Wireless Handhelds to Support Clinical Nursing Practicum

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ABSTRACT

This paper reports our implementation and evaluation of a wireless handheld learning environment used to support a clinical nursing practicum course. The learning environment was designed so that nursing students could use handhelds for recording information, organizing ideas, assessing patients, and also for interaction and collaboration with peers during an on-site clinical practicum. Our wireless handheld learning environment was field tested during a three-week practicum session. Analysis of data showed that both the instructor and the student benefited from using the Personal Digital Assistant (PDA) environment. The handhelds not only provided students with scaffolds to enhance learning but also facilitated peer cooperation and interaction with the instructor. Issues resulted from our implementation included things like the capacity of handhelds, network access, and participants’ preconceptions on using PC-based systems.

Keywords

Wireless, Handhelds, Clinical nursing practicum, Nursing education, PDAs

Introduction

“I was lucky to find a seat on the bus on my way to the hospital. I took out my PDA and checked the concept map I had drawn last night. I found a link was missing! I added it. …”

“At the daily morning report, a doctor and his nurse reported how they handled a patient who cried for leaving the hospital and disrupted the ward last night. I recorded their report and wrote down key terms with my PDA. … I later looked up the terms in my PDA’s Nursing Dictionary.”

“The patient was curious about our PDA. We explained that it was for recording conversations and writing assignments. … After the clinical interview, we returned to the nursing station and used the PDA to log into the course server to fill out the Patient’s ABC record. … I saw my patient getting up from the bed and chatting with his neighbors, and then walking to the yard. He looked to be weighted down with a heavy heart. I switched my PDA to the Symptom Assessment page and record what I had observed. Unfortunately, the speed of the network was somewhat slow, and I couldn’t finish the task. …”

“The instructor first asked everybody to transmit the concept maps to her notebook and then discussed with everyone individually. … At the end of the meeting, the instructor asked us to download reading materials from her notebook to our PDA.”

“On the bus going home, I didn’t use the PDA for fear of running out the battery. The first thing I did after going home was to charge my PDA and to synchronize it with my PC ….”

(Adopted from students’ journals in the study)

The use of handheld computers in clinical settings has been on the rise in recent years. Handheld computers have served not only as personal organizers but also as facilitators of efficient clinical diagnostic reasoning (Rempher, Lasome & Lasome, 2003). Surgeons, for example, have used PDAs to simplify data entry and retrieval at the patient’s bedside (Fowler, Hogle, Martini & Roh, 2002). Family practice residencies have also used handhelds as medication reference tools, electronic textbooks, clinical computational programs, and tracking of patient information (Criswell & Parchman, 2002). Healthcare professionals use PDAs to find appropriate medications, check for drug interactions, calculate dosages, and consult other clinical references (Tooey & Mayo, 2003). Today’s nurses have even used handheld-computer-based support systems to obtain patients’ preferences for functional bedside performance (Ruland, 2002). The use of handheld technology in clinical practice has been well documented. Huffstutler, Wyatt, and Wright (2002) suggested that these advanced technologies must be integrated into the nursing curricula to foster students’ proficiency in adapting to varied and expanding complex information systems.
The theory-practice gap in clinical nursing education has long been documented in the literature as a critical area that needs improvement (e.g., McCaugherty, 1991; Hewison & Wildman, 1996; Landers, 2000). Landers’s (2000) overview of the literature suggests that nursing instructors need to identify methods where students can more readily recognize the theoretical constructs underpinning successful nursing practice. Nursing instructors also need to play a key role in facilitating students’ application of clinical learning practices. Traditional clinical teaching has previously required one faculty member to supervise many students in a variety of settings, which has often included remote/distant sites. Geographic dispersal has posed challenges to faculty and students in the realm of timely responses to student needs, clinical monitoring, and student learning (Ndiwane, 2005). Even though the clinical area is considered to be at the center of nursing education, students still often express dissatisfaction with their clinical training: citing inadequate support from teachers in the clinical setting (Clifford, 1992; Lee, 1996).

