no significant differences were found in the comparison between the final and initial questionnaires (p = 0.618). The discrepancy between the measures before and after obtained a media of 1.24 [IQR 0.44;2.22] with no differences between groups.

Figure 3 shows the box plot of the scores from 0 to 10 for the pre-intervention and post-intervention tests, as well as the discrepancy in scores between the two.

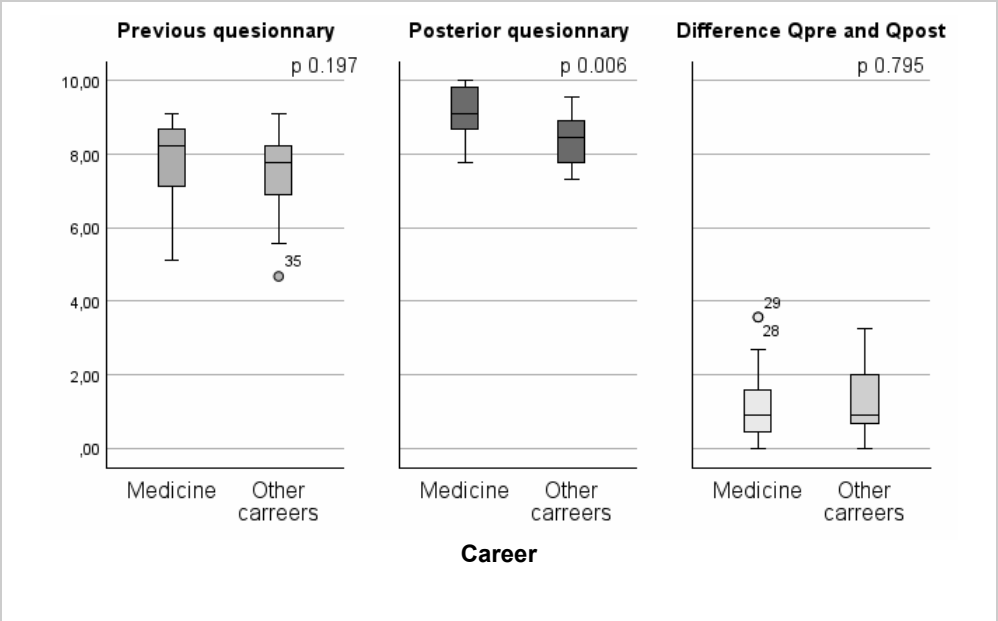


Figure 3. *Boxplot questionnaires by career*

A linear regression model was carried out with the discrepancy score competence questionnaires variable.
Equality of variances was accepted with a normal distribution of the standardized errors (p 0.200), independent errors (p 2.210), homogeneity of variances, and no extreme observations with substantial influence.

The variances were marginally associated (p = 0.052) with the simulation score but not with the other variables (age, gender, medical student status, or prior training). Doing a simulation training was associated with a 14.5% variability in the contrast pre-post intervention score (R-squared 0.1450). The predictive model formula for global score was 2.990 - 0.481x Simulation score -0.482 x Med_no + 0.113 x Age - 0.151 x Gender + 0.142 x Previous training.

4.4.3. Participant satisfaction

Across uMARS test sections, no differences were found between medical students and those from other fields. The highest average scores by sections were observed in information (5.00 [4.31;5.00]) and functionality (4.75 [4.06;5.00]), followed by design aesthetics (4.33 [4.00;5.00]), engagement (4.20 [3.80;4.80]), and lastly, subjective quality (3.61 [SD 0.53]).

Questions 1, 18, 19, and 20 received response values of 2. Most of the questions (26/30 the 86.67%), received a minimum value of 3 from a Likert up to 5, being 5 excellent.

Figure 4.A shows the answers on the uMARS test in Likert scale from 1 to 5 [22]. And **figure 4.B** presents the participants as perception of the training received was assessed using a 5-pointed Likert scale.
No question obtained a response lower than 3, values 1 and 2 were not selected by any participant. No differences were found between the participants who were medical students or from other fields for any question. The scores obtained were 4.39 (SD 0.577) for the perception of understanding the concepts provided, 4.17 (SD 0.769) for the ability to explain them, 4.24 (SD 0.736) for the skill to recognize emergency situations, and 4.33 (SD 0.560) for the ability to act appropriately.

