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Virtual Assistance System Applied in Learning About Pressure Ulcers

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ABSTRACT

Pressure ulcers have a negative impact on the health system, seriously affecting patients on stretchers or wheelchairs who are constantly in the same position, injuring skin tissue and becoming an expensive treatment due to complication of the patient by limiting him to move freely, being worrying about the increase in patients affected with these injuries who are not treated correctly by the medical staff or tutor in charge, for this reason it is important to maintain prevention and care measures for affected patients, with a trained medical personnel who are in charge of many disabled patients who cannot move on their own, and may be injured with chronic wounds due to inadequate treatment, highlighting that medical personnel play a fundamental role in the prevention of pressure injuries by keeping them moving on the surface where the patient supports the weight of his body. According to the problem raised, in this investigation a virtual assistance system applied to learning about pressure ulcers was conducted, providing guidance and information to medical personnel through a multimedia platform, taking advantage of a new form of tele-education with educational materials regarding to these conditions. Through the operation of the system, it was possible to determine that it works with an efficiency of 92.04%, highlighting its user evaluations that determined the appropriate material for them, guaranteeing better learning regarding the prevention and care of patients with pressure ulcers.

1. Introduction

One of the problems that the health system has been facing due to the constant cases of patients are pressure ulcers [1], which constitute a problem of injury to the skin and underlying tissue due to pressure or friction for a long time on the same position [2]. These lesions can occur on hard surfaces that are close to the skin, and these types of lesions are commonly observed in patients who are bedridden or in a wheelchair due to being unable to move for a long time [3].

This serious health problem generates a considerable economic impact on the health system, quantifying approximately 5% of its annual expenditure in the entire system [4], since hospitals are mainly those places where the highest proportion of patients affected by these injuries manifest themselves. putting the patient's health in a serious situation due to an infection caused by these

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injuries [5], limiting the patient to move freely and even preventing him from being able to conduct an effective treatment of any disease that he may suffer [6]. Currently, the number of patients affected by pressure ulcers is considerable and is constantly increasing around the world, reporting a prevalence of 16.7% in Mexico, a prevalence of 39.2% in Brazil, and in Spain reported a prevalence of 6.14% [7].

According to the values mentioned, the percentage of patients affected by pressure ulcers varies in each country, and it continues to be a common problem for all [8]. The prevention and care measures for patients with pressure ulcers is a job assigned to nursing staff, since the work of these health professionals is to provide them with mobilization, cleaning, and injury prevention, characteristics that are related to pressure ulcers. Pressure [9]. For this reason, patients and medical personnel must be trained on the prevention and care of these injuries, so that they can apply the appropriate procedures for these injuries, which in many cases can be chronic wounds [10]. Likewise, there are inadequate prevention methods against the different existing injuries, which do not allow the decrease in the prevalence of pressure ulcers [11], therefore, a virtual assistance system must be conducted that provides a reliable methodology on the prevention and care of patients. with pressure ulcers.

The objective of this research is to develop a virtual assistance system applied to learning about pressure ulcers to improve the method of prevention and care for patients with ulcers, which in many cases can be chronic lesions, taking advantage of a new form of assistance. through a multimedia platform that prioritizes interactive learning. Its development is based on providing guidance and information to medical personnel through a multimedia platform, using Adobe Flex for the dynamic presentation of learning materials on the web, applying an evolutionary development model that allows evaluating medical personnel before and after what learned about pressure ulcers.

In section II, a review of the literature regarding previous research is conducted. In section III, the methodology of the system is conducted by detailing a model of instructive logic through a block diagram. In section IV, the development of the learning model of the system is conducted. In section V, the results achieved by the system are made. In section VI, the discussion of the system is conducted. In section VII, the conclusion and recommendation are made.

2. Literature Review

Interactive learning for teaching about pressure injuries is essential so that medical personnel can prevent and care for patients vulnerable to these injuries, making it necessary to take advantage of a multimedia platform that prevents the increase in patients with pressure injuries through systems. For example: In [12], the researchers mention that, despite having a technological advance applied to the medical area, there is no reduction in the prevalence rate of pressure injuries in the medical system around the world, affecting the health of patients hospitalized and leading them to worsen their injuries that are related to the mortality rate as they are chronic, therefore, they decided to develop a system of textile sensors applied for the detection and monitoring of pressure in hospitalized patients. The researchers' procedure is based on using a set of resistive sensors placed on the textile substrate used by the patient, allowing the pressure generated by parts of the patient's body lying on the hospital stretcher to be controlled by means of pulses. As a result, they presented an 81.7% efficiency in monitoring the pressure caused by the body, concluding that this proposed system uses improved sensors that respond to the pressure caused by the patient to avoid injuries.