Many initiatives have been undertaken in an effort to bridge the theory-practice gap. An important innovation is to support students’ learning in the clinical setting with modern technology. The incorporation of emerging technology into clinical areas has demonstrated its potential to provide more student learning opportunities, create innovative teaching practices, and promote current, accurate information retrieval systems for nursing care (Jeffries, 2005). In recent years, handheld technology has been considered as a possible application for supporting students’ learning in clinical practice. For example, Lehman (2003) used handheld computers to observe and to maintain records of students’ performance of clinical tasks in a clinical setting. Ndiwane (2005) used the Nightingale Tracker system, which connected a server and handheld devices with telephone lines, to allow timely communication between clinical faculty and students in community-based clinical settings. Their system also allowed for easy transmission, retrieval, and management of student-generated clinical data. Faruque et al. (2005) applied geospatial information technology to support academic practice, faulty outreach, and education initiatives at a nursing education institution. Studies in nursing education have found that personal digital assistants (PDAs) were an effective student learning resource, especially for reference materials, during students’ clinical practicals (Miller et al., 2005); and PDAs may facilitate the application of evidence-based knowledge to clinical practice (Stroud, Erkel, & Smith, 2005). Greenfield (2007) provided nursing students with PDAs equipped with a drug information program and found that some medication errors could be reduced at the point of care. Farrell (2008) found that most nursing students used PDAs in real time at the bedside primarily to access drug information and they agreed that PDAs enhanced their pharmacological knowledge (but not their contextual knowledge). The small and light-weight handhelds are easy to carry throughout learning activities, which makes it particularly useful for using in clinical sites. As White et al. (2005) pointed out, PDAs were probably the most useful tools for supporting students in clinical settings, where the pace is fast and resources may not be readily available.

A recent guest editorial by Billings (2005) in the Journal of Nursing Education, in response to the increased use of handheld devices by health care agencies and classrooms, urged nurse educators to take advantage of the power of mobile wireless technologies to create more learner-centered teaching. Wireless technologies such as WiFi, Bluetooth, and Infrared (IR) extend the power of handhelds so that students can use the devices to access Internet, to share and exchange files, and to submit and download data. Handhelds may also promote interactions among students and teachers (Lai & Wu, 2006). In our survey of articles in nursing education, we found that very few studies have incorporated the wireless capability of handheld devices in clinical training practices. Our literature search found only two studies that used the wireless features of handhelds in clinical training. White and et al. (2005) used only the wirelessly beam (IR) feature in their study, and students beamed their document to the instructor’s PDA in the clinical site once a week. The study by Garrett and Jackson (2006) equipped students’ PDA with WiFi and cell phone/GPRS (General Packet Radio Service) and showed that students mainly used the PDAs as electronic reference tools rather than for data recording and communication. The wireless features of PDAs were used limitedly and not actually incorporated into students’ learning process in the two studies.

Our present study is an attempt to respond to the challenges advocated by Billings, and to respond to the needs of nursing education practitioners. When placed in clinical settings, nursing students usually have limited opportunities to access computers, as most nursing sites allow computer access to “employees only.” They also have limited opportunities to interact with their nursing instructors. The aim of this study was to implement a wireless handheld learning environment, which took advantages of the mobility and wireless connectivity of handhelds, to support students’ learning in the clinical setting and to facilitate increased interactions among students and teachers. This paper reports our implementation and evaluation of such an environment in support of students enrolled in a Clinical Nursing Practicum course, an essential course for helping student link theory and practice during their final stage of professional training.
The wireless handheld learning environment

The environment was developed through a close collaboration with an experienced nursing instructor. The instructor has taught psychiatric nursing clinical practicum at a junior nursing college for over 20 years. She had participated in a study of using handhelds in a classroom environment and had modest knowledge and skills with PDAs. We identified the various needs of an effective clinical practicum by conducting several rounds of interviews with the instructor and observing the actual practices of her clinical learning sessions in a local hospital. Functionalities of the environment which would facilitate the instructor’s utilizing handhelds in the practicum were identified and implemented. The handheld learning environment was designed to support nursing students in recording information, organizing ideas, assessing patients, collaborating with peers, and interacting with the instructor during an on-site clinical practicum.

Figure 1 shows the hardware components of our wireless handheld learning environment. Students who enrolled in the course were provided with a PDA equipped with IR, Bluetooth, and WiFi wireless capabilities. They could use IR to share files with each other, Bluetooth to submit (download) materials to or from the instructor’s notebook, or WiFi to access the Internet. The instructor’s notebook and PDA were also equipped with wireless capabilities. A course server was hosted under the campus LAN (Local Area Network) of the nursing college. The instructor and students could use their PDA to access the Internet and the course server from the hospital, by ways of wireless access points (APs), which then connected to the hospital LAN and to the campus LAN.
We have developed a series of application tools to meet the instructor’s needs, of which some were general-purpose tools (such as message board and discussion forum), while others were designated for psychiatric nursing practice (e.g., symptom assessment scales, nursing dictionary). Figure 2 shows the menu page which appeared when students logged into the course server using the Pocket PC IE browser. The Announcement feature shows course information and instructor’s messages to students. Patient’s ABC and Symptom assessment are online tools to support students’ observations of patients’ mental status. Reflective journals was the place where students could reflect upon what occurred during their daily practicum. Students could check the meaning of a nursing term and then listen to its pronunciation in the nursing Dictionary. Students could locate helpful documents such as PDA usage tips, nursing assessment procedures, and other useful resource links in the Resources section. Online discussions with peers were facilitated by using the Forum icon. Students could use the Interview tool to keep records of audio conversations with patients. The Portfolio feature allowed students to organize homework and individual learning materials. A concept map application tool and an audio-recording program were also included in the PDAs for student use. We describe several of the tools in detail below.

