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EDUCATIONAL TECHNOLOGIES DEVISED TO TEACH BASIC LIFE SUPPORT TO ADOLESCENTS: A SCOPING REVIEW

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ABSTRACT

Objective: to map the educational technologies devised to teach Basic Life Support to adolescents.
Method: a scoping review conducted according to the Joanna Briggs Institute methodology and carried out between May and November 2022, in seven databases and Google Scholar, to answer the following question: "Which are the educational technologies devised/used about Basic Life Support for adolescents?". By means of inclusion/exclusion criteria, two independent reviewers selected the articles resorting to the EndNote® and Rayyan® software programs. Forms adapted from the *Joanna Briggs Institute* were used for data extraction and methodological analysis. The data were reported by means of the PRISMA-ScR checklist extension and the protocol of this study is published in: https://doi.org/10.17605/OSF.IO/P87SV.
Results: a total of 34 articles were selected, which were organized into six categories of educational technologies: 1) Audiovisual; 2) Computational; 3) Learning kits; 4) Mobile devices; 5) Printed material; and 6) Manufactured. This topic has appeared in publications since 1975, especially in medical journals, mainly by European and North American authors. The materials included were 16 experimental and 18 quasi-experimental trials, of varied methodological quality levels and predominantly conducted with High School students.
Conclusion: the educational technologies mapped were as follows: videos, films, Digital Versatile Disc, images, music, audiovisual narratives, games, virtual reality/avatar, web courses, computational software, computer and smartphone apps, task cards and manikins (including manufactured ones). Although there are countless educational technologies on Basic Life Support for adolescents, they have not allowed achieving good levels of practical skills, mainly when they propose to teach ventilation to lay people.

DESCRIPTORS: Cardiopulmonary resuscitation. Educational technology. Technology. Adolescent. Teaching materials.

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TECNOLOGIAS EDUCACIONAIS ELABORADAS PARA ENSINAR SUPORTE BÁSICO DE VIDA AO ADOLESCENTE: REVISÃO DE ESCOPO

RESUMO

Objetivo: mapear as tecnologias educacionais elaboradas para ensinar suporte básico de vida ao adolescente.
Método: revisão de escopo, conduzida conforme metodologia *Joanna Briggs Institute*, realizada entre maio e novembro de 2022, em sete bases de dados e no *Google Scholar* para responder à pergunta: "Quais as tecnologias educacionais elaboradas/utilizadas sobre suporte básico de vida para adolescentes?". Dois revisores independentes selecionaram, mediante critérios de inclusão/exclusão, os artigos usando os programas EndNote® e Rayyan®. Utilizou-se formulários adaptados da *Joanna Briggs* para extração e análise metodológica. Os dados foram reportados pela extensão do checklist PRISMA-ScR e o protocolo deste estudo está publicado em: https://doi.org/10.17605/OSF.IO/P87SV.
Resultados: selecionou-se 34 artigos, os quais foram organizados em seis categorias de tecnologias educacionais: 1) Audiovisuais; 2) Computacionais; 3) Kits de aprendizagem; 4) Dispositivos móveis; 5) Material Impresso; e 6) Manufaturadas. Este tema é publicado desde 1975, sobretudo por revistas médicas, cujos autores são principalmente europeus e norte-americanos. Foram incluídos 16 ensaios experimentais e 18 quase-experimentais, de qualidade metodológica variável, realizados, predominantemente, com estudantes de nível médio.
Conclusão: as tecnologias educacionais mapeadas foram: vídeos, filmes, *Digital Versatile Disc*, imagens, músicas, narrativas audiovisuais, jogos, realidade virtual/avatar, *web* cursos, *software* computacional, aplicativos para computador e smartphone, cartões de tarefa e manequins (incluído os manufaturados). Embora haja inúmeras tecnologias educacionais sobre Suporte Básico de Vida para adolescentes, estas não têm proporcionado o alcance de bons níveis de habilidade práticas, principalmente quando se propõem a ensinar ventilação para leigos.

DESCRITORES: Reanimação cardiopulmonar. Tecnologia educacional. Tecnologia. Adolescente. Materiais de ensino.

