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REVIEW ARTICLE

Use of digital technologies in the cardiopulmonary resuscitation teaching-learning process: an integrative review

Uso das tecnologias digitais no processo ensino-aprendizagem em ressuscitação cardiopulmonar: revisão integrativa

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ABSTRACT

Objective: The aim was to identify the scientific evidence available in the literature on the use of digital technologies for the teaching and learning of cardiopulmonary resuscitation. **Method:** Integrative literature review performed on the PubMed, CINAHL, Scopus, SciELO and LILACS databases. One hundred six studies were identified and of these, only eight made up the sample. **Results:** The main technologies identified and considered effective were virtual simulators, online courses, Telegram and HeartCode™, involving affective, cognitive and psychomotor skills. Virtual simulation was the most adopted and effective for the development of cognitive, psychomotor and affective skills. **Conclusion:** This study contributes to research, teaching and care by presenting a framework of scientific evidence related to the articulation of digital technologies and the teaching of cardiopulmonary resuscitation, exposing digital pedagogical possibilities for the best practices and de-velopment of cognitive, psychomotor and affective skills.

Descriptors: Teaching; Educational Technology; Cardiopulmonary Resuscitation; Review.

RESUMO

Objetivo: Identificar as evidências científicas disponíveis na literatura sobre o uso de tecnologias digitais para o ensino e aprendizagem da ressuscitação cardiopulmonar. **Método:** Revisão integrativa da literatura realizada nas bases PubMed, CINAHL, Scopus, SciELO e LILACS. Foram identificados 106 estudos e destes, apenas 8 compuseram a amostra. **Resultados:** As principais tecnologias identificadas e consideradas efetivas foram a simulação virtual, curso *online*, *Telegram* e *HeartCode*™, envolvendo as habilidades afetivas, cognitivas e psicomotoras. A simulação virtual foi a mais adotada e efetiva para desenvolver habilidades cognitivas, psicomotoras e afetivas. **Conclusão:** Este estudo contribui para a pesquisa, ensino e assistência por apresentar um arcabouço de evidências científicas quanto à articulação de tecnologias digitais e ensino da ressuscitação cardiopulmonar, expondo possibilidades pedagógicas digitais para as melhores práticas e desenvolvimento de habilidades cognitivas, psicomotoras e afetivas.

Descritores: Ensino; Aprendizagem; Tecnologia Educacional; Reanimação Cardiopulmonar; Revisão.

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INTRODUCTION

Anyone who was born after the 80s and was exposed to technologies in the early stages of life is considered a "digital native", highlighting their early and comfortable access to the use of technologies. The "digital immigrant", on the other hand, is the individual born before the 1980s, or prior to the existence of digital technology, although both are exposed to technological devices and their current challenges[1].

In the teaching and learning process, traditional methods are still applied preferentially and may not be able to provoke the ideal stimulus for learning[2,3]. This is a worrisome factor given the changes in students' profile regarding the use of technologies and the need to achieve better results and keep the motivation to learn and improve the development of their skills[3].

Educational technology is defined as the use of digital resources in the teaching process and the use of tools to improve the teaching and learning process, which enhance students' socio-educational development and access to information and knowledge[1].

When considering the teaching and learning process on the theme of Cardiopulmonary Resuscitation, the construction of knowledge, acquisition of psychomotor skills and development of positive attitudes require a standard of excellence for their proper performance[4].

It is known that, for students and health professionals, education based on innovative, current and technological pedagogical resources, such as cardiopulmonary resuscitation, contributes to effective learning and consequently, a quality performance with better patient survival. However, the scientific deepening of the coordination of technology with the teaching of cardiopulmonary resuscitation is still little explored[5].

This incipient scenario of scientific deepening to adopt several digital technologies as the foundation of education on cardiopulmonary resuscitation is associated with the recommendation made by the International Liaison Committee on Resuscitation and the American Heart Association, to adapt the teaching of resuscitation to the target audience, considering that digital natives, through motivating strategies, assist in the development of clinical competence for cardiopulmonary resuscitation[6].

Faced with the need to understand this scenario, the aim of this study was to identify the scientific evidence available in the literature on the use of digital technologies for the teaching and learning of cardiopulmonary resuscitation.

METHODS

This is an integrative review structured in six steps: development of the study question; definition of databases and inclusion and exclusion criteria; definition of the information to be extracted from the selected studies; evaluation of studies included in the review; interpretation of results; presentation of the review/synthesis of knowledge[7].