**Patient’s ABC**

A mental patient’s Appearance, Behavior, and Conversation (ABC) with others are indicators of the patient’s mental state. One of the nursing student’s daily tasks is to observe and record their patient’s ABC’s and submit them to the instructor at the end of the day. It also serves as a basis for students’ clinical interviews with patients. This task is traditionally conducted by using a paper-based observation sheet. We incorporated the traditional observation sheet into our handheld system so that students could denote their observations on a patient using their PDA and submit it to the instructor online. Figure 3 shows a student (Kelly) who was editing a patient’s ABC page. The [Hint] buttons (when tapped) provide students with suggestions for observing a patient. All students’ completed patients’ ABC records were kept in the course server and could be accessed by instructors and students when needed.

![Figure 3. Patient’s ABC page](image)

**Symptom assessment**

Several important symptom assessment scales were introduced to students in their theory courses before entering the practicum session, including the Scale for the Assessment of Negative Symptoms (SANS; Andreasen, 1983) and its complementary instrument the Scale for the Assessment of Positive Symptoms (SAPS; Andreasen, 1984). When conducting a standard clinical interview, students need access to the two scales in order to evaluate patients’ symptoms. In the past, the instructor did not carry out the symptom assessment activities during the practicum due to
the lengthiness of the scales, which is inconvenient to carry around when exercising nursing tasks. The SANS scale has 25 assessment items, each with 5 to 6 symptom descriptions, while the SAPS scale consists of 34 items, each with 6 symptom descriptions. We have incorporated the two scales in our system so that students could conduct assessment tasks using their PDA. Figure 4 shows a page from the SANS scale which lists assessment categories of hallucination. Figure 5 is the page which follows when students select the “Auditory Hallucination” category. Students would then need to check one of the symptom descriptions which best suited the patient. Once students finished the assessment and tapped the “submit” button, the assessment results would be transmitted to the database in the course server.

Figure 4. Symptom assessment for hallucination

Figure 5. Checking a patient’s symptom of auditory hallucination
Reflective journals

Students were required to write daily reflective journals in the hospital to improve awareness of their own learning. Reflective journals allowed students to better assess their needs, and at the same time, allowed the instructor to provide them guidance and support. Figure 6 is a reflective journal written by a student, which read as follows:

“… Although there were nurses and the therapist around, we felt scared because of being surrounded by so many patients. I felt very uncomfortable. … I know I shouldn’t feel this way. I should try to get along with the patients -- no matter how seriously ill they are. …”

In the following mood check-boxes, one student indicated the feeling of being terrified and helpless. After seeing the journal, the instructor immediately wrote words of encouragement on the online feedback form, and then provided additional support for the student the following day. With the PDA-based reflective journals, the instructor could know students’ conditions promptly and provide them with timely feedback, which was just not possible with previous paper-written journals.

![Figure 6. The reflective journals](image)

![Figure 7. The psychiatric nursing glossary](image)
Nursing dictionary

We constructed a glossary of frequently used psychiatric nursing terms (see Figure 7) as part of our handheld system that students could use during their practicum. Students could check the meaning of a nursing term (in Chinese) and listen to its pronunciation (in English) via their PDA. The dictionary tool is especially helpful when students read a patient’s medical history and when for discussion with the instructor or peers (where the use of English terms was essential).

Discussion forum

To promote interactions among students, the instructor, and the nurse mentors, a discussion forum was created on our handheld system. Students could either respond to the instructor’s postings or initiate their own topics of interest by using their PDA in the hospital or via the PC at home. The nurse mentors could use PCs to join in discussions where ideas and experiences from the field could be shared. Each week during the practicum, the instructor initiated a discussion topic regarding issues involving students’ clinical practice. For example, in Figure 8, the instructor posted the question “Should patients call nurses by their first name?” Calling a person’s first name is acceptable in most western cultures but is uncommon in Taiwanese culture. In Taiwanese culture, calling a person by their first name is done only with very close friends or family members. The posting, consequently, generated much discussion among the students and with nurse mentors.

