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Development of a virtual learning environment for cardiorespiratory arrest training*

Desenvolvimento de ambiente virtual de aprendizagem para a capacitação em parada cardiorrespiratória

Desarrollo de ambiente virtual de aprendizaje para la capacitación en paro cardiorrespiratorio

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ABSTRACT

Objective: To develop a Virtual Learning Environment (VLE) aiming at the training of nursing team workers and emergency vehicle drivers in Basic Life Support (BLS) to attend Cardiorespiratory arrest, and to evaluate the quality of its contents among specialists in the area of Emergency and Urgent care. **Method:** Applied research of technological development. The methodology used was based on the Instructional Design Model (ADDIE), which structures the teaching-learning planning in different stages (analysis, design, development, implementation and evaluation). The VLE was composed of texts elaborated from bibliographic research, links, edited video from a simulation scenario in the laboratory and questions to evaluate the fixation of the content, organized in modules. **Results:** After its development, it was evaluated as adequate to satisfy the needs of the target public, by eight expert judges, which was made available for electronic access. **Conclusion:** The VLE has potential as a tool for training and qualification in BLS, as it can be easily integrated with other pedagogical approaches and strategies with active methodologies.

DESCRIPTORS

Information Technology; Education, Continuing; Heart Arrest; Cardiopulmonary Resuscitation; Emergency Nursing.

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INTRODUCTION

A number of authors have been unanimous assuming cardiovascular arrest (CA) as an extreme medical emergency, the results of which may lead to irreversible sequelae and death if appropriate measures are not quickly taken[1].

In the event of a CA, the diagnosis should be rapid and accurate, the Emergency Service should be activated immediately, and Cardiovascular Resuscitation (CPR) procedures should be initiated early[2]. However, the correct implementation of CPR is listed among the factors determining survival during the first 24 hours, and also one of the main determinants for patient survival[3-4].

Nevertheless, patient care outside the hospital environment is one of the major challenges, and the availability of epidemiological data that may provide support for improving care in this context is essential.[5] It also requires rapid and efficient care, scientific knowledge and technical skills from the professionals who carry out the actions.

In addition to professionals, family members and patients themselves report the benefits of family being present during CPR, it is important that the population also have the skills to identify a cardiac arrest and perform the necessary maneuvers[6], which corroborates the American Heart Association's (AHA) recommendation that there should be instruction for lay people on first aid techniques, aiming at preventing and minimizing the deaths and disabilities resulting from this event[2].

The development of a simulated computer learning environment in CPR has also been described by other authors, with positive results, especially in demonstrating that this type of learning eliminates ethical issues of real situation, both the student's stress and the risk for the patient, besides allowing the control of situation in which the patient undergoes CA[7].

The concept of education should not be summarized as the simple transference of knowledge, instead, it should be an instrument of awareness for its construction. In health services, improvements must be constant, the worker must be concerned with the quality of care provided, working and being educated continuously, given the rapid change in protocols and adoption of new care practices[8].

Faced with this profile, permanent (or continuous) education presents itself as an alternative for health service workers, as a process of dynamic learning, based on the needs of professionals, allowing answers to the questions of their daily lives.

Permanent Health Education (PHS), implemented through the National Policy on Permanent Education in Health (PNEPS – *Política Nacional de Educação Permanente em Saúde*), became SUS' (Unified Health System – *Sistema Único de Saúde*) strategy for the training of health workers through work-based learning aimed at transforming professional practices through the usage of technologies and active methodologies. It also plans to transform everyday situations into learning, and it is important that this process is motivating for the worker[9]. There is evidence that empowering workers through permanent education is essential to ensure cooperation and satisfaction[10].

Therefore, the appropriation of new practices or even the development and use of technological resources as strategies are necessary for the learning process to be productive and enjoyable, but without losing sight of its main goal of knowledge dissemination.

Efforts to gather scientific knowledge and establish protocols of care for CA have intensified with every passing year, highlighting the publication of the AHA Guidelines for CPR and Emergency Cardiovascular Care (ECC).

However, this knowledge must be transferred to practice. In this sense, adopting the permanent education as strategy mediated by the computer, an important instrument in the modern world, can be an effective alternative in this teaching-learning process. Positive experiences with the use of computers in health education have demonstrated that this technology improves learning, making the educational process more flexible through new ways of teaching and learning[11-12].