In [13], the researchers mention that pressure ulcers are generated in areas of the body that are under constant pressure, mainly in those people who are in wheelchairs, producing these conditions in the buttocks, which is why these conditions should be avoided. injuries with proper treatment and

prevention measures such as cushions or movements from time to time, therefore, they decided to develop an intelligent seating system applied to disabled patients to alleviate pressure injuries. The researchers' procedure is based on being able to perform an intelligent seat to monitor pressure points by applying force sensors distributed at strategic points on the person's seat through an extension/retraction mechanism at the base of the seat. As a result, they presented an 83.6% efficiency in monitoring the pressure points of the patient's seat, reaching the conclusion that this proposed system monitors the seat pressure correctly due to the good distribution of the sensors.

In [14], the researchers mention that the current technology applied in medicine has not been able to deal with the conditions of pressure ulcers that are frequently suffered by those disabled people who are in bed or in wheelchairs, even if they use cushions or custodial care. doctors, the prevalence continues to increase in the country due to lack of knowledge, therefore, they decided to develop an intelligent wheelchair seating system applied in patients with pressure ulcers. The researchers' procedure is based on the use of 9 air chambers in different ways to support the patient's weight over time, likewise, an air pressure sensor controlled by a microcontroller is used. As a result, they presented a 90.31% efficiency in controlling the air pressure in the patient's wheelchair, concluding that this proposed system offers comfort to the patient when inflating and deflating the air chambers with the microcontroller.

In [15], researchers mention that pressure ulcers cause painful wounds in the body due to high pressure on the same part of the patient's body, likewise, this high pressure restricts blood flow and leads to tissue necrosis the skin, being observed with occurrence in patients limited to move freely, diabetic people and elderly on stretchers, therefore, they decided to develop a flexible pressure control mechanical system to prevent pressure injuries. The researchers' procedure is based on developing a prototype consisting of 90 thin pressure sensors for the best flexibility in the seat, controlling these sensors by means of an Arduino nano card due to its small size for greater patient comfort. As a result, they presented an 87.08% efficiency in controlling the air pressure in the patient's seat, reaching the conclusion that this proposed system tries to calculate the seat pressure well for comfort.

3. Methodology

The methodology proposed for this system will allow the medical staff or the tutor in charge of the patient to handle various methodologies about the prevention and care of the patient through virtual assistance, providing an interactive learning environment about these injuries that have been affecting many patients in situation of disability, applying an instructive logic model, as shown in Figure 1, which allows the user to be evaluated before and after what has been learned about pressure injuries.

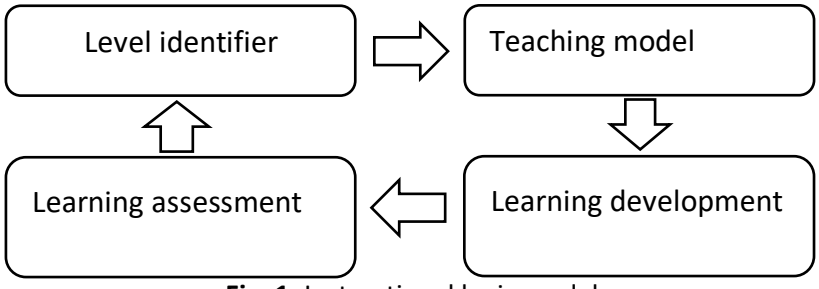

Fig. 1. Instructional logic model

Level identifier consists of identifying the level of knowledge of the user through a previous evaluation to know the application of their knowledge and experiences when solving problems and practical challenges about pressure ulcers to anticipate their way of teaching and can take advantage of their learning by average of the system according to the level determined by the evaluation.

Teaching model, consists of planning the objectives and goals for the user according to the result of their anticipated evaluation, establishing a study plan that seeks to cover what the user requires to complement their knowledge about pressure ulcers and guarantee the quality of system learning by adapting to its user needs.

Development of learning consists of providing specific knowledge so that the user can acquire certain information through methods proposed by the system based on their level of knowledge, likewise, the user will understand the methodologies of prevention and patient care for a better development about the various existing cases of pressure injuries by strengthening their learning.

Learning evaluation consists of evaluating the knowledge acquired by the user during their training, in such a way as to measure the learning objective regarding pressure injuries by analysing their capacity for knowledge, skills and/or attitudes attributed to the training received through the system, visualizing the reality of the user, and making the decision according to the level presented.

4. Development of the Learning Model

The development of the learning model was elaborated applying an incremental prototype that allows us to add new elements as the training progresses, adding a common framework that consists of four layers, as shown in Figure 2. In turn, the warehouse of the Course content is managed in a database where educational materials and evaluation questions are stored according to the topic learned, keeping an important record of the user's learning. The level of knowledge of the user, allows the system to dynamically manage the relevant training for the user and provide convenient learning, applying Adobe Flex for the presentation of the materials on the web.