Concept maps

The instructor encouraged students to construct concept maps with their PDAs to help students organize their ideas on assessing patients’ mental problems, performing nursing diagnosis, and outlining nursing care plans. Traditionally, students used paper and pencil methods to draw concept maps. In this study we offered students a PDA-based concept mapping tool, PicoMap, developed by the labs of Highly Interactive Computing in Education (Hi-CE) of the University of Michigan (http://hice.org/pocketpc). The PicoMap tool allows students to create and edit concept maps and to exchange such maps via IR beaming. Figure 9 is an example concept map in which a student depicted her assessment of a patient’s condition from physical, emotional, intellectual, social, and spiritual perspectives.
Methodology

To evaluate the effectiveness of the handheld learning environment, we incorporated the use of PDAs in a three-week nursing clinical practicum session conducted by the nursing instructor (who collaborated with us in developing the environment) in a clinical setting. The practicum session was designed to provide students with clinical experiences in the area of psychiatric nursing. We were interested in knowing the benefits and problems of implementing such an environment in an authentic clinical setting. Our evaluation focused on answering the following three questions: (1) what were students’ feedback on the features of the PDA-based environment in terms of perceived advantages and disadvantages?, (2) what were the benefits of the PDA-supported clinical practicum as compared to the previous ones?, and (3) what issues might occur when implementing such a PDA-based practicum session? Various qualitative data resources were collected in order to address the three questions. Although it might be preferable to implement a control-group experimental design in our evaluation, the small enrollment size of the practicum session made this approach infeasible. Alternatively, we asked the participants to compare their experiences of the previously attended traditional practicum sessions with the present one so that the effectiveness of the handheld learning environment could be identified.

Participants and settings

Six female students enrolled in the practicum session were each provided a PDA to use throughout the practicum. The PDA used was a HP iPAQ 2210 model powered with a Microsoft Windows CE operating system, 64MB memory, and an 802.11b wireless network card. The PDA came with many built-in application tools such as Pocket Word, Pocket PC IE, and Media Player. Students were trained in using PDAs prior to attending the clinical practicum. Two training sessions were held at the nursing college; each session lasted one and a half hours. Training activities included operations on data input, file management, software installation, wireless settings, Internet surfing, file transmission via IR and Bluetooth, synchronization of the PDA with PCs, PicoMap, and trial use of the handheld learning system.

The clinical practicum setting in the study was a private middle-size mental hospital located in central Taiwan. Two experienced nurses from the hospital served as mentors to guide students’ clinical practices. All nursing stations in the hospital had computers which were designated for medical management and students were not allowed to use

Figure 9. A PicoMap created concept map
them. The computers were networked under a hospital LAN, which was connected to the Internet via an ADSL line with a 768 Kb downloading and 128 Kb uploading rate. No wireless access facilities had been established in the hospital. To support students using PDAs to access the Internet and the course server, we set up two 802.11g wireless APs under the hospital LAN, one at the ward where students had their clinical learning practice, the other at the meeting room where they had meetings with the instructor. The course server was located at the nursing college under the campus LAN, which was connected to the Internet via TANet (Taiwan Academic Network).

Learning activities

Students’ primary daily activities in the hospital included attending to the hospital’s morning report, practicing morning care and routine nursing, participating in patients’ team therapeutics, and participation in a discussion session held by the instructor. The six students were paired into three teams and each team was responsible for caring for an assigned patient. The team members collaborated on most learning tasks and were encouraged to share and discuss their individual assignments with all other students. Students’ assignments included patient’s ABC observations, symptom assessment, clinical interviews, drawing concept maps, reflective journals, and in the end, outlining a nursing care plan. Students usually did the assignments during their free time in the hospital. While at the discussion session, the instructor closely monitored students’ daily progress, and the students used their PDA to submit homework and to download learning materials from the instructor’s notebook (via Bluetooth). Students often wrote their daily reflective journals and joined in the online discussion forum during their free time in the hospital or after returning home.

Data collection and analysis

Various data sources were collected for analysis, which included: students’ reflective journals; open-ended questionnaires answered by the students, the instructor, and the four nurses (including two nurse mentors) who worked in the same ward with the students; interviews with the students and the instructor after the practicum; and our field observation journals. Due to the small size of the participants, our analysis of data was primarily qualitative rather than quantitative. The authors first examined the collected data and identified contents which could be placed into the three evaluation question categories. Similar contents which addressed the same theme were then combined. Finally, arguments in support of various themes were justified. The results discussed in the following session were based primarily on the questionnaire data, along with the support from other data resources (such as interview data and field observation journals).