TECNOLOGÍAS EDUCACITIVAS ELABORADAS PARA ENSEÑAR SOPORTE VITAL BÁSICO A ADOLESCENTES: REVISIÓN DE ALCANCE

RESUMEN

Objetivo: mapear las tecnologías educativas elaboradas para enseñar Soporte Vital Básico a adolescentes.
Método: revisión de alcance, realizada conforme a la metodología del *Joanna Briggs Institute* entre mayo y noviembre de 2022, en siete bases de datos y en Google Académico para responder la siguiente pregunta: "¿Cuáles son las tecnologías educativas elaboradas/utilizadas sobre Soporte Vital Básico dirigidas al público adolescente?". Mediante criterios de inclusión/exclusión, dos revisores independientes seleccionaron los artículos usando los programas EndNote® y Rayyan®. Se emplearon formularios adaptados del *Joanna Briggs Institute* para la extracción de datos y el análisis metodológico. Los datos se reportaron por medio de la extensión de la *checklist* PRISMA-ScR y el protocolo de este estudio está publicado en: https://doi.org/10.17605/OSF.IO/P87SV.
Resultados: se seleccionaron 34 artículos, que fueron organizados en seis categorías de tecnologías educativas, a saber: 1) Audiovisuales; 2) Informáticas; 3) Kits de aprendizaje; 4) Dispositivos móviles; 5) Materiales impresos; y 6) Fabricadas. Este tema ha sido objeto de publicaciones desde 1975, especialmente en revistas especializadas en Medicina, y principalmente con autores europeos y norteamericanos. Se incluyeron 16 ensayos experimentales y 18 cuasiexperimentales, de calidad metodológica variable y mayoritariamente realizados con estudiantes de nivel medio.
Conclusión: las tecnologías educativas que se mapearon fueron las siguientes: videos, películas, *Digital Versatile Disc*, imágenes, música, narrativas audiovisuales, juegos, realidad virtual/avatar, cursos *web*, *software* de computación, *apps* para computadoras y *smartphones*, fichas de tareas y maniquíes (incluyendo los fabricados). Aunque se dispone de innumerables tecnologías educativas sobre Suporte Vital Básico para adolescentes, no ha permitido lograr buenos niveles de habilidades prácticas, principalmente cuando se proponen enseñar ventilación a personas comunes.

DESCRIPTORES: Reanimación cardiopulmonar. Tecnología educativa. Tecnología. Adolescente. Materiales didácticos.

INTRODUCTION

Cardiopulmonary Arrest (CPA) remains the most serious emergency with the worst prognosis[1]. The American Heart Association (AHA) report pointed out that only 10.4% of the patients with Out-of-Hospital Cardiac Arrest (OHCA) survive the initial hospitalization. In this context, only 39.2% of the adults receive Cardiopulmonary Resuscitation (CPR) by lay people and only 11.9% have had an Automated External Defibrillator (AED) applied[2].

Even with important improvements in the CPR protocols, survival from OHCA is at the same level since 2012[2]. The solution to this problem involves teaching and training lay people in Basic Life Support (BLS). According to the survival chain of an OHCA, BLS is the term that designates the cardiopulmonary resuscitation stages. The stages targeted at lay people consist in activating the Emergency Medical Service (EMS), performing immediate high-quality CPR and applying rapid defibrillation[3].

Among the lay people who need to be trained in BLS, there are adolescents who, in addition to learning, can teach CPR to their peers[4]. However, researchers from Denmark[5] and Canada[6] pointed out that structural, political and economic limitations hinder this process. On the other hand, a study of the Randomized Controlled Trial (RCT) type showed that, when adolescents receive training, they have practical skills and self-confidence to effectively help CPA victims[7].

In this sense, with a view to interposing adolescents' low level of knowledge on this topic, the AHA and the European Society of Resuscitation recommend training through instructional design in combination with educational technologies and teaching by instructors[8–9].

However, to make use of these technologies, instructors need answers about gaps in the literature involving this topic. For example, it is not yet known which technologies are used to teach BLS to adolescents, in which context they can be applied and what their effectiveness or limitations are. For better use of technologies, it is necessary to know their construction and validation process, which audiences are most benefited and if they are permeated by studies with methodological quality that enables replication and safety of their indications. It should be noted that preliminary searches[10] carried out in May 2022 did not find ongoing or concluded scoping reviews that would answer the question of this study.

In this context, knowing the scientific production on educational technologies is relevant, as it will enable nurses and other health professionals teaching and Evidence-Based Practice (EBP). Thus, the objective was to map the educational technologies devised to teach Basic Life Support to adolescents.

