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ARTÍCULO ORIGINAL

Recovery of simulators as learning resources in nursing

Recuperación de simuladores como recursos del aprendizaje en Enfermería

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ABSTRACT

Background: the use of anatomical simulators as teaching aids or learning resources in medical education allows students to develop skills; however, they sometimes experience deterioration in their technical and aesthetic preservation due to years of use, which prevents their optimal utility.

Objective: to describe the recovery of the technical and aesthetic state of the anatomical simulators -manikins- of the Nursing program due to their importance in teaching.

Methods: a qualitative investigation was conducted at the Villa Clara University of Medical Sciences from March 2023 to March 2024. Theoretical methods were used: analytic-synthetic, historical-logical, and inductive-deductive; and empirical ones: documentary analysis of the Nursing curricula, digital review related to simulators, and interviews with

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key informants to verify the importance of their recovery and the level of satisfaction of their users.

Results: eight human anatomical model simulators were recovered by implementing an action plan and resorting to innovation and creativity: new accessories were designed to replace the original ones, necessary materials were purchased, and other plastic ones were recycled for being soft and flexible; furthermore, discarded anatomical parts were recovered to replace missing ones. The final product was evaluated based on expert criteria.

Conclusions: the repair process was positively evaluated according to the proposed indicators. The recovered manikins constitute a solution to existing problems with the acquisition of teaching aids, and their economic contribution fosters saving foreign currency by avoiding their purchase on the international market.

MeSH: material resource management; teaching materials; education, nursing; education, medical.

RESUMEN

Fundamento: el uso de simuladores anatómicos como medios de enseñanza o recursos del aprendizaje en la educación médica permite desarrollar habilidades en los estudiantes; pero en ocasiones experimentan deterioro en su conservación técnica y estética por los años de explotación, lo cual impide su utilidad óptima.

Objetivo: describir la recuperación del estado técnico y estético de los simuladores anatómicos –maniquíes- de la carrera de Enfermería por su importancia en la docencia.

Métodos: se realizó una investigación cualitativa en la Universidad de Ciencias Médicas de Villa Clara, durante marzo 2023- marzo 2024. Se emplearon métodos teóricos: analítico-sintético, histórico-lógico e inductivo- deductivo; y empíricos: análisis documental de los programas de estudio de Enfermería, revisión digitalizada relacionada con los simuladores, y entrevista a informantes clave para comprobar la importancia de su recuperación y nivel de satisfacción de sus usuarios.

Resultados: se recuperaron ocho simuladores de modelo anatómico humano, mediante el cumplimiento de un plan de acción y recurriendo a la innovación y creatividad: se diseñaron nuevos accesorios para remplazar los originales, se compraron los materiales necesarios y se reciclaron otros de plástico por ser suave y flexible, además, se recuperaron piezas

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anatómicas desechadas para reponer las ausentes. El producto final fue valorado por criterios de especialistas.

Conclusiones: el proceso de reparación fue valorado positivamente según los indicadores propuestos. Los maniquíes recuperados constituyen una solución a problemas existentes con la adquisición de medios de enseñanza, y su aporte económico propicia ahorrar divisas por su compra en el mercado internacional.

DeCS: gestión de recursos materiales; materiales de enseñanza; educación en Enfermería; educación médica.

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INTRODUCTION

Simulation in higher education in general as a didactic strategy allows experimentation and the development of skills in students, by bringing them closer to similar situations, and fostering greater confidence and security necessary to face certain experiences and the understanding of knowledge in practice, through systematic work of approximation in training and performance.[1]

In this regard, Vidal *et al*.,[2] assume in their research that in medical education, both secondary and higher, the use of these aids in the teaching-learning process, including evaluation, is important.

Some bibliographies[3,4] confirm various types of simulators used in learning strategies, among them: the standardized patient, the human simulator, the hybrid patient, virtual simulators, and skill simulators.

