Feasibility of incorporating PDAs into a PBL approach to medical education at the University of Wollongong

Rattiporn Luanrattana

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Feasibility of Incorporating PDAs into a PBL-Approach to Medical Education at the University of Wollongong

A thesis submitted in partial fulfilment of the requirements for the award of the degree

Doctor of Philosophy

from

University of Wollongong

By

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School of Information Systems and Technology
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Abstract

This thesis addresses the feasibility of incorporating personal digital assistants (PDAs) into a problem-based learning (PBL) approach to medical education at the University of Wollongong (UOW). The contribution of this study highlights guidelines regarding what PDA functionalities and factor/aspects to consider for the adoption of PDAs into PBL-medical curriculum.

Four major PDA functionalities which are appropriate for medical education in PBL-approach are found based on the attitudes, knowledge and experiences of participants, these being (i) clinical-log, (ii) reference, (iii) communication and (iv) personal information management (PIM) functions.

Further, two major aspects which may influence the incorporation of PDAs are identified, namely technical and practical aspects. The technical aspects comprise (i) data security and information privacy, (ii) data transmission and network connectivity, (iii) maintenance and support and (iv) interoperability. The practical aspects emphasise (i) education and training, (ii) electromagnetic interference (EI) and (iii) resource and financial implications.
Declaration

I, Rattiporn Luanrattana, declare that this thesis, submitted in partial fulfilment of the requirements for the award of Doctor of Philosophy, in the School of Information Systems and Technology, University of Wollongong, is wholly my own work unless otherwise referenced or acknowledged. The document has not been submitted for qualifications at any other academic institution.

Rattiporn Luanrattana

March 2010
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Other publication

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<thead>
<tr>
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<th>Description</th>
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<tbody>
<tr>
<td>AMIA</td>
<td>American Medical Informatics Association</td>
</tr>
<tr>
<td>APSS</td>
<td>Adaptive Packet and Scheduling</td>
</tr>
<tr>
<td>ARM</td>
<td>Advanced RICS Machine</td>
</tr>
<tr>
<td>ARS</td>
<td>Audience Response Systems</td>
</tr>
<tr>
<td>ASP</td>
<td>Active Server Page</td>
</tr>
<tr>
<td>AWMA</td>
<td>Alternating-Wireless-Media Access</td>
</tr>
<tr>
<td>BAN</td>
<td>Body Area Network</td>
</tr>
<tr>
<td>CCU</td>
<td>Cardiac-Care Unit</td>
</tr>
<tr>
<td>CDPD</td>
<td>Cellular Digital Packet Data</td>
</tr>
<tr>
<td>CD-ROM</td>
<td>Compact Disc Read Only Memory</td>
</tr>
<tr>
<td>CEDIR</td>
<td>Centre for Education Development and Interactive Resources</td>
</tr>
<tr>
<td>CPU</td>
<td>Central Processing Speed</td>
</tr>
<tr>
<td>CT</td>
<td>Computerised Tomography</td>
</tr>
<tr>
<td>DSSS</td>
<td>Direct Sequence Spread Spectrum</td>
</tr>
<tr>
<td>EBM</td>
<td>Evidenced-Based Medicine</td>
</tr>
<tr>
<td>EHR</td>
<td>Electronic Health Records</td>
</tr>
<tr>
<td>EI</td>
<td>Electromagnetic Interference</td>
</tr>
<tr>
<td>EMR</td>
<td>Electronic Medical Record</td>
</tr>
<tr>
<td>EPR</td>
<td>Electronic Patient Record</td>
</tr>
<tr>
<td>EthIR</td>
<td>Ethernet connection into a wireless network access point</td>
</tr>
<tr>
<td>FHSS</td>
<td>Frequency Hopping Spread Spectrum</td>
</tr>
<tr>
<td>GB</td>
<td>gigabyte. 1 gigabyte is 1000000000bytes.</td>
</tr>
<tr>
<td>GP</td>
<td>General Practitioner</td>
</tr>
<tr>
<td>GPRS</td>
<td>General Packet Radio Services</td>
</tr>
<tr>
<td>GPS</td>
<td>Global Position Systems</td>
</tr>
<tr>
<td>GSM</td>
<td>Graduate School of Medicine</td>
</tr>
<tr>
<td>GUI</td>
<td>Graphic User Interface</td>
</tr>
<tr>
<td>HIPAA</td>
<td>Health Insurance Portability and Accountability Act</td>
</tr>
<tr>
<td>HIS</td>
<td>Hospital Information Systems</td>
</tr>
<tr>
<td>HPP</td>
<td>Health Privacy Principles</td>
</tr>
<tr>
<td>HRIPA</td>
<td>Health Record and Information Privacy Act</td>
</tr>
<tr>
<td>HTML</td>
<td>Hypertext Mark-up Language</td>
</tr>
<tr>
<td>ICD</td>
<td>International Classification of Diseases</td>
</tr>
<tr>
<td>ICU</td>
<td>Intensive Care Unit</td>
</tr>
<tr>
<td>IDC</td>
<td>Implantable Cardio converter-Defibrillator</td>
</tr>
<tr>
<td>IEEE</td>
<td>Institute of Electrical and Electronics Engineers</td>
</tr>
<tr>
<td>ILA</td>
<td>Integrated Learning Activities</td>
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<tr>
<td>IP</td>
<td>Internet Protocol</td>
</tr>
<tr>
<td>ISO</td>
<td>International Organisation for Standardisation</td>
</tr>
<tr>
<td>IT</td>
<td>Information Technology</td>
</tr>
<tr>
<td>ITS</td>
<td>Information Technology Service</td>
</tr>
<tr>
<td>J2ME</td>
<td>Java 2 Platform Micro Edition</td>
</tr>
<tr>
<td>JSP</td>
<td>Java Server Page</td>
</tr>
<tr>
<td>Acronym</td>
<td>Description</td>
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<tr>
<td>LAN</td>
<td>Local Area Network</td>
</tr>
<tr>
<td>LLL</td>
<td>Life-Long Learning</td>
</tr>
<tr>
<td>MIDP</td>
<td>Mobile Information Device Profile</td>
</tr>
<tr>
<td>MIMS</td>
<td>a supplier of medical information</td>
</tr>
<tr>
<td>MRI</td>
<td>Magnetic Resonance Images</td>
</tr>
<tr>
<td>NHMRC</td>
<td>National Health and Medical Research Council</td>
</tr>
<tr>
<td>NLM</td>
<td>the National Library of Medicine</td>
</tr>
<tr>
<td>OS</td>
<td>Operating Systems</td>
</tr>
<tr>
<td>OSCE</td>
<td>Objective Structure Clinical Examination</td>
</tr>
<tr>
<td>PAN</td>
<td>Private Area Network</td>
</tr>
<tr>
<td>PBL</td>
<td>Problem-Based Learning</td>
</tr>
<tr>
<td>PDA</td>
<td>Personal Digital Assistants</td>
</tr>
<tr>
<td>PELS</td>
<td>Patient Encounter Log Systems</td>
</tr>
<tr>
<td>PHR</td>
<td>Patient Health Record</td>
</tr>
<tr>
<td>PIM</td>
<td>Personal Information Management</td>
</tr>
<tr>
<td>PIN</td>
<td>Personal Identification Numbers</td>
</tr>
<tr>
<td>PIPEDA</td>
<td>Personal Information Protection and Electronic Document Act</td>
</tr>
<tr>
<td>PKI</td>
<td>Public key infrastructure</td>
</tr>
<tr>
<td>POC</td>
<td>Point of Care</td>
</tr>
<tr>
<td>RF</td>
<td>Radio Frequency</td>
</tr>
<tr>
<td>RSS</td>
<td>Reality Simple Syndication</td>
</tr>
<tr>
<td>SSH</td>
<td>Secure Shell, a network protocol that allows data to be exchanged using a secure channel between two networked devices.</td>
</tr>
<tr>
<td>SSL</td>
<td>Secure Sockets Layer</td>
</tr>
<tr>
<td>UOW</td>
<td>University of Wollongong</td>
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<tr>
<td>US</td>
<td>Ultrasonography</td>
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<tr>
<td>USB</td>
<td>Universal Serial Bus</td>
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<tr>
<td>VPN</td>
<td>Virtual Private Network</td>
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<tr>
<td>WAP</td>
<td>Wireless Application Protocol</td>
</tr>
<tr>
<td>WEP</td>
<td>Wired Equivalent Privacy</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organisation</td>
</tr>
<tr>
<td>Wi-Fi</td>
<td>Wireless Fidelity</td>
</tr>
<tr>
<td>WLAN</td>
<td>Wireless Local Area Network</td>
</tr>
<tr>
<td>XTND</td>
<td>Extend</td>
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Chapter I
Introduction

1.0 Background

Personal digital assistants (PDAs) have become a popular tool among physicians and medical trainees (Kho, Henderson et al. 2006). In the medical profession, PDAs are used for various purposes by healthcare professions and students (Kho, Henderson et al. 2006; Lindquist, Johansson et al. 2008). However most of these users are physicians, and the devices assist them in patient tracking, documentation, clinical decision making in order to decrease the number of adverse events and enhance their learning (Kho, Henderson et al. 2006; Lindquist, Johansson et al. 2008).

On the other hand, medical trainees indicate that medical text books, drug references and medical calculators are the most powerful software applications (Kho, Henderson et al. 2006). This is because such devices provide a powerful functionality for medical data management, which allows users to increase clinical knowledge (Kho, Henderson et al. 2006). PDAs are also used in formal classroom instruction, in specific classroom activities and in real clinical environments for reference lookup, patient education and electronic documentation (Kho, Henderson et al. 2006).

PDAs seem to be a valuable tool in both the medical profession and education. However, the appropriate PDA functionalities and influence factors for incorporating PDAs into problem-based learning (PBL)-medical curricula have yet to be evaluated and determined. Therefore there is a need to conduct a feasibility study for the incorporation of PDAs into a PBL-approach to medical education at the University of Wollongong.
1.1 Introduction to Relevant Issues to Study

Four major issues are related to this research, these being (i) PDA devices in general and their use in industry, (ii) PDA use in the medical profession and education, (iii) medical education using both traditional and problem-based learning (PBL) curriculum approaches and (iv) technology adoption in a PBL-medical curriculum.

1.2 Research Aim and Objectives

The aim of this research is to study the appropriateness and feasibility of incorporating PDAs into PBL-medical curriculum by using the Graduate School of Medicine (GSM) at the University of Wollongong (UOW) as a case study.

The three major objectives of this research are (i) to understand the appropriate PDA functionalities for a PBL-medical curriculum and (ii) to thereby understand the factors which may influence the incorporation of PDAs into a PBL-medical curriculum, and (iii) to thereby determine how PDAs can be incorporated into a PBL-medical curriculum.

Potential research regarding PDA use in the UOW PBL-medical curriculum

The literature review comprises four major aspects regarding PDA characteristics, PDA use in industry, PDA use in both the medical profession and education and a review of medical curriculum using both traditional and PBL-approaches. There are a number of medical schools in the US and UK that have already utilised PDA devices as a learning tool for students and medical faculty in studying and teaching medicine. However the appropriate PDA functionalities, factors for incorporating PDAs into a PBL-approach and specific strategy for the incorporation of PDAs into the PBL-medical
curriculum have yet to be specified. Therefore there is an opportunity to conduct a feasibility study into the incorporation of PDAs into a PBL-approach to medical education at the UOW. Thus there is a need to conduct this research in order to best utilize PDAs in a PBL-approach.

Therefore two major research questions are addressed in this study:

(1) What are the appropriate PDA functionalities for a PBL-medical curriculum?;

(2) What are the factors/aspects which may influence the incorporation of PDAs into the UOW PBL-medical curriculum?;

1.3 Contributions of this Study

The contributions to this study are threefold: (i) the basic PDA functionalities to facilitate medical study in PBL-approach, (ii) the factors/aspects to be considered for the deployment of PDAs into a PBL-medical curriculum, (iii) the feasibility of incorporating PDAs into a PBL-medical curriculum.

The significance of this study is related to a generic prototype for future deployment of PDAs into medical education using a PBL-approach. The outcomes of this study could be used as a guideline for deploying PDAs and appropriate functionalities into such medical education.

1.4 Organisation of the Thesis

The thesis chapters are organised into 5-major components (Figure 1.1), including introduction and literature reviews (Chapters I-III), conceptual framework (Chapter IV), research methodologies (Chapter V), the UOW PBL-medical curriculum (Chapter VI), and research outcomes and conclusion (Chapters VII-X).
Chapter I Introduction. The chapter introduces the background, relevant issues, aims and objectives, as well as the contributions of this study.

Chapter II PDA Overview and PDA use in industry. This chapter reviews and discusses the general characteristics of PDA devices, the general use of PDAs, and what PDA and functionalities have been used in the industry.

Chapter III PDA use in the Medical Profession and Education. PDA use in both the medical profession and education is reviewed and discussed in this chapter. The objectives of conducting these literature reviews are, firstly, to identify what PDA functionalities are being used by both the medical profession and education; secondly, to determine the different functionalities in these two areas; thirdly, to identify what PDA functionalities are being
used in other medical schools and for what purposes; fourthly, to determine the benefits, limitations and barriers of PDA use in both the medical profession and education; and importantly, to identify the issues to consider for PDA use in these two areas.

Chapter IV Conceptual Framework. A conceptual framework regarding PDA use in medical education in general is derived from the literature reviews in Chapters II and III. The chapter identifies PDA functionalities and relevant aspects for the incorporation of PDAs in general, based on the current use of PDA devices in both the medical profession and medical education in a general curriculum context.