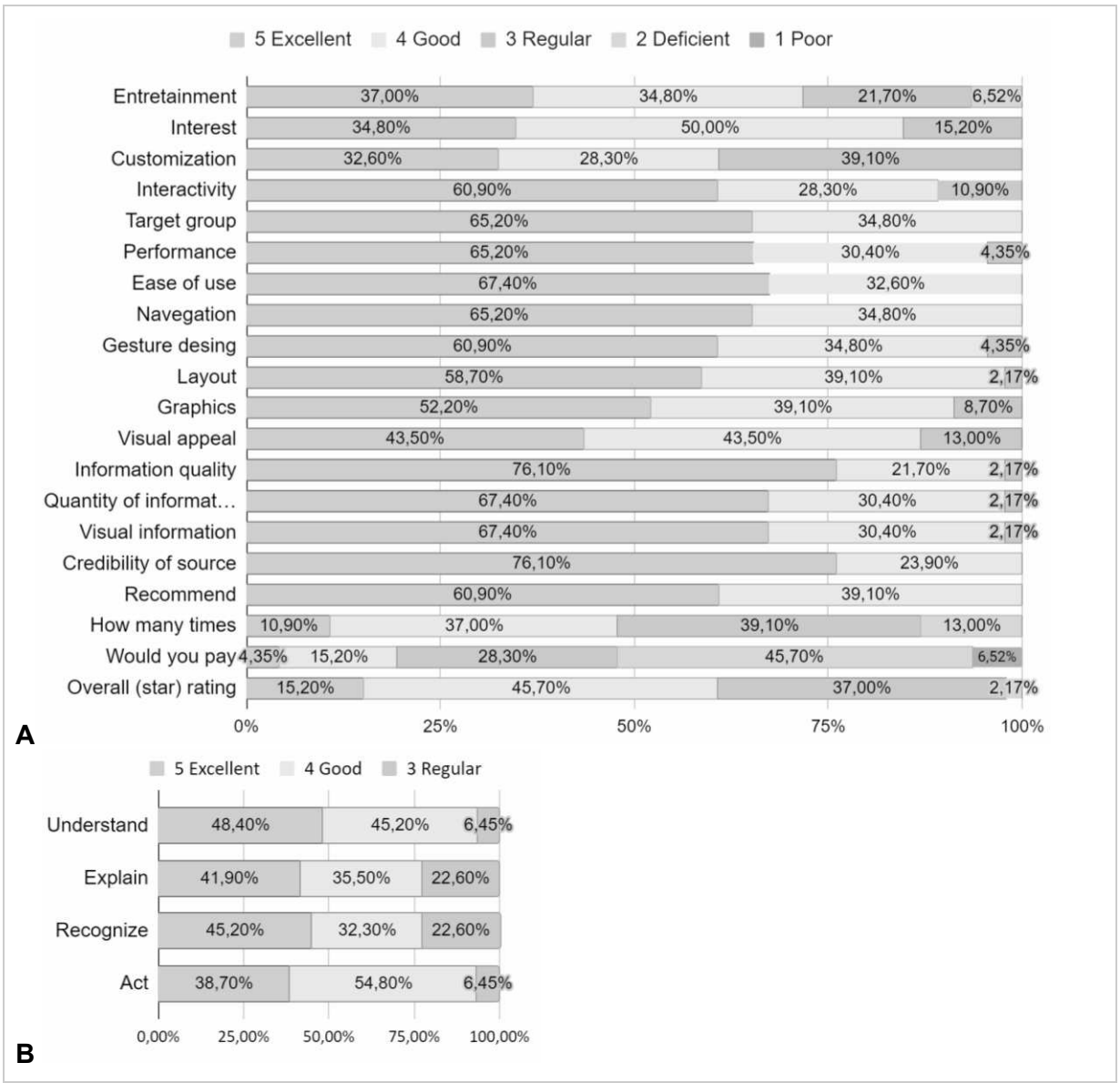


Figure 4. (A) *Stacked bar chart of uMARS questions and* ***(B)*** *self-evaluation answers*

5. DISCUSSION

5.1. Interpretation

An information and communication technology-supported first aid training intervention was feasible, irrespective of the type of undergraduate student. The incorporation of a preliminary

self learning training available with mobile app, was positively rated/evaluated, encouraged participation, and enabled flexible learning.