Virtual Learning Environments (VLE), for example, can broaden access to education when employed both as a support for face-to-face classroom activities and as support for blended learning or distance learning activities conducted exclusively online[13].

In view of the above, the following question arose: how can one develop a VLE that makes it possible to educate professionals who work in the CA service?

In order to do so, this study aimed at the development of a VLE for permanent education in CA with a Basic Life Support (BLS) approach aiming at the training of nurses and drivers of emergency vehicles who work in the Mobile Life Support Services (*Serviços de Atendimento Móvel de Urgência* – SAMU), as well as evaluating the quality of its contents for the teaching of the CA with specialists in the area of Emergency and Urgent care.

METHOD

This is an applied research of technological development, involving the construction and the evaluation of a VLE, directed to the BLS in the CA[14]. This study was based on a pedagogical framework based on the constructivist approach according to Vygotsky, since it is the one that best adapts to the proposed objectives.

According to Vygotsky's theory, the individual can use technical instruments or tools as sources of information, and the teacher is a mediator of the development of learning. Therefore, a VLE can be used as a mediator in the teaching-learning process[15].

The VLE was built based on the Instructional Design Model – ADDIE (analysis, design, development, implementation and evaluation) presented by Filatro, in agreement with the Galvis Panqueva methodology[16]. This model of instructional design structures teaching-learning planning in five distinct stages: 1. Analysis: initial phase, moment of understanding needs and defining content; 2. Design: definition of objectives and planning of activities; 3. Development: development of theoretical material and conversion to the chosen technological language; 4. Implementation: execution of the program; 5. Evaluation: the planned results are compared with those obtained[17].

The first stage, analysis, involved the characterization of the target audience, topic choice, definition of educational objectives and available resources. In the second stage, design, the content was organized, divided into sequential and complementary modules, organized according to a flow chart to guide VLE navigation paths. Content sequencing was done in a storyboard format using slides in the Microsoft Office PowerPoint 2007®.

In the next stage, development, a computer technician made the conversion of all the theoretical material organized in the previous phase into the proposed technological tools. HTML (Hypertext Markup Language), PHP (Personal Home Page) and CSS (Cascading Style Sheets) technologies were used.

In the implementation stage, the VLE was made available on an educational platform, allowing access through the internet, so that the first tests were carried out by the team that idealized it.

The evaluation of the virtual learning environment was carried out by eight specialists with experience in the area of Emergency and Urgent care, with a minimum of a Master's degree, training in BLS and proven experience of five years or more in Emergency and Urgent care and in assistance activities or teaching, in order to verify the Adequacy of the content and strategies used for the learning process of the target audience. The number of judges was determined according to International Organization for Standardization and International Electrotechnical Commission ISO/IEC 14598-6, which recommends at least eight participants in each category of evaluators[18].

At this stage, the VLE was submitted to expert judges with the objective of evaluating items related to usability, that is, if it corresponded to the educational proposal for which it was intended, using an instrument constructed considering the specifications described by the Brazilian Association of Technical Norms (*Associação Brasileira de Normas Técnicas* – ABNT) ISO/IEC 9126 and ISO/IEC 14598-6, adapted from the model used by researchers in this area of knowledge[18-20]. This instrument was composed by the characterization of the sociodemographic data and the approach of the aspects of the program: audiovisual quality (technical aspects) and content quality (pedagogical aspects), analyzed in items related to response time, interface quality and content. The technical quality to be evaluated by computer specialists was not considered in this study, since its requirements would involve in-depth knowledge in the field.

To evaluate each of these aspects, the instruments included the summative method in Likert scale, where sub-items were presented and for each one was assigned a value: (1) unsatisfactory, (2) reasonable, (3) satisfactory, (4) excellent, in addition to ensuring a space for the participant to make his/her justification, if he/she had indicated satisfactory, reasonable or unsatisfactory for some category analyzed, as for other comments or suggestions for improvements.

Criteria have been established to define VLE's performance. Agreement of at least 80% among the expert judges was the decision criterion on adequacy for use, that is: 49 to 64 points: it is adequate for use; 33 to 48 points: adequate, but requires adaptations; 17 to 32 points: requires modifications to be used; 16 points: unsuitable for use.

The data were organized using spreadsheets elaborated in Microsoft Excel® 2010, in which the results were released. For the analysis of the data, the sum of the individual values and the mean of the final value were presented in figures.

