Wireless devices in nursing education

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Abstract

Objective. This article sought to explore the adoption of wireless devices in university nursing teaching and address their repercussion on future professionals. **Methodology**. This is a bibliographical study conducted in 2011, which analyzed international publications on the use, review, application, opinion, and experimentation of wireless devices in university nursing teaching of wireless technology in nursing teaching. The following databases were used: Medline and Science@Direct. **Results.** A total of 503 articles were extracted and 77 were selected, of which 40 investigated the Personal Digital Assistant (PDA), 13 the clicker (Student Response Wireless System), and six the smart phone. The use of mobile devices has experienced strong growth during the last five years, especially PDAs. **Conclusion**. Use of mobile devices in university nursing teaching has grown in recent years, especially PDAs.

Key words: education, nursing; teaching materials; educational technology.

Dispositivos inalámbricos en la educación enfermera

Resumen

Objetivo. Explorar la adopción de los dispositivos inalámbricos en la enseñanza universitaria de enfermería y abordar su repercusión para los futuros profesionales. **Metodología.** Estudio bibliográfico realizado en 2011 en el que se analizaron las publicaciones internacionales sobre el uso revisión, aplicación, opinión y experimentación de los dispositivos inalámbricos (tecnología inalámbrica) en la enseñanza universitaria de enfermería. Se utilizaron las bases de datos Medline y Science@Direct. **Resultados.** Se extrajeron 503 artículos y se seleccionaron 77, de los cuales, 40 investigaron la PDA (Personal Digital Assistant), 13 el clicker (Sistema inalámbrico de Respuesta del Estudiante) y 6 el teléfono inteligente. El uso de dispositivos móviles ha experimentado un fuerte crecimiento en los últimos cinco años,

especialmente la PDA. **Conclusión.** El uso de dispositivos móviles en la enseñanza universitaria de enfermería ha crecido en los últimos años, especialmente el de la PDA.

Palabras clave: educación en enfermería; materiales de enseñanza; tecnología educacional.

Dispositivos sem fio na educação em enfermagem

Resumo

Objetivo. Explorar a adoção dos dispositivos sem fio no ensino universitário de enfermagem e abordar sua repercussão para os futuros profissionais. **Metodologia.** Estudo bibliográfico realizado em 2011 no que se analisaram as publicações internacionais sobre o uso revisão, aplicação, opinião e experimentação dos dispositivos sem fio no ensino universitário de enfermagem da tecnologia sem fio no ensino de enfermagem. Utilizaram-se as bases de dados Medline e Science@Direct. **Resultados.** Extraíram-se 503 artigos e foram selecionados 77, dos quais, 40 pesquisaram a PDA (Pessoal Digital Assistant), 13 o clicker (Sistema sem fio de Resposta do Estudante) e 6 o telefone inteligente. O uso de dispositivos móveis experimentou um forte crescimento nos últimos cinco anos, especialmente a PDA. **Conclusão**. O uso de dispositivos móveis no ensino universitário de enfermagem cresceu nos últimos anos, especialmente o da PDA.

Palavras chave: educação em enfermagem; materiais de ensino; tecnologia educacional.

Introduction

Educational strategies have been changing at the rhythm of technological progress in our society. It is a fact, the introduction of information and communication technologies (ICTs) in university teaching in general, and in health sciences careers, in particular. Technological media have become part of the formation and evaluation instruments in numerous study plans throughout the world; social networks to teach and learn telemedicine,[1] or videos on YouTube to teach medical-surgical nursing[2] are some examples. The ICTs contribute with numerous benefits to both teachers and students:[2-4] they permit professors to have more time for other tasks, formative processes are open and flexible, accomplish more personalized teaching, raise interest and motivation from students, improves communication/contact between professor and student, as well as educational efficiency, promoting individual learning.