The study question was structured through the PICO strategy – Patient, Intervention, Comparison, Outcomes[8]. The acronym P (population) addressed students and health professionals; the acronym I (intervention) involved the identification of digital technology-based strategies for cardiopulmonary resuscitation and their effectiveness; the acronym O (outcome) involved the teaching and learning process about cardiopulmonary resuscitation. The acronym C (comparison) was not used in the question development. Thus, the guiding question was: What is the scientific evidence available in the literature regarding the adoption of digital technology strategies for the teaching and learning process of cardiopulmonary resuscitation of students and health professionals?

No review studies corresponding to the use of digital technologies for the teaching and learning of cardiopulmonary resuscitation were found in the national and international literature.

The scientific evidence was identified in August 2020 through virtual access to the following databases: Latin American and Caribbean Health Sciences Literature (LILACS) by consulting the Virtual Health Library (VHL); Medical Literature Analysis and Retrieval System Online (MEDLINE) accessed through the PubMed® portal; Cumulative Index to Nursing and Allied Health Literature (CINAHL) via Main Collection (Thomson Reuters); Scopus (Elsevier); and Scientific Electronic Library Online (SciELO).

In PubMed®/MEDLINE and Scopus, the descriptors in English were selected in Medical Subject Headings (MeSH), namely: Video-audio Media; Teaching; Educational Technology; Cardiopulmonary Resuscitation. The search strategy used was: Video-audio Media OR Audiovisual Media AND Teaching AND Educational Technology AND Cardiopulmonary Resuscitation.

In CINAHL, the descriptors in English were selected in Titles: Video-audio Media; Teaching; Educational Technology; Cardiopulmonary Resuscitation. The search strategy adopted was: Video-audio Media AND Teaching AND Educational Technology AND Cardiopulmonary Resuscitation.

In LILACS and SciELO, were used Health Sciences Descriptors (DeCS) of the Virtual Health Library (VHL) and the Portuguese, English and Spanish versions were adopted: Video-audio Media (*Mídia Audiovisual*), Teaching (*Ensino*), Educational Technology (*Educação Tecnológica*), Cardiopulmonary Resuscitation (*Ressuscitação Cardiopulmonar*). The following strategy was used: Mídia audiovisual AND Ensino AND Ressuscitação Cardiopulmonar

AND Educação tecnológica. The search was performed by two independent researchers simultaneously, who standardized the sequence of use of descriptors and crossings in each database. Then, the results obtained were compared.

The study included: original articles; aimed at students and health professionals; focused on cardiopulmonary resuscitation in adults in Basic Life Support; without language delimitation and time frame. The following were excluded: editorials; theses; dissertations; review articles; and those that did not answer the research question.

First, 106 studies were identified and submitted to the first stage of selection by two professionals independently through the reading of titles and abstracts using a free web-based review program called Rayyan Qatar Computing Research Institute (Rayyan QCRI), found at https://rayyan.qcri.org[9].

Through this program, the studies identified in a determined database can be exported and selected in an organized and fast way with the due blindness of the auxiliary researcher, thereby guaranteeing the reliability and methodological precision of this process[9].

Finally, the publication selection process was presented according to recommendations of the Preferred Reporting Items for Systematic Reviews and Meta-Analyzes (PRISMA), as shown in Figure 1.

In 11 studies, there were divergences between the evaluation of researchers. These were referred to a third researcher, responsible for deciding on their inclusion or exclusion. Then, the full reading was carried out to define the final sample (n=8).

For the extraction and synthesis of information from the selected studies, a validated instrument was used. The following criteria were prioritized: authors, year, origin, objective, technological resource and/or media used and outcome[10].

The level of evidence of studies was evaluated considering: level I – meta-analysis of controlled and randomized studies; level II – experimental study; level III – quasi-experimental study; level IV – observational, cohort, case control studies; level V – evidence from systematic review of descriptive and qualitative studies; level VI – evidence from a single descriptive and qualitative study; and level VII – researchers' and experts' opinions. According to this classification, levels I and II are considered strong evidence, III and IV are moderate and V to VII are weak[11].