The project was approved by the Research Ethics Committee of the Universidade de São Paulo at Escola de Enfermagem de Ribeirão Preto (protocol number 622.897), meeting the requirements of Resolution 466/12 of the National Health Council.

RESULTS

A VLE for the teaching of CPR with BLS approach was developed according to the described planning, being available at the electronic address: <http://www2.eerp.usp.br/Nepien/PCR>.

After entering the address, the user would have access to the homepage, which contains the title, a welcome text and guidance about the VLE content, its purpose and authorship. The menu is at the top of the screen, in a horizontal line, presenting the navigation modules, comprising the buttons: Home, Historical Aspects, Anatomy and Physiology, Biosafety, Concepts, Algorithms, Simulation and Questions (Figure 1).

From the home screen, the user can navigate the virtual environment following the order of the modules or at random. However, although they were independent, the modules were designed according to a flow of information that facilitates the understanding of the user.

When searching for any of the modules, the user has access to a page composed of the title and objectives of the module, identifying the goal to be reached with the reading, followed by the content index, represented by icons. Each icon presents a complete text, contextualizing the topic in a singular way, stimulating the search for knowledge, as shown in Figure 2.

Each module provides external links, which can be visited by the user, to deepen the subject studied. Likewise, the list of articles used as references can be accessed by learners. All modules have a similar structure.

In order to represent a real-life situation, a Scenic and Robotic Simulation was included to reproduce scenes representative of daily health and to approach the problem of CA in a non-hospital environment that was recognized by laypeople.

The scenario of this simulation was structured in the Simulation Laboratory of the EERP/USP, with a trained amateur patient/actor and health professionals specialized in the thematic area CA/CPR, using the ResusciAnne Mannequin and Automatic External Defibrillator (AED) for training, for Performing the maneuvers of CPR and defibrillation. Given this simulation modality, CPR practices in BLS were guaranteed according to the AHA Guidelines.

To evaluate the acquisition of knowledge, an interactive questionnaire was created composed of 20 multiple choice

questions related to all the content displayed in the previous modules, for user feedback, the correct and incorrect questions were quantified and the correction for these incorrect answers were presented.

Eight expert judges were invited to evaluate the items that composed the VLE, seven nurses and one physician, with master and PhD, specialists in the area of Emergency and Urgent care, who made important suggestions.

Items related to the Technical Aspects (response time and interface quality) and Pedagogical Aspects (content) of the VLE were evaluated.

The evaluation of the item Technical Aspects with the concepts attributed by the specialists is presented in Figure 3.

Figure 4 shows the results of the evaluation of the VLE Pedagogical Aspects for CA training.

The final result obtained by the arithmetic mean of the sum of the evaluations of the VLE Technical and Pedagogical Aspects for CA training by the eight specialists is shown in Figure 5.

VLE obtained a mean of 61 points, so that, being between 49 and 64 points, it was considered adequate for the use.

Figure 1 – Initial screen of access to the Virtual Learning Environment for Training in Cardiovascular Arrest – Ribeirão Preto, SP, Brazil, 2015.

Figure 2 – Screen of the module "Algorithms" of the Virtual Learning Environment for Training in Cardiovascular Arrest – Ribeirão Preto, SP, Brazil, 2015.