Within this current, electronic devices like table-top computers, laptops, PDAs, or smart phones play a fundamental role. Within the last five years, accompanied by technological progress, emergent line of research has appeared on the use of wireless devices in university teaching.[5-7] The inherent portability of these devices overcomes some of the limitations of the traditional PCs. The new didactic instruments break the traditional spatiotemporal barriers, permitting rapid access to online information anytime and anywhere. Introducing these devices to university classrooms will facilitate their adoption by future healthcare professionals and will permit saving time and will avoid mistakes in making clinical decisions. Hence, the quality of care provided in primary and specialized care environments will be notably increased, which will have direct repercussions on user satisfaction. Actions of healthcare providers will more rapid and secure, given that they

can verify treatments and diagnostic decisions issued. This work seeks to explore the adoption of wireless devices in university nursing teaching and address its repercussion in future healthcare professionals. To accomplish this objective, we propose a search and comparative analysis of international publications on this theme.

Methodology

Review, protocol, and registry. To perform the comparative analysis, the authors used formal methods to ensure a precise search process. The aim of this study was not merely to group all the existing proof on the use of wireless devices in nursing education, but to establish guidelines based on evidence for health professionals. To identify the works, we followed the recommendations from the PRISMA standard.[8] Hence, prior to starting the literature search and extraction of the subsequent data, a protocol was developed describing each step, along with the inclusion criteria.

The research questions proposed were: What wireless devices are being used in university nursing teaching? And, is sufficient evidence available to broadly adopt wireless devices in university nursing teaching? The inclusion criteria were the following: articles with date of publication between January 1970 and August 2011 (IC1), which deal on the use, description, application, or evaluation of any wireless device in university nursing teaching (IC2). Articles were included since January 1970 (IC1), a date since which works have been registered in the bibliographic databases reviewed. We have tried to conduct a complete search and due to this we feel that all the articles found during the study period must be included. The search was carried out through Medline and Science@Direct bibliographic databases. This selection was motivated given that these databases index publications of relevant scientific interest in the object matter under study. The search process began on 01 August 2011 and ended on 17 August 2011. Eligibility criterion (IC2) is included to answer the proposed research questions. To complete the search, a follow up of the citations was carried out along with a detailed examination of the references to make the review more exhaustive.

The search chain used was ("nurse education" OR "nursingeducation" AND *PAL*), where *PAL* is: wireless, PDA, PDAs, e-portfolio, e-portfolios, PC tablet, PC tablets, mobile, smart phone, podcasting, clickers or clicker. When necessary, the search was adapted to the characteristics of the search engines of the databases. To choose the works, we explored the title, abstract, and key words of the articles, adopting the eligibility criteria identified. We proceeded to a partial or complete reading of the articles that could not be discriminated from the abstract to discover if these fulfilled or not with the eligibility criteria. All the activities described were carried out jointly by both authors of the work. Substantial agreement was reached between the authors (kappa = 0.94, CI 95% = 0.91, 0.97). Discrepancies between the authors were discussed until reaching 100% agreement.

Classification of the articles. The works were classified according to the following facets: *type of contribution*, according to the research approach used, which is independent of the rest of the facets; and *type of wireless device employed or analyzed* in the article. In the first facet, we found: a) *Research through evaluation*: techniques that have been implemented in practice and of which an evaluation is performed. This means that it shows how the technique is implemented in practice and what consequences it bears, by using experimentation. Generally, the advantages and inconveniences of the proposals evaluated are analyzed; b) *Solution proposal:* a solution is proposed (new or an extension of an existing one) for a problem. The benefits and applicability of the solution is shown through a small example, application, or a good line of argument, but a formal empirical analysis of the proposal is not carried out; c) *Opinion articles*: these express someone's personal view on whether a determined technique is good or bad or on how things should be done. These articles are not based on related works

or on research methodologies; and, d) *Review articles*: these describe the most relevant studies published and propose new lines of research and application.