Results and discussion

Feedbacks on the PDA learning environment

In the questionnaire, we asked students to give their comments on advantages and disadvantages of the PDA-based features in the learning environment. Table 1 is the summary of the number of students reporting on each feature. Almost all students reported that they had benefited from the features provided by the PDA environment. Some problems were encountered, however, when using some of the features. Students indicated that the use of Patient’s ABC had saved great amount of time because they could record patient’s data on site and upload it for instructor’s feedback soon afterwards. Some students did complain, however, about the occasionally slowness or connecting problems with the network (via WiFi). Students considered the Symptom assessment feature very convenient because they could revise the assessment scales whenever they observed that the conditions had changed for their patient. One student commented: “By allowing us to revise the assessment scales, we could see not only the progress of a patient but also of ourselves.” Some suggested that it would be good to allow viewing the history of previously filled assessment scales, instead of only the latest version, so that the progress of their patient could be compared and analyzed. One student also indicated problems on connecting to the network. In using the Reflective journals, students appreciated the convenience when reflecting upon the day’s learning. This also provided a means for getting prompt feedback from the instructor. One student said that a disadvantage of the PDAs was the lack of “emotional icons” when writing the journal. Another student indicated her occasionally difficulty on accessing the Internet when
using the feature. All students considered the Discussion forum a good place for sharing experience and gaining alternative viewpoints.

As to using Bluetooth and IR, students loved its “quickness” and proved to be less troublesome because files could be transmitted directly between two PDAs without first connecting to a computer network. The only problem students mentioned was that the instructor had to remember to enable her Bluetooth before the transmission. All students enjoyed sharing files with peers via IR and thought it was convenient in facilitating discussion and learning from others. In using PicoMap software to draw concept maps, the benefits students reported were as follows: easy and fast to draw, easy to comprehend and memorize, ready for use when a thought is generated, and the ease of creating “clean” concept maps. Students found it inconvenient, however, in that the PicoMap only allowed 12 characters per node with only 32 nodes per concept map. This limitation was due to the small size of the PDA screen, which also prevented students from viewing an entire concept map (which consisted of more than 8 to 10 nodes).

Table 1. Number of students reported advantages and disadvantages on the features of the handheld learning environment

<table>
<thead>
<tr>
<th>Feature</th>
<th>advantages</th>
<th>disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient’s ABC*</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>Symptom assessment*</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Reflective journals*</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Discussion forum*</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Homework submission via Bluetooth</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>Sharing data via IR</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Concept maps (PicoMap)</td>
<td>6</td>
<td>6</td>
</tr>
</tbody>
</table>

Note. * Accessed via WiFi network

A major problem raised by the students in using the PDA environment was the “connectedness” of the WiFi network. Due to the somewhat dated network infrastructure of the hospital, we could only manage to set up two APs in the hospital: one near the ward and the nursing station, and one in the meeting room. Students found it inconvenient when they tried to access the network at other locations in the hospital. Some students attempted working in the yard of the hospital, and found the wireless signals to be weak or even non-existent. Students also indicated occasional slowness of the network while accessing the Internet or the course server, especially when there were many individuals vying for access. The sluggishness of the network was attributed to the hospital’s small bandwidth ADSL connection with the Internet, with a 768 Kb downloading and 128 Kb uploading rate. We attempted to resolve the situation by modifying some of our application tools. For example, the Symptom assessment scales could originally only be used when connecting to the Internet. We added the offline viewing/editing feature so that students could also use it even without network access. Students could submit their work later when they had access to the network. These modifications provided students with more flexibility and mobility in using the PDA tool. This also reduced network traffic which, in turn, improved network access speed. Nevertheless, a broader network bandwidth and wider wireless coverage would still be desirable for future implementations.

Comparison with previous practicum sessions

Questionnaires and after-practicum interviews were used to ask students, the instructor, and the four nurses about their observed differences between the present PDA-using practicum session and the previous non-PDA-using practicums. We summarize their comments (below) in terms of the learning process, interactions among peers and instructor, and course management.

Learning process

The most cited differences which students stated were in regard to taking notes and recording conversations with patients. These two features provided by the PDAs spared students from memorizing excruciating details and made their learning more efficient. Students pointed out:
“The major difference was that I could now take notes whenever I wished. Without the PDA, we had to try very hard to recall what was done that day.”