METHOD

This is a scoping review conducted following the recommendations of the *Joanna Briggs Institute* (JBI)[11] and reported in accordance with the *Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews* (PRISMA-ScR) checklist[12]. The protocol for this study is published in the Open Science Framework: https://doi.org/10.17605/OSF.IO/P87SV; and in the *Online Brazilian Journal of Nursing*. For dealing with public domain data, this research did not require approval from any ethics committee.

This review, carried out between May and November 2022, followed five steps: (1) Definition of the study question; (2) Definition of inclusion/exclusion criteria; (3) Definition of the type of source and elaboration of the search strategy for each database; (4) Selection and extraction of studies; and (5) Analysis of the evidence and presentation of the results.

The research question was elaborated based on the PCC acronym, where P (Population) – Adolescents, C (Concept) – Educational technologies and C (Context) – Basic Life Support. Thus, the following was asked: “Which are the educational technologies devised/used about Basic Life Support for adolescents? Inclusion/exclusion criteria were defined for each letter of the PCC acronym. Thus, studies whose population consisted of adolescents aged between 10 and 19 years old were included[13]; as well as those that, within the Concept, used educational technologies and that had been contextualized to BLS teaching.

Articles that were not published in full or that only presented educational strategies without use of technologies were excluded, given that they were well-delimited by the current literature[14]. This review evaluated research studies of all methodological designs and did not establish time limits or language restrictions.

The searches were performed in the Medical Literature and Retrieval System online (MEDLINE) databases via the National Center for Biotechnology Information (NCBI/PubMed); Cumulative Index to Nursing & Allied Health Literature (CINAHL) via the Thomson Reuters collection; Web of Science (WoS) via Clarivate Analytics and Embase via Elsevier, accessed through the Journals Portal of the Coordination for the Improvement of Higher Education Personnel (*Coordenação de Aperfeiçoamento de Pessoal de Nível Superior*, CAPES); *Literatura Latino-Americana e do Caribe em Ciências da Saúde* (LILACS), Índice Bibliográfico Español en Ciencias de la Salud (IBECS) and *Base de Dados em Enfermagem* (BDENF) via *Biblioteca Virtual em Saúde* (BVS). Google Scholar searches were also performed.

The research strategy followed three stages[15]. In the first one, a search was carried out in the MEDLINE (NCBI/PubMed) and CINAHL databases to identify the terms contained in titles, abstracts and indexing descriptors. In stage two, a second search was performed using the terms from the first stage with the descriptors identified in the second. In the third, the researchers searched the lists of references for studies that might not have been retrieved in the first two stages.

Chart 1 presents the construction syntax, descriptors/keywords and Boolean operators employed in the high-sensitivity search in the MEDLINE/NCBI/PubMed databases. The other strategies can be verified in the scoping review protocol: https://doi.org/10.17605/OSF.IO/P87SV

Chart 1 – Construction syntax, descriptors/keywords and Boolean operators used in the MEDLINE/NCBI/PubMed databases. Teresina, PI, Brazil, 2022.

MEDLINE/NCBI/PubMed
((“Adolescent”[Mesh Terms] OR (Adolescent) OR (Adolescence) OR (Adolescents) OR (Adolescents, Female) OR (Adolescents, Male) OR (Teenager) OR (Teenagers) OR (Teens) OR (Youth) OR (“High School”) OR (“School Children”) OR (“Middle school”) OR (“High school students”)) AND (“educational technology”[MeSH Terms] OR “teaching materials”[MeSH Terms] OR (“technology”[MeSH Terms] AND “health education”[MeSH Terms]) OR (educational technology) OR (teaching materials) OR (Instructional Technology) OR (Technology, Educational) OR (Technology, Instructional) OR (Audiovisual Aids) OR (“Instructional Film and Video”) OR (e-learning) OR (Multimedia) OR (mobile phone application) OR (mHealth) OR (Communications Media) OR (Education, Distance) OR (Pamphlets) OR (audio-Video Demonstration) OR (Virtual Reality) OR (Education Resuscitation) OR (web course) OR (serious game))) AND ((Basic Cardiac Life Support) OR “resuscitation”[MeSH Terms] OR “cardiopulmonary resuscitation”[MeSH Terms] OR “heart massage”[MeSH Terms] OR (Resuscitation) OR (Cardiopulmonary Resuscitation) OR (Heart Massage) OR (CPR) OR (B-CPR) OR (CO-CPR) OR (Code Blue) OR (Life Support, Basic Cardiac) OR (Mouth-to-Mouth Resuscitation) OR (cardio pulmonary resuscitation) OR (reanimation) OR (resuscitation orders) OR (cardiac massage) OR (massage, heart))

*MEDLINE/PubMed: *Medical Literature and Retrieval System online* via the *National Center for Biotechnology Information*.