Chapter V Research Methodology. The chapter introduces the approach and methods that were adopted to conduct this study in order to identify the appropriate answers to all research questions. The focus of this feasibility study is on social aspects (medical education professionals) and culture (in medical education) (Becker, Geer et al. 1977). Therefore a mixed-methods approach has been used for this study in order to seek knowledge, attitudes and experiences from the insights (depth) and general perception (breadth) of experts on particular aspects. The data collection was designed and conducted by using interviews and a web-based survey, and then analysed using Nvivo and SPSS applications, respectively. Internal and external validity were verified by using a triangulation approach (methods triangulations and data triangulation), together with generalisation.

Chapter VI The UOW PBL Medical Curriculum. The chapter reviews and discusses the context, structures and content of the UOW PBL-medical curriculum. Reviewing and understanding of the context and structure of the UOW PBL-curriculum is important, as it allows the researcher to identify opportunities for deploying PDAs in a PBL-context.
Chapter VII PDA Functionalities. The interview and web-based survey data regarding PDA functionalities are reported and discussed, respectively. The interview results are evaluated in the context of the literature review and conceptual framework, while the web-based survey results are compared to the interview results. These findings determine the specific PDA functionalities appropriate for a PBL-medical curriculum.

Chapter VIII IT Aspects. The interview and web-based survey data regarding IT aspects are also reported and discussed, respectively. The interview results are evaluated in the context of the literature review and conceptual framework, while the web-based survey results are compared to the interview results. These findings identify the important IT aspects to be considered before deploying PDAs in a PBL-medical curriculum.

Chapter IX Practical Aspects. In this chapter, the interview and web-based survey data regarding practical aspects are reported and discussed, respectively. The interview results are evaluated in the context of the literature review and conceptual framework, while the web-based survey results are compared to the interview results. These findings determine the important social aspects for incorporation of PDAs into a PBL-medical curriculum.

Chapter X Conclusion and Recommendations. The chapter summarises the answers to all research questions, including the appropriate PDA functionalities and aspects to consider before deploying PDAs into a PBL-medical curriculum. The chapter also summarises the limitations of this study and suggests future research directions.
Chapter II

Literature Reviews of Basic Features of PDAs
and PDA Use in Industries

2.0 Chapter Overview

The purposes of this chapter are threefold, firstly, to review the general features and characteristics of PDAs, including general hardware and software features and PDA platforms. Secondly, it is essential to understand the benefits, limitations and barriers of PDA use in general before deploying PDAs into any particular area. This would provide a basic foundation of PDAs and how to best utilise such devices for particular use. Finally, PDAs are one of many mobile computers, which were designed and used in any area whether for individual use or at the organisational level. Therefore, the final purpose of this chapter is to review the use of these devices in various industries as well as the benefits and limitations of such devices, including online media, cyber politics, engineering, business, agriculture, etc.
2.1 General Overview of PDAs

PDAs were first used in the 1990s (Laskin and Davis 2004; Fleet and Blandford 2005; Holubar and Harvey-Banchik 2007). Nowadays PDAs have become generic devices, which are commonly used in society in both a personal and professional sense because they are affordable and portable (Jansen and Ayers 2005). PDAs were derived from address books and calculators, and subsequently became tools which can be used as personal information management (PIM) systems, data entry and storage tools (Laskin and Davis 2004; Jansen and Ayers 2005).

2.2 PDAs

It is a fact that PDAs were originally developed to be used as calculators as well as electronic organisers, databases, spreadsheets and other basic software applications (Holubar and Harvey-Banchik 2007). PDAs originated from Palm, and later Microsoft gradually developed the PocketPC. Generally, the characteristics of PDAs can be discussed in terms of general hardware features, standard software features, different types of operating systems (OS) and other mobile technologies.

2.2.1 General Hardware Features

PDAs are approximately 6 ounces in weight with dimensions of only 3-inches wide and 4-inches high or about palm size. PDAs incorporate a display and keyboard into a single device with a built-in microprocessor. The screen display of PDAs comes in both colour and black and white flat-panel, similar to laptop computers with an energy-efficient mode. The display is essentially a touch screen. Therefore there are various ways for data entry approaches, namely touch screen using a stylus, attachable keyboard, touch-sensitive keyboard, voice recognition function and handwriting recognition.
Although PDAs have different approaches for data entry, there is no single data entry method that is appropriate for any large amount of data (Flanders, Wiggins et al. 2003; Laskin and Davis 2004). PDA memory is generally an energy-efficient memory chip. PDAs normally come with access port and software applications, which allow data to be synchronised between personal computers and PDAs (Flanders, Wiggins et al. 2003). Moreover, PDAs provide mobility, accessibility and capacity in accessing and storing information (Fleet and Blandford 2005).

2.2.2 General Software Features

The features of PDAs include internet access, simple e-mail client software applications, spreadsheet and database programs, word processing, digital camera, handwriting-recognition, display characteristics, wired- and wireless-networking capabilities, personal information management (PIM), decision support tool via remote access to educational materials, and to other information systems (Flanders, Wiggins et al. 2003; Fletcher, Erickson et al. 2003; Jansen and Ayers 2005). The general functionalities of PDAs are managing appointments, keeping contact details, sending and receiving email messages over wired or wireless networks, voice recording, viewing documents and receiving phone calls- a so called, “resource boundary management tool” (Laskin and Davis 2004; Fleet and Blandford 2005; Jansen and Ayers 2005). Nowadays, PDAs have the ability to process multimedia information, record digital audio or dictation, capture images and view audio files such as voice, images, sound and video (Laskin and Davis 2004; Jansen and Ayers 2005).

PDAs can synchronise the data back to either a desktop or laptop computer for backing up of files (Laskin and Davis 2004). PDA technology, therefore, is an emerging technology from organizer, pager, smartphone and
networking into a single device. Moreover PDAs are like a small size computer that can be carried in the pocket.

2.2.3 PDA Platform: Palm OS, Linux, PocketPC and Symbian OS

PDAs have various types of OS. Each OS supports different types of information and synchronisation protocols to the desktop computers. The three major OS are PalmOS, Linux and Microsoft PocketPC (James 2004; Jansen and Ayers 2005; Holubar and Harvey-Banchik 2007). Moreover the major categories of PDAs are Palm, PocketPC, PDA phones and Smart phones (Jansen and Ayers 2005). Smartphones that use Symbian OS are Nokia, Sony-Ericson and Motorola. However, there is a similarity between the devices which use Symbian OS and Microsoft OS. The following section describes the differences among PalmOS, Linux, PocketPC and Symbian OS (James 2004; Jansen and Ayers 2005). The use of mobile wireless devices is vulnerable to various threats, therefore mobile wireless devices threats and security issues are discussed in section 3.4.6.

PalmOS, Pocket PC and others

Although there are various types of PDAs nowadays, the majority are divided into three categories based on OS, these being PalmOS, PocketPC and others.

PalmOS

PalmOS was first used with a combination of electronic planner together with other additional functionalities (Laskin and Davis 2004; Fleet and Blandford 2005; Holubar and Harvey-Banchik 2007). PalmOS was first developed by the Palm group and utilised by the US Robotics Company for handheld computers. Later the company was owned by 3Com before establishing its own company, so called “Palm” (Holubar and Harvey-Banchik 2007). The
advantages of Palm over other OS are, firstly, it allows programming developers to build varieties of software applications on its OS. However, the majority of Palm software applications cannot be directly transferred and used in other computers without having them translated into the proper format for a PC. Therefore translator programs are necessary for data compatibility when transferring data from Palm to PC (Holubar and Harvey-Banchik 2007). Secondly, PalmOS requires a small amount of memory space as this OS have a small file size (Laskin and Davis 2004; Fleet and Blandford 2005). Moreover Palm PDAs normally have longer battery life than others. On the other hand, the limitation of PalmOS is the screen brightness. Palm also intensively consumes large memory space for certain applications involving multimedia files. Therefore it has difficulty in playing back any kind of multimedia files. PalmOS-based manufacturers are Palm, Sony and Handspring (Laskin and Davis 2004).

PalmOS is popular and easy to use. Many types of application software are available for PalmOS based-systems (Jahan, Gretter et al. 2002; Naylor 2002; Choi 2005). Another reason why PalmOS became the most popular is the price is less expensive than the PocketPC. Moreover PalmOS is widely used in the medical profession due to a large number of medical software applications being available compared with other PDA platforms (Fischer, Stewart et al. 2003; Busch, Barbaras et al. 2004; Lapinsky 2007).

PocketPC

The Microsoft Windows PocketPC operating systems was also established in late 1990s for handheld computers. This OS also includes Windows CE, PocketPC and Windows Mobile (Holubar and Harvey-Banchik 2007; Lapinsky 2007). PocketPC is another type of PDA that uses Microsoft Windows as the OS. Unlike PalmOS, PocketPC operating systems do not require translator programs when transferring data from handheld computers
to PC (Holubar and Harvey-Banchik 2007). The advantage of PocketPC over PalmOS is that it supports multimedia files and voice functions. The size of PocketPC is larger than Palm with less battery life (Busch, Barbaras et al. 2004). Various PocketPC manufacturers are iPaq from HP, and Compaq, Toshiba and Casio. Furthermore, some models of PocketPC are using PocketPC phone (Laskin and Davis 2004; Lapinsky 2007).

However, PocketPC requires more memory space and faster processor speed. This is the reason why the price of PocketPC is more expensive than PalmOS. PocketPC became less popular than PalmOS because of the limited software availability. Another drawback of PocketPC is its speed of operation as it requires many processing cycles to finish a simple task (Anonymous 2005c; Holubar and Harvey-Banchik 2007), and shorter battery life than Palm (Naylor 2002; Lapinsky 2007). PalmOS-based systems, therefore, become popular in medicine (Naylor 2002; Anonymous 2005c; Lapinsky 2007) even though the basic software applications for handheld computers are available in both PalmOS and PocketPC OS (Holubar and Harvey-Banchik 2007).

**Other operating systems for PDAs and other mobile technologies**

Other PDA platforms are Linux, Symbian, Epoc and Psion (Lapinsky 2007). However, there is another type of PDA, which is called “smartphone” or “PDA phone”, which are different from PDAs that use PalmOS or Microsoft Windows for PocketPCs.

**Linux**

Linux OS is used for a limited number of PDAs (Laskin and Davis 2004).
Symbian OS

Symbian OS is also known as EPOC which was created for Psion Series 5 PDA. The latest Symbian was written for ARM (Advanced RISC Machine) and StrongARM processors that have a processor speed more than 100 MHz. Such programs are stored on flash memory and read only memory (ROM) that can be upgraded later on. The threat of Symbian is maintaining code compatibility with other platforms. That is a major reason why third party developers face a steep learning curve (James 2004).

A good design of Symbian OS is that each software application can run on its own protection process. This may imply that it is unable to access other memory in the OS. A strong point of Symbian is that it cannot execute code of other devices. On the other hand, software installation packages can be installed via a PC suite by retrieving and opening from attachments (James 2004).

Blackberry is also one type of mobile phone, which has become popular with a number of doctors using this device in clinical settings (Lapinsky 2007). In addition, the Blackberry mobile phone is generally designed for mobile business users rather than general consumers. The functionalities of Blackberry are more towards phone, e-mail, Internet and short message services rather than supporting other software applications (Moses 2006). Therefore there is still an inadequate numbers of third party software applications which support Blackberry. Its price is still more expensive than other gadgets with equivalent specifications. Almost Blackberry phones have no Wi-Fi connectivity except for the newer model (Moses 2006).

Table 2.1 summarises the differences among the three categories of OS for PDAs and other OS being used for mobile technology.
Table 2.1 Differences between different platforms: Palm OS, Pocket PC, and other operating systems

<table>
<thead>
<tr>
<th>Traditional features</th>
<th>PalmOS</th>
<th>Pocket PC</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OS: memory-efficient (PalmOS consumes less memory space)</td>
<td>OS: memory consumption (size of Windows PocketPC OS is large therefore it requires more memory space)</td>
<td>Used for limited number of PDAs</td>
</tr>
<tr>
<td></td>
<td>Easy to access</td>
<td>Faster processor speed</td>
<td>Interface of SymbianOS is similar to PocketPC (Microsoft Windows)</td>
</tr>
<tr>
<td></td>
<td><strong>Device:</strong> cost-effective (PalmOS is less inexpensive than PocketPC systems)</td>
<td><strong>Device:</strong> more powerful, feature rich and expandable device.</td>
<td>Has limited number of medical software available (e.g. medical calculators, charge capture, drug database, reference, specialty)</td>
</tr>
<tr>
<td></td>
<td><strong>Software applications:</strong> many medical software applications available</td>
<td><strong>Software applications:</strong> has limited number of medical software availability</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Drawbacks:</strong> more complicated user interface, heavier and more expensive</td>
<td></td>
</tr>
<tr>
<td>Present features</td>
<td><strong>OS:</strong> richer features, more expandable</td>
<td><strong>OS:</strong> become lighter, user friendly interface</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Device:</strong> lighter weight, has expandable memory</td>
<td><strong>Device:</strong> more powerful, feature rich and expandable device.</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Software applications:</strong> many medical software applications available</td>
<td><strong>Software applications:</strong> has more number of software developer networks.</td>
<td></td>
</tr>
</tbody>
</table>
With different features from different OS, the choice of OS to use is generally based on user preferences, software applications and cost (Laskin and Davis 2004).

2.3 PDAs: Benefits, limitations and barriers

2.3.1 Benefits

Commonly, there are seven benefits (Table 2.2) of PDA devices based on their general use. These benefits are speed, cost and effectiveness of devices, memory capacity, connectivity, reliability, small size and light weight, portability and mobility of devices.

Speed. PDAs provide fast access to information via broadband mobile communication and accessibility (Hallam 2001; Cus-Babic, Rebolj et al. 2003; Fletcher, Erickson et al. 2003). The processor speed of PDAs becomes faster than older PDA models.

Cost-effectiveness. PDAs provide cost-effective communication (Hallam 2001; Fletcher, Erickson et al. 2003).

Memory capacity. PDA memory capacity is available as internal storage and storage cards for storing data (Cus-Babic, Rebolj et al. 2003).