There are various classifications of simulators based on the concept of "fidelity"; this term defines the degree of realism of the models used. In general, three simulation modalities are

described: low fidelity, intermediate fidelity, and high fidelity.[4] Low-fidelity ones are the most economical and are often the first choice to incorporate students into the use of clinical simulation techniques.[5]

Simulation in medical sciences education as a learning tool represents a significant modality as a didactic strategy that allows students to experiment and develop skills; however, the preservation of their technical and aesthetic state over years of use causes deterioration that prevents their optimal utility.

In the Nursing program at the Villa Clara University of Medical Sciences, there are 11 human simulators of the anatomical model, -manikins-, and considered low-fidelity for nursing skill training. Of these, seven are full-body and four are half-body. These teaching resources have been in use for over 15 years with marked deterioration: cracks, detachment of limbs, and other problems that have prevented their use in different subjects of the Nursing program.

For this reason, the authors, graduates in Electro medicine and Nursing respectively, based on the teachings of one of the most important and influential scientists of the 20th century, Albert Einstein, whose contributions to physics have been a guide for both health specialties, took as a reference his phrase: "In times of crisis, imagination is more effective than intellect".[6]

In Cuba, where a sustained economic, commercial, and financial blockade imposed by the United States government is maintained, it is difficult to acquire new simulators to replace the current ones in all the medical universities on the island. At the Villa Clara University of Medical Sciences, the Nursing department needs to rescue these teaching aids, so the objective of the research is to describe the recovery of the technical and aesthetic state of the anatomical simulators -manikins- of the Nursing program due to their importance in teaching.

METHODS

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A qualitative investigation was conducted at the Villa Clara University of Medical Sciences, from March 2023 to March 2024, for the recovery of the technical state of the simulators -manikins- of the Nursing program. The population consisted of the 11 simulators available to the program and the sample of 8 of them, intentionally selected for recovery: 6 full-body and 2 half-body.

The following theoretical methods were used:

- Analysis-synthesis: for the foundation of the research, understanding the problem and study of the bibliography.
- Historical-logical: to learn about the historical background of the researched topic.
- Inductive-deductive: for the analysis of the solution to consider for the presented problem.

Empirical methods:

- Documentary analysis: of the Nursing curricula in their different training programs to learn about the subjects that require the permanent use of simulators, the digital search for the types of simulators that exist worldwide, their prices on the international market, manufacturing material, and the review of the technical state of the simulators for the exclusive diagnosis of each defect, and classification according to the type of breakage.
- Interview with key informants (students and professors): conducted in two stages: initial and final, to verify the importance of recovering the simulators and the level of satisfaction with the results of the products. For this, 10 professors from different Nursing subjects were interviewed, and 10 students: 5 from the bachelor's degree and 5 from the short-cycle higher technical training.

The recovered products were evaluated based on the criteria of three specialists, among them, two graduates in Nursing, masters in sciences, researchers and assistant professors: one head of the Nursing department; the other, dean of the Faculty of Nursing and Health Technology of that academic institution; both with over 10 years of teaching experience. The

third specialist is a graduate in Electro medicine with over 40 years of experience in the profession. The indicators for the product evaluation were: its pertinence, utility, feasibility, applicability, and effectiveness.

RESULTS AND DISCUSSION

In the analysis of the Nursing curricula, it was found that there are basic subjects for student training that require the use of simulators:

- Nursing Fundamentals: taught in the first year of the bachelor's degree in the regular daytime course and in the short-cycle higher technical training. For learning the skills of different basic procedures in the training of the nursing professional: injection, measurement of vital signs, bed bath, among others.
- Nursing Care for Adult Patients: taught in the second year so that the student acquires the necessary skills in medical-surgical patient care with specific techniques for each system.
- Gynecological-Obstetric Nursing: an elementary subject in the care of women, pregnant women, postpartum women, and newborns, which involves many basic and specific techniques of the specialty.

In the detailed search on the use of information and communication technologies (ICT) in the design of types of simulators, it was evidenced that virtual simulation technologies have currently been developed for education in the medical sciences, which has strengthened the practice of skills in students in training.