Regarding facet 2, the types of devices sought were: a) *The Personal Digital Assistant* (PDA) is a hand-held computer initially designed as an electronic agenda (calendar, list of contacts, memo pad, and reminders) with a writing recognition system. These electronic devices began being used in 1990; b) *Smart phone*: it is a commercial term used to define a mobile phone that also offers PDA functions. It can have programs installed to increase its data processing and connectivity; these can be installed by the manufacturer, the telephone service operator, or by a third party. Some examples of so-called smart phones are: Smartphone, BlackBerry, iPhone, and all those with the Android operational system, like for example: Google NexusOne, Motorola Milestone, and Sony Ericsson XperiaArc; c) *Clicker*: this device, also known as classroom response system (CRS) or audience response system (ARS), is a small transmitter that sends a signal to a receptor when pressing the proper buttons; d) *PC tablet*: this is a laptop computer with which it is possible to interact through a touch screen. It is used with a stylus pen or with the fingertips, without the need for a physical keyboard or a mouse, working as a computer, but more aimed at web surfing and multimedia resources. Recently, tablets have emerged that incorporate mobile phones; these are called 3G tablets; and, e) *Media players*: these devices store, organize, and play video, audio, and image files. A generic player with MP3 audio compression format is an example of a media player.

Results

Selection of studies. The search found 503 articles of which 394 were discarded because they were clearly irrelevant after revising the titles, abstracts, and key words that appeared in said articles upon not fulfilling inclusion criterion 2 (IC2). Of the 109 remaining articles, partial examination of the text was conducted for 52 articles because their abstracts were insufficient to determine if they fulfilled criterion IC2. After this last review, 37 articles were withdrawn, which left a total of 72 articles included in the review. Additionally, five more studies were included after revising the references of these articles, finally selecting 77 works.

Characteristics of the studies. A total of 77 articles were included in the review of research on the application of wireless devices in nursing teaching, with 87% of them published as of 2005. Table 1 presents the number of articles in both dimensions studied: type of article and wireless device used. Upon analyzing the type of article, the most frequent was that of evaluation (40.3%), followed by that of solution (31.2%), opinion (24.7%), and review with 3.9%. The most researched device in nursing teaching during the study series was the PDA with 40 works (51.9% of the studies), followed by clickers (16.9%), smart phones (7.8%), media players (5.2%), mobile phones (2.6%), and PC tablets (1.3%); in the 14.3% representing the remaining articles were on the use of more than one device.

The preferred type of contribution is the proposal of a solution in some academic course (20 works with PDAs and five with Clickers), although interest for experimentation is observed (12 experiments with PDAs and six with Clickers). It is worth noting that a deficit exists of reviews on smart phones, portfolios, and podcasting, probably because an important number of works published is still not available. To explore the impact of the works selected in the scientific publication, the articles chosen were organized based on the number of citations found in Google Scholar. A database has been used instead of Journal Citation Report (JCR) or Web of Science because it encompasses a higher number of disclosure forums, although greater effort is necessary to filter the data. Additionally, it has been demonstrated that its use is efficient for bibliometric studies like the g index.[9] As noted in Table 2, of the 12 articles equaling or surpassing 20 citations, 21 articles deal with PDAs, and one deals with clicker.

Table 1. Number of publications per type of article and wireless device used

Type of device	Type of article				
	Solution	Evaluation	Opinion	Review	Total
Mobile phone	2	0	0	0	2
PC tablet	1	0	0	0	1
Media player	1	1	2	0	4
Smart phone	2	3	1	0	6
Clicker	6	5	1	1	13
PDA	12	20	6	2	40
Total	24	31	19	3	77

Table 2. Studies included in the review on nursing education with mobile devices according to type of article, year of publication, journal, and number of citations in Google Scholar