Connectivity. PDA devices have the ability to connect to small area networks via Infrared or Bluetooth, and Internet connectivity via Wi-Fi (Cus-Babic, Rebolj et al. 2003).

Reliability. PDA devices are efficient and reliable tools for accessing information (Cus-Babic, Rebolj et al. 2003; Fischer, Crowell et al. 2005).

Small size, light weight, portability and mobility. PDAs are generally small as well as light weight, PDAs, therefore, provide portability and mobility for
users to carry and use anywhere, anytime (Cus-Babic, Rebolj et al. 2003; Fletcher, Erickson et al. 2003).

*Longer battery life.* Current models of PDAs generally have longer battery life than the older models (Shneyder 2002; Lu, Xiao et al. 2005). Table 2.2 summarises the benefits, limitations and barriers of PDA devices in general.

**Table 2.2** Benefits, limitations and barriers of PDAs

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Limitations</th>
<th>Barriers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed</td>
<td>Data entry</td>
<td>Compatibility</td>
</tr>
<tr>
<td>Cost-effective</td>
<td>Small-screen size</td>
<td>Negative bias in using PDAs</td>
</tr>
<tr>
<td>Memory capacity</td>
<td></td>
<td>Cost</td>
</tr>
<tr>
<td>Connectivity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reliability</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small size</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longer battery life</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 2.3.2 Limitations

The limitations of PDAs (Table 2.2) are generally speaking, difficulty in data entry, slow processing speed, poor battery life and small screen size. On one hand, the limitations of PDA devices were derived from the physical presence of the devices, for instance, having limited screen size would directly affect the size of screen to display and record information on the devices via stylus, free-hand writing or digital keyboard. On the other hand, other limitations of PDAs were dependent on the specification of devices from the manufacturers, for instance, processing speed, which would affect the battery life.

*Data entry.* Entering or recording data on PDAs by using stylus or free-hand writing could be troublesome for PDA users due to small screen (Cus-Babic, Rebolj et al. 2003; Mattana, Charitou et al. 2005).
Small-screen size. PDAs with small screen lead to the difficulty for inputting data while large screen could reduce portability and mobility of devices (Cus-Babic, Rebolj et al. 2003; Han, Olivier et al. 2008). However, small screen size can establish user privacy as the size of the screen can limit information to be displayed, which is difficult for others to view (Han, Olivier et al. 2008).

2.3.3 Barriers of using PDAs

Barriers of using PDAs (Table 2.2) refer to any factor which could impact on PDA use. Such impacts could delay or stop people from using PDAs for personal use or deploying PDAs at an organisational level. These barriers include compatibility of PDAs with software, hardware or network connectivity, negative bias of using PDA and cost of PDA devices, as well as the cost of deploying and incorporating PDAs into an organisation (Mattana, Charitou et al. 2005).

Incompatibility. Incompatibility of software, hardware and network connectivity could affect PDA use. For instance, problems with incompatibility among software, hardware or systems could arise while transferring data between PDAs and computers especially when using any particular software. Such incompatibility could impact the data transfer between two different devices (Mattana, Charitou et al. 2005).

Negative bias in using PDAs. Mattana, Charitou et al. (2005) indicated that having negative perception regarding PDA use could become a major barrier in deploying or using PDAs in any organisation.

Cost. Cost could be a factor in developing and implementing PDA applications and systems (Mattana, Charitou et al. 2005).
2.4 Use of PDAs in Industry

The development of mobile technology has dramatically changed since it was launched in the market. Surprisingly, PDAs are widely used in different industries for various purposes. For the clothing industry, future clothing technology will emphasise on wearable technology (Palomo-Lovinski 2008). Such technology is generally referred to as mobile technology, which provides the wearer with full mobility while wearing or using it for their daily activities without interfering with their work, these being PDAs, mobile phones or mobile computers (Palomo-Lovinski 2008). In addition, PDAs are popular with a number of users, for instance, healthcare providers, engineers, assembly line workers, etc. (Palomo-Lovinski 2008). The use of PDAs and other mobile technologies facilitate people in obtaining and providing information, understanding and being understood within a group or community (Fox, Andrews et al. 2008). There is evidence that the use of PDAs can be applied to various industries from online media, cyber politics, engineering, business, agriculture, navigator, education, general industries, etc. (Table 2.3).

Table 2.3 PDA use in different industries

<table>
<thead>
<tr>
<th>Industries</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Online media</td>
<td>Search tool, communication tool</td>
</tr>
<tr>
<td>Cyber politics</td>
<td>View blueprints, mark-up design change, on-site project document enquiries</td>
</tr>
<tr>
<td>Civil engineering</td>
<td>Internet access, access to reference resources, classroom assessment and evaluation, special education, communication tool with peers, collaborators and participants and educational tool for research</td>
</tr>
<tr>
<td>Educational tool</td>
<td>Generating reports describing business performance</td>
</tr>
<tr>
<td>Business</td>
<td>Accessing market price information</td>
</tr>
<tr>
<td>Agriculture</td>
<td>Mobile guide terminal for visually impaired pedestrian</td>
</tr>
<tr>
<td>Navigator</td>
<td>Health providers, engineer, assembly workers, restaurant business</td>
</tr>
<tr>
<td>General industries</td>
<td></td>
</tr>
</tbody>
</table>
**Online media.** In online media, PDAs are used for receiving electronic newspaper in term of content and distribution with Really Simple Syndication (RSS) feeds (Beyers 2004). Further, PDAs were also used as an electronic search tool on the internet (Han, Olivier et al. 2008). In the case of PDA phones, they can be used as a communication tool. PDA phone users generally use the devices to facilitate their daily work and to communicate with others, including making phone calls, downloading data from the internet, sending text and multimedia messages, etc (Wilson and Thang 2007).

**Cyber politics.** For border security or immigration control at airports, PDAs are used for tracking individual citizen demographic information from daily updated citizen individual data (Gronbeck and Wiese 2005).

**Engineering.** In engineering, the use of PDAs has been incorporated into the engineering field. For instance, PDAs with GPS (Global Positioning System) technology were used for facilitating roadway workers in civil engineering (Roth, Multer et al. 2006). The devices enable the workers to receive real-time and accurate information regarding territory status information and receive work authorisation from dispatchers as well as communicate among roadway workers in different locations (Roth, Multer et al. 2006).

In civil engineering, PDAs can be used in a construction project for wireless data transmission, network-based document management systems, recording project data (e.g. supply delivery records, progress updates, project management systems, project financial management, etc.) (Cus-Babic, Rebolj et al. 2003).

Six-benefits of using PDAs in civil engineering were found. Firstly, it decreased task redundancy in project operation. Secondly, it decreased responding period regarding project tasks. Thirdly, it decreased task revision. Fourthly, PDA use in civil engineering facilitated in maintaining construction
standards and also enhanced the flow of information. Fifthly, PDAs also provided simple document management. Finally, PDA use in civil engineering also enhanced quality of project management and the ability to accomplish project on time (Cus-Babic, Rebolj et al. 2003).

In civil engineering, drawing software application is essential for viewing blueprints, mark-up design changes, on-site project document queries and synchronisation via PDAs, for instance, AutoDesk’s OnSite View (Cus-Babic, Rebolj et al. 2003).

Business. In the business sphere, PDAs have been used to generate reports describing business performance (Fletcher, Erickson et al. 2003).

Agriculture. PDAs and other mobile technologies have been used in agriculture for farmers to access market price information via mobile internet, wireless application protocol (WAP) or text message (Anonymous 2006).

Navigator. Mobile prototypes of guided terminal for visually impaired pedestrian by using PDA or 3G mobile phone (Garaj, Jirawimut et al. 2003; Han, Olivier et al. 2008).

Educational tool. PDAs have been used in education not only for learners but also educators and parents for recording diary, daily log-keeper, contact information, for instance, college students, university employees, school teachers and mothers with preschool children (Fu 2007). Spelman (2002) indicated that PDAs are used as learning portfolios to record students’ learning progress, as well as study plans in English language courses for non-English speakers. Generally, the impacts of PDA use in education are: firstly, PDAs facilitate students in learning anywhere and anytime; secondly, PDAs provide new technology in education; thirdly, PDAs change the concept of learning from classroom environments to virtual classroom environments;
finally, PDAs also provide flexible contact between educators and learners (Arun and Teng Yap 2000).

**General industry.** PDA use occurs in general industry in terms of wearable gadgets (Palomo-Lovinski 2008). Wearable computers impact technology use for instance, for healthcare providers, engineers, assembly workers and any person who needs access to information while on the fly (Palomo-Lovinski 2008).

Further, PDAs and other mobile computer are used for educational purposes, for instance, *internet access, access to reference resources, classroom assessment and evaluation, special education, communication with peers, collaborators and participants, and educational tool for research,* (Fletcher, Erickson et al. 2003; Voithofer 2005; Oishi, Koo et al. 2008). The following are the examples of how PDAs are used in education.

Oishi et al. (2008) used PDAs as a data gathering tool for a quick survey to study the difference regarding the culture, interpersonal perceptions and happiness in social interaction among European Americans, Asian Americans and African Americans.

PDA-based *classroom assessment and evaluation* had been used in high schools in South Africa (Palen, Graham et al. 2008). PDAs were also used in other evaluation in medicine, dentistry, college for daily report and alcohol use in the community (Palen, Graham et al. 2008).

In addition, PDAs are recommended to be used in *special education* for assisting students in higher education or career-technical education (Abell, Bauder et al. 2005; Dukes, Shaw et al. 2007) and for facilitating students with Asperger syndrome in recording homework and reminders for daily activities (Smith Myles, Ferguson et al. 2007), for example, essay organisation, word
prediction for spelling difficulties (Dukes, Shaw et al. 2007), to-do-list, schedule, organiser (Smith Myles, Ferguson et al. 2007).

Abell, Bauder et al. (2005) also indicated that the use of PDAs in either general or special education is beneficial for both educators and learners in accessing online information, in particular when implementing an online curriculum.

Smith Myles, Ferguson et al. (2007) indicated that PDA use in special education is compatible for students with Asperger Syndrome, as PDAs provide organising functions which assist students to manage their daily activities, time table and school activities. In special education, PDAs can support students in their learning environment, as such devices assist students to be independent learners, as well as to be less dependent on teachers and other educational professionals (Smith Myles, Ferguson et al. 2007).

Research tool. PDAs have been used as data collection tools in a number of evaluation researches, for instance, level of condom use in the community (Fletcher, Erickson et al. 2003; Palen, Graham et al. 2008). PDAs have proved to be a useful data collection tool in conducting research as they are generally small enough to carry. PDA devices provide portability, functionality and ease of use for data collection while offsite besides in an office or laboratory environment (Fletcher, Erickson et al. 2003). Further, PDAs are an effective data collection tool as they generate less or no missing data (Fletcher, Erickson et al. 2003).

Robotic research. PDA has been used as a robotic controller for testing and optimising a physical simulation of the walking machine to perform various actions, for instance, exploring the environment, avoiding obstacles, or escaping from deadlock circumstances (Manoonpong, Pasemann et al. 2007).
The benefits of using PDAs as data collection tools in research are twofold. Firstly, the data can be stored safely. Secondly, it is cost-effective in terms of the data collection process. PDAs provide data safety—using PDAs as data collection tool in research generates minimal missing data as data being entered on PDAs are tied with programming for required data fields, therefore the chance of having unrecorded data is very rare (Fletcher, Erickson et al. 2003). However, data can be lost in the case of memory failure, program malfunction or loss of battery (for old PDA model) (Fletcher, Erickson et al. 2003).

2.4.1 Benefits of PDAs in industry

There are a number of benefits regarding PDA use in various industries. These benefits (Table 2.4) reflect how PDAs are being incorporated into different workplaces.

**Table 2.4 Benefits of PDA use in industry**

<table>
<thead>
<tr>
<th>Benefits of PDA use in Industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information sharing</td>
</tr>
<tr>
<td>Portability and mobility</td>
</tr>
<tr>
<td>Cost saving</td>
</tr>
<tr>
<td>Convenient</td>
</tr>
<tr>
<td>User friendly</td>
</tr>
<tr>
<td>Time-saving</td>
</tr>
<tr>
<td>Provide immediate data validation</td>
</tr>
<tr>
<td>Accurate, reliable and consistent</td>
</tr>
<tr>
<td>Consume less manpower for data collection</td>
</tr>
<tr>
<td>Communication tool</td>
</tr>
</tbody>
</table>

*Information sharing.* The use of PDAs in industry allows information to be shared over the network connectivity. For instance, the majority of PDAs, PDA phones and other mobile computing technology have the ability to
provide dynamic conversation sharing via the internet (Abell, Bauder et al. 2005; Thomas 2006).

Moreover, for education, the benefit of using PDAs in terms of information sharing is exchanging and sharing lectures notes and learning resources among peers by direct beaming to peers’ devices (Abell, Bauder et al. 2005). Moreover, any free-learning resources can also be downloaded from the internet (Abell, Bauder et al. 2005). PDAs facilitate students in sharing information, collaborating and support among peers (Abell, Bauder et al. 2005).

Portability and mobility. PDAs provide portability and mobility of information, which are beneficial once PDA devices are deployed and used in various industries (Swarts 2006). For example, PDAs are portable for note taking (Abell, Bauder et al. 2005; Swarts 2006).

Cost- and time-saving. PDAs are affordable (Abell, Bauder et al. 2005). Further, in the education sphere, using PDAs could reduce cost in classroom assessment and evaluation (Abell, Bauder et al. 2005; Palen, Graham et al. 2008). PDA-based assessment require less time for participants to complete than paper-based assessment (Fletcher, Erickson et al. 2003; Palen, Graham et al. 2008).

Convenient. PDA provides ease of use in the sense that the devices are enjoyable in conducting classroom assessment and evaluation (Palen, Graham et al. 2008). Further, in special education, the devices can be used as communication tools between parents and teacher, which is beneficial for parents in term of monitoring their children’s learning progress (Abell, Bauder et al. 2005).