Simulation practice facilitated the acquisition of technical skills according to protocols and quality standards. Clinical simulation favoured the theory integration in a contextual setting and provided a safe and effective teaching environment. It is consistent with a study conducted on nursing students supporting the positive impact of serial simulation activities on learning, satisfaction, and self-confidence. The students reported being satisfied with the experience and felt confident in their performance [25]. Overall simulation scores were high. The seizures section scored lower, potentially due to less given importance. The differences between groups on certain questions could be prior healthcare competence. Having theoretical material available beforehand facilitates the integration of skills and the automation of the steps to follow.

It can be stated that the intervention was effective and useful for both healthcare and non-healthcare undergraduate students. This is consistent with another study which concluded that the intervention significantly improved students' competence and confidence regarding cardiopulmonary resuscitation skills [26].

Simulation impacted the overall intervention outcome regardless of age, gender, academic program, and previous training. The remaining variability could be explained by the theoretical training provided through the mobile application. This is consistent with a meta-analysis that demonstrated a significant improvement in skills with mobile learning intervention, namely to significantly enhance the skills, knowledge, satisfaction, and confidence among nursing students [19]. The data obtained in our observational trial allow for extending this assertion to medical students and even non-healthcare university degrees.

The results of the uMARS test were satisfactory regarding the design and content of the Moodle application. It demonstrated an increase in theoretical participation due to accessibility. The majority of students expressed their belief that they have acquired the skills to understand, recognize, and act appropriately in emergencies. It is consistent with the meta-analysis that determined that students were more satisfied with the mobile learning intervention and had more confidence than those who received traditional teaching methods [19].
Participants felt that they had acquired the competence and skills necessary to deal with medical emergencies as first responders.

The intervention was primarily conducted by a senior, a sixth-year medical student, and the results were statistically significant. It is consistent with a study that demonstrated medical students are able to train as volunteer instructors to teach basic life support and CPR techniques [28, 29].
It is proposed that senior health science students could offer the course to students from other disciplines or non-healthcare fields.

5.2. Generalizability

The total number of students enrolled in an official degree program at UVIC-UCC is 1.365 [27]. Although the sample size exceeded the calculated sample size for this type of study, the studied population was not representative. Nonetheless, this study is reproducible to other context and fields since aim training population for first aids.

5.3. Limitations

Due to challenges faced in developing the web application, the course was made using the Moodle mobile application. This prevents undergoing training without enrolling in the university institution. Future plans include completing the application's development to make it accessible

to the general population and offering theoretical content and self-assessment quizzes on various topics.

Time constraints prevented making it challenging to assess long-term competence retention. However, the mobile application could address this issue by providing accessible information and updates. It is recommended to renew the course to general population and conduct simulations periodically to reinforce knowledge retention. The application is a support for ongoing learning.

6. CONCLUSION

Simulation is an indispensable tool in first aid education that promotes the automation of actions and participant satisfaction.

ICT on smartphones can be an alternative to traditional face-to-face teaching, facilitating adaptation to the learning pace of each student. Having the mobile application means having access to updated information at any time and place and being able to consult it in case you have to act in a first aid situation.

It is recommended to regularly implement first aid training in university degrees and integrate the mobile application for theoretical teaching.

7. DECLARATIONS

7.1. Ethics approval and consent to participate

This study complies with the ethical principles of the Declaration of Helsinki. Participants were informed about the project, data handling, and their rights, and provided informed consent. Ethical approval 295/2023 was obtained from the Research Ethics Committee of the University of Vic Central - University of Catalonia (UVic-UCC) December of 2023.
The study did not receive any external funding and the authors declare no conflicts of interest.

7.2. Data availability statement

The data that support the findings of this study are available from the corresponding author, E Esteban-Valverde, upon reasonable request.

7.3. Disclosure statement

No potential conflict of interest was reported by the author(s).

7.4. Funding

The author(s) reported there is no funding associated with the work featured in this article.