Dávila Cervantes[3] and Rodríguez González *et al*.[7] have shown their experiences in the use of new simulators considered high-fidelity: clinical simulators, body manikins, task trainers, and those designed using virtual reality (VR) with a high value of US $3499.00 on the international market, according to the study conducted in the United Kingdom where the global medical simulation market is expected to grow at a compound annual rate of 15.0% from 2022 to 2029. It is expected to reach more than 5.28 billion dollars by 2029 from 1.5 billion dollars in 2020.[8]

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Another statistical study in the global market[9] expresses a forecast until 2032, of $3.53 billion in the design or purchase of manikins using computers to simulate components of the anatomical system, known as mannequin-based simulation, which can also be used to predict how that system would react under various circumstances. The use of manikins allows for more realistic simulations, which can result in more accurate forecasts. Those classified as low-fidelity, used at the Villa Clara University of Medical Sciences, are priced in China ranging from $410.00 to $590.00.[10]

For the recovery of the simulators, the manufacturing material was assessed: it was found that seven of them were manufactured with silicones, latex, and PVC (87.5%), and only one, with plaster coated with plastic (12.5%).

In the review of the technical state of the 11 simulators registered in the Nursing department's inventory, it was found that 100% were markedly deteriorated. For their study for recovery purposes, an intentional sample of 8 was taken.
Table 1 shows the diagnosis for the classification and evaluation of the technical state of the 8 simulators -manikins-. They were classified into: 4 full-body adults (50%), 2 full-body babies (25%), and 2 half-body adults (25%).

Regarding the type of breakage, 7 were diagnosed with detachment of the joints of upper and lower limbs, trunk, head, and anatomical parts (87.5%); and the adult simulator (pregnant) also had fractures of hands, head, shoulders, and feet (12.5%). By their technical state, 100% were evaluated as being in poor condition.

Table 1. Results of the diagnosis for the classification and evaluation of the technical state of the simulators -manikins- selected for recovery. Nursing Department. Villa Clara University of Medical Sciences. March 2023-March 2024

Simulator	Classification and Manufacturing Material	Type of breakage	Technical State

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Adult	Full-body	Detachment of upper and lower limbs by their joints and anatomical parts	Poor
Adult	Silicone, latex and PVC	Same as above	Poor
Adult	Full-body. Silicone, latex and PVC	Same as above	Poor
Adult pregnant	Full-body. Plaster coated with plastic	Same as above + Detachment of lower limbs and anatomical parts.	Poor
Baby	Full-body. Silicone, latex and PVC	Detachment of lower limbs and anatomical parts	Poor
Baby	Full-body. Silicone, latex and PVC	Same as above	Poor
Adult	Half-body. Silicone, latex and PVC	Detachment of lower limbs and anatomical parts.	Poor
Adulto	Half-body. Silicone, latex and PVC	Same as above	Poor

Source: analysis of classification and technical state diagnosis.

It is observed that the majority of identified problems consist of the detachment of the joints of upper and lower limbs, trunk, head, and anatomical parts. In this sense, the loss of fastening attachments (screws, washers, plastic and metal nuts) deteriorated by oxidation and fractures is noted; which resulted in the separation of the parts that make up the body of the manikins. Likewise, cracks caused by the use of wires for repair on previous occasions are observed in the one manufactured with plastic material. Figure 1 shows examples of the diagnosis of the technical state of the simulators.

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Fig. 1. Examples of the technical state of the simulators based on the diagnosis performed.
Nursing Department. March 2023-March 2024
Source: images taken by the authors.

In the interview conducted in the first stage with 20 key informants, 100% declared the importance of recovering simulation-based teaching aids because of how practical and useful they are for acquiring skills in nursing student training; this criterion was an important element to consider for assessing the solution to the posed problem. In general, the 10 professors (50%) recognize that there is a need to improve teaching aids (manikins) for the different subjects that require skill practice and evaluation, but they are in a state of maximum deterioration due to years of use.

The 10 students expressed interest in improving these teaching aids because it facilitates the acquisition of practical skills and influences their better training prior to their interaction with the patient. They affirm that these teaching aids are not only used in teaching, but also in vocational training and professional guidance activities, as well as community intervention for health promotion.