Reference	Type of article	Device	Year	Fuente	Nº citations
Garrett and Jackson[10]	Evaluation	PDA	2006	Nurse Educ Today	38
Bogossian *et al.,* [11]	Evaluation	Tablet PC	2009	Nurse Educ Today	2
Gagne[12]	Review	Clicker	2011	Nurse Educ Today	0
Patterson *et al.,*[13]	Evaluation	Clicker	2009	Nurse Educ Today	4
Wu *et al*.,[14]	Evaluation	PDA	2010	Nurse Educ Today	0
Broussard[15]	Evaluation	Clicker	2010	Nurse Educ Pract	0
McLeod and Mays[16]	Evaluation	PDA	2008	Nurs Clin North Am	5
Efstathiou and Bailey[17]	Evaluation	Clicker	2011	Nurse Educ Today	0
Lee *et al.,*[18]	Evaluation	PDA	2010	Asian Nurs Resh	0
George *et al*.,[19]	Evaluation	PDA	2010	J Prof Nurs	3
Dearnley *et al*.,[5]	Evaluation	SP	2008	Nurse Educ Pract	7
Young *et al*.,[20]	Evaluation	MP	2009	Nurse Educ Today	4
Berglund *et al*.,[21]	Solution	PDA	2007	Int J Med Inform	28
Clay[22]	Solution	SP	2011	Nurse Educ Today	0
Cornelius and Gordon[23]	Opinion	PDA	2008	Nurse Educ Today	0
Lee and Bakken[24]	Solution	PDA	2007	Int J Med Inform	6
Taylor[25]	Review	PDA	2005	Crit Care Nurs Clin North Am	6
DeBourgh[26]	Solution	Clicker	2008	Nurse Educ Pract	23
Jones *et al.,*[27]	Solution	Clicker	2009	Teach Learn Nurs	1
Jensen *et al.,*[28]	Opinion	Clicker	2009	Nurse Educ Pract	7
Phillippi and Wyatt[29]	Opinion	SP	2010	Comput Inform Nurs	1
Russell *et al.,* [30]	Solution	Clicker	2011	Nurse Educ	0
Solecki *et al*., [31]	Evaluation	Clicker	2009	Int J Nurs Pract	0
Mareno *et al*.,[32]	Solution	Clicker	2010	Int J Nurs Educ Scholarsh	0
Filer[33]	Evaluation	Clicker	2010	Nurs Educ Perspect	1
Skiba[34]	Solution	Clicker	2006	Nurs Educ Perspect	13

Table 2. Studies included in the review on nursing education with mobile devices according to type of article, year of publication, journal, and number of citations in Google Scholar (cont.)

Reference	Type of article	Device	Year	Fuente	Nº citations
Johnston *et al*.,[35]	Evaluation	SP	2010	Int J Nurs Educ Scholarsh	0
Lymn and Bowskill[36]	Solution	SP	2010	Nurs Stand	1
Zurmehly[37]	Review	PDA	2005	Nurs Educ Perspect	2
Kuiper[38]	Solution	PDA	2010	Int J Nurs Educ Scholarsh	2
Williams and Dittmer[39]	Evaluation	PDA	2009	Nurs Educ Perspect	2
Newman *et al.,*[40]	Evaluation	PDA	2009	Collegian	1
Clark *et al.,*[41]	Solution	PDA	2009	J Nurses Staff Dev	3
Anonson *et al*.,[42]	Solution	PDA	2008	J Healthc Inf Manag	0
Stroud *et al.*[43]	Evaluation	PDA	2009	J Am Acad Nurse Pract	7
Koeniger-Donohue[44]	Solution	PDA	2008	J Nurs Educ	20
Trangenstein *et al*.,[45]	Solution	PDA	2007	Stud Health Technol Inform	4
Greenfield[46]	Solution	PDA	2007	J Nurs Educ	31
Newman and Howse[47]	Solution	PDA	2007	Comput Inform Nurs	7
Bakken[48]	Solution	PDA	2006	Stud Health Technol Inform	7
Dreher[49]	Solution	PDA	2006	Stud Health Technol Inform	4
Tilghman *et al.,*[50]	Solution	PDA	2006	ABNF J	10
Scollin *et al.,*[51]	Solution	PDA	2006	Comput Inform Nurs	18
Altmann and Brady[52]	Solution	PDA	2005	Int J Nurs Educ Scholarsh	22
Davenport[53]	Solution	PDA	2005	Nurse Educ	0
White *et al.,*[54]	Opinion	PDA	2005	Nurse Educ	24
Kneebone *et al*.,[55]	Solution	PDA	2003	Med Teach	13
Bakken *et al.,*[56]	Solution	PDA	2004	Int J Med Inform	36
Moore *et al*.,[57]	Opinion	PDA	2002	Proc AMIA Symp	11
Brubaker *et al*.,[58]	Solution	PDA	2009	Nurs Educ Perspect	2
Farrell and Rose[59]	Evaluation	PDA	2008	J NursEduc	22
Fox *et al.*,[60]	Evaluation	PDA	2007	J Allied Health	1
McClunie-Trust[61]	Opinion	PDA	2006	Stud Health Technol Inform	2
Smith and Pattillo[62]	Opinion	PDA	2006	Nurse Educ	7
Miller[63]	Evaluation	PDA	2005	J Nurs Educ	44
Scordo[64]	Opinion	PDA	2003	AACN Clin Issues	21
Cibulka and Crane-Wider[4]	Solution	PDA	2011	J Nurs Educ	0
Brown *et al*.,[65]	Solution	Various	2010	Pract Midwife	0
Pilcher and Bedford[66]	Opinion	MP	2010	Neonatal Netw	0
Long and Edwards[67]	Opinion	MP	2010	J Nurses Staff Dev	0
Greenfield[68]	Evaluation	MP	2011	J Nurs Educ	0
MacKay and Harding[69]	Evaluation	MP	2009	Nurs Prax N Z	1
Morris and Maynard[70]	Solution	SP	2010	Worldviews Evid Based Nurs	1
Trangenstein[71]	Opinion	Various	2008	Nurs Clin North Am	1