7.5. Authors' contributions

EEV, LLG, GGC, and AEV contributed to the conception and design of the study and to the development of the ad hoc research materials. EEV and LLG conducted the practical simulation training as instructors. EEV was responsible for data collection and formal data analysis. All authors contributed to the validation and interpretation of the data obtained from the pre–post tests, simulation checklists, descriptive variables, and the results of the analyses.All authors participated in drafting, critical revision, and editing of the manuscript. EEV was a major contributor in writing the manuscript. All authors read and approved the final manuscript.

7.6. Acknowledgements

I would like to express gratitude to close individuals such as Pedro, Mª Jesús, Ana, and Ignacio, and my menthors whose unwavering support has been invaluable during the most challenging moments of this project.

We would like to thank the University of Vic-University of Catalonia for their collaboration, especially the Faculty of Medicine, which has allowed us to develop this project.

7.7. Authors' information

Eva Esteban-Valverde, MD and Nurse, collaborator at the Universitat de Vic - Universitat Central de Catalunya (UVic-UCC). Pneumology resident physician at Universitary Hospital Miguel Servet, Spain.

Griselda Gonzalez-Caminal, PhD in Education, Physiotherapist and Expert in Clinical Simulation. Research Group on Transformative Innovation and Simulation (GRITS), Spain

Ana Esteban-Valverde, BDc, MSc, teacher at the Public Education Center of Aragon Government, Spain.

Lluís Llauger-García, MD, PhD, Emergency physician at Althaia Xarxa Assistencial of Manresa. Institute for Research and Innovation in Life and Health Sciences in Central Catalonia (IRIS-CC). Associate Professor at the Faculty of Medicine of the UVic-UCC, Spain

8. REFERENCES

1. Wyckoff MH, Greif R, Morley PT, Ng KC, Olasveengen TM, Singletary EM, et al. 2022 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations: Summary from the Basic Life Support; Advanced Life Support; Pediatric Life Support; Neonatal Life Support; Education, Implementation, and Teams; And First Aid Task Forces. Circulation. 2022 Dec 20;146(25):483-557.
2. Minna S, Leena H, Tommi K. How to evaluate first aid skills after training: a systematic review. Scand J Trauma Resusc Emerg Med. 2022 Nov 8;30:56.
3. Ferrer Roca R, Gómez López R, López de Sá E, Ariza Solé A. Accreditation in the management of cardiac arrest in Spanish hospitals. CAPAC Project. SEC. 2023;
4. Papadopoulou A, Ferreira J, Higgins J, Parvanova Raül Romeva Rueda A. Declaración por escrito presentada de conformidad con el artículo 123 del Reglamento sobre la creación de una Semana Europea del Paro Cardiaco. CERCP. 2012;
5. Perkins GD, Gräsner JT, Semeraro F, Olasveengen T, Soar J, Lott C, et al. European Resuscitation Council Guidelines 2021: Executive summary. 2021;
6. Marsh-Armstrong BP, Seng E, Ting-Wei F, Saka S, Greenberg M. Effectiveness of rescue Me CPR! smartphone app providing real-time guidance to untrained bystanders performing CPR. Heliyon. 2023 Oct 12;9(10):e20908.
7. Pollack RA, Brown SP, Rea T, Aufderheide T, Barbic D, Buick JE, et al. Impact of Bystander Automated External Defibrillator Use on Survival and Functional Outcomes in Shockable Observed Public Cardiac Arrests. Circulation. 2018;137(20):2104–13.
8. Wik L, Kramer-Johansen J, Myklebust H, Sørebø H, Svensson L, Fellows B, et al. Quality of Cardiopulmonary Resuscitation During Out-of-Hospital Cardiac Arrest. JAMA. 2005 Jan 19;293(3):299–304.
9. Newman H, Rudra S, Burrows L, Tromans S, Watkins L, Triantafyllopoulou P, et al. Who cares? A scoping review on intellectual disability, epilepsy and social care. Seizure: European Journal of Epilepsy. 2023 Apr 1;107:35–42.
10. Williams IA, Morris PG, McCowat M, Gillespie D. Factors associated with illness representations in adults with epileptic and functional seizures: A systematic review. Seizure: European Journal of Epilepsy. 2023 Mar 1;106:39–49.
11. Zarisfi F, Pek JH, Oh JHH, Loke JH, Lim SH. Singapore first aid guidelines 2021. Singapur Med J. 2021 Aug;62(8):427-432.