RESULTS

Of the studies comprising the sample, the oldest was published in 2010, the most recent in 2019, 7 (87.5%) in

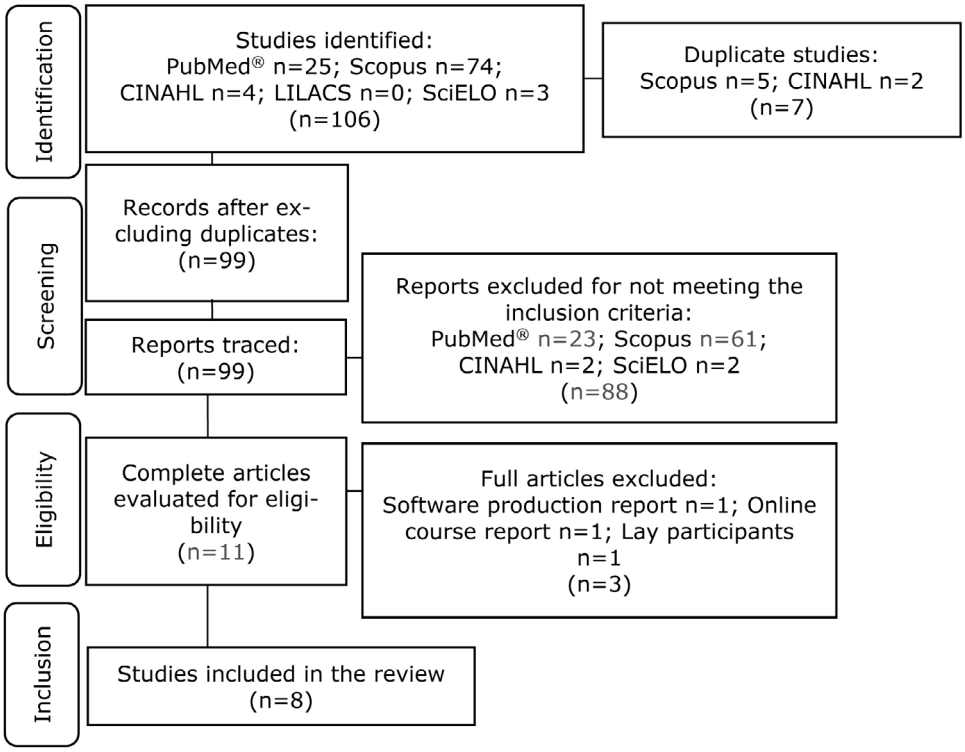

Figure 1. Flowchart of the study selection, according to recommendations of the Preferred Reporting Items for Systematic Reviews and Meta-Analyzes. Passos, MG, Brazil, 2020.

international journals and 1 (12.5%) in a national journal. Most, 7 (87.5%) studies, were characterized as moderate evidence.

The sample of the present research is synthesized in Chart 1, considering objective, method and level of evidence.

Five main technological strategies to enable the teaching and learning process of cardiopulmonary resuscitation were identified, as follows: virtual reality simulator (50.0%); Telegram® (12.5%); Compact Disc-interactive program (12.5%); online course (12.5%) and HeartCode™ BLS (12.5%).

The information related to the resource and/or media used, the skill assessed and the intervention are shown in Chart 2.

The following have proven more effective in the teaching and learning process of cardiopulmonary resuscitation: Telegram® – effective for the development of cognitive ability (knowledge in cardiopulmonary resuscitation); Online course – effective to develop cognitive and psychomotor skills for cardiopulmonary resuscitation; HeartCode BLS – effective for developing cognitive and psychomotor skills; and virtual simulator – effective for developing cognitive, psychomotor and affective skills.

In the studies included, the virtual reality simulator was the most adopted for the teaching of cardiopulmonary resuscitation, as well as the most effective for the development of cognitive, psychomotor and affective skills in this context.

DISCUSSION

Based on the findings of this review, scientific evidence that supports the teaching and learning process of cardiopulmonary resuscitation through digital health technology can be included, indicating its effectiveness. This is an important resource given the accelerated growth of information that fosters the expansion of research on this topic.

As the use of digital technology-based strategies is considered an innovative pedagogical alternative and often effective in different educational contexts, its adoption in the scope of the health teaching and learning process is encouraged[20]. In this perspective, the small sample of primary studies identified in the present study indicates the need for deepening and scientifically exploring the use of digital technology for the teaching of cardiopulmonary resuscitation, aiming mainly at the development of well-designed methodological research with a stronger level of evidence that contributes to the demonstration of the effectiveness of each strategy[16].