User friendly. PDAs provide a user friendly interface (Palen, Graham et al. 2008).
Provide immediate data validation. For research, data which has been gathered via PDAs can be immediately used for data analysis without re-entering to the computer. The data is directly available for data analysis (Fletcher, Erickson et al. 2003; Palen, Graham et al. 2008). In education, educators and learners receive a number of benefits from using PDAs for self-recording of grades, learning outcomes and monitoring students’ learning progress (Abell, Bauder et al. 2005).

Accuracy, reliability and consistency of information. Data being gathered from PDAs is more accurate and consistent than paper-based tools, as the latter tend to generate more errors and missing data (Fletcher, Erickson et al. 2003; Palen, Graham et al. 2008). Moreover, using PDAs as a data collection tool in research provides reliable data entry while using in the field (Fletcher, Erickson et al. 2003).

Consume less manpower for data collection. Using PDAs as a data collection tool in assessment and evaluation research could save manpower in converting paper-based data to computer-based data for further data analysis (Fletcher, Erickson et al. 2003; Palen, Graham et al. 2008).

2.4.2 Limitations of PDAs in industry

The limitation of PDA use in industry is more toward setup cost. Palen, Graham et al. (2008) indicated that in assessment and evaluation research using PDAs as the data collection tool, the setup cost is generally more expensive than paper-based data collection. However, it is cost-saving in terms of economy of scale if assessment and evaluation are repeated in different populations (Palen, Graham et al. 2008).

Generally, there are three major aspects to be considered before incorporating PDAs into any industry. These aspects are (i) ease of use, (ii) benefits of using PDAs in particular industry, and (iii) compatibility of PDAs to personal
or daily activity and life styles (Fox, Andrews et al. 2008). This is because the devices could affect the social activity and human interaction among each other (van Dijck 2008).

2.5 Chapter summary

PDAs are mobile devices which can be incorporated into any area in different industries. The benefits, limitations and barriers of PDA use are similar to each other even though PDAs are used in different industries. The purposes of PDA use could affect to the selection of PDA platforms, functionalities, network connectivity, security and other relevant technical aspects. According to PDA platforms, there are general features of PDAs to consider before deploying a particular PDA platform into an organisation for daily activities, these being size, central processing (CPU) speed, screen resolution, device memory, expansion capacity, network connectivity and cost. However, the most important PDA features for the incorporation of PDA use into medical education in a PBL-approach are more toward expansion capacity, screen resolution, small size and light weight therefore devices can provide the portability and mobility for users. Further the solution for selecting a particular technology should be based on the minimum requirements, purpose and standards of areas being applied.

According to the literature, PDAs have been used in various industries, and can be applied to the UOW-PBL medical curriculum as following.

Firstly, the use of RSS feeds for content distribution from online media can be applied to the UOW-PBL medical curriculum for educational purposes, for instance, school time tabling, school events, clinical skills schedule.

Secondly, what PDA users and medical school need to aware of are the security of PDA devices and data being stored on PDAs, especially before encountering border security as part of cyber politic. For instance, all
computers and mobile devices can be seized by border security officers before crossing the US border. Therefore it is possible that the privacy of information can be released, especially patient information, personal information, financial data, banking account, research data, etc. Hence, users need to be aware of possible security breaches during travelling.

Thirdly, the use of PDAs with GPS technology in civil engineering can be applied to medical education, particularly when students are dispersed into clinical placement around NSW. This would provide the opportunity for the medical school to track where students are while offsite.

Fourthly, the design of wearable technology in general industry could facilitate PDA use in healthcare, medical professionals as well as medical education. This is because the effectiveness and efficiency of PDA use is not only dependent on functionality and device features but also how it could be used and wear without inflexible movement and obstructed their daily activities especially in clinical placement.

Lastly, there are various PDA functions which have been generally used in education. Such functions can be applied to medical education, these being recording diary for daily activities, daily log, contact information of peers, clinicians, clinical preceptors and medical faculty. Other PDA uses in education can be applied to medical education, these being (i) accessing reference and information from the internet, (ii) communicating with others, classroom assessment, classroom evaluation, (iii) recording reminders and scheduling tasks, and (iv) gathering and collecting data for research.

Chapter III is a literature reviews of PDA use in healthcare and the medical profession. This chapter provides the basic foundation for researchers to better understand the use of PDAs, functionalities, barriers and issues around the incorporation of PDAs in healthcare and the medical profession.
Chapter III
PDA Use in Healthcare and the Medical Profession

3.0 Chapter Overview

This chapter reviews the literature regarding PDA use in healthcare and the medical profession. The purposes of conducting literature reviews in both areas are threefold: firstly, to better understand the use of PDAs in such areas; secondly, to identify the PDA functionalities, benefits, limitations and barriers of PDA use, as well as other issues in relation to the incorporation of PDAs in healthcare and the medical profession; and finally, to formulate a basic understanding of PDA use and their functionalities in real practice, in particular the medical profession.

The outcomes of the literature reviews from this chapter will assist us to determine and evaluate the differences between PDA use and their functionalities in these areas, in particular the medical profession and medical education in a later chapter. Further, the context of PDA use in medical education is discussed in this chapter.
3.1 Use of PDAs in Healthcare and Medical Professions

The major PDA functions were firstly designed for executive use, in order to replace paper. Handheld computers can elevate notes, tasks, to-do lists, daily plans and reminders for any appointments. Such devices have become popular in different fields, especially healthcare, clinical areas, and also in medical education (Alvarez 2002).

Normally, PDAs are small computers, which are widely used as electronic organizers and similar purposes. To effectively use PDAs in any healthcare organisation, they need to be integrated into the healthcare organisation systems and connected into a network for communication and data sharing (Turner, Milne et al. 2005).

Most physicians use PDAs at the point of care (POC) to access drug information (checking drug interactions), clinical references and clinical information (Jerant 1999; Carroll and Christakis 2004; Mattana, Charitou et al. 2005; Stroud, Erkel et al. 2005) for clinical decision support, prescribing medication, ordering additional clinical tests, viewing lab results wirelessly, and tracking patient records, exchanging information between physicians during changing wards, (Jahan, Gretter et al. 2002; Larkin 2003; Carroll and Christakis 2004; Mattana, Charitou et al. 2005; Turner, Milne et al. 2005; Cricelli 2006; Jotkowitz, Oh et al. 2006). There are a number of standard software applications available for such usage (Fischer, Crowell et al. 2005; Martins and Jones 2005). Doctors, therefore, feel that references are a useful PDA function in their profession (Fischer, Crowell et al. 2005).

For instance, paediatricians use PDAs to enter and access patient data at remote locations or POC (Carroll and Christakis 2004; Mattana, Charitou et al. 2005). Frequently used software applications in the medical profession are
pharmacopoeias, medical reference and clinical calculators (Jotkowitz, Oh et al. 2006).

PDAs have been used in various clinical placements, for instance, the Canadian intensive care unit, for wireless data transmission between the clinical staff. Moreover, pen-based PDAs were implemented in a pilot study for clinical data capturing in Glasgow, UK (Turner, Milne et al. 2005). In addition, Anaesthesiologists use PDAs for accessing related references (Jerant 1999), medical calculator, charting within wards, billing and record keeping of patient information (Jahan, Gretter et al. 2002).

Further, clinical workflows, clinical information and diagnosis information cannot be practically accessed during the medical visits by medical and nursing staff at the patients bedside or in emergency situations (Andrade, von Wangenheim et al. 2003a). Such situations can be improved by integrating the use of handheld computers with a wireless network connection to central servers in order to provide data accessibility at the patient’s bedside (Andrade, von Wangenheim et al. 2003a; Jotkowitz, Oh et al. 2006). The advantage of this system is that it allows medical and nursing staff to access medical images, clinical encounters and medical findings via handheld computers using a web-based interface (Andrade, von Wangenheim et al. 2003a; Jotkowitz, Oh et al. 2006). The systems are also compatible with other systems, therefore integration is possible (Andrade, von Wangenheim et al. 2003a).

PDA use in healthcare and the medical profession is beneficial to these professions as PDAs provide speed and convenience in accessing information with wireless network connectivity. Further, PDAs also provide mobility for doctors and healthcare workers in accessing information without disturbing their daily activities, for instance, the devices provide the ability to access information anywhere and anytime (Martins and Jones 2005).
There has been growth in using PDAs in the medical profession due to their portability, ease of use, information accessibility, data storage capacity and mobility in accessing data at patient bedsides (Holubar and Harvey-Banchik 2007; Yu, Houston et al. 2007). To date, PDAs have been used in different areas in medicine, for instance, surgical, clinical nutrition, homecare, etc. (Holubar and Harvey-Banchik 2007; Yu, Houston et al. 2007).

Yu, Houston et al. (2007) indicated that 40 percent of US physicians use PDAs in their clinical settings for accessing references and medical calculators. There is evidence that PDA use in the medical professions can decrease the number of medical errors and develop quality healthcare (Holubar and Harvey-Banchik 2007; Yu, Houston et al. 2007). On the other hand, the physician trainees tend to use PDAs for administrative work, date-book, daily planners and PIM rather than accessing medical references (Holubar and Harvey-Banchik 2007; Yu, Houston et al. 2007).

Moreover, handheld computers have been used for clinical decision making and e-learning in medical education, as they can provide a user friendly interface and multimedia tools enabling students to learn at their own pace (Larkin 2003; Nyun, Aronovitz et al. 2003). Nyun and Aronovitz (2003) indicated that using Palmtop-based devices in patient safety curriculum as an educational tool has a high degree of acceptance from clinicians and students. At present, there are many medical schools that use PDAs in medical education, for instance, the Department of Family Medicine, University of Rochester, which started using PalmOS-based PDAs in 2000. At Rochester, it is compulsory for all medical residents to use PDAs for their learning (Anonymous 2005c). Further, there are several reasons why PDAs are used in medical and nursing professions.

Firstly, PDAs provide speed for data collection and data analysis (Jao, Hier et al. 2003). Secondly, PDAs are becoming widely used for educational
purposes, which are reviewed and discussed later in this chapter. In addition, there are many studies that have looked at why medical and nursing schools include PDAs in their education and training program (Masys, Brennan et al. 2000; Lopez, Kolecki et al. 2004; Mays and Boston 2004; Anonymous 2005b).

3.2 PDA functionalities in healthcare and the medical profession

PDAs are used in healthcare and the medical profession by various professionals, including physicians, nutrition clinicians, pharmacists, care-workers, etc. Physicians, however, seem to be the largest groups who use and incorporate PDAs into their work and daily activities. On the other hand, the current standard care and practice in nursing is becoming accessible via handheld computers or PDAs.

In addition, PDAs are used for keeping up-to-date with medical literature, implications for medical education, accessing clinical guidelines and evidence-based medicine (EBM) (Cricelli 2006). PDAs can be used in accessing relevant information with regard to clinical decision making, tracking clinical encounters, checking curriculum and using as a contact book (Cricelli 2006).

In brief, PDAs are generally used for four major functions in healthcare networks (Table 3.1). Those functionalities are for PIM or general software applications, referencing, special functions for clinical works and administration and communication functions.
Table 3.1 A summary of PDAs functionalities in healthcare and the medical profession

<table>
<thead>
<tr>
<th>Functions</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PIM</strong></td>
<td>Address book, calendar, Diary/Personal Organizer</td>
</tr>
<tr>
<td><strong>Reference</strong></td>
<td>Quick reference, e-book, e-textbooks: e.g. 5-Minute Consult, 5-Minutes Pediatric Clinical Consult, Harrison’s Principles of Medicine, Redbook 2000, Tarascon Pharmacopoeia, Cline, respiratory condition, pharmaceutical databases, EBM, electronic databases, Handlogo, ICU, Electrocytes and Nutrition, Skyscape, Clinical PDA Solutions, Merck Manual, Pediatric RedBook MedHand’s software, Franklin e-publishers, UpToDate, etc. Drug references and drug databases: e.g. Epocrates Rx, the Johns Hopkins Antibiotic Guide, Physicians’ Desk Reference, Micromedex, mobileMicromedex, Lexi-Comp’s On-Hand, The Sanford Guide, A2Zdrugs, LexiDrugs, iFacts, ABX guide, the Lothian Drugs Formulary, e-MIMS, pock pharmacopoeia Prescribing drugs: e.g. Dr.First’s Rcopia, ZixCorp’s PocketScript, Caremark’s iScribe, ePhysician Electronic databases: e.g. the National Library of Medicine, MEDLINE, PubMed for Handhelds, pharmaceutical database Clinical guidelines: e.g. the American Diabetic Association Clinical Practice Recommendations, the Obesity Guidelines by the National Institutes of Health, guideline material, etc.</td>
</tr>
<tr>
<td><strong>Special functions for clinical works and administration</strong></td>
<td>Clinical assessment: e.g. Dietary assessment tool during clinical encounters</td>
</tr>
<tr>
<td></td>
<td>Decision support tool: e.g. MedDecide, MedWarrior, OPNET Patient care Electronic health regards (EHR) Patient tracking &amp; patient management: e.g. StatCom, PatientKeeper, PatientTracker, WardWatch, Mutual software, MedAmerica Mutual software, HandEchart Medical calculators: e.g. MedMath, MedCalc, MedRules, ICUMath, Kidometer, MedTools, Framingham calculator, ABG Pro, Pregnancy Wheel, Pregnancy Calculator, etc. Database programs: e.g. Pendragon’s forms, HandDbase, JFile Ordering clinical test and viewing clinical data (test results): e.g. lab results, clinical test, radiology images, CT or MRI scan Recording medical notes &amp; formulating referral letters: e.g. Dragon Naturally Speaking software Software applications for nutrition clinician: Dietary management, Medical nutrition Other applications for General healthcare and medical professionals (e.g Physicotherapist) Patient education: document, audio, PodCast, video stream, live-PodCast, document forms or Nutrihand Education and research: e.g. students log function, research tools, Pendragon Other functions: e.g. Anthropometric, Biochemical, DocAlerts, health monitoring, Mobile CME, MP3 player, entertainment, body area network</td>
</tr>
<tr>
<td><strong>Communication</strong></td>
<td>E-mail, billing, cell-phone technology Patient communication: e-mail, short messages, reminders</td>
</tr>
</tbody>
</table>
**Personal information management function**

*PIM function* include address book/phone book, calendar, memo and e-mail, which doctors and clinical users can use to keep contact information and appointments (Criswell and Parchman 2002; Jahan, Gretter et al. 2002).