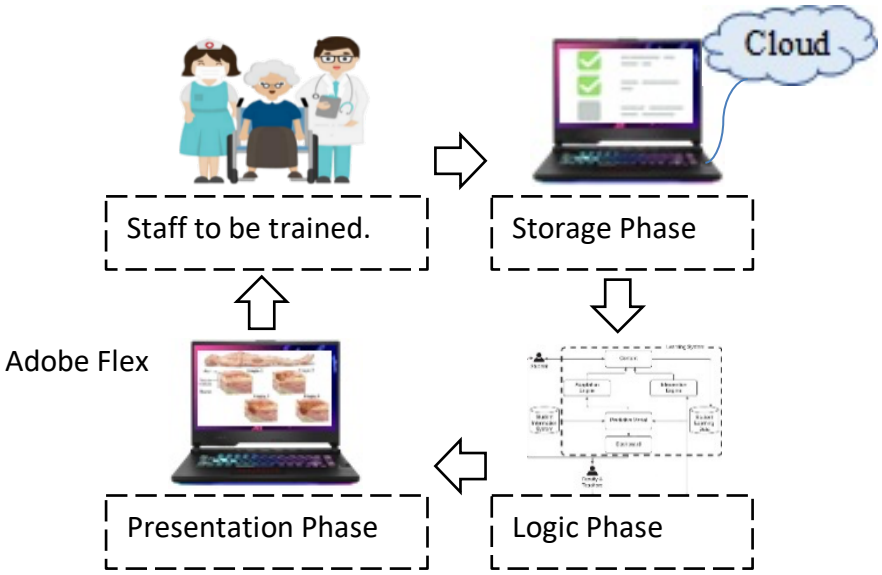

Fig. 2. Development of the learning model

The storage phase presents a database that includes the user's evaluation tests at the beginning of their training and at the end of their training through the system, likewise, it maintains the user's data to be able to start their training based on the qualification obtained. , choosing the right topic so that he continues learning correctly.

The logical phase entails the user's responsibility for learning by providing the evaluations at the beginning and end of the training, being able to infer on the topic corresponding to each user. This phase uses the theory of response to the item, providing various algebraic formulas that facilitate the prompt response of the user's evaluation, allowing the appropriate selection of the corresponding training, as well as the preparation of the evaluation at the end of it by using the following algebraic function, Eq. (1):

$$P_{i,j}[\theta_j] = c_i + [1 - c_i]\frac{e^{1.7a_i[\theta_j - b_i]}}{1+e^{1.7a_i[\theta_j - b_i]}} \quad (1)$$

Where ($P_{i,j}$) is the probability that the user (j) correctly hits the test (i), (Θ_j) is the user's ability, (a) is the statistical index, (b) is the level of the test, (c) is the hit rate, the value 1.7 is the constant for this algebraic expression.

The presentation phase presents a flexible platform so that the user can use it for their learning by improving the level of presentation and interaction with the system. This phase presents the multimedia platform, letting the logic layer control the user's learning by receiving the results of the interaction with the system [16].

5. Results

The results obtained from the assistance system confirm the good management of the multimedia platform for learning by medical personnel or the tutor in charge of the patient about Pressure Ulcers through a computer, showing an orderly interaction in charge of the presentation phase to a good modern learning benefited by the new technologies developed.

According to the evaluation of the system, a mathematical technique was used that predicts the possible results randomly in the simulation, conducting two personal evaluations for each user of different knowledge to validate their capacity according to the conditions of the pressure injury, determining an efficiency of 92.04% in user learning regarding the assistance system.

The result obtained by the assistance system contributes to the learning of medical personnel by providing a new adaptive tele-education approach based on their knowledge of pressure ulcers, by offering better interaction and more time capacity with the multimedia platform provided. by Adobe Flex in the system presentation phase.

This system shows in detail an important learning tool through didactic materials, combining the instructional operation and educational experience in the pedagogical needs, guaranteeing the learning of medical personnel about the prevention and care of pressure ulcers in patients, that there are various cases to be treated in hospitals.

From the result obtained from the system, it is determined in an experimental framework that the system quickly selects the didactic material that corresponds to the user with respect to their level of knowledge, likewise, its implementation in the various health centres will allow medical personnel to improve the experimental part regarding pressure ulcers that has been affecting many patients.

6. Discussion

Prevention methods for pressure ulcers allow a new interaction of medical personnel with a multimedia platform that provides constant learning; therefore, the proposed methodology differs from other systems, for example, the research carried out by, where [12] researchers They decided to implement a system of textile sensors applied for the detection and monitoring of pressure in

hospitalized patients. Obtaining as a result an efficiency of 81.7%, but this proposed system uses high-cost sensors that is not feasible, likewise, they can be fragile with an abrupt posture.