This review confers originality to science in the context of teaching cardiopulmonary resuscitation for compiling a framework of reliable, current and consistent scientific evidence that presents the articulation of technology with the learning of this theme. It also clarifies the pedagogical strategies indicated and the most used, specifying its effectiveness for the development of cognitive, psychomotor and affective skills for cardiopulmonary resuscitation.

The most prevalent strategy identified in this integrative literature review was the virtual simulation of cardiopulmonary resuscitation. It was prioritized for scientific deepening, mainly because of its broadness and completeness in the evaluation of effectiveness in the development of the necessary triad for the formation of clinical competence in cardiopulmonary resuscitation, which is composed of cognitive (knowledge), psychomotor (practical skills) and affective (attitudes and behaviors) skills of an individual.

A quasi-experimental study of medical students tested the effectiveness of a virtual simulator for developing cognitive skills (knowledge) and psychomotor skills in cardiopulmonary resuscitation. A significant improvement in knowledge and practical skills was found in participants to which this strategy was applied, given the motivation for learning brought by the virtual teaching environment[16].

Virtual simulation has been considered an important and innovative tool for the training of human resources in health with emphasis on the formation of knowledge and training of skills. It has potential for changing the education paradigm, which stands out in many aspects, when compared to traditional teaching-learning methods[21,22].

Since Basic Life Support is often the first stage of teaching students about the resuscitation of a patient in critical health condition, this is a fundamental skill to be developed in undergraduate health courses[23]. It is essential to provide students with the opportunity to participate in training based on technologies that arouse their interest, such as virtual simulators, if possible, in association with other teaching modalities for a more efficient learning on cardiopulmonary resuscitation[24].

The development and identification of the effectiveness of technology-based strategies are more commonly addressed[16] in terms of cognitive and psychomotor skills for cardiopulmonary resuscitation. However, the assessment of the affective abilities/attitudes of individuals towards the teaching and learning process of this theme has been widely valued by studies using virtual simulation as a technological resource in the present research[15,16,19].

A study of medical students to explore their experiences in relation to training for cardiopulmonary resuscitation by means of a virtual simulator demonstrated its effectiveness for the development of affective skills such as improvement of students' tension level, concentration, self-efficacy and satisfaction with the teaching strategy[16].

Chart 1. Synthesis of primary studies included in the integrative literature review according to objective, methodological design, level of evidence and conclusion.

Study	Objective	Methodological design Level of evidence	Conclusion
E1[12]	To investigate the effectiveness of basic life support education through social media in medical interns.	Quasi-experimental, before and after study conducted with 119 medical students. Level of evidence III.	Positive effect on learning through continuing education in the classroom combined with the use of Telegram®.
E2[13]	To compare the effectiveness of two basic life support training programs for newly graduated nurses and nursing students.	Quasi-experimental, conducted with 187 nursing students and 107 newly graduated nurses. Level of evidence III.	The use of the Compact Disc interactive training program and by traditional method showed low acquisition of knowledge and skills.
E3[14]	To evaluate the student learning using an online basic life support course.	Quasi-experimental conducted with 94 students. Level of evidence III.	Contribution to learning through the use of a 20-hour online course in a Virtual Learning Environment (VLE).
E4[15]	To understand the perceptions of cardiopulmonary resuscitation instructors regarding the use of a virtual simulator in cardiopulmonary resuscitation education for health professionals.	Quasi-experimental conducted with 30 doctors and nurses. Level of evidence III.	Acquisition of knowledge and skills from training using virtual reality simulator.
E5[16]	To explore the experiences of medical students with use of a virtual simulator training on cardiopulmonary resuscitation.	Quasi-experimental conducted with 12 medical students. Level of evidence III.	The use of virtual reality scenarios demonstrated success in the development of affective skills.
E6[17]	To explore the retention of knowledge and skills of medical students using virtual simulation.	Quasi-experimental conducted with 36 medical students. Level of evidence III.	The training with use of virtual simulator with avatar showed better results in knowledge gain compared to simulation using a high-fidelity manikin.
E7[18]	To compare performance based measures of cardiopulmonary resuscitation skills of two types of cardiopulmonary resuscitation courses in nursing students.	Quasi-experimental conducted with 604 nursing students. Level of evidence II.	The use of HeartCode™ BLS with medium fidelity manikin has shown satisfactory results compared to training with instructors and use of low fidelity manikin.
E8[19]	To investigate how a virtual simulation scenario with use of avatars influences the experiences and feelings of medical students and the retention of knowledge about cardiopulmonary resuscitation.	Quasi-experimental conducted with 12 medical students. Level of evidence III.	Virtual reality simulator with avatar using scenarios and feedback from instructors proved effective for acquiring knowledge and developing skills.