“It saved me lots of time in doing homework. Whenever I had a thought or found useful information, I wrote it in my PDA. After going home, I did my homework by referring to what I had written. It now only took me one or two hours to complete the homework -- compared to four or five hours before.”

“The difference was that we had opportunities to use the high-tech product. It was convenient to take to anywhere, record information, and learn at anytime. We indeed gained a lot from using it.”

We have found that students used PDAs to do homework, take notes, record talks, and look up terms wherever needed (at the hospital, on the bus, or at home). Similar observations were also described in White et al. (2005).

The four nurses were asked about students’ performance in the PDA-enhanced clinical practicum versus the older, more traditional method. The nurses agreed with the students about the benefits of taking notes and recording conversations using the PDAs. In addition, they thought the use of PDAs to access reference materials in the PDA or resources in the Internet had greatly helped the students. The nurses pointed out that “PDAs help students find out a patient’s problem promptly.” and “students could use PDAs to search for answers anytime.” Another noted difference stated by the nurses was that students had integrated more theories into practices, which was due to the abundant materials and useful tools provided in the PDAs. One of them wrote:

“... This time the students could review theories first [by using their PDAs] and use PDAs on the spot, which saved both time and effort. Drawing concept maps gave them a clear picture of the concepts to be learned, and the maps could also serve as a review summary.”

Koeniger-Donohue (2008) also found that the use of PDAs not only saved students’ time, but students also spent more time with patients because it was not necessary to leave the patient’s room to look up information. By drawing concept maps on their assessment of a patient’s conditions, students would clearly organize their ideas and see what information they already had or were missing and yet to be collected. The nurses expressed that the students of the present session were more organized and analytical in learning.

The instructor observed the differences from more pedagogical viewpoints. She considered her students became engaged and self-directed in learning, attained better theory knowledge, and had stronger self-confidence. She believed that the symptom assessment scales and the concept mapping tool had played a crucial role in the improvement of students’ learning. When assessing a patient’s problem, students had to follow the assessment scales item by item to determine one’s symptoms. In doing so, they clearly learned the definitions of symptoms and the procedures for doing assessment. Thus, the PDA-based tools acted as learning scaffolds to support students’ assessing patients, organizing ideas, and allowed for reflection of students’ learning. The benefits indicated by the instructor were consistent with previous studies. Miller et al. (2005) found that students decreased their reliance on textbooks and clinical faculty after substantial use of the PDAs. PDAs also supported students’ formulation of questions associated with clinical situations. Ndiwane (2005) found students were confidence in providing patient care independently while using PDAs.

In summary, students enjoyed the convenience and time-saving aspects that the PDA tools had brought to the learning process, which were confirmed by the nurses’ observations. Nurses in the clinical sites indicated that students integrated more theories into practices and became better organized in learning. The course instructor, believed the PDAs served as a scaffolding and support system during students’ clinical practices, which resulted in engaged, self-directed, and more confident students.

**Interactions among peers and instructor**

In the practicum, students were paired in teams and had to collaborate on several activities and assignments, such as taking care of an assigned patient, conducting clinical interviews, and writing a nursing caring plan. All students commented that they had better interaction with peers when compared to their previous non-PDA-using practicum sessions. They attributed the effects to the immediacy and the file transmission features offered by the PDAs. With the PDA in hand, students could finish tasks far sooner than before and could easily exchange each other’s work (via IR) for discussion. The results were in accordance with our previous study (Lai & Wu, 2006) in which PDAs were used to support cooperative learning activities. Student commented on the questionnaires about how they had interacted with others:
“... This time we discussed and finished tasks such as the Patient’s ABC, interviews, and observations on the spot which greatly enhanced our interactions.”
“We usually did reports together, first drawing maps individually, and then having discussion; or we divided the work so that we could finish it sooner, and then transmitted the maps to each other.”
“This time we could prepare the data on site and then transmitted it to each other during discussion. We would reach conclusions very soon. In our previous sessions, we prepared the data after going home and emailed to others. We could hardly have time for face-to-face discussion.”

The instructor expressed that she was now able to identify students’ problems sooner and provide more individualized instruction when PDAs were incorporated into the clinical practicum. She attributed her improved interactions with students primarily due to the inclusion of online reflective journals. She also enjoyed the experience of beaming files (using IR) to/from students and considered her relationship with students “greatly enhanced” by the high-tech use. Students, additionally, admitted that their interactions with their instructor were increased due to the use of PDAs. With the PDA handy, they could easily show their work to the instructor, or even transmit it to the instructor’s PDA or notebook, during practicum discussions. As a result, they could get timely feedback from the instructor, which in turn increased the frequency of student-instructor interactions. Students’ increased interactions with the instructor were supported by the following statements:

“We had more interactions because I could transmit my written materials to the teacher and discuss my problems soon after. …”
“The teacher received everyone’s work immediately [via Bluetooth] during discussion sessions. She knew clearly how much we had learned and gave us appropriate feedback accordingly.”
“It used to take a while for receiving the teacher’s feedback after we emailed our work. Now, we got the result right away via Bluetooth.”