For selection of the studies, two independent reviewers were involved, both with expertise in BLS and educational technologies (PKL/RSM). Disagreements were managed by a third reviewer (MOM), who issued an opinion for inclusion and/or exclusion of the conflicting studies. A pre-test was carried out with the reviewers to assess the consensual "calibration" before selection of the studies. The pre-test obtained an agreement rate of 94%.

The results were imported into *EndNote Web*, where investigation of duplicity of bibliographic references took place[16]. For analysis, selection and exclusion of the articles, the Rayyan software (Qatar Computing Research Institute, Doha, Qatar) was used[17].

Publications were included or excluded first by reading their titles and abstracts. Subsequently, they were read in full and evaluated according to the inclusion/exclusion criteria. In this sense, the texts from the Gray Literature had the same evaluation dynamics (peer review).

The data were extracted according to an instrument based on the model available in the JBI manual[11], which was transcribed into *Microsoft Office Excel* 365/2022, in the form of a synoptic chart, whose variables were as follows: authors, journal, year, country, study locus, language, objective, design, level of evidence, population, technology, results, conclusions, theoretical framework and technology construction and/or validation process.

Although it is not mandatory to assess the methodological quality of the studies, it was decided to carry out this assessment based on the two methodological designs identified. Thus, each study included had its methodological quality assessed using two instruments from the *JBI's Critical Appraisal Tools*[18], one for quasi-experimental studies (with 9 items) and the other for experimental articles (with 13 items). In addition to this evaluation, the articles also had their Level of Evidence (LE) classified according to Melnik's recommendations[19].

The screening process and the results are presented in figures and diagrams that accompany a descriptive summary of the surveyed variables. The technologies found were synthesized, based on the way in which they were applied, into six analytical categories. It is to be noted that all the technologies incorporated were contemplated by Nietsche's framework as educational technologies[20].

RESULTS

A total of 3,280 publications were identified:1,567 in MEDLINE/PubMed,1,038 in EMBASE, 232 in CINAHL, 40 in LILACS/BVS, 17 in BDENF/BVS, 7 in Web of Science, 29 in IBECS and 350 in Google Scholar. After excluding duplicates and applying inclusion/exclusion criteria, 34 articles comprised the sample according to the flowchart shown in Figure 1.

Of the 34 articles, 7 (20.5%) were published in the *Resuscitation* journal, which concentrated the largest number of studies on the theme. Another 27 journals published between one and two studies. The oldest text is from 1975 and the highest number of publications was between 2016 and 2019: 18 (52.9%).

The European continent concentrated the highest number of publications with 24 (70.5%) studies, with emphasis on Spain and Belgium with five (14.7%) each, followed by the American continent, with five (14.7%) research studies, four (11.7%) from the United States of America (USA) and one (2.9%) from Brazil. There were three (8.8%) Asian studies, two (5.8%) from India and one (2.9%) from South Korea; one (2.9%) from Eurasia published in Turkey and another (2.9%) in cooperation by USA and Sweden (2.9%).

As for the languages, 28 (82.3%) studies were published in English, four (11.7%) in Spanish, one (2.9%) in Hungarian and one (2.9%) in Portuguese. With regard to the design, 18 (52.9%) were quasi-experimental, with Level III in the pyramid of evidence, and 16 (47%) were randomized controlled trials, with Level II.