Chart 2. Characterization of primary studies included in the integrative literature review according to the resource and/or media used, evaluated skill and intervention.

Study	Resource and/or media used	Skill evaluated	Intervention
E1[12]	Telegram®.	Cognitive (knowledge).	Training through lectures in the classroom. A pre-test questionnaire was applied before. Afterwards, half of participants received continuing education through Telegram® - sending summaries of the materials presented in short texts, pictures and educational videos. The others received no additional training. Three months after the lecture, a questionnaire was applied using the Telegram® for post-test assessment.
E2[13]	CD interactive training program.	Cognitive and psychomotor.	Training carried out for eight weeks with participation of two groups: (1) CD interactive training program including a manikin for unsupervised practice; (2) Traditional program (lecture, demonstration of the technique and supervised practice). There was no pre-test, but two post-tests, one performed a week later and the second performed eight weeks after training.
E3[14]	Online course.	Cognitive and psychomotor.	Development of a 20-hour online course. In the virtual learning environment, participants were accompanied by tutors and at the end of the theoretical study, the theoretical/practical assessment was scheduled. Data collection was used in the pre/post-test period, consisting of 20 objective tests and a 20-item checklist to assess the skills developed.
E4[15]	Virtual simulation.	Affective (perception and satisfaction regarding virtual simulation).	Participants adopted virtual reality simulation using an avatar. Participants completed a questionnaire focused on perceptions in relation to current education and the theme, before and after the simulation.
E5[16]	Virtual simulation.	Affective (level of tension, concentration, self-efficacy, satisfaction).	Training conducted in four virtual reality scenarios with avatar. After each scenario, participants received feedback. The second identical training session was held after six months. An interview guide focused on the experiences of the training sessions was used.
E6[17]	Virtual simulation.	Cognitive and psychomotor.	The first phase of the study consisted of training through a 10-minute lecture followed by a familiarization of approximately 20 minutes with the virtual environment. Then, the intervention of virtual reality, consisting of four short scenarios (4-5 minutes) was performed. After each scenario, feedback (3-5 minutes) was provided. After six and 18 months, a similar session was held without the introductory lecture. Pre and post-test were performed.
E7[18]	HeartCode™ BLS with high-fidelity manikin feedback.	Cognitive and psychomotor.	Participants took the online didactic component of the HeartCode™ BLS course and went to a laboratory to train their psychomotor skills. In another group, participants underwent training with instructors and used traditional manikins - four hours of training. After participants completed the training steps, they were evaluated immediately with use of a high-fidelity manikin.

Continue...

Chart 2. Continuation.

Study	Resource and/or media used	Skill evaluated	Intervention
E8[19]	Virtual simulation.	Affective (self-efficacy, concentration) and cognitive.	A 10-minute lecture was held. Afterwards, participants were familiarized with the interface features of the virtual simulator. Then, simulation was performed in four virtual reality scenarios using avatar. In each scenario, the trainees received feedback from an instructor. A second session was held after six months using the same scenarios as the first session. A questionnaire was applied after the simulations, investigating the reflections on the experiences lived.

Another quasi-experimental study that identified doctors' and nurses' perceptions of the learning of cardiopulmonary resuscitation through virtual simulator corroborates this context. The conclusion was that this strategy was effective for the development of affective skills for resuscitation, mainly regarding participants' higher satisfaction with the strategy used[15].

As important as "knowing" and "knowing how to do", are the attitudes, i.e., the behaviors characterizing the affective ability of an apprentice in the face of the teaching and learning process. Skills such as self-efficacy, satisfaction, motivation, concentration, leadership, confidence, among others, are important emotional characteristics for the development of clinical competence and should be better explored in scientific papers[25].

Thus, in the context of teaching cardiopulmonary resuscitation, the virtual simulator stands out among other strategies based on technology and innovation, and becomes a powerful educational resource[26], as well as valid, acceptable and effective for the development of the necessary skills for students and health professionals[27,28].

The main limitation of this study was the lack of research clarifying the effectiveness of strategies based on digital technology for teaching cardiopulmonary resuscitation. Although the presence of certain gaps in the methodological description of studies included in the sample has made their characterization difficult, it did not interfere with the quality of the evidence exposure.