Course management

The instructor conceded that the use of PDAs had spared her from trivial course management and minimized many time-consuming tasks that had existed with the more traditional method of administration. For example, by logging into the system, she would know who had turned in the assignments on time and who had not, which had freed her from the frustration of constantly having to remind students the deadlines. She appreciated the use of online tools such as Patient’s ABC, Symptom assessment scales, and Reflective journals which provided students with clear instructions and formats to complete assignments and allowed her to give students timely feedback. The instructor said she now had more time to guide students with in-depth discussions during the practicum session. As pointed out by Huffstutler et al. (2002), additional time would be needed for class preparation using PDAs as a teaching strategy, the instructor admitted that it was challenging for her to learn all the “technology stuff” and to manage students’ use of the PDAs at the beginning. However, she considered all those “sweet burdens.”

Implementation issues

Several implementation issues arose during the course of our study, which included the following: the capacity of PDAs, internet resources, and students’ preconceptions about using PCs.

PDA capacity

Several studies (e.g., Guerrero, Ochoa, & Pino, 2006; Garrett & Jackson, 2006; Lai & Wu, 2006) have identified limitations of using PDAs in learning: data input, screen size, memory capacity, processing power, and battery life. Several problems raised by our students in the study were due to some of these limitations. The most frequently mentioned problem was the fear of losing their data when the PDA’s battery was low. The PDA model used in our study had an approximate 8-hour battery life when fully charged, but the battery life is far shorter when wireless functions such as IR, Bluetooth, or WiFi were enabled or when the PDA screen was left on. The loss of battery power was very inconvenient for students. When batteries failed, the PDA would return to its default settings. This meant that the data in the PDA would be erased and would require reinstallation of software. When batteries were running low, students would interrupt their work either to charge the battery or to borrow a back-up PDA from the instructor. Students were reminded to fully charge their PDA before coming to the hospital; however, even the instructor sometimes would forget to charge the PDA. The instructor also complained about battery problems in the
questionnaire. We do not consider the battery problems encountered here to be a major obstacle for the incorporation of PDAs into clinical practicum training. One could easily resolve this by replacing PDAs with more current models, which have longer battery lives and which do not erase data and programs even when battery failure occurs. Another problem occurred in our study was some unexpected system halts of the PDAs. The unexpected system halts sometimes resulted from students’ improper use of the PDA. When an operation was not immediately responding (e.g., opening a link on a web page), some students would keep tapping on the PDA, causing system halts. Yet, some system halts may have been possibly due to the PDA’s processing power or memory capacity, or the stability of the software application. We believe the mature of mobile technology would eventually resolve the problems.

Internet resources

Although abundant nursing resources are available via the Internet, few such resources are designed or adapted for use with PDAs, especially those for Chinese web sites. Students often had trouble viewing Internet PC-based web pages with their small PDAs. Viewing conditions would undoubtedly be worsened if the web was designed with various character settings, many pictures, or animations. In the worst cases, some web pages would result in system halts with the PDA. We could only accommodate the situations by offering important resources with PDA-displays formatted on our course server. There are growing numbers of Chinese Internet subscription resources which can be accessed and viewed via PDA software -- such as AvantGo (http://www.avantgo.com/). The incorporation of such software in future implementations should enable students to access and to view more Internet resources via their PDA.

Preconceptions about using PCs

We have found that the participants’ conceptions about using PDAs were influenced by prior use of PCs. The PDAs in our study used a Pocket “Windows” operating system and had similar PC Windows tools such as File Manager, Internet Explorer (IE), Pocket Word, and Pocket Excel. The look and feel of the Pocket Windows system was similar to that of a PC except for its small size screen. All our participants were experienced PC users. This facilitated the easily transfer of PC skills to that of the PDA. We observed that PC-based skills worked well most of the time, but sometimes students became confused. Closing a PC application window, for example, usually results in terminating the application. In the PDA system, however, it only closes the window (but does not terminating the application program). The application program can only be terminated by entering a system setting page to explicitly stop it. If there are too many applications running at the same time, the performance of a PDA will become slow. Students often found their PDA system responded very slowly, or even halted, without noticing the cause of the problem -- because they thought they had “closed” (terminated) the application program.