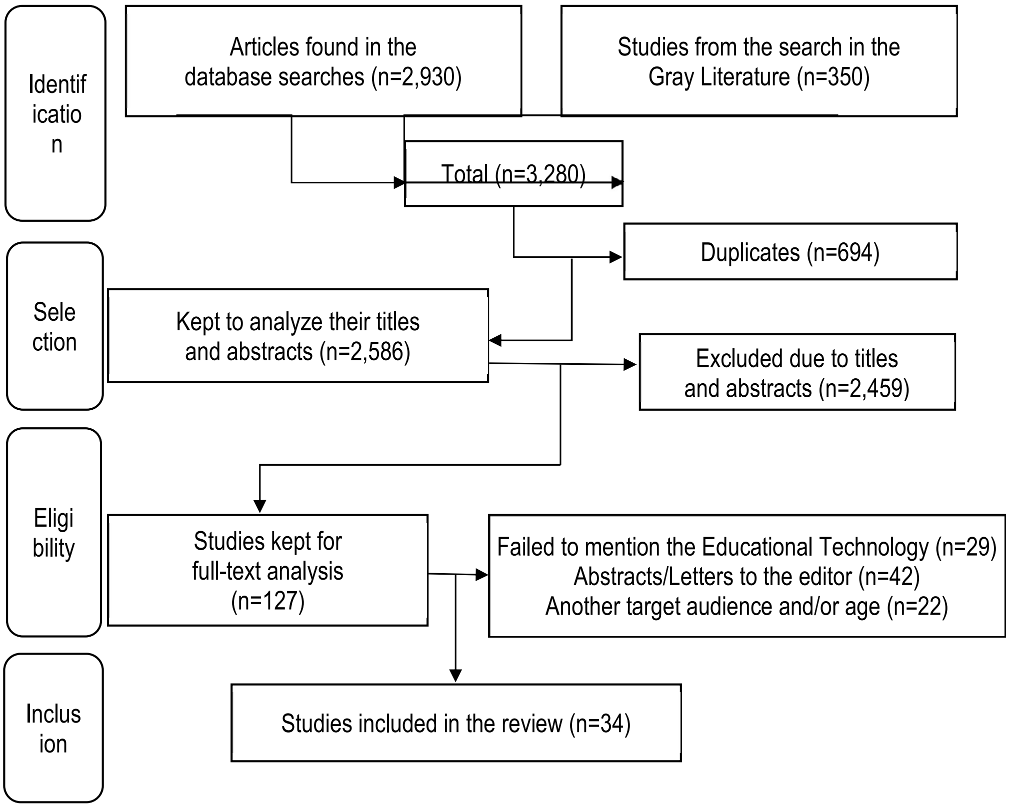

Figure 1 – PRISMA-ScR flowchart (adapted) corresponding to selection of the articles included in the review. Teresina, PI, Brazil, 2022.

The critical methodological evaluation, indicated by the JBI instrument, revealed that, despite meeting most of the criteria indicated for quality assessment, the experimental studies did not meet important items related to allocation and blinding of the participants, the researcher and those responsible for providing treatment and outcome evaluators. It was found that 14 quasi-experimental studies met most of the quality assessment requirements indicated by the instrument, being considered of good quality. The main points not met were related to the presence of a Control Group and/or the performance of multiple measurements.

All 34 studies were directed, in their entire sample, to 19,878 adolescent students. Of these articles, 17 (50%) were carried out with 8,977 High School students, two (5.8%) with 313 Elementary School adolescents, two (5.8%) involving 547 Elementary and High School students and, in 13 (38.2%) surveys, there was no description of the schooling level corresponding to the 10,041 participants involved.

Only two (5.8%) articles grounded elaboration/development of the technology on assumptions from educational theories, with the cognitive theory of multimedia learning as the only one adopted[21–22]. Another two (5.8%) used the “peer learning” methodology when applying the test, despite not creating the technology based on educational theoretical assumptions[23–24].

In only one (2.9%) study it is asserted that the technology was validated, but without detailing this process[25]. In 21 (61.7%) articles, there is not enough clarification regarding the validation process. Of the 13 (38.2%) that present data on the construction method, there is diverse information that they are elaborated by universities[26–27]; resuscitation councils[22,28–34]; entities such as the Red Cross[24]; or based on a systematic review[35].

All studies proposed to assess theoretical and/or practical knowledge in BLS after applying the technologies. However, only 11 (32.3%) use instruments built and validated for this measurement. They did so with the following: *The HANDDS program* directives[25]*;* pediatric specialists[36]; *Handbook of Competence and Motivation* guidelines[37]*; West Midlands* directions [38]*;* the "*Program for high School Students (PROCES)* guidelines[34] and, in six (17.6%) surveys, the *Cardiff test*[22–23,32,35,39,40] was adapted.