CONCLUSION

By observing the aspects analyzed, the main teaching and learning strategies for cardiopulmonary resuscitation identified in this review were the following: virtual reality simulator, Telegram®, Compact Disc-interactive program, online course and HeartCode™ Basic Life Support. The most effective strategies for learning were Telegram®, online course, HeartCode BLS and virtual simulator. In the studies included, the virtual simulator was the most adopted strategy for the teaching of cardiopulmonary resuscitation, as well as the most effective to develop cognitive, psychomotor and affective skills in this context.

This study contributes to health research, care and teaching by presenting a range of reliable scientific evidence regarding the articulation of digital technology and teaching and learning of cardiopulmonary resuscitation, in addition to clarifying pedagogical possibilities, thereby facilitating the best practices based on the exposure of the effectiveness of strategies presented.

REFERENCES

1. Kesharwani A. Do (how) digital natives adopt a new technology differently than digital immigrants? A longitudinal study. Information & Management. 2020;57(2):e103170. https://doi.org/10.1016/j.im.2019.103170.
2. Silva AN, Senna MAA, Teixeira MCB, Lucietto DA, Andrade IM. O uso de metodologia ativa no campo das Ciências Sociais em Saúde: relato de experiência de produção audiovisual por estudantes. Interface Comun Saúde Educ. 2020;24:e190231.https://doi.org/10.1590/interface.190231.
3. Alves MG, Batista DFG, Cordeiro ALPC, Silva MD, Canova JCM, Dalri MCB. Production and validation of a video lesson on cardiopulmonary resuscitation. Rev Gaúcha Enferm. 2019;40:e20190012. https://doi.org/10.1590/1983-1447.2019.20190012.
4. Everett-Thomas R, Yero-Aguayo M, Valdes B, Shekhter I, Rosen LF, Birnbach DJ. An assessment of CPR skills using simulation: Are first responders prepared to save lives? Nurse Educ Pract. 2016;19:58-62. https://doi.org/10.1016/j.nepr.2016.05.003.
5. Reis RK, Melo ES, Costa CRB. Simulação no ensino de emergência para estudantes de enfermagem. Rev Cuid. 2020;11(2):e853. https://doi.org/10.15649/cuidarte.853.