It is evident that the perception of the interviewees regarding the necessary restoration of these teaching aids is fundamentally justified in the advantages they attribute to them for acquiring skills in practicing techniques specific to the profession for nursing staff training, and their use in extracurricular activities, therefore, they become indispensable for the teaching-learning of the different study programs.

Taking into account the aforementioned result, the recovery of the simulators -manikins- proceeded by implementing an action plan:

- Classify the simulators according to the type of deterioration, and the material needed for their restoration.
- Review the storage to verify the existence of anatomical parts in good condition that can be used.

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- Acquire in some cases necessary irreplaceable materials and the creation of accessories to replace the original ones for the adequate and lasting repair of these simulators. For this, the purchase of necessary materials and the recycling of plastic bottles made of soft and flexible material were carried out as shown in Figure 2 for the elaboration of plastic washers.

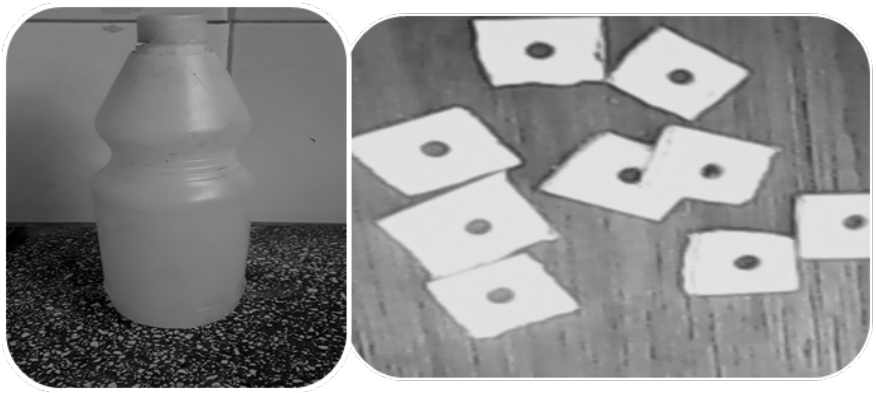

Fig. 2. Recycled plastic bottle, used in making washers. Nursing Department. Villa Clara University of Medical Sciences. March 2023-March 2024
Source: images taken by the authors.

For the recovery of these simulators, innovation was resorted to and in some cases the use of irreplaceable elements for correct functioning and durability; the authors considered the type of manufacturing material and the degree of deterioration to select the appropriate material for their restoration. Initially, discarded anatomical parts were recovered to replace missing ones; however, for the placement of upper and lower limbs, it was necessary to purchase other elements: screws, nuts, and washers, which were placed in the joints of hands, shoulders, and legs, as these are the areas of greatest movement and rotation and to secure them since due to their characteristics and functions it was necessary to maintain their original framework.

Certain parts could be replaced with washers with threads made from recycling plastic bottles, which had the advantage of avoiding damage to the manufacturing material due to corrosion of metal screws, and they were also used to adapt parts damaged by fractures and

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cracks. Recycled hoses were also used to replace some long screws to be placed in areas of less movement like knees, feet, and neck. Figure 3 shows an example of the placement of a screw with plastic and metal washers on the simulator's arm.

Fig. 3. Placement of a screw with plastic and metal washers on the simulator's arm. Nursing Department. Villa Clara University of Medical Sciences. March 2023-March 2024
Source: images taken by the authors.

In the second stage of the interview with key informants to learn about the level of satisfaction with the recovery of the simulators, all the teachers stated that they agreed with the final result; they justified their response with the criterion that simulation-based teaching aids allow developing critical reasoning, decision-making, and practical skills in students.

The students agreed in their responses by expressing that their satisfaction is due to the possibility of having an aid that helps them practice techniques specific to the profession, which in the previous state of the simulators was difficult to perform; they also considered that it favors the integration of theory with practice, which coincides with other studies.[11,12]

These responses indicate that in the Nursing program, the use of simulators as teaching aids is a very accepted tool for skill training, a different criterion from that found in the study by Martínez Felipe *et al*., cited by Pinargote-Chancay *et al.,*[13] with nurses in Mexico, who perceived traditional hospital practices as more useful, compared to simulated practices.