Table 2. Studies included in the review on nursing education with mobile devices according to type of article, year of publication, journal, and number of citations in Google Scholar (cont.)

Reference	Type of article	Device	Year	Fuente	Nº citations
Hao *et al.,*[7]	Opinion	Various	2006	AMIA Annu Symp Proc	0
Maag[72]	Solution	MP	2006	Stud Health Technol Inform	10
Farrell[73]	Evaluation	PDA	2006	Aust Nurs J	3
Billings[6]	Opinion	Various	2005	J Nurs Educ	10
Valaitis and O'Mara[74]	Solution	Various	2005	Comput Inform Nurs	2
Spurlock *et al*.,[75]	Opinion	Various	1999	Semin Nurse Manag	0
DeBaca[76]	Opinion	Various	1984	J Contin Educ Nurs	1
Rollo[77]	Opinion	Various	1976	Nurs Times	0
Mertz[78]	Opinion	Various	1970	NLN Publ	0
Lange[79]	Opinion	Various	1970	NLN Publ	0
Folgueras[80]	Opinion	Various	1970	NLN Publ	0
Porter and Tousman[81]	Evaluation	Clickers	2010	J Nurs Educ	1

SP: Smart phone; MP: Mobile phone; MP: Media player

Table 3 shows, in order of number of articles published, if the journal is indexed in the ISI Journal Citation Report (JCR), and if this prior condition is positive, the quartile it was in at the time of the study. The two journals publishing the most works (22.1% of the total) are indexed in JCR, which shows the quality and repercussion of these works.

Table 3. Journals with highest number of publications and quality indices

Journal	Nº of publications	ISI JCR	Quartile
Nurse Education Today	9	Yes	Q2
Journal of Nursing Education	8	Yes	Q3
Nursing Education Perspectives	5	No	-
Studies in Health Technology Informatics	5	No	-
Computers, Informatics, Nursing	4	Yes	Q3
International Journal of Nursing Education Scholarship	4	No	-
Nurse Educator	4	Yes	Q3
Nurse Education in Practice	4	No	-
Remaining journals (bellow or equal to 3)	37	-	-

Discussion

From the study conducted, it is noted that the PDA is the most evaluated device in university nursing teaching. PDAs have been used as educational tools both in theoretical classes as in clinical practices. In addition, if the wireless device has a location system, the information and the activities can be adapted to the context where the student is. Some studies have demonstrated that students save time when they use PDAs because they do not have to leave the patient when they need to search for information,[44] besides increasing accuracy and reducing errors made.[52] Using PDAs has also been associated to improved leadership capacities, trust, and self-efficiency.[54] However, some experimental studies[59] state that using PDAs has adverse effects with respect to knowledge acquisition. The advent of the smart phone, a natural evolution of the PDA, which includes functions of a mobile phone, opens new possibilities of application to the educational practice.