12. Foster E, Carney P, Liew D, Ademi Z, O'Brien T, Kwan P. First seizure presentations in adults: beyond assessment and treatment. J Neurol Neurosurg Psychiatry. 2019 Sep 1;90(9):1039–45.
13. Couper K, Hassan AA, Ohri V, Patterson E, Tang HT, Bingham R, et al. Removal of foreign body airway obstruction: A systematic review of interventions On behalf of the International Liaison Committee on Resuscitation Basic and Paediatric Life Support Task Force Collaborators. 2020;
14. Battles J, King H. Training Guide: Using Simulation in TeamSTEPPS® Training. AHRQ. 2016;
15. Roussin CJ, Weinstock P. SimZones: An Organizational Innovation for Simulation Programs and Centers. Academic Medicine. 2017 Aug 1;92(8):1114–20.
16. Riera Claret C, Espino Datsira S. Simulación. De la estrategia institucional al caso concreto. Editorial Graó; 2021.
17. Bolatli G, Kizil H. The Effect of Mobile Learning on Student Success and Anxiety in Teaching Genital System Anatomy. Anat Sci Educ. 2022 Jan 1;15(1):155–65.
18. Chen B, Wang Y, Xiao L, Xu C, Shen Y, Qin Q, et al. Effects of mobile learning for nursing students in clinical education: A meta-analysis. Nurse Educ Today. 2021 Feb 1;97:104706.
19. Greif R, Lockey A, Breckwoldt J, Carmona F, Conaghan P, Kuzovlev A, et al. European Resuscitation Council Guidelines 2021: Education for resuscitation. Resuscitation. 2021 Apr 1;161:388–407.
20. Bauman EB. Games, Virtual Environments, Mobile Applications and a Futurist's Crystal Ball. Clin Simul Nurs. 2016 Apr 1;12(4):109–14.
21. Esteban-Valverde E, Llauger-García L, Gonzalez-Caminal G. Combining self-learning through mobile app with simulation to increase competency in first-aid for non-medical students: design of a new course for education students. EDULEARN24. 2024 July 1; 2372-2381.
22. Martin-Payo R, Carrasco-Santos S, Cuesta M, Stoyan S, Gonzalez-Mendez X, Del Mar Fernandez-Alvarez M. Spanish adaptation and validation of the User Version of the Mobile Application Rating Scale (uMARS). Journal of the American Medical Informatics Association. 2021 Nov 25; 28(12):2681–6.
23. Thalheimer W. The Learning-Transfer Evaluation Model: Sending Messages to Enable Learning Effectiveness. 2018;
24. Fernandez E. Estudios epidemiológicos (STROBE). Medicina clínica. 2005 Dic 125; S1: 43-48.
25. Zapko KA, Ferranto MLG, Blasiman R, Shelestak D. Evaluating best educational practices, student satisfaction, and self-confidence in simulation: A descriptive study. Nurse Educ Today. 2018 Jan 1;60:28–34.
26. Manuel SA, Tanna DB, Patel HK, Bose N. Preparing future Indian medical graduates for emergencies at the Foundation Course: Do the knowledge and self-confidence increase after basic cardiac life support training? Indian J Anaesth. 2022 May 1;66(5):358–67.
27. AQU Catalunya. EUC. 2022 [cited 2024 May 17]. Informes grados Estudis Universitaris de Catalunya (EUC). Available from: https://estudis.aqu.cat/euc/es/
28. A. Ismail et al. Local medical students can be instructors for life-saving first-aid courses for lay people: a descriptive study from Gaza. The Lancet. 2019 Mar; 393:31.
29. von Amelunxen B, Kirk S, Hind J, Illibauer J, Krall C, Lessing S, Noyelle A, Murphy PMJ, Sterz F. A six-year teaching life supportive first aid program to eventually generate peer trainer pupils: a prospective case control study. BMC Med Educ. 2023 Jul 5;23(1):496. doi: 10.1186/s12909-023-04476-x. PMID: 37407965; PMCID: PMC10324247.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- MaterialBMC.pdf