There is significant diversity of technologies involved in teaching BLS to adolescents. For this reason, and because they present different operational characteristics, six categories were synthesized for analysis: Audiovisual; Computational; Learning kits, Mobile device technologies; Printed material; and Manufactured (Figure 2). However, eight (23.5%) studies fell into more than one category by assessing the effect of more than one technology[22,24,32,39,41–44].

The Audiovisual category had the highest number of studies with 15 (44.1%) publications. Of these, 10 (29.4%) used videos/films/DVDs[26,32,36,39–43,45–46], two (5.8%) verified the effectiveness of music associated with video[34,44]; two (5.8%) used drawings combined with video[47] and images[22] and another (2.9%) evaluated audiovisual narratives to teach BLS to adolescents[48].

In the second category, 11 (32.3%) studies involving computational technologies were identified. Of these, three (8.8%) evaluated games[27,38,49]; two (5.8%) addressed virtual reality[43,50]; three (8.8%) examined web courses and/or Education at a Distance (EAD) courses[31,41,51]; two (5.8%) tested interactive computer programs[28] and computer software[52], and one (2.9%) evaluated learning based on computer apps[53].

In the third category, 9 (26.4%) studies were mapped that used kits for learning and self-learning in BLS[24–25,29,33,35,39,44,54–55]. In most of the studies, they consisted of Videos/DVDs and manikins. Others contained cell phone apps for feedback on compressions[39], manuals[55], task cards[24], instructional leaflets[33] and music to guide compression speed[44].

The fourth category included four (11.7.8%) publications with technologies for mobile devices[23,32,39,56]. In this sense, a study evaluated the "StartnHart" app, which combined videos and texts to instruct the viewers to perform BLS[23]; another one verified whether the "HELP Notfall" app increased the quality of bystander CPR[56]; one study compared a mobile app to video[32], and another study used the "PocketCPR" smartphone app to assess the practical skills acquired by the participants in a BLS course[39].

In the fifth category, three (8.8%) articles were included that evaluated the use of printed material for BLS education[21,22,24]. One study assessed the importance of designing instructional tools through task cards[21]; another one verified the effectiveness of the task cards associated with video[24] and a research study investigated whether learning the BLS from the images produced better learning results than video[22]. No technologies evidencing the use of comics, booklets and folders were identified. However, there are printed manuals and instructional leaflets as complementary technologies to the learning kits[33,55].

In the sixth category, two (5.8%) studies that used manufactured technologies were mapped[24,42]. In the first study, a customized manikin was used to assess CPR learning after video-guided teaching[42]. In the second one, a foam manikin and plastic bags were employed to teach compressions and ventilations[24]. In both studies, these technologies were not used in isolation.

A complete synthesis of the mapped productions can be seen in Appendix I and in OSF (https://doi.org/10.17605/OSF.IO/P87SV). It contains year, author, country, level of evidence, methodological evaluation, objective, educational technology/categories, main results and conclusions involving educational technologies to teach BLS to adolescents.