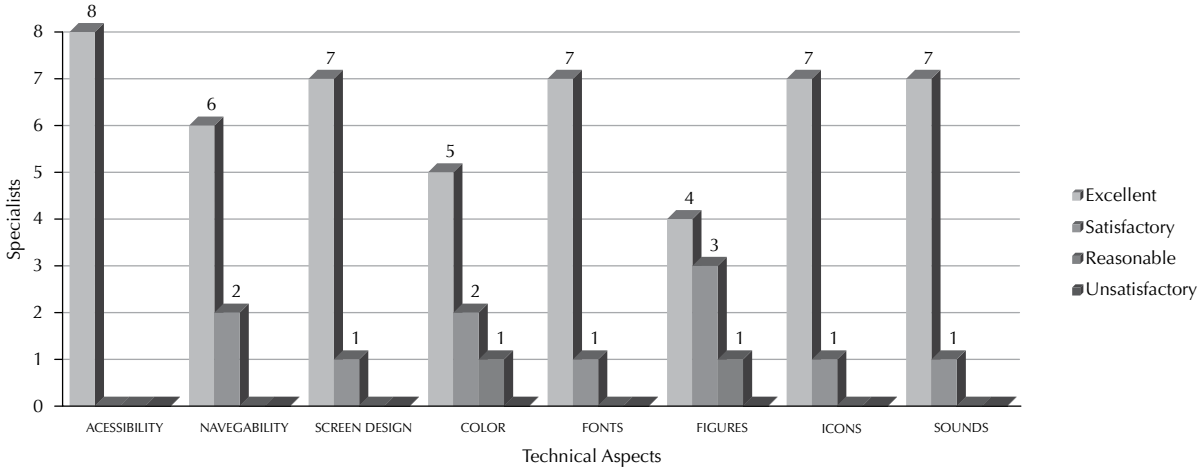

Figure 3 – Results of the evaluation of the Technical Aspects of the Virtual Learning Environment for Training in Cardiovascular Arrest by the eight specialists – Ribeirão Preto, SP, Brazil, 2015.

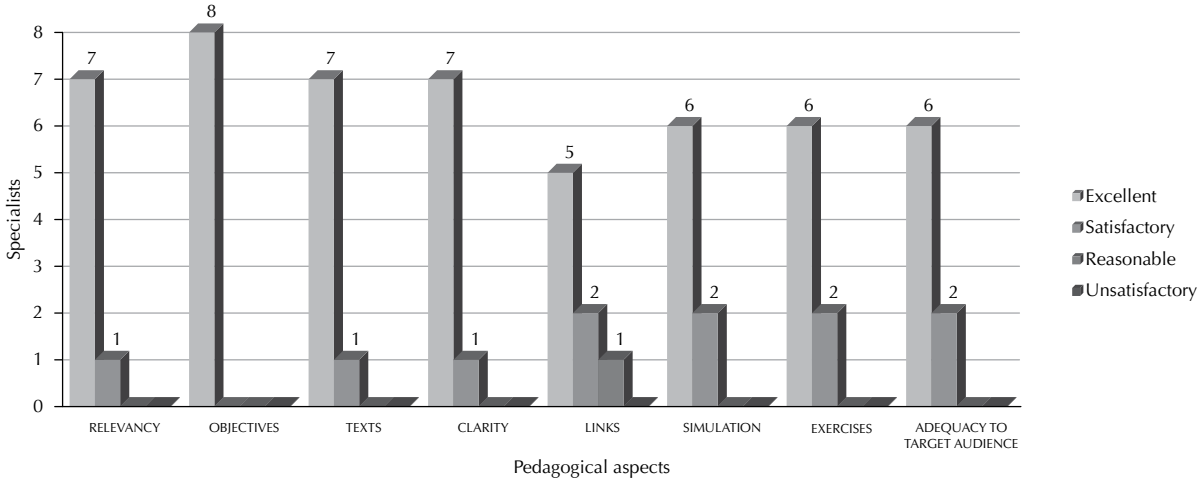

Figure 4 – Results of the Evaluation of the Pedagogical Aspects Virtual Learning Environment for Training in Cardiopulmonary Arrest by the eight specialists – Ribeirão Preto, SP, Brazil, 2015.

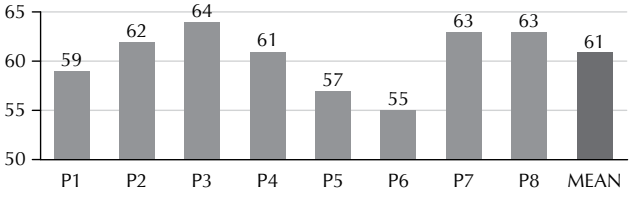

Figure 5 – Final result of the evaluation of the Virtual Learning Environment for Training in Cardiovascular Arrest by the eight specialists – Ribeirão Preto, SP, Brazil, 2015.

DISCUSSION

A well-planned VLE should enable the use of a variety of resources to achieve its educational objectives, therefore, usability analysis is a fundamental step in a user-centered design and is translated into user-friendliness, meaning that users must achieve the objectives, generating the expected results.

This VLE was built with the purpose of assisting and complementing activities carried out in the classroom, or for the user, through the internet, to build their own learning. This model of education meets the pedagogical framework used, based on Vygotsky's theory, in which knowledge is acquired in an interactive way.

In the evaluation of the Technical Aspects, in the response time item, it is important to consider the accessibility categories, whose objective is to evaluate the ease of accessing the pages of the virtual environment, and navigability, whose evaluation contemplates the way to change pages, access, links and button operation[21].