**Address Book.** Address book is used in keeping the resident, fellow faculty, pharmacy, local hospital, laboratory and specialists contact numbers (Criswell and Parchman 2002; Jahan, Gretter et al. 2002; Lewis and Sommers 2003; Briggs 2004; Sargeant 2005; Anonymous 2005c).

**Calendar.** Calendar is used as a planner for important dates, meetings and personal scheduling (Criswell and Parchman 2002; Jahan, Gretter et al. 2002; Lewis and Sommers 2003; Carroll and Christakis 2004; Sargeant 2005; Anonymous 2005c).

**Diary/Personal Organizer.** The electronic diary can be used as a clinical diary for recording any clinical treatment, for instance, recording diabetes mellitus and glycaemia control for patients in certain cases (Jahan, Gretter et al. 2002; Sargeant 2005; Kitchiner 2006). Moreover paediatricians use PDAs for office management (Carroll and Christakis 2004; Stroud, Erkel et al. 2005).

**Reference**

Reference resources for PDAs and other mobile computers seem to be the most important functionality for healthcare and medical professionals as this function provides convenient and immediate access to resources anywhere and anytime, especially with internet connectivity. *Referencing software applications* enable physicians to access clinical information. Further, frequent referencing software include *e-textbooks, 5-Minute Consults, Harrison’s Principles of Medicine, Redbook 2000, Tarascon Pharmacopoeia* and *Cline.* These references are used by both physicians and medical students.
as they can access them without carrying textbooks. Another example is electronic prescription, which can be done via PDAs (Jahan, Gretter et al. 2002; Lin and Vassar 2004; Kitchiner 2006).

On the other hand, another example of PDA use in the medical profession is that nutrition clinicians use PDAs for accessing various references in relation to nutrition information for their patients. Further, veterinary schools and hospitals incorporate PDAs for veterinary study as well as in teaching hospital (Swarts 2006). Clinical references, clinical procedures and any necessary comprehensive databases are also incorporated for both educators and learners in a veterinary teaching hospital for year-4 students in their clinical rotations, including anesthesia, cardiology and similar (Swarts 2006).

Medical textbooks

Medical books and textbooks (Fischer, Crowell et al. 2005; Holubar and Harvey-Banchik 2007) are also available in electronic format (see e-textbooks in Table 3.1) (Criswell and Parchman 2002; Fischer, Stewart et al. 2003; Lewis and Sommers 2003; Al-Ubaydli 2004; Carroll and Christakis 2004; Stroud, Erkel et al. 2005; Anonymous 2005c; Kitchiner 2006; Charney 2007; Holubar and Harvey-Banchik 2007; Lapinsky 2007). Medical textbooks for PDAs are also available in particular areas, for example, anatomy, neurology, respiratory condition, intensive care unit management, etc. (Naylor 2002; Martins and Jones 2005; Lapinsky 2007; Levy 2008). Moreover, Pocket Acrobat Reader allows medical doctors to read any up-to-date journal articles directly from PDAs (Turner, Milne et al. 2005).

EBM software applications

EBM applications are used to improve the contribution of the EBM via Internet connectivity, for instance, the University of Toronto provides EBM application software for PDAs (Al-Ubaydli 2004; Sargeant 2005).
Drug reference software applications

Drug reference software applications are popular in clinical medicine, for instance, drug dosage or drug information specialists and pharmaceutical databases (drug database) (Fischer, Crowell et al. 2005; Martins and Jones 2005; Holubar and Harvey-Banchik 2007; Yu, Houston et al. 2007; Levy 2008). Pharmaceutical database is a drug reference software application, which provides drug guidelines for supporting prescription decisions and providing a reference for medication (Martins and Jones 2005; Holubar and Harvey-Banchik 2007). Drug databases are significant software applications for both nurses and doctors to look-up medications and useful for prescribing medications.

For example, PDAs are used by physicians for prescribing drugs via Palm Pilot, Handspring, Jornada, Cassiopeia or iPAQ (Martins and Jones 2005; Pizzi, Suh et al. 2005; Holubar and Harvey-Banchik 2007; Levy 2008). Moreover, physicians also use either PDAs or smartphones to issue electronic drug prescriptions, which are available from various software providers (see prescribing drugs in Table 3.1) (Lewis and Sommers 2003; Carroll and Christakis 2004; Anonymous 2005c; Holubar and Harvey-Banchik 2007). These software applications also allow the user to keep track of dosages, amounts and refills of the medication for each patient. Such software applications should be available when needed (Lewis and Sommers 2003).

The majority of PDA users in healthcare and the medical profession use the drug reference software applications to assist their daily work (Criswell and Parchman 2002; Stroud, Erkel et al. 2005; Turner, Milne et al. 2005).

The applications, which are normally used in medicine, are Epocrates Rx and the Johns Hopkins Antibiotic Guide, as these are widely used not only in the medical profession but also by medical students, residents, medical assistants, dentists, pharmacists, etc. (Fischer, Crowell et al. 2005; Lu, Xiao et al. 2005;
Drug references and drug interactions, however, are different in each country, in particular the drug names that are used differently in the US, Australia and New Zealand. In addition, Australia and New Zealand can possibly use e-MIMS for PDAs whereas many different choices of such software applications are available in the US (Kitchiner 2006).

The benefits of using drug references for PDAs are threefold. Firstly, it provides portability in accessing drug information, drug interactions at hand rather than carrying a handbook of drug information. Secondly, drug reference software applications for PDAs also provide other useful information besides drug information, these being, drug interaction and incompatibility of medication. Finally, the majority of drug reference software applications for PDAs support live update once PDAs are synchronised with network computers. These allow the list of drugs to be updated with the recent medications, interactions, dosing information or even taken out from its reference in case of being obsolete. Therefore healthcare and medical professionals can access the most up-to-date and accurate information at all times (Holubar and Harvey-Banchik 2007).

**Electronic databases**

Electronic databases can be accessed through Internet sites, internet search tools, for instance, the National Library of Medicine (NLM) (www.nlm.nih.gov/mobile), MEDLINE, PubMed for Handhelds (Fischer, Crowell et al. 2005; Holubar and Harvey-Banchik 2007).
Clinical guidelines

There are a number of clinical guidelines, which are available in PDA format (Levy 2008) (see list of clinical guideline in Table 3.1). The majority of clinical guidelines are available in PDF format, which can be viewed by Adobe Acrobat reader for personal computers on PDAs or Mobipocket (Holubar and Harvey-Banchik 2007). On the other hand, such guidelines can be viewed by using web-browser applications if created in html format, for instance, iSilo or iSiloX (Holubar and Harvey-Banchik 2007). Using html viewers is convenient for healthcare or medical professionals in accessing any frequently used clinical guidelines (Holubar and Harvey-Banchik 2007). In addition, junior doctors are the majority users of accessing clinical guidelines, as they can be accessed wirelessly and directly via PDAs, for instance, therapeutic guidelines (Turner, Milne et al. 2005; Kitchiner 2006).

Special software applications in other areas

Special software applications are used in various areas, including emergency department operations, order entry, POC, clinical trials, charge capture, information capture and decision support information access (Lin and Vassar 2004). Examples of other special software applications are patient tracker, tracking lab results, and managing patient databases. The majority of these software applications are compatible with both Palm and PocketPC (Lin and Vassar 2004).

Clinical assessment

PDAs have been used by doctors as clinical assessment guidelines for patients’ eating and smoking habits during clinical encounters (Cohen, Leviton et al. 2006). Physicians also use PDAs as data collection tools during clinical encounters (Fletcher, Erickson et al. 2003; Martins and Jones 2005).
Clinicians use PDAs to gather, enter and store data at the POC, later the data can be uploaded to a central computer. Clinicians also use PDAs for recording patient information, patient logs, clinical hours, clinical reports and clinical references (Stroud, Erkel et al. 2005). Moreover PDAs are widely used in many department units in a hospital, for instance, emergency medicine residency training programmes for recording patient care exposure and follow-up procedures, etc (Mattana, Charitou et al. 2005). Therefore using PDAs in clinical practice can assist doctors and clinical residents in accessing and managing information (Al-Ubaydli 2004).

**Decision support tool**

PDAs are used as clinical decision support tools for patients’ diet at POC (Martins and Jones 2005; Cohen, Leviton et al. 2006), and adherence to cholesterol clinical practice guidelines (Wenzel, Goff et al. 2007). One example of a decision support tool application for PDAs is *MedDecide*. *MedDecide* is a set of clinical predication rules which was developed using Satellite Forms™ (Yu, Houston et al. 2007). Diagnosis systems for PDAs are generally an expert system which assists doctors in diagnosing patients (Vouyioukas, Maglogiannis et al. 2007). Example applications are *MedWorrior and OPNET* (Vouyioukas, Maglogiannis et al. 2007; Yu, Houston et al. 2007).

**Electronic health records**

An electronic health records (EHR) or clinical data comprises an individual; health information, which may contain clinical testing regarding radiology, discharge orders, medications and other related health information. For instance, healthcare and medical professionals use PDAs for retrieving or tracking lab results, clinical test results, radiology images, X-ray, computerized tomography (CT), ultrasonography (US), magnetic resonance
images (MRI) scans, and endoscopic images (Martins and Jones 2005; Turner, Milne et al. 2005). These endoscopic images can be viewed and stored in PDA memory (Andrade, von Wangenheim et al. 2003a; Turner, Milne et al. 2005). Moreover, these images can be shared among doctors and clinical staff via a the wireless local area network (WLAN) (Andrade, von Wangenheim et al. 2003a; Turner, Milne et al. 2005).

Generally, information in a EHR can be remotely accessed and transmitted from one healthcare provider to elsewhere for decision making, improving health outcomes and wellbeing of patients (Clarke and Meiris 2006). PDAs, PDA phones or SmartPhones can be used to access and transmit such comprehensive EHR data (Clarke and Meiris 2006). The benefit of accessing EHR via PDAs is that it provides immediate access of patients’ information for doctors at any location within hospital environments (Vouyioukas, Maglogiannis et al. 2007). For instance, PDAs were used in nursing and medical practices in a pilot experiment (Andrade, von Wangenheim et al. 2003a).

**Patient tracking and patient management**

PDAs are also used for outpatient and inpatient management (Holubar and Harvey-Banchik 2007). Patient tracking and patient management are useful software applications for PDAs and other mobile devices in healthcare and the medical profession nowadays as the healthcare environment is more demanding and complicated than ever before. The benefits of PDA patient tracking and patient management software applications are fourfold, these being (i) save time, (ii) eliminate unnecessary cost, (iii) increase patient throughput and (iv) enable healthcare providers and medical institutions to deliver better clinical care. Patient tracking systems also include EHR as well as hospital information systems (HIS) (Fischer, Crowell et al. 2005; Martins and Jones 2005; Egan and Sandberg 2007). Such applications are used to
keep track with the patient records (Jahan, Gretter et al. 2002; Briggs 2004; Lin and Vassar 2004), document patient information and allow the physicians to search for patients’ data from databases (Briggs 2004).

For example, PDA diabetes electronic tracking systems are used by doctors for improving the process of patient care and patient management (Jones and Curry 2006). PDAs are also used in a critical care setting at Mt. Sinai Hospital, Canada (Mattana, Charitou et al. 2005).

A number of PDA reference software applications (Martins and Jones 2005; Yu, Houston et al. 2007), allow physicians to analyse patients’ food intake or exercise, therefore physicians can generally provide advice on personal nutrition and fitness plans for their patients and monitor patients remotely (Martins and Jones 2005; Anonymous 2007). On the other hand, patients can follow, track information and workout based on their personal fitness and nutrition plan in relation to doctors’ advice, whether their PDAs are offline or online (Anonymous 2007).

Example patient tracking systems are StatCom (www.statcom.com), PatientKeeper (www.patientkeeper.com) or patient logs (Criswell and Parchman 2002; Lewis and Sommers 2003; Al-Ubaydli 2004; Carroll and Christakis 2004; Stroud, Erkel et al. 2005; Anonymous 2005c; Kitchiner 2006), PatientTracker (www.handheldmed.com) and WardWatch (www.torlesse.com), HandEchart (www.ddhsoftware.com) and MedAmerica Mutual software (www.medamerica.com) (Al-Ubaydli 2004). In addition, these programs are recommended for use by physicians, advanced practice nurses, interns, residents and nurse clinicians (Lewis and Sommers 2003). However the use of these software applications must follow the health information privacy legislations (e.g. the Health Insurance Portability and Accountability Act (HIPAA) for US, Health Record and Information Privacy Acts (HRIPA) for NSW, etc.) in order to protect patient privacy. Therefore
the recommended security procedures for protecting the patient data are data encryption and password protection techniques (Lewis and Sommers 2003).

These software applications provide detailed information for users to reduce medical errors and adverse events (Al-Ubaydli 2004). However, most patient tracking applications are still expensive and complicated for general use (Dalhousie 2005). To date, patient tracking and patient management software applications for PDAs allow healthcare workers and physicians to track patients, which assist hospital or healthcare providers to identify the location of patients and PDAs. Therefore healthcare providers can better utilise and manage equipment as well as improve patient throughput and reduce the loss of PDAs or mobile devices.