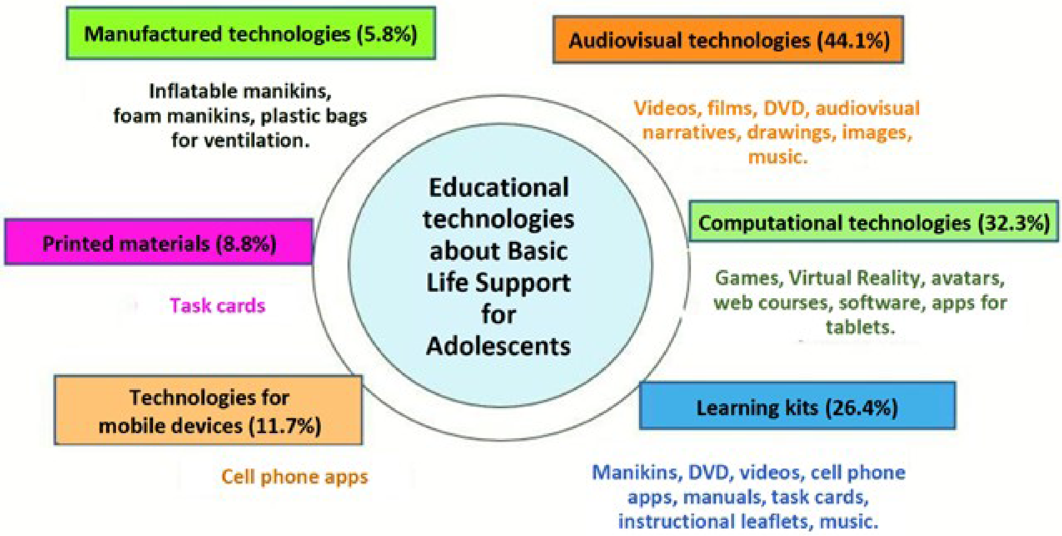

Figure 2 – Categories and educational technologies identified in the studies. Teresina, PI, Brazil, 2022.

DISCUSSION

Research involving the use of educational technologies to approach health with young people is scarce[57]. In this sense, this scoping review mapped BLS technologies for adolescents. The findings revealed that the most used educational technologies are audiovisual, such as: video, DVDs, films and music.

The following can be mentioned among the positive results involving audiovisual technologies: improvement in theoretical knowledge[26,34,36,39,42–44], equivalence to traditional teaching[41], increased gains in practical skills[32,36,44–46] and enhanced intention and confidence to resuscitate[39,40,42]. However, there is no consensus that there is an increase in post-intervention skills[26,32]. In addition to that, a research study evidenced that the effect of forgetfulness emerges faster when video is used to teach BLS at a distance[41].

To mitigate the effect of forgetfulness within this category, periodic reviews[58] and combination of audiovisual resources can be offered to complement instructor-led training[32,40,42,43,45]. In this sense, feedback mechanisms and songs can be used, as they favor knowledge memorization and retention[34,44].

Among the technologies that involved the use of computers, educational games, virtual reality, web courses, software programs and apps were mapped.. The articles that evaluated educational games and training with virtual reality advise their use combined with traditional training[38,50] focused on young people[27], as they provide a significant change in confidence to perform CPR[43,50].

On the other hand, although educational games improved the quality of the CPR practice[27], they did not provide chest compression percentiles within the range recommended by the AHA[38,49]. And, even with the increase in theoretical knowledge after attending web courses and/or EAD courses[41], there was no significant increase in the practical skills[51].

However, it was found that these limitations can be mitigated when using interactive computer programs with instructor feedback[28] or computer software with electronic feedback[52]. Even with software use, there are limitations in the practices related to ventilation[28]. It is therefore verified that computational technologies demand focus on practical teaching to improve CPR skills.

The kits showed that, far beyond the passivity of receiving training, adolescents can be CPR instructors[25,33,35,54]. The kits increased the correct answers on BLS[25,29,35,39,44,59], as well as the intention[59], confidence and ability to act[39]. Nevertheless, even with improvements in the CPR practice[44], good immediate[29] and long-term [29,44,55] retention, practical CPR teaching in the face-to-face format is recommended[39,55,59].

Among the limitations involving kits, the following are mentioned: cost, lack of evaluation of the training given by adolescents to the community and low percentiles of correct answers for performing ventilation techniques, checking vital signs and opening the airways[24,35,55]. Among the positive points are their power to disseminate instructions to large audiences[30,35)] and waiver of a health professional to teach the course.

Due to the benefits arising from this training modality and to overcome the aforementioned barriers, it is suggested that the kits contain instructional videos and that the CPR manikin be shared[25]. Alternative devices to teach Hands-Only CPR can also be used[24], as this adaptation can ease mass training[29].

The articles with technologies for mobile devices reveal that apps are the most used tool. However, even with the improvement in the CPR depth rates performed by adolescents[32,56], especially when it is used to provide depth feedback[39], there are significant guidelines that contraindicate its use.

If the app is used synchronously with the conduction of OHCA[56], it does not motivate performing CPR[23]; delays the time to call for help, early identify CPA and performs the first compression; and has lower effectiveness than more economically accessible technologies[32].

If, on the one hand, the apps identified in this review did not perform well in the BLS teaching process, on the other hand, there is diverse evidence that, when used as an alert device, they trigger people who quickly provide assistance, thus generating improvements in the survival rates[60].

Only one study showed that the Video Instruction group with feedback from a cell phone app and manikin practice obtained higher scores and confidence in the ability to act[39]. In this sense, the use of BLS teaching apps through mobile devices is justified when they are applied as a complementary technology to traditional teaching or when as a compression feedback instrument.