In this context, accessibility and navigability are fundamental aspects, as they should be facilitators so that the user can access the screens without difficulty, which increases their interest.

In the quality of the interface, the visual aspects should be evaluated, considering the design of the screens, choice of colors, size and type of the letters, consistency of the figures, suitability of the icons and sound clarity. It is recommended that the design be aesthetically pleasing to gain the attention of the user. In addition, visual information should facilitate learning. All screens must have the same functional structure, with the distribution of the icons, colors, choice of letters and figures[21].

The VLE layout was formatted contemplating these elements, and the design was rated as excellent by most experts.

Color is a very significant element and should be used with discretion as it can set a tone but also cause distraction[21]. For the VLE development we chose shades of pink for the background, to highlight the red and black used in the drawing of the logo. One expert suggested using a white background, but as it would contrast sharply with the top bar and logo colors, the background color was not changed.

Fonts should facilitate viewing and reading of screens[21]. It has been suggested by a specialist to increase the size of the fonts. Thus, the option of zooming the screens was inserted, allowing the user to adjust the font size according to their need.

Still according to the authors mentioned above, the images must be realistic to facilitate learning. Thus, the figures have a great importance, since they allow a visualization of the information described in the texts, providing better fixation of the studied content. In the development of VLE for training in CA, limitations were found in the elaboration of the module Anatomy and Physiology, related to the quality of the images, which was identified by the specialists, and there is a need for their adaptation. In the Biosafety module, because it was considered adequate in request of one of the judges regarding the use of the correct apron, the image was modified. The photos of the module Algorithms were considered adequate and objective.

Signaling an activity helps organize the sequence of information[22]. For this VLE were created icons with legend, simply clicking on them to access the desired topic. It is worth mentioning the positive evaluation regarding the targeted icons.

Regarding sound, the literature emphasizes that this should complement and not compete with the information[22], which was corroborated by the specialists when evaluating the item Simulation, pointing out that the sound became tiring in the introduction of the video and the voice interfered in the emphasis of the content at a given moment. In view of these observations, the introduction time was shortened and the audio was reviewed in the video, adjusting it as much as possible.

VLE for CA qualification was planned considering the importance of the textual elements. Regarding the content, some studies indicate that the texts should be simple, paragraphs and sentences should be short. To facilitate reading, the content should be divided into small blocks, avoiding to use the screen bearing, not to cause distraction and increase the understanding of the reading[22].

For the elaboration of the texts, current articles and the AHA recommendations for CPR were used. After the specialist' assessment, adjustments were made in some paragraphs, which were considered long, and most texts occupy only one screen and few need to use the text scroll bar.

External links have been inserted referring documents that the user can access directly through the internet. These are intended to enrich the content, suggesting references and ways to deepen the subject. The use of links in English was questioned by the specialists, in view of the target audience. After the review, only those with the option of caption in Portuguese were kept. These refer to the AHA and were maintained because of the importance of this institution for the subject in question.

Simulation is a strategy that has been gaining space as a teaching method, through the development of an environment with the representation of a real event, offering a learning laboratory[23-24]. With this objective, this technological resource was used in the virtual environment, subsidizing the creation of a video that reproduces a real situation, aiming to awaken in the user a moment of reflection. The video was rated as excellent or satisfactory.

Among the suggestions made by the specialists, in addition to the audio changes already mentioned, are the initial orientation on the scenario, the review of the start times of the CA, the adequacy of a scientific term and the complementation of information in the scrolling texts. All of these changes were made. The experts also highlighted the quality of the guidelines to the layperson and the emphasis on the concept of quality CPR. One expert pointed to the quality of the content of the video, since it gives subsidies for the answers of the exercises.

It is worth mentioning the inclusion of exercises that allow the user to evaluate the knowledge acquired, providing feedback to the learning[25].

In the VLE for CA training, the user has the possibility to obtain an evaluation of the knowledge acquired with interactivity, as suggested by Vygotsky, that is, performing the learning fixation exercises and, from the moment the response is sent, the system allows access to the results correction page.

The suggestion of one of the experts was accepted, which suggested the complementation of technical terms according to international standards.

Considering the analysis of the specialists, a final revision of the VLE was accomplished and the modifications made, taking into account most of the suggestions.

CONCLUSION

The present study had as proposal to develop and evaluate a VLE for the training in CA, of workers of the nursing team and drivers of emergency vehicles that work in SAMU.