**Ordering clinical tests**

Doctors are able to order additional clinical tests and treatment procedures directly at patient bedside any POC by entering the request from a drop-down menu box. Online ordering the clinical test is time-saving rather than filling out a paper-based request form (Turner, Milne et al. 2005).

**Recording medical notes and formulating referral letters by voice recording**

Recording medical notes or note taking are useful functions for physicians as they can record clinical encounters, problem finding, diagnoses, additional clinical tests and treatment, drug information and additional follow up programs. Moreover, doctors can record clinical information wirelessly to database servers in real-time (Turner, Milne et al. 2005). In addition, doctors can record data via a voice recording function on PDAs and store data on database servers by using voice recognition software to transcribe voice input data into text. Therefore doctors can complete patient history notes and formulate referral letters (Turner, Milne et al. 2005). However, the built-in
microphones may give poor quality of voice therefore a better solution is to use a small attachable microphone for recording voices. Voice-recognition software, for instance, *Dragon Naturally Speaking software*, is recommended as it discovers errors, corrections and new wording quickly (Turner, Milne et al. 2005). Turner et al. (2005) indicated that using PDAs to record full-patient information—name, patient identification number, date of birth—is faster than recording on paper-based records (Turner, Milne et al. 2005). The doctors found that using PDAs in tracking patient information is faster than paper-based systems (Turner, Milne et al. 2005).

**Medical calculators**

Medical calculator software applications for PDAs are one of many useful PDA applications for physicians. Generally, such applications come as a package with a combination of medical calculator, medical algorithm as well as medical formulas (Holubar and Harvey-Banchik 2007). These software applications are generally used for calculating any frequent use of medical formulas in clinical setting (Fischer, Crowell et al. 2005; Yu, Houston et al. 2007) and calculating the body mass and fetal weight (Criswell and Parchman 2002; Fischer, Stewart et al. 2003; Lewis and Sommers 2003; Carroll and Christakis 2004; Kitchiner 2006). There are a number of available medical calculator software applications for PDAs (see list of medical calculators in Table 3.1) (Jahan, Gretter et al. 2002; Lewis and Sommers 2003; Carroll and Christakis 2004; Fischer, Crowell et al. 2005; Anonymous 2005c; Kitchiner 2006; Swarts 2006; Yu, Houston et al. 2007).

**Database program**

Database programs allow users to create a custom database or share a database with other users, such as *Pendragon’s Forms, HanDbase* or *JFile* (Anonymous 2005c). For instance, *HanDBase* is a professional database
management software for palm-top or Windows with form designers and MS-Access conduit (Al-Ubaydli 2004; Anonymous 2005c). The data can be shared among colleagues’ PDAs by beaming and syncing data (Briggs 2004).

**Dietary management**

PDAs have been used in medical nutrition for more than 20-years (Holubar and Harvey-Banchik 2007). PDAs are used as programming calculators for preparing parenteral nutrition formulas, which are effective, efficient, time and money saving, and decrease errors (Charney 2007; Holubar and Harvey-Banchik 2007).

Dietary management functionality is also another useful PDA function which physicians or patients can use to assist patients with diabetes as the devices allow patients to control their protein and caloric requirements (Holubar and Harvey-Banchik 2007). Further, PDAs are also used in dietary assessment for recording energy and nutrient information (Holubar and Harvey-Banchik 2007).

**Physiotherapy**

PDAs have a great impact for physiotherapists in their professional activity and personal daily activity as a time management tool (Fleet and Blandford 2005).

**Patient education: Distributing and providing reference materials for patient in relation to medical condition**

For patients’ and healthcare professionals’ education, physicians also use PDAs for distributing educational materials for patients and healthcare professionals in various formats, including *document, audio, PodCast, video stream, live-PodCast or document forms* (Holubar and Harvey-Banchik 2007).
Complementary and alternative medicine software applications are introduced and used by patient for self-efficacy, safety concern, supporting decision point of service information and patient education (Fischer, Crowell et al. 2005). For example, diabetes patients can access carb counting software applications in PDA format, as distinct from textbooks or websites (Fillman 2006).

**Student log software application**

In general, there are various key terms that refer to clinical-log as some medical schools call them student-log, patient-log or portfolio (Maughana, Finlayb et al. 2001). The use of clinical-log can formulate a good structure of clinical situations (Dolmans, Schmidt et al. 1999). Clinical-log is a practical and feasible method to record students’ clinical experiences (Alderson and Oswald 1999; Bertling, Simpson et al. 2003; Gordon, McNew et al. 2007). One record of clinical-log represents clinical problems of individual patients (Gordon, McNew et al. 2007).

Generally, clinical-log was started from paper-based clinical-log or a written clinical-log to electronic clinical-log (Dolmans, Schmidt et al. 1999; Bardes, Wenderoth et al. 2005). The traditional clinical-log was in paper-based form, which is simple and inexpensive to implement (Bardes, Wenderoth et al. 2005). Paper-based clinical-logs were successfully used to record clinical experiences, especially in community settings (Alderson and Oswald 1999).

Web-based case-log or web-based clinical-log allows medical schools to identify expectations from patient encounters (Bardes, Wenderoth et al. 2005). It also allows students to effectively record their clinical encounters. On the other hand, a web-based clinical-log also allows medical faculty to track students’ progress on clinical skills by downloading students’ clinical-log information directly via databases (Bardes, Wenderoth et al. 2005;
Gordon, McNew et al. 2007). A comparison between paper-based clinical-logs and electronic clinical-logs is presented in Table 3.2.

<table>
<thead>
<tr>
<th>Paper-based clinical-log</th>
<th>Electronic clinical-log</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simple and inexpensive to implement</td>
<td>Facilitate a complex data analysis</td>
</tr>
<tr>
<td>Inefficient to use if comparing to electronic clinical-log</td>
<td>Require less personal time in accessing, retrieving and analysis data being kept in the systems</td>
</tr>
<tr>
<td>Easy to navigate with well-designed user interface</td>
<td>Enable medical faculty to know which clinical encounters are differ from others in particular aspects</td>
</tr>
<tr>
<td>Facilitate closely attention from medical faculty</td>
<td></td>
</tr>
<tr>
<td>Enable medical faculty to know which clinical encounters are differ from others in particular aspects</td>
<td></td>
</tr>
</tbody>
</table>

**Table 3.2** A comparison between paper-based and electronic clinical-log (Bardes, Wenderoth et al., 2005; Gordon, McNew et al., 2007)

**Purposes of using clinical-log**

Generally, the purposes of using clinical-log are twofold: (i) to record clinical encounters or patient problems and; (ii) to keep track of medical students’ logs during their clerkship in primary care (Jahan, Gretter et al. 2002; Kurth, Silenzio et al. 2002; Sargeant 2005).

A clinical-log, however, is not a record of any diagnosis (Bardes, Wenderoth et al. 2005). Clinical-logs are used in organising the content and students’ learning activities during clinical placements. A clinical-log represents periodical or systematic records of students learning activities and experiences during their internship or clerkship in order to facilitate and improve students’ learning experiences (Dolmans, Schmidt et al. 1999). Secondly, the use of electronic clinical-logs is to identify the range of clinical problems being seen by students (Alderson and Oswald 1999).

However the major purposes of using clinical-logs are similar among different medical schools. The only difference is that the content being recorded on the log is based on the context of medical curriculum at each
medical school. A clinical-log is normally used when students are in clerkship or internship year (Dolmans, Schmidt et al. 1999; Bardes, Wenderoth et al. 2005).

Many medical schools have developed clinical logs to monitor student activities and experiences during their clinical practices, for instance, the School of Medicine, Columbia University, the University of Wales, College of Medicine, etc. The University of Wales, College of Medicine incorporates the use of portfolio as a part of medical study. Medical students are encouraged to record clinical experiences and encounters on their portfolio as medical study assessment. Logs are used to quantify and qualify the students’ case mix, the opportunity of the students to perform their knowledge and skills while practicing as the problem-based learning (Millikan and Hauge 2001; Kurth, Silenzio et al. 2002; Jotkowitz, Oh et al. 2006).

**Why clinical-log is important for medical education and clinical practice?**

There are several reasons why medical schools encourage students to use clinical-logs during their medical study. Firstly, the logs are used to quantify and qualify the students’ clinical experience throughout their clinical year. Secondly, the logs are used for supervising students, recording clinical encounters and gathering student feedback while they are away from the medical school for their practices, for instance, patients’ characteristics and their learning outcomes. Lastly, the logs are used as the students’ documentation for the medical school to use for program evaluation (Kurth, Silenzio et al. 2002; Bertling, Simpson et al. 2003; Jotkowitz, Oh et al. 2006).

**Information being recorded on clinical-log**

Numerous information is recorded on clinical-logs. Such information is used to facilitate students in learning medicine and enhancing medical faculty to
easily monitor students’ learning progress and experiences being encountered in any clinical environment. In addition, the information being recorded on clinical-logs must contain no patient identification (Bakken, Cook et al. 2003; Bertling, Simpson et al. 2003). For example, patient names and medical record numbers are not allowed to be recorded on clinical-logs.

According to the Nation Patient Safety Education Framework (Walton 2005) and Charting the Safety and Quality of Health Care in Australia (2004), it is advisable to record any medical errors, adverse events or near miss cases. Table 3.3 represents information being recorded on clinical-log from different medical schools.

**Table 3.3 Components of electronic clinical-log**

<table>
<thead>
<tr>
<th>Information being recorded in electronic clinical-log</th>
</tr>
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<tbody>
<tr>
<td>Summary of patient history</td>
</tr>
<tr>
<td>Evaluation of patient history over 6-months</td>
</tr>
<tr>
<td>Time of patient meeting</td>
</tr>
<tr>
<td>Gender of patient</td>
</tr>
<tr>
<td>Specific clinical activities</td>
</tr>
<tr>
<td>Personal reflections (comments area)</td>
</tr>
<tr>
<td>Cross references</td>
</tr>
<tr>
<td>Portfolio summary</td>
</tr>
<tr>
<td>List of patient problems</td>
</tr>
<tr>
<td>Diary of students interaction with patient/daily patient problem</td>
</tr>
<tr>
<td>Type of insurance</td>
</tr>
<tr>
<td>Level of participants (level of involvement)</td>
</tr>
<tr>
<td>Simultaneous reflection</td>
</tr>
<tr>
<td>Personal notes</td>
</tr>
<tr>
<td>Self-perception</td>
</tr>
</tbody>
</table>

**Summary of patient history.** This information represents clinical/medical condition that patients previously have, for instance, chronic pain, etc. (Maughana, Finlayb et al. 2001).

**List of patient problems.** The reason why the list of patient problems needs to be recorded rather than recording diagnosis is that it is important for students to practice and formulate their clinical reasoning skills before diagnosing any patient (Dolmans, Schmidt et al. 1999).
Evaluation of patient story over 6 months (Maughana, Finlayb et al. 2001);

Diary of student interaction with patients. This information represents daily patient placements, which students have been encountered (Dolmans, Schmidt et al. 1999; Maughana, Finlayb et al. 2001).

Time of patient meeting (Gordon, McNew et al. 2007)

Type of insurance (Gordon, McNew et al. 2007)

Gender of patient (Gordon, McNew et al. 2007)

Level of participant/level of involvement. Students should be able to identify their level of participation in relation to clinical problems during their clinical encounters (Gordon, McNew et al. 2007).

Specific clinical activities (Gordon, McNew et al. 2007)

Comment area. This is an area where students can put their reflections their personal clinical experiences and skills toward clinical problems that they have encountered. It is an important area in clinical-logs (Gordon, McNew et al. 2007).

Simultaneous reflection. – This reflection represents interactions and identification about what students gained or learned on each clinical encounter (Maughana, Finlayb et al. 2001).

Personal notes. This information represents any lecture notes from attending tutorials (Maughana, Finlayb et al. 2001).

Cross references. This information represents other related teaching and other sources (Maughana, Finlayb et al. 2001).

Personal reflection. This information represents students’ reflections regarding what has been done well and what has not been done well, for instance, the relationship or communication between doctor and patient (Maughana, Finlayb et al. 2001).
**Self-perception.** This information represents specific things that students have learned from each clinical case, for example, change in students, perception towards clinical problems, quality of presentation mode based on patients’ case history or their perceptions towards what they have learned during their clinical encounters (Maughana, Finlayb et al. 2001).

**How clinical-log works**

The use of a clinical-log can assist medical faculty and medical schools in identifying students’ clinical experience and comparing programs among institutions (Dolmans, Schmidt et al. 1999). A clinical-log allows medical faculty and tutors to investigate how well the goal of each clerkship has been achieved in different hospital or clinical settings (Dolmans, Schmidt et al. 1999). Tutors are able to access student involvement with their patient and contact information regarding the information in their portfolio (Maughana, Finlayb et al. 2001). Students can identify their learning gap from their clinical encounters and experiences that they record in clinical-logs (Dolmans, Schmidt et al. 1999). Clinical-logs allow students and medical faculty to react based on students learning activities and clinical experiences during encounters (Dolmans, Schmidt et al. 1999; Mattana, Charitou et al. 2005).

For a *web-based case log*, the log can be accessed via a particular web-site or via the Internet connectivity. Therefore students are required to have Internet access and login to a website for recording their clinical experiences and encounters being required by the medical school (Bardes, Wenderoth et al. 2005). It is recommended that students should record their experiences and data on a clinical-log as soon as possible after having a clinical encounter with patient (Bardes, Wenderoth et al. 2005). In some cases, students may record their clinical encounters and experiences, which they have with more than one patient (Bardes, Wenderoth et al. 2005). It is suggested that the
databases should have a counter for numbering the clinical encounters being experienced by each student (Bardes, Wenderoth et al. 2005). Bardes, Wenderoth et al. (2005) indicated that students should be encouraged to complete clinical-logs before submitting them to school. Further, it is possible that they can edit or modify before submitting to the medical school.