6. Greif R, Lockey AS, Conaghan P, Lippert A, Vries W, Monsieurs KG. European Resuscitation Council Guidelines for Resuscitation 2015: Section 10. Education and implementation of resuscitation. Resuscitation. 2015;95:288-301. https://doi.org/10.1016/j.resuscitation.2015.07.032.
7. Whittemore R, Knafl K. The integrative review: updated methodology. J Adv Nurs. 2005;52(5):546-53. https://doi.org/10.1111 / j.1365-2648.2005.03621.x.
8. Santos CMC, Pimenta CAM, Nobre MRC. The PICO strategy for the research question construction and evidence search. Rev Latino-Am Enfermagem. 2007;15(3):508-11. https://doi.org/10.1590/S0104-11692007000300023.
9. Ouzzani M, Hammady H, Fedorowicz Z, Elmagarmid A. Rayyan–a web and mobile app for systematic reviews. Syst Rev. 2016;5(210):e-10. https://doi.org/10.1186/s13643-016-0384-4.
10. Ursi ES, Gavão CM. Prevenção de lesões de pele no perioperatório: revisão integrativa da literatura. Rev Latino-Am Enfermagem. 2006;14(1):124-31. http://dx.doi.org/10.1590/S0104-11692006000100017.
11. Melnyk BM, Fineout-Overholt E. Evidence-based practice in nursing & healthcare: a guide to best practice. 2. ed. Philadelphia: Wolters Kluwer Health/ Lippincott Williams & Wilkins; 2011.
12. Ziabari SMZ, Kasmaei VM, Khoshgozaran L, Shakiba M. Continuous Education of Basic Life Support (BLS) through Social Media; a Quasi-Experimental Study. Arch Acad Emerg Med [Internet]. 2019 [cited 2020 Marc. 10];7(1):e4. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6377214/pdf/aaem-7-e4.pdf.
13. Mardegan KJ, Schofield MJ, Murphy GC. Comparison of an interactive CD based and traditional instructor-led Basic Life Support skills training for nurses. Aust Crit Care. 2015;28(3):160-7. https://doi.org/10.1016/j.aucc.2014.06.001.
14. Tobase L, Peres HHC, Tomazini EAS, Teodoro SV, Ramos MB, Polastri TF. Basic life support: evaluation of learning using simulation and immediate feedback devices. Rev Latino-Am Enfermagem. 2017;25:e2942. https://doi.org/10.1590/1518-8345.1957.2942.
15. Wong MAME, Chue S, Jong M, Benny HWK, Zary N. Clinical instructors' perceptions of virtual reality in health professionals' cardiopulmonary resuscitation education. SAGE Open Med. 2018;6:1-8. https://doi.org/10.1177/2050312118799602.
16. Creutzfeldt J, Hedman L, Felländer-Tsai L. Cardiopulmonary Resuscitation Training by Avatars: A Qualitative Study of Medical Students' Experiences Using a Multiplayer Virtual World. JMIR Serious Games. 2016;4(2):e22. https://doi.org/10.2196/games.6448.
17. Creutzfeldt J, Hedman L, Felländer-Tsai L. Effects of pre-training using serious game technology on CPR performance: an exploratory quasi-experimental transfer study. Scand J Trauma Resusc Emerg Med. 2012;20:79. https://doi.org/10.1186/1757-7241-20-79.
18. Kardong-Edgren SE, Oermann MH, Odom-Maryon T, Ha Y. Comparison of two instructional modalities for nursing student CPR skill acquisition. Resuscitation. 2010; 81(8):1019-24. https://doi.org/10.1016/j.resuscitation.2010.04.022.
19. Creutzfeldt J, Hedman L, Medin C, Heinrichs WL, Felländer-Tsai L. Exploring virtual worlds for scenario-based repeated team training of cardiopulmonary resuscitation in medical students. J Med Internet Res. 2010;12(3):e38. https://doi.org/10.2196/jmir.1426.
20. Cochrane T, Cook S, Aiello S, Harrison D, Aguayo C. Designing Virtual Reality Environments for Paramedic Education: MESH360. Proceedings ASCILITE. Show Me The Learning [Internet]. 2016 [cited 2020 Marc. 10]. Adelaide. Available from: https://pdfs.semanticscholar.org/1454/a9c6113ad1ef727f226dd0e8d8885ddefe03.pdf.
21. Santos CA, Souza Júnior VD, Lanza FF, Lacerda AJ, Jorge BM, Mendes IAC. Jogos sérios em ambiente virtual para ensino-aprendizagem na Saúde. Rev Rene. 2017;18(5):702-9. https://doi.org/10.15253/2175-6783.2017000500019.
22. Lewis ZH, Swartz MC, Lyons EJ. What's the Point?: A Review of Reward Systems Implemented in Gamification Interventions. Games Health J. 2016;5(2):93-9. https://doi.org/10.1089/g4h.2015.0078.
23. Kim J, Park JH, Shin S. Effectiveness of simulation-based nursing education depending on fidelity: a meta-analysis. BMC Med Educ. 2016;16:152. https://doi.org/10.1186/s12909-016-0672-7.
24. Reime MH, Johnsgaard T, Kvam FI, Aarflot M, Engeberg JM, Breivik M, et al. Learning by viewing versus learning by doing: A comparative study of observer and participant experiences during an interprofessional simulation training. J Interprof Care. 2017;31(1):51-8. https://doi.org/10.1080/13561820.2016.1233390.
25. Menezes ABC. Gamificação no ensino superior como estratégia para o desenvolvimento de competências: um relato de experiência no curso de psicologia. Rev Docência Ens Sup. 2016;6(2):203-22. https://doi.org/10.35699/2237-5864.2016.2093.

26. Semeraro F, Scapigliati A, Ristagno G, Luciani A, Gandolfi S, Lockey A, et al. Virtual Reality for CPR training: How cool is that? Dedicated to the "next generation". Resuscitation. 2017;121:e1-e2. https://doi.org/10.1016/j.resuscitation.2017.09.024.

27. Espinosa CC, Melgarejo FS, Ruiz RM, García-Collado AJ, Caballero SN, Rodríguez LJ, et al. La realidad virtual como método de enseñanza de la reanimación cardiopulmonar: un estudio aleatorizado. Emergencias [Internet]. 2019 [cited 2020 Marc. 10];31(1):43-6. Available from: https://dialnet.unirioja.es/servlet/articulo?codigo=6737638.

28. Allcoat D, Mühlenen A. Learning in virtual reality: Effects on performance, emotion and engagement. Res Learn Technol. 2018;26:e13. https://doi.org/10.25304/rlt.v26.2140.