After its development, according to the methodology proposed, the VLE was evaluated by specialists who pointed it as a tool that could contribute to the qualification of the professionals who work in the Pre-Hospital Care, subsidizing the students with theoretical-practical content indispensable for the quality assistance of the CA victims.

Thus, it is considered that the objectives of this study were reached, and the VLE is available at the following electronic address: <http://www2.eerp.usp.br/Nepien/PCR>.

It should be emphasized that the VLE has the potential to be used as a tool in the qualification and training of people in BLS, because it is easily integrated with other pedagogical approaches and strategies with active methodologies. It provides advances in CA training as it brings the most current

scientific evidence, as well as economic advantages, and can be accessed from computers, tablets or cell phones, by professionals and laypeople. In addition, it provides the user with the possibility to evaluate their immediate knowledge with feedback by monitoring their theoretical performance scores, which also allows them to return to topics that were not very sedimented in learning.

It is hoped by this study that pedagogical strategies with the capacity to produce broader results, addressing an increasing number of individuals are encouraged. By facilitating the diffusion of knowledge, and thus the adoption of more effective techniques, these strategies fulfill their main objective: the socialization of new practices and practices based on evidence.

As a future proposal, the authors intend to evaluate the functional performance of VLE for CA training as an instrument to support teaching and learning, along with nursing assistants and technicians and drivers of emergency vehicles that work in Basic Life Support.

A study limitation refers to the restriction of training for laypeople, nursing team workers and emergency vehicle drivers in BLS. Future research should extend this training to all professionals, including physicians, so that Advanced Life Support is also contemplated.

RESUMO

Objetivo: Desenvolver um Ambiente Virtual de Aprendizagem (AVA) visando à capacitação de trabalhadores da equipe de enfermagem e condutores de veículo de emergência em Suporte Básico de Vida (SBV) no atendimento à Parada Cardiorrespiratória, e avaliar a qualidade do seu conteúdo junto a especialistas na área de Urgência e Emergência. **Método:** Pesquisa aplicada, de produção tecnológica. A metodologia utilizada foi baseada no Modelo de Design Instrucional (ADDIE), que estrutura o planejamento de ensino-aprendizagem em estágios distintos (*analysis*, *design*, *development*, *implementation and evaluation*). O AVA foi composto por textos elaborados a partir de pesquisa bibliográfica, *links*, vídeo construído a partir de um cenário de simulação em laboratório e questões para avaliar a fixação do conteúdo, organizados em módulos. **Resultados:** Após a sua construção, foi avaliado como adequado para satisfazer às necessidades do público-alvo, por oito juízes especialistas, sendo disponibilizado para acesso eletrônico. **Conclusão:** O AVA tem potencial como ferramenta para formação e capacitação em SBV por ser facilmente integrado a outras abordagens pedagógicas e estratégias com metodologias ativas.

DESCRITORES

Tecnologia da Informação; Educação Continuada; Parada Cardíaca; Ressuscitação Cardiopulmonar; Enfermagem em Emergência.

RESUMEN

Objetivo: Desarrollar un Ambiente Virtual de Aprendizaje (AVA) con vistas a la capacitación de trabajadores del equipo de enfermería y conductores de vehículos de emergencia en Soporte Básico de Vida (SBV) en la atención al Paro Cardiorrespiratorio y evaluar la calidad de su contenido junto a los expertos en el área de Urgencia y Emergencia. **Método:** Investigación aplicada, de producción tecnológica. La metodología utilizada estuvo basada en el Modelo de Diseño Instrucional (ADDIE), que estructura la planificación de enseñanza-aprendizaje en etapas distintas (*analysis*, *design*, *development*, *implementation and evaluation*). El AVA estuvo compuesto de textos elaborados mediante investigación bibliográfica, enlaces, video construido a partir de un escenario de simulación en laboratorio y cuestiones para evaluar la fijación del contenido, organizados en módulos. **Resultados:** Después de su construcción, fue evaluado como adecuado para satisfacer las necesidades del público meta por jueces especialistas, estando disponible para acceso electrónico. **Conclusión:** El AVA tiene potencial como herramienta para formación y capacitación en SBV por ser fácilmente integrado a otros abordajes pedagógicos y estrategias con metodologías activas.

DESCRIPTORES

Tecnología de la Información; Educación Continua; Paro Cardíaco; Resucitación Cardiopulmonar; Enfermería de Urgencia.

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