Web-based clinical-logs also allow students to have the right to edit their log. However the modification of clinical-log data would be recorded on the database in a number of versions (Begg, Dewhurst et al. 2008). It would not allow students to overwrite/replace their clinical-log data on the same record.

In addition, students are able to access their own clinical-log whilst medical faculty can access students’ clinical-logs so medical faculty can provide comment and feedback to students (Gordon, McNew et al. 2007).

Benefits and constraints of clinical-log

Benefits of clinical-log

Generally, there are a number of benefits of clinical-logs. Firstly, clinical-log data can be used as an indicator to identify how well the programs are met (Dolmans, Schmidt et al. 1999; Mattana, Charitou et al. 2005). Secondly, the use of clinical-log can assist medical faculty to identify students’ experiences and what type of clinical experiences that students should have (Dolmans, Schmidt et al. 1999; Bertling, Simpson et al. 2003; Bardes, Wenderoth et al. 2005). Thirdly, the information being recorded on clinical-log allows medical faculty to determine whether students are having the right clinical experiences, which are required by the medical school (Bardes, Wenderoth et al. 2005). Finally, the use of clinical-logs can facilitate a better structure of medical education.

Clinical-logs should be incorporated into clinical supervision activities (Dolmans, Schmidt et al. 1999). In addition, various medical schools provide
the use of electronic clinical-logs in different forms, for instance, web-based clinical-log, PDA clinical-log, or mobile PDA clinical-log (Bardes, Wenderoth et al. 2005; Gordon, McNew et al. 2007).

Table 3.4 summarises the benefits and constraints of clinical-log in various forms, including paper-based clinical-log, e-clinical-log, web-based clinical-log and PDA-based clinical-log according to the literature (Dolmans, Schmidt et al. 1999; Kurth, Silenzio et al. 2002; Bertling, Simpson et al. 2003; Newman 2003; Bardes, Wenderoth et al. 2005; Mattana, Charitou et al. 2005; Gordon, McNew et al. 2007).
### Table 3.4 Benefits and constraints of clinical-log

<table>
<thead>
<tr>
<th>Types of log</th>
<th>Benefits</th>
<th>Constraints</th>
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</thead>
<tbody>
<tr>
<td><strong>Clinical-log in general</strong></td>
<td>1. Assist clinical director in identifying how well the programs are</td>
<td>1. Require administrative work regarding maintenance and support</td>
</tr>
<tr>
<td></td>
<td>2. Assist medical faculty in identifying students’ clinical experiences</td>
<td>2. Consume development and implementation cost</td>
</tr>
<tr>
<td></td>
<td>and what type of clinical experiences students should have</td>
<td>3. Any technical problem may occur while being used</td>
</tr>
<tr>
<td></td>
<td>3. Allow medical faculty in identifying whether students are having the right clinical experiences which are required by medical school</td>
<td>4. Require software installations</td>
</tr>
<tr>
<td></td>
<td>4. Facilitate a better structure of medical education</td>
<td>5. Require proper back-up</td>
</tr>
<tr>
<td><strong>E-clinical-log</strong></td>
<td>5. Allow medical faculty to track students’ clinical experiences</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6. Facilitate complex data analysis</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7. Consume less time in accessing, retrieving and analysing data</td>
<td></td>
</tr>
<tr>
<td></td>
<td>8. Well-design user interface facilitate the ease of navigating log</td>
<td></td>
</tr>
<tr>
<td></td>
<td>9. Enable medical faculty in identifying which clinical encounters differ from one another in particular aspects</td>
<td></td>
</tr>
<tr>
<td><strong>Web-based clinical-log</strong></td>
<td>10. Provide immediate access to data</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11. Enable medical faculty to track students’ clinical experiences at anytime</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12. Enable students to log their clinical experiences anytime</td>
<td></td>
</tr>
<tr>
<td></td>
<td>13. Enable students to record their personal reflections on their clinical encounters</td>
<td></td>
</tr>
<tr>
<td><strong>PDA-based clinical-log</strong></td>
<td>14. Allow immediate record clinical experiences directly on PDAs</td>
<td>6. Require extra money to acquire PDA device</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7. Prefer to use other devices in recording clinical experiences</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8. Require technical skills for software installations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9. Unfamiliar with the devices</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10. Consume large amount of development and implementation cost</td>
</tr>
</tbody>
</table>

Further, the benefits of electronic clinical-log are sixfold (Table 3.4). Firstly, the electronic clinical-log allows medical faculty to track students’ clinical experiences (Bertling, Simpson et al. 2003; Gordon, McNew et al. 2007). Secondly, they facilitate complex data analysis. Thirdly, they require less personal time in accessing, retrieving and analysing data being kept in the
system. Fourthly, a well-designed user interface facilitates ease of navigating the log (Bardes, Wenderoth et al. 2005). Moreover, an electronic clinical-log facilitates a close supervision between medical faculty and medical students. Finally, electronic clinical-logs enable medical faculty to identify which clinical encounters differ from one another in particular aspects (Bardes, Wenderoth et al. 2005).

There are four benefits of web-based clinical-logs (Table 3.4). Firstly, Web-based clinical-logs provide medical faculty with immediate access to data so they are able to identify the type of clinical experiences that students have encountered (Gordon, McNew et al. 2007). Secondly, with web-based clinical-logs, medical faculty are able to check students’ clinical experiences at any time. Thirdly, they are able to identify whether a student has any learning gap (Gordon, McNew et al. 2007) as clinical-log facilitates students to identify their actual clinical experiences based on required clinical experiences. Finally, students are able to log their clinical experiences anytime they want and; it allows students to have comments on each of their clinical experiences (Gordon, McNew et al. 2007).

Moreover, the benefits of using a PDA-based clinical-log (Table 3.4) is that it allows students to immediately record their clinical encounters and experiences on their PDA, then data synchronisation can be done later to protect data loss (Newman 2003; Mattana, Charitou et al. 2005; Gordon, McNew et al. 2007).

Barriers of electronic clinical-logs

Bardes, Wenderoth et al. (2005) indicated that there are barriers of using electronic clinical-logs. Firstly, it may increase the systems administrative work regarding systems maintenance and support. Secondly, there is the cost of implementing and maintaining systems (Bardes, Wenderoth et al. 2005). Thirdly, technical problems can occur while using a clinical-log. Fourthly,
students may have problems regarding software installation. Finally, problems can arise from improper back-up that may give rise to loss of data (Kurth, Silenzio et al. 2002). To resolve such barriers, instructions and procedures for setting the system must be clearly defined. Then the medical school needs to ensure that adequate support is available for backing up data at certain periods (Kurth, Silenzio et al. 2002).

For a *PDA-based clinical-log*, students may refuse to use such devices for logging their clinical experiences for several reasons. Firstly, students may not want to purchase their own PDA as they may not want to spend extra money on additional devices. Secondly, students may prefer to use any existing resource, which may facilitate them in recording clinical encounters instead of using a PDA-based clinical-log, for instance, a web-based clinical-log. Thirdly, additional software installation on PDAs could be troublesome. Fourthly, not all students like to use PDAs. Lastly, medical schools may choose to invest in implementing clinical-log systems for other mobile devices in terms of flexibility, accessibility and screen size visibility, for instance, TabletPC (Gordon, McNew et al. 2007).

**Components to be considered for web-based clinical-log**

It should be noted that the interface of web-based clinical-log needs to be simple and useful for users to enter data via a computer screen. For example, providing limited free text areas would not be useful for both students and faculty to record/respond to comments and feedback (Bardes, Wenderoth et al. 2005).

Reports from web-based clinical-log or any format of clinical-log could be ineffective if such reports provide only the counters (number of clinical encounters), which show frequency of clinical problems being seen by each student (Bardes, Wenderoth et al. 2005).
A web-based clinical-log system should be powerful enough to keep appropriate and useful information for both students and medical faculty. For instance, the information being recorded on a clinical-log should be useful enough for both students and faculty to feedback upon (Gordon, McNew et al. 2007).

The system should be simple to use, easy to navigate with a user friendly interface (Gordon, McNew et al. 2007). Students should not spend most of their time recording information on clinical-logs. It is suggested that students should spend no more than one minute in recording information to a clinical-log (Gordon, McNew et al. 2007). Further, a web-base clinical-log system must be reliable (Gordon, McNew et al. 2007). System authentication should be easy to login (Gordon, McNew et al. 2007).

**Research tools**

PDAs can be used as research tools for data collection. Software applications allow PDA users to create forms, for example, *Pendragon*. Using PDAs enables both medical and nursing students to conduct various clinical surveys by using PDAs as data entry rather than paper-based form (Kitchiner 2006).

**Other tools**

There are other PDA functionalities which are used for *Anthropometric, Biochemical, DocAlerts, health monitoring, Mobile CME, MP3 player, entertainment*, (Aziz, Atallah et al. 2007; Holubar and Harvey-Banchik 2007; Vouyioukas, Maglogiannis et al. 2007; Sillence and Briggs 2008), *Language translator* (Stroud, Erkel et al. 2005), etc.

For instance, PDAs are used for monitoring and alerting people, in case patients or clients of healthcare providers need help in relation to their medical conditions (Sillence and Briggs 2008).
Another patient monitoring system is that PDAs are used for hospital recovery monitoring systems. PDAs are incorporated with wireless body sensors, so called “body area network (BAN)” (Vouyioukas, Maglogiannis et al. 2007), which are worn by a patient after having surgery (Aziz, Atallah et al. 2007; Vouyioukas, Maglogiannis et al. 2007). The systems can capture pulse waveforms, the heart rate of the patient (Aziz, Atallah et al. 2007; Vouyioukas, Maglogiannis et al. 2007), breathing frequency, oxygen saturation, blood pressure, pupil size and amount of fluids infused (Vouyioukas, Maglogiannis et al. 2007). However such systems were designed to be used while patients are admitted in the hospital during their recovery periods (Aziz, Atallah et al. 2007).

**Communication software applications**

*Communication software applications* allow physicians to send and receive emails and gain Internet access via wireless handheld devices (Lin and Vassar 2004; Sargeant 2005; Anonymous 2005c), for instance, e-mail, billing software, etc.

*E-mail*. Reading e-mail from PDAs at leisure time is time saving for doctors. Replying to e-mail, however might be inconvenient using PDAs (Sargeant 2005; Turner, Milne et al. 2005).

*Billing*. Other applications that can be used for communication purpose are e-prescription, billings and coding of patient visits (Jahan, Gretter et al. 2002; Carroll and Christakis 2004; Stroud, Erkel et al. 2005). However, the major concern is patient data confidentiality (Lin and Vassar 2004).

*Cell phone technology*. Medical information, text, and medical images can be sent and received in any remote site using cell phone technology capability within any covered network area (Kitchiner 2006).
**Patient communication**

PDAs also facilitate communication among patients, doctors and healthcare providers, for instance, patients can send information via PDAs to their healthcare providers (Holubar and Harvey-Banchik 2007; Sillence and Briggs 2008).

Sillence and Griggs (2008) indicated that PDAs can be used to upload health information of a healthcare’s client directly to hospital in case of emergency. Moreover, the healthcare workers also used PDAs to communicate with colleagues in different locations and transmit information to relevant recipients (Sillence and Briggs 2008).

In summary, understanding the use of PDAs in the healthcare profession and medical education are twofold. Firstly, PDA use can improve advance nursing practice and nursing education is needed. On the other hand it also assists in medical practice and education (Stroud, Erkel et al. 2005; Jotkowitz, Oh et al. 2006).

However it is necessary to understand advantages and disadvantages of using PDAs in medical and nursing professions. Therefore these aspects are reviewed and discussed in the next sections.

**3.3 Benefits of PDAs in healthcare and medical professions**

There are 12-major benefits of PDA use in healthcare and the medical profession particularly in busy units. The benefits of PDA use in such professions are similar to the use of PDAs in other areas. Table 3.5 summarises the benefits to be found in healthcare and the medical profession.
Table 3.5 Benefits of PDA use in healthcare and medical professions

<table>
<thead>
<tr>
<th>Benefits of PDA use in Healthcare and Medical Professions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time-saving</td>
</tr>
<tr>
<td>Interchange-ability of patient appointment</td>
</tr>
<tr>
<td>Accuracy and consistency of information</td>
</tr>
<tr>
<td>Decrease adverse event</td>
</tr>
<tr>
<td>Efficient and convenient</td>
</tr>
<tr>
<td>Portability and mobility</td>
</tr>
<tr>
<td>Longer battery life</td>
</tr>
<tr>
<td>Clinical practice suitability</td>
</tr>
<tr>
<td>Slim and light weight</td>
</tr>
<tr>
<td>Wireless accessibility</td>
</tr>
<tr>
<td>Data storage capacity with expandable memory module</td>
</tr>
<tr>
<td>Cost-saving, require no maintenance service and low training requirements</td>
</tr>
</tbody>
</table>

*Time saving.* PDA use in the medical profession provides fast access to information (Al-Ubaydli 2004; Martins and Jones 2005). Using handheld computers in clinical practice can increase the accuracy of clinical data. This means that users can store relevant clinical information on their handheld computer anywhere they go (Al-Ubaydli 2004).

Fischer, Crowell et al. (2005) indicated that a number of physicians use PDAs in their profession for accessing references, for instance, drug databases (from the American College of Physicians-American Society of Internal Medicine). The research has proven that accessing drug databases and interactions via PDAs can save physicians’ time (Martins and Jones 2005) and also decrease adverse events from drug dosage and interactions (Fischer, Crowell et al. 2005; Martins and Jones 2005).

*Interchange-ability of patient appointment.* PDAs allow interchange of patient appointments from one-time visits to weekly appointments (Al-Ubaydli 2004).
**Accuracy and consistency of information.** PDAs allow doctors to access information more precisely and accurately, especially increasing accuracy in prescribing medication (Martins and Jones 2005; Holubar and Harvey-Banchik 2007). Further, PDAs provide faster data retrieval and more convenience in accessing medical references and patient information rather than paper-based investigation data (Al-Ubaydli 2004; Stroud, Erkel et al. 2005).