In comparison with the study mentioned in reference [12], which focused on the development of a system of textile sensors for detecting pressure in hospitalized patients, our virtual assistance system offers a complementary approach by providing comprehensive educational resources alongside technological advancements. While the textile sensor system primarily targeted monitoring pressure points, our system goes beyond detection to equip medical personnel with the knowledge and skills necessary for effective pressure ulcer prevention and care. Additionally, our study's incorporation of personalized evaluations and adaptive tele-education ensures a tailored learning experience, enhancing the system's overall efficacy in addressing the complexities of pressure ulcer management.

The investigation conducted by [13], where the researchers decided to implement an intelligent seating system applied to disabled patients to alleviate pressure injuries. Obtaining as a result an efficiency of 83.6%, but this proposed system uses an abrupt mechanism that affects the comfort of the patient when it detects high values of pressure on the seat, likewise, the force sensors present a variation in their operation.

Contrasting with the research outlined in reference [13], which introduced an intelligent seating system for pressure ulcer prevention in disabled patients, our virtual assistance system offers a broader educational focus while still leveraging technological innovations. While the intelligent seating system primarily aimed to alleviate pressure injuries through sensor-based monitoring, our system enhances medical personnel's understanding of pressure ulcer prevention and care through interactive learning modules and personalized assessments. Moreover, our study's emphasis on rapid selection of didactic materials based on user proficiency levels further enhances the efficiency and effectiveness of the learning process, distinguishing it from previous technological interventions.

The investigation conducted by [14], where the researchers decided to implement an intelligent seating system for wheelchairs applied to patients with pressure ulcers. Obtaining as a result an efficiency of 90.31%, but this proposed system uses a manual mechanism, so the patient is limited by not using it in the best way.

In contrast to the study discussed in reference [14], which proposed an intelligent wheelchair seating system for patients with pressure ulcers, our virtual assistance system provides a complementary educational component alongside technological advancements. While the intelligent wheelchair seating system focused on providing comfort through air chambers controlled by a microcontroller, our system enhances medical personnel's knowledge and skills in pressure ulcer prevention and care. By incorporating personalized evaluations and an adaptive tele-education approach, our system ensures a tailored learning experience, enabling medical personnel to effectively address the challenges associated with pressure ulcers beyond technological interventions alone.

The investigation conducted by [15], where the researchers decided to implement a flexible pressure control mechanical system to prevent pressure injuries. Obtaining as a result an efficiency of 87.08%, but this proposed system does not perform an automatic movement, making it difficult for the patient to manipulate it, on the other hand, they do not highlight the importance of the power source.

Unlike the research detailed in reference [15], which introduced a flexible pressure control mechanical system for preventing pressure injuries, our virtual assistance system offers a more comprehensive educational approach while still integrating technological innovations. While the flexible pressure control mechanical system aimed to control seat pressure using thin pressure sensors and an Arduino nano card, our system enhances medical personnel's understanding of

pressure ulcer prevention and care through interactive learning modules and personalized assessments. Additionally, our study's emphasis on rapid selection of didactic materials based on user proficiency levels enhances the efficiency and effectiveness of the learning process, distinguishing it from previous technological interventions.

7. Conclusion and Recommendations

The implementation of a virtual assistance system for learning about pressure ulcers has proven highly effective in enhancing the knowledge and skills of medical personnel in the prevention and management of these injuries. By integrating innovative technologies with interactive educational resources, our system offers a comprehensive solution that goes beyond traditional technological interventions, addressing both the detection and effective management of pressure ulcers.

The results of our study highlight the importance of personalized assessment and an adaptive approach in the learning process. By utilizing mathematical techniques to predict outcomes in simulations and offering individual evaluations, our system ensures a tailored learning experience that adjusts to the specific needs and knowledge levels of each user, thereby enhancing the efficiency and effectiveness of the educational process.

Our work underscores the transformative potential of technology in the healthcare field, particularly in the realm of medical education and training. By providing a virtual platform that combines advanced technology with interactive educational resources, our system paves the way for enhanced quality of care and a significant reduction in the incidence of pressure ulcers.

It is crucial for healthcare institutions and medical training programs to integrate similar virtual assistance systems into their continuing education programs. By doing so, they can ensure that medical personnel are constantly updated with the best practices and technologies in the prevention and management of pressure ulcers, thereby improving the quality of care provided to patients.

Further studies are recommended to assess the long-term impact of implementing virtual assistance systems on clinical practice and patient outcomes. This will allow for a deeper understanding of how these technologies can influence the reduction of pressure ulcer incidence, as well as overall improvement in patient health outcomes.

A promising area for future research could focus on integrating artificial intelligence and data analytics into virtual assistance systems for even more precise detection and management of pressure ulcers. By leveraging advanced algorithms and machine learning, these systems could provide real-time personalized recommendations for pressure ulcer prevention and treatment, thereby enhancing responsiveness and effectiveness in patient care.

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