Although the authors do not entirely agree with the opinion of Ávila *et al*.[14] who point out bioethical training as a very important element of simulation in medical education, they do recognize that this interaction with the manikin allows perceiving whether patients' rights are protected, whether their safety and privacy are guaranteed, during the students' learning process. In this regard, Novoa Burgos[15] assumes in his research that: "... simulation-based learning is a bridge between classroom learning and real clinical experience that does not put real patients at risk and avoids certain dangers of real clinical environments and offers the opportunity to perfect skills".

At the University of Monterrey, Mexico, Rodríguez González *et al*.,[7] state that there is a high level of satisfaction with the use of clinical simulation during the training of medical students. This type of simulation as a teaching-learning strategy dates back to the late 1990s in developed countries. It constitutes a teaching tool for the teaching-learning process in health, characterized by work in controlled scenarios with a set of aspects that mimic real situations where students develop their clinical performance. Prior to its application, it requires defining specific and comprehensive scenarios consistent with the student's competencies and educational stage.[16]

Unfortunately, Cuba does not have this type of simulation in the training scenarios for medical science students. It is necessary to point out that the use of any type of simulation is an effective method; but in its medical universities, although the use of simulators has been improved, those classified as low-fidelity still persist; however, user satisfaction criteria are comparable with studies conducted in other countries.[5]

In an investigation by Knobel *et al*.,[17] related to the use of low-cost handcrafted simulators for teaching obstetrics, students express their importance in their learning process, especially in acquiring skills to solve clinical problems and reduce anxiety in situations similar to simulated ones, which indicates that these aids, regardless of their classification, are a didactic and ideal tool for learning in the medical sciences.

The use of simulators has several advantages: the possibility of repeating the procedure, error correction, and the perception of personal and procedure-inherent difficulties.[18] The

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authors reiterate their importance for the training of nursing professionals since they allow practicing different techniques until mastering them, as an attribute of respect for human dignity and clinical safety: objectives of bioethics in the nursing care process.

The specialists evaluated the recovered product and opined, regarding its pertinence, that it was timely and effective work due to the need for simulator restoration. The Electro-medicine specialist referred to its adequate functionality materialized in the manikins being fit for use and appreciated that despite not corresponding to the functions of the professional authors of the work, they took innovative elements into account for the solution to the problem.

Also evaluated were the utility, benefit, and advantages offered by the recovery of these teaching aids by estimating their high cost on the international market despite being low-fidelity; they agreed on the possibility of their application in other teaching scenarios in Villa Clara province that present the same difficulties with simulators, taking into account the guarantee of the work's results.

The repaired simulators have been used in teaching and extracurricular activities since March 2024. Among the extracurricular activities are: interest circle exhibitions, open house events, and community projects, and it also contributed to achieving positive results in the program evaluation when shown to the National Accreditation Board (JAN), as well as to the Health Ministry visit received at the beginning of the school year, who also manifested the quality in the state of the simulators. Figure 4 shows images during the work of recovering the teaching aids.

Fig. 4. Images during the work of recovering the teaching aids
Source: images taken by the authors.

The generalization process has now begun with the childbirth simulator for teaching in Gynecology and Obstetrics at the "Mariana Grajales" Gynecological-Obstetric University Hospital in Santa Clara.

Scientific contribution

The study conducted for the recovery of the simulators favors the teaching-learning process and allows learners to perfect the level of theoretical and practical knowledge necessary to execute their work as future professionals. The achievement of the results demonstrated the use of alternatives to reverse the described problematic situation based on the economic, pedagogical, and environmental impact with the use of low-cost (plastic) materials that encourage thinking and acting innovatively as support for environmental care and economic contribution to the country.

CONCLUSIONS

The technical and aesthetic state of eight human simulators that were in extreme deterioration was recovered, to contribute to the educational teaching process and extracurricular activities in Nursing. These teaching aids have been used with very good acceptance by students and professors, and evaluated by specialists as adequate as they constitute a solution to existing problems with the acquisition of teaching aids in the face of the barriers imposed by the blockade; the solution offers a recognized economic contribution by saving the country their purchase on the international market.

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Declaration of interests

The authors declare no conflict of interest.

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