Students also had to get used to the arrangement of menu application buttons in the PDA, which appeared at the bottom of the screen rather than at the top of a PC screen (e.g., Pocket Word vs. Word). Students were sometimes frustrated when failing to find a feature which was not available in the PDA or had different operating procedures than the PC (e.g., setting of character size in IE). Participants who had used a PC based system expected similar features to appear in the PDA. PDA based systems are, in fact, only “pocket-size” versions of those in a PC in terms of the hardware and its applications. The practicum instructor was even subject to having to adjust from the use of PC based applications to that of the PDA. The instructor used to grade students’ assignment in the PC Word and was very disappointed to find the “Revision Marks” feature absent from Pocket Word. Some of our difficulties in communicating with the instructor when developing the handheld system and conducting the experiment were due to her unintentionally mapping of the PC based models to the PDA. We believe that more training hours may be warranted to allow both the instructor and students to learn the limitations of a PDA and overcome conflicting models that result from prior use of a PC based system.

Other issues

We had initial concerns about disturbing regular nursing practices when introducing PDAs into the clinical site. After conducting the study, our initial concerns were proved to be unnecessary. All of the nurses involved in the study were very positive about students’ use of PDAs and did not consider it a problem to the nursing practices. The nurses responded in the questionnaire:

“It simplified the task procedures and caused no troubles to the hospital and the patients.”
“It helped us understand the future trend of using technology in nursing practices and we acquired new information. Using PDAs is convenient for keeping records of nursing processes.”

The nurses envied students’ access to PDAs and expressed the desire to use PDAs in their future practice. The findings correspond to Farrell’s (2008) study in which the nurses encouraged students to use the PDA for accessing information in real time. Farrell also pointed out that some students in her study thought using PDAs in front of patients seemed rude. Our observation showed that the concern was not necessary. We found patients’ initial reaction to the PDAs was often that of curiosity towards the use of this technological device. Patients quickly got used to the students’ use of PDAs, eventually viewing them as almost routine tools of the clinical staff. Students had expressed few non-technical concerns about using PDAs in the clinical site. One concern which was voiced by almost every student was fear of losing their PDA in the hospital. PDAs were loaned to students for the three-week practicum period. They were reminded that the device was expensive and had to be well taken care. Due to its pocket-small size, students thought it would be easy to lose or to be stolen. Students felt a little insecure about carrying such an expensive technologically advanced device around the hospital throughout the practicum.

Conclusions

In the instructor’s final comments (expressed in the questionnaire), she wished that “one day all the clinical sites will become wirelessly connected.” The instructor stated that the handheld environment was a great “breakthrough” in what had been years of difficulties in conducting effective clinical practicum. The wireless handheld environment not only provided students with tools for taking notes, recording information, and accessing resources but also facilitated their collaboration with peers and improved interactions with the instructor. Ultimately, the PDAs acted as cognitive scaffolding tools to support student learning in the clinical site. Our findings were different from Garrett and Jackson’s (2006) study, in which they found the PDAs mainly used as electronic reference tools, rather than data recording and communication devices. We believe the differences were mainly due to the design of the PDA-based tools, which did not closely integrate into the learning activities. Our implementation was a more integrative one where we incorporated several key clinical learning instruments into the PDA system. We have addressed the utilization of handheld devices in terms of pedagogical underpinnings by building the learning environment based on collaborative, contextual, and constructivist principles (as indicated in Patten, Sánchez, & Tangney, 2006). Our findings showed that the wireless handheld environment in a clinical nursing practicum was both technologically appropriate and pedagogically sound.

As we have discussed, there were limitations in our present approach such as sluggishness of the Internet access in the clinical site, short battery life of the PDAs, constraints on the PDA software (i.e., PicoMap), limited PDA-adapted web resources, and students’ confusion about the interface of PDAs with their previous PC using experience. However, the limitations were far overshadowed by the potential benefits. Slowness or inconvenience of hospital network access was mainly due to older network infrastructures which could be easily remedied. Issues such as short battery life could be resolved with newer model PDAs. We believe that some of the limitations and confusion about PDA based systems could be resolved with additional training. Some of the hardware and software problems would be alleviated by the maturation of future mobile technologies. PDAs have the potential of revolutionizing and transforming the way clinical practicum is conducted in nursing training settings. Finally, the results of the present study were primarily based on qualitative data collected from small number of participants, future study may want to recruit more participants and implement an experimental design to explore the effectiveness of the handheld learning environment from quantitative aspects.

References