There were few studies that used printed material. Two[21,24] adopted task cards and one research study investigated whether BLS learning from video produced better results than images. As reported, some learning kits contained manuals, task cards, and instructional booklets.

It is believed that, through the advent of digital technology, printed materials are being replaced by high-cost and low-dispersion technologies. However, this review pointed out that not everything that is digital or technological is efficient[38,53]. In this sense, before choosing a technology, its need, cost, effectiveness and usability must be evaluated.

The research studies involving task cards had antagonistic results. In the first study involving this printed material, by adopting the spatial contiguity principle, improvements in learning about the ventilation volume and rate were identified[21]. Some researchers point out that production of these tools opens up possibilities, as it deals with a visual resource with clear and appealing information that can be easily viewed and capable of providing assimilation of the content[61].

By combining the task cards with other technologies, but without the foundation of educational theories, the second study identified that the results of the practices revealed a lower ventilation volume, depth and CPR speed[24]. The European Resuscitation Council clarifies that teaching ventilation is complex and should only be encouraged for people trained in this procedure[62]. In addition to excluding teaching of ventilation for lay people, institutions such as the AHA do not guide checking the central pulse, as an unsuccessful attempt at this measurement can delay CPR maneuvers[3].

When assessing the teaching and learning effects of images compared to video, it was found that the former are not inferior to the latter[22]. This scoping review noticed that, when the technologies were designed according to educational theories, they generated good learning outcomes[21–22]. It is worth noting that the European Resuscitation Council approach groups educational theories as one of the principles of resuscitation science[62].

The manufactured technologies identified in this research were devised with the objective of verifying whether low-cost devices are effective for CPR teaching. The two studies that used these artifacts converged by pointing out that, even though they provide increased knowledge and long-term learning retention[(24)], they are inferior to the traditional teaching method[24,42].

These findings corroborate data found in a survey on the *Kids Save Lives* (KSL) program. KSL aims at disseminating CPR principles among school-aged children through low-cost materials. However, the beneficiaries have low knowledge, skills and knowledge retention[63].

Similarly, a research study carried out in Spain evidenced that low-cost technologies were able to increase the students' level of knowledge about CPR; however, there was a reduction in the knowledge level after two months of training[64]. In this context, there is a need to identify or even develop new studies that may reveal technologies that generate knowledge and skills, but associated with better learning retention rates.

Another fact that draws the attention concerns the construction and validation process of the technologies used. Most of the studies do not clarify how or if this stage was conducted. In the same sense, despite having the common intention of measuring the benefits of technology on theoretical and practical knowledge, even on the same topic, most of the studies do not use common instruments that allow for a valid and reproducible comparison across the surveys. Thus, what is considered good knowledge and/or practice in CPR in a given study may not be so in another.

For a similar reason, a systematic review study found it difficult to establish the ideal time to carry out an emergency intervention. Among the reasons pointed out, we mention the low methodological quality of the studies that did not adopt generalizable variables which could be compared across the studies[65]. When considering that any test needs to be reproducible, it is suggested to develop standardized instruments to measure BLS knowledge and practices.

CONCLUSION

This scoping review made it possible to map educational technologies on Basic Life Support for adolescents. The studies revealed that this topic has appeared in publications since 1975, especially in medical journals, mainly by European and North American authors. The research studies were carried out through experimental and quasi-experimental trials and with variable methodological quality, predominantly directed at High School students.

Among the technologies mapped, we can mention the following: videos, films, DVDs, images, music, audiovisual narratives, games, virtual reality/avatar, web courses, computational software, computer and smartphone apps, task cards and manikins (including manufactured ones). Although there are countless educational technologies on BLS for adolescents, they have not provided good levels of practical skills, mainly when they propose to teach ventilation to lay people.

The gaps found in the studies are the absence of details on the construction and validation process of the technologies and instruments that assessed knowledge and practice, the lack of theoretical basis in the development process, the low number of studies in Latin America, the absence of publications on this theme in the African continent, and the limited number of studies that evaluated low-cost technologies.

It is therefore suggested that new studies be carried out involving educational technologies based on a reproducible process of construction, validation and effectiveness assessment. It is also proposed that, when applying these technologies, training be provided to enhance practical skills so that this knowledge is consistently translated into clinical care with real patients.

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NOTES

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