A wireless device that is reaching great popularity is the *Clicker*. This device permits creating creative learning environments, with a broad range of pedagogic opportunities for teachers: optional tutorials, formal classes, and cooperative learning through small discussion groups.[82] Additionally, it has the capacity to gather immediate and anonymous feedback from students in the classroom.[81] The responses selected by the students to questions made by the professor can be exposed and analyzed with a video beam, normally in histogram form or as a bar graph. Our study confirms that this device is a promising educational tool and its use has extended in all types of universities and careers,[83] including careers in nursing.[32] Because of its simplicity, the professor needs minimum technical knowledge and other wireless devices like mobile phones can be adapted as clicker through specific software. Multimedia players permit students to retrieve and play podcast recordings in English of complete classes or any other multimedia material provided by the professor. Although these devices are easily handled and their cost is minimal, our study shows that few have been researched in nursing education because their limited functions are included in PDAs and smart phones.[68]

With the advent of the European Higher Education Area, wireless devices open an opportunity to adapt teaching to the distinct capacities and learning styles of students. A combination of technological media can promote active learning and facilitate reflexive and critical thought from students. In addition, a recent study[84] showed that the use of wireless technology improves communication among the nursing team and diminishes response times for hospitalized patients. Hence, using these devices in classrooms will facilitate their adoption by future healthcare professionals. Another added advantage of the most advanced mobile devices, like smart phones and PDAs, is their access to the new cloud services.[85] In the cloud, the resources found in the internet are lodged dynamically in different applications and services, with this whole process being transparent for the user. Thus, teachers will upload teaching materials onto the cloud and the students will get to them through access mechanisms to the traditional network, employing smart phones and PDAs.

Not everything is advantageous, we also found some inconveniences in these types of devices like their small screens and the difficulty represented by using pocket-sized devices.[10] Also, the new technologies challenge the traditional nursing culture and, hence, barriers must be overcome: some nursing professionals do not support the use of these devices by students[21] and other professionals[11], and bedridden inpatients tend to be reticent and fearful of students using the wireless devices.[21] Besides, the security of transmitting data in these devices can be solved through encrypting algorithms, while control to access is usually constructed via authentication mechanisms based on roles, but fear remains from students of the accidental loss of data or of the applications contained in them,[51] as well as the fear of losing the device through theft.[11]

Conclusions. This work presents the results of a review of literature related to the use wireless technology in university nursing teaching. A comparative analysis was conducted and it has been shown that using mobile devices has undergone strong growth in the last six years, especially the use of PDAs. The results of this work also prove that further research is necessary on the experimentation of the use of clickers and smart phones in nursing teaching, so educators and professionals can effectively and efficiently benefit from the latest technological progress. Nevertheless, evidence exists that wireless devices are tools that improve the security and quality of healthcare and treatment, which could suggest its teaching and care application. A future line of work is a systematic review of the use of smart phones and multimedia players, as well as a meta-analysis of empirical studies on PDAs and clickers, so that a statistical power can be reached higher than the primary studies available, upon collecting a high number of observations. Likewise, our study was limited to works on wireless devices within the setting of health sciences. To obtain more sound conclusions, it is necessary to study adopting these devices in teaching other disciplines unrelated to health. As future work, the authors will address a review of the use of wireless devices in teaching other disciplines.

Limitations of the study. The procedures used in this study can present some limitations. Although the comparative study was done by following a previously established protocol, our intervention is decisive in the selection search chains. In this work, the search chains were not too restrictive, and proof of this is that of the 503 results produced by the search chains, 77 were selected after applying the inclusion criteria. Thereby, we consider that this sample is sufficient to obtain valid conclusions. Another aspect to keep in mind is that some publications may not be clearly classified. In this case, two researchers assigned the categories to each work, reaching agreement on 100% of the works.

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