**Decrease adverse event.** Using PDAs in accessing drug information can decrease adverse drug reactions (Fischer, Crowell et al. 2005; Martins and Jones 2005). PDA use in the medical profession not only supports doctors in decision making but also decreases errors in decision making, paperwork and professional miscommunication (Martins and Jones 2005). For patient care, PDAs are beneficial for patients as automatic reminders with built-in alarms for taking medications (Abell, Bauder et al. 2005).

**Efficient and convenient.** Using PDAs in the medical profession can facilitate physicians in accessing information more effectively, efficiently and conveniently (Yu, Houston et al. 2007), especially accessing EHR and HIS (Fischer, Crowell et al. 2005; Martins and Jones 2005).

**Portability and mobility.** PDAs provide portability and mobility for physicians or medical practitioners in accessing information anywhere and anytime especially at the bedside or POC for EBM, EMR and HIS (Martins and Jones 2005; Yu, Houston et al. 2007) in real-time (Jerant 1999; Buranatrived and Vickers 2002; Criswell and Parchman 2002; McLeod, Ebbert et al. 2003; Carroll and Christakis 2004; Mattana, Charitou et al. 2005; Stroud, Erkel et al. 2005). The devices allow healthcare workers and physicians to deliver essential clinical information among each other wherever and whenever they need it (Turner, Milne et al. 2005).
**Longer battery life.** PDAs have longer battery life than laptops or tablet PCs and operate with a rechargeable battery (Al-Ubaydli 2004). For some reason, battery life is still a major problem for PDAs as the battery only lasts for three to four hours. Therefore doctors should always turn-off the wireless connection if no connection is required. Other strategies to overcome the limited battery life are to have it fully charged and to recharge and acquire a spare battery (Turner, Milne et al. 2005).

**Clinical practice suitability.** PDAs are suitable for clinical practice, especially for a long shift work (Al-Ubaydli 2004).

**Slim and light weight.** PDAs are slim and light weight – less than one pound (Stroud, Erkel et al. 2005). Nurses and physicians can easily put them in their pocket while working in wards or visiting patients at their bedside.

**Wireless accessibility.** PDAs contain a wireless access device. The majority of PDAs are integrated with wireless technology, for instance, Bluetooth and 802.11b connection (Criswell and Parchman 2002; Stroud, Erkel et al. 2005).

**Data storage capacity with expandable memory module.** The memory capacity of PDAs used to be a disadvantage. These days, this problem has been solved. The majority of PDAs now have separate storage space besides their own built-in memory space. Expandable memory modules come with different forms and different amount of storage capacity for users to choose, for instance, compact flash memory; secure digital/multimedia card, Secure Digital Card (SanDisk Corporation) and memory stick with different size and capacity up to 4 GB (Naylor 2002; Choi 2005). Therefore health and medical related software applications including medical images can be stored on PDAs (Naylor 2002; Naylor 2002; Choi 2005).

Further, the major barriers to using PDAs by paediatricians were the difficulty of data entry methods and small-screen size (Carroll and Christakis...
However, this problem was solved after expandable memory modules became available with different capacities for different types and PDAs (Choi 2005).

Cost saving, requiring no maintenance service and low training requirements. The final three advantages are cost saving, no requirements for maintenance and support, and low training requirements (Criswell and Parchman 2002; Al-Ubaydli 2004). The costs per user are lower than desktop computers (Criswell and Parchman 2002).

3.4 Limitations of PDA use in healthcare and the medical profession

The limitations of PDA use in healthcare and the medical profession are summarised in Table 3.6.

Table 3.6 Limitations of PDA use in healthcare and medical professions

<table>
<thead>
<tr>
<th>Limitations of PDA use in Healthcare and Medical Professions</th>
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</thead>
<tbody>
<tr>
<td>Inconvenience data entry methods</td>
</tr>
<tr>
<td>Limited display (small screen size and low screen resolution)</td>
</tr>
<tr>
<td>Easy to be damaged and possible data lost</td>
</tr>
<tr>
<td>Limited wireless connectivity and low bandwidth</td>
</tr>
<tr>
<td>Not versatile</td>
</tr>
<tr>
<td>Inconvenient data synchronisation in hospital environment</td>
</tr>
<tr>
<td>High cost in developing and implementation</td>
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</tbody>
</table>

PDAs have inconvenient data entry methods, which may not appropriate for lengthy patient records (Fischer, Stewart et al. 2003; Al-Ubaydli 2004). Further, most PDAs are limited in graphics applications and representations (small screen size) (Criswell and Parchman 2002). Occasionally, PDA
devices are *easily damaged by accidental dropping* (Martins and Jones 2005). As a result, there is a *possibility of losing data*. The risk of using PDAs for the log system might lead to loss of data. However, other potential risks of using PDAs in clinical education have not been investigated (Kurth, Silenzio et al. 2002).

PDAs could have *limited access to wireless connectivity* if used in remote areas (Martins and Jones 2005). The cost of hiring people for implementing and maintaining PDAs could be dramatically high (Martins and Jones 2005). In terms of versatility, PDAs are *not as versatile* as desktop computers (Criswell and Parchman 2002). In addition, *problems with data synchronisation in hospitals or healthcare environments* could arise. The problem of data synchronisation mostly occurs together with network security concerns as doctors and clinical staff tend to synchronise their PDAs at hospital PCs (Turner, Milne et al. 2005). In hospitals, users are not allowed to use any desktop computers if not logged on to the hospital network (Jahan, Gretter et al. 2002; Turner, Milne et al. 2005). Other limitations of PDAs are *low bandwidth for data transmission*, and *low screen resolution* (Fischer, Stewart et al. 2003).

### 3.5 Barriers for PDA use in healthcare and medical professions

Generally, there are barriers regarding PDA use in the healthcare and medical sectors, including *interception* (Lin and Vassar 2004), *systems incompatibility* (Martins and Jones 2005; Holubar and Harvey-Banchik 2007), *availability of software applications for PDAs* (Holubar and Harvey-Banchik 2007), *lack of healthcare standards, inability to meet organisational standards or the shortcomings of IT solutions* (Lin and Vassar 2004), *inadequate network connectivity* (Lin and Vassar 2004), *lack of*
organisational support, uncomfortable with using technology or insufficient training (Lin and Vassar 2004), dramatically changing technology, high implementation cost and insufficient resources (Lin and Vassar 2004; Lu, Xiao et al. 2005). In order to overcome such barriers, there are the important aspects (section 3.7) which are essential to pre-consider before deploying PDA use into healthcare and the medical sphere.

*Insufficient training (technology difficulty).* Inadequate training of using PDA technology and its applications could lead to ineffective use of PDAs in the medical profession and medical education. It is possible that users may not realise what PDA applications are useful for their work (Lapinsky, Weshler et al. 2001; Lu, Xiao et al. 2005; Lapinsky 2007). Appropriate initial and follow-up training on the use of PDAs for the medical profession is recommended in order to gain the optimum use of PDA technology (Lapinsky, Weshler et al. 2001). For instance, anywhere access is still limited in mobile technology for caregivers and healthcare providers (Fischer, Stewart et al. 2003).

*Dramatic change of technology (Technical difficulty).* Dramatic change of technology or technical difficulty could be a barrier to PDA use in either the medical profession or medical education. Technical difficulties could arise from incompatible PDA platforms, obsolescence of technology, lack of internet access and network connectivity, unavailable software applications and difficulties in data synchronisation (Lu, Xiao et al. 2005). These difficulties also include the rapid change of technology which would give raise to cost of technology, support and maintenance. Topps et al. (2003) indicated that PDA devices have an approximate lifetime around 2-years.

*Equity of accessing information.* Equity of accessing information is an important aspect as it is necessary to ensure that students would have equal access to information wherever they are, whether students access online
resources via a network computer, mobile devices or a physical learning resource centre. Walton et al. (2005) indicated that it is very important to have learning resources for students to access while at their clinical placements. Moreover, it has been proved that students who have clinical encounters in community and clinical placements, are more able to access online resources than students dispersed in rural and regional areas (Walton, Childs et al. 2005). Therefore it is essential to ensure that students have equity in accessing learning resources and materials, especially online resources, effectively and efficiently (Draper and Seivl-Keevers 2005; Walton, Childs et al. 2005).

3.6 PDAs in US medical schools

The majority of medical schools are already using PDAs in medical education (Carroll and Christakis 2004; Wilson, Billingsley et al. 2005). For instance, George Washington University School of Medicine, Johns Hopkins School of Medicine, Thomas Jefferson Medical College in Philadelphia, Georgetown University, Columbia University, Medical School, Stanford University School of Medicine, The Medical College of Wisconsin, and School of Medicine Wayne State University, etc.

PDAs for medical students and residency programs

Medical students tend to use PDAs for keeping patient logs, clinical experience and to bridge the gap in their clinical experiences by using spreadsheet applications. It has been proved that PDAs are feasible and practical devices for medical education (Stroud, Erkel et al. 2005). PDAs are also used in residency programs for data collection in family practice (Stroud, Erkel et al. 2005). Moreover paediatricians use PDAs for office management (Carroll and Christakis 2004; Stroud, Erkel et al. 2005). The following is a
list of medical schools that have already integrated PDAs in to their medical education.

**George Washington University.** The medical school at George Washington University has investigated the use of PDAs among medical students. The use of PDAs by different groups of students, particularly year 3 and 4, was evaluated in various aspects, for example, different platforms (PalmOS and PocketPC), ease of use, depth of information, product cost, and target audience. PDA software applications were selected to use in this project based on a needs assessment (Wilson, Billingsley et al. 2005). The results of the survey and software evaluation indicated that the medical students tend to the medical reference software applications in order to widen their clinical knowledge and experience rather than the clinical consultation software application (Wilson, Billingsley et al. 2005). An array of PDA functionalities is currently used in medical education, these being drug information, calculators and referencing tools, textbooks, clinical guidelines, OSCE and clinical log (Washington 2006). Furthermore, the George Washington University, School of Medicine has successfully implemented the audience response systems (ARS) for PDA users in the Department of Emergency Medicine (Washington 2006).

**Johns Hopkins University School of Medicine.** Johns Hopkins University School of Medicine, the Massachusetts Medical Society and the Health Science Centre have included PDAs in their medical curriculum. Medical students are able to read educational articles from each course, and take tests via PDAs (Anonymous 2005c). At Johns Hopkins, PDAs are used for storing clinical references and guidelines, medical calculator, messaging services and tracking electronic patient records (EPR) (Hopkins 2002; Hopkins 2006a; Hopkins 2007a). Currently, John Hopkins University School of Medicine currently has five PDA projects: Gastroenterology & Hepatology CME
Anytime (Division of Gastroenterology and Hepatology), MData Handheld Rounding Tool (Department of Surgery), Opiod Program (John Hopkins Centre for Cancer Pain Research), Patient Tracker Tool (Office of Academic Computing), PatientKeeper Tool (Clinical Practice Association) and Point of Care Information Technology (POC-IT) (Division of Infectious Diseases) (Hopkins 2006). Firstly, the aim of the Gastroenterology and Hepatology CME Anytime project is to provide common information about gastroenterology and hepatology disorders in an interactive graphical format with content written by a multidisciplinary team of physicians experienced in providing a treatment for these diseases. The highlights of this project are providing portable opportunity, cross-platform accessibility of the PDAs, stay current with the clinical information, save time and save money (Hopkins 2007). Secondly, the MDdata Handheld Rounding Tool project is used for tracking patients, viewing treatment results and communicating clinical information to others (Awad 2006). Thirdly, the Hopkins Opiod Program project is to facilitate appropriate conversions from one opioid or route of administration to another. However, this Opioid conversion program is not yet compatible with new the Palm TX. The Patient Tracker Tool and PatientKeeper Tool projects are tools for patient management, with which users are able to track patient information, laboratory results and web-based chart capture. These tools allow the users to wirelessly synchronise data from any hospital unit and; they are able to transfer data from one user to another. These tools help to increase revenue, reduce cost, time and medical errors, support faculty workflow, improve data accuracy and efficiency (Bittle 2004). Finally, the aim of the POC-IT project is to develop a tool for providing physicians with a more efficient standard of care. Therefore, the POC-IT systems provide concise clinical standard guidelines information that the physicians need at the point of care (Hopkins 2007).
Data synchronisation techniques between PDAs and central servers are available with both wired and wireless via a USB PDA cradle and wireless network. The IEEE 802.11b networking protocols have been used as the wireless connection standard at Johns Hopkins (Hopkins 2002; Hopkins 2007b). Moreover, numerous data security and privacy techniques are used to protect against unauthorised access, for instance, data encryptions that are used together with network encryption software, authentication access control by verifying username and password and timeout features (Hopkins 2002; Hopkins 2007b).

*Thomas Jefferson Medical College.* Thomas Jefferson Medical College in Philadelphia has been using a PDA patient encounter log system (PELS) to track procedures performed by medical students. The PELS helps students to document their clinical and educational experiences during their clerkships. The systems are used to record the case-mix of patients, physical findings, vital signs and severity of disease, to track patient laboratory data without locating a paper chart, to record limited clinical information at the bedside and to access current laboratory data and to document supervision during their clerkship (Louis, Rattner et al. 2003; Lopez, Kolecki et al. 2004; Jefferson 2006). Students and faculty are able to review summaries of students’ experiences and to compare with the clerkship learning objectives. The other PDA functionalities are used at Thomas Jefferson Medical College include patient tracking, looking up relevant references, text pager, displaying radiology images, physician directory, Internet and simple-email access and PIM. Moreover, other medical software applications have been used in medical education. For instance, OSCE is used for history-taking, physical examination and data analysis skills, practice session with immediate feedback, writing a clinical template for selected clinical problems and discussing with faculty members (Lopez, Kolecki et al. 2004; Jefferson 2006).
Future goals of using PDAs in medical education is to test the wireless PDA-based for