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A web-based e-learning application for wound diagnosis and treatment

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ARTICLE INFO

Article history:

Received 7 January 2014

Received in revised form

20 May 2014

Accepted 10 June 2014

Keywords:

Pressure ulcer

E-learning

Adaptive tutorial systems

Image processing

Computational intelligence

Nursing informatics

ABSTRACT

Pressure ulcers (PrU) are considered as one of the most challenging problems that Nursing professionals have to deal with in their daily practice. Nowadays, the education on PrUs is mainly based on traditional lecturing, seminars and face-to-face instruction, sometimes with the support of photographs of wounds being used as teaching material. This traditional educational methodology suffers from some important limitations, which could affect the efficacy of the learning process. This current study has been designed to introduce information and communication technologies (ICT) in the education on PrU for undergraduate students, with the main objective of evaluating the advantages and disadvantages of using ICT, by comparing the learning results obtained from using an e-learning tool with those from a traditional teaching methodology. In order to meet this major objective, a web-based learning system named *ePULab* has been designed and developed as an adaptive e-learning tool for the autonomous acquisition of knowledge on PrU evaluation. This innovative system has been validated by means of a randomized controlled trial that compares its learning efficacy with that from a control group receiving a traditional face-to-face instruction. Students using *ePULab* gave significantly better ($p < 0.01$) learning acquisition scores (from pre-test mean 8.27 (SD 1.39) to post-test mean 15.83 (SD 2.52)) than those following traditional lecture-style classes (from pre-test mean 8.23 (SD 1.23) to post-test mean 11.6 (SD 2.52)). In this article, the *ePULab* software is described in detail and the results from that experimental educational validation study are also presented and analyzed.

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1. Introduction

Pressure ulcers (PrU) are considered as one of the most challenging problems for Nursing professionals in their daily practice, whatever is the assistance speciality they are

working on. The PrU care usually suffers from a high variability and uncertainty in decision-making tasks carried out by nurses, not only when dealing with prevention strategies but also when considering the evaluation of the wound and the pharmacological treatment to be administered [1,2]. All

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<http://dx.doi.org/10.1016/j.cmpb.2014.06.005>

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these aspects are on the basis of the interests that Nursing professionals pursue when they are proposed to enroll on an education activity to improve their skills in PrU evaluation and wound care-taking. On the other hand, getting a better education on PrU diagnosis and treatment, not only by professionals but also by undergraduate students, could become the most effective strategy to reduce the use of pharmacological products with not-yet-demonstrated benefits, and also to homogenize the clinical interventions and increase the efficiency of decision-making protocols for PrUs.

Nowadays, the education on PrUs for undergraduate students is mainly based on traditional on-campus learning, with face-to-face classes and the common use of real PrU photographs as teaching aid. The most frequent educational objectives are usually focused on two main aspects: (1) to facilitate the comprehension of the risk factors related to PrU incidence and prevention; and (2) to provide the students with the necessary knowledge to identify accurately and classify correctly each one of the different types of wounds, on the basis of the four classical PrU evolution stages proposed in USA in 1989 by the NPUAP (*National Pressure Ulcer Advisory Panel*), and adapted with minor changes in 1999 by the EPUAP (*The European Pressure Ulcer Advisory Panel*) in Europe [3]. Furthermore, that theoretical education is usually complemented with other practical activities, which the students can carry out when attending the practical clinical sessions in which they are able to observe PrU wounds in a real clinical context and try the therapeutic criteria they learned at the classroom. Nevertheless, this traditional education suffers from some important limitations that could compromise the efficacy of the learning process: on the one hand, in traditional education schemes the students behave usually as passive subjects during their learning process, as the classical teaching methodology is difficult to arouse their motivation and interest; on the other hand, a high variability in the learning process is generated during the clinical sessions, so that it is not possible to control the entire educational environment – its final configuration depends on the eventual existence or absence of PrU wounds in the clinical unit in which each student is temporary practicing, as well as on the offer of opportunities for the student to get involved in the care of the existing PrUs of that clinical unit. Having all these aspects into account, it is not possible to guarantee that all the students can observe and care for PrUs and, furthermore, the number of PrUs that each student can observe is limited and different to that of their classmates; finally different evolution stages and high variable treatments could be found by each student when dealing with the PrUs of patients in the clinical unit they are involved in during their practical sessions. To conclude, the traditional education on PrUs makes difficult to homogenize the acquisition of knowledge and practice by the undergraduate students, while it does not guarantee yet the learning of the same concepts and the enjoyment of the same education opportunities on PrUs evaluation. This fact could also determine the subsequent variability of the PrU care carried out by the Nursing professionals when the join finally the Health system. Moreover, the continuing education on PrUs of these Nursing professionals usually suffers from the same limitations as the undergraduate education above, as it is difficult to arouse the motivation and participation of

these Health workers in their own education on PrU diagnosis and treatment.

With the aforementioned problems, this current study has been designed to introduce the information and communication technologies (ICT) in the education on PrUs for undergraduate students, and evaluate its advantages by comparing the results from this e-learning strategy with those obtained with traditional teaching methods. Many studies have appeared in the last decade which show the impact of ICT on Nursing education (see [4,5] as two conclusive reviews on this particular subject). However, although the methods based on e-learning have gained an increasing popularity in the last few years and become effective strategies constituted as a real alternative to traditional teaching tools, some authors have recently pointed to the necessity of improving the validity of the studies which evaluate the effectiveness of e-learning tools, advancing by this way to the optimization of the methodological design of those studies [4]. Similar studies from the more general field of biomedicine have also shown the advantages of incorporating e-learning systems into professional education programs. In [6] the design of an e-learning virtual reality-based software system to be used for the developing skills in dental restoration is presented. According to the authors, the errors from dental surgeries can be significantly reduced and in some cases entirely eliminated by the use of e-learning systems based on therapeutic interventions simulation techniques. As a more recent example, in [7] the use of an on-line e-learning system for pharmacy interns in critical care settings showed significant improvement in interns' knowledge and practice.

Educational software has become an autonomous discipline of Software Engineering, with its own design, implementation and evaluation [8,9] methods. Being part of this educational software, *adaptive learning systems* could be considered as a step forward in themselves, so that they could offer the users even more pedagogical and didactic opportunities [10,11]. In the particular case of software tools for the learning of Nursing processes and interventions, a very recent study [12] has shown the importance of the quality of the e-learning system, as well as the adequateness of the design of the user's interface, as the main factors determining the perception of the utility and usability of the software by the Health professionals.

The software developed for this study consists of the necessary modules for teaching, monitoring and evaluating undergraduate students and Nursing professionals enrolled in continuing education programs. This software has been named ePULab (*Educational-Pressure Ulcer LABORatory*) and allows the users to enjoy an autonomous learning of PrU diagnosis and treatment by offering them several difficulty levels, which adapt automatically the complexity of the proposed questions to the dexterity that each user shows while they interact with the e-learning system. The software has been also designed to give the appropriate feedback by offering the users the opportunity of monitoring their own learning progress, as well as identifying and correcting the errors made in the evaluation of different testing cases of PrUs proposed by experts. The development of this tool has been focused on the promotion of significant and consolidated learning of PrUs by Nursing students, with the main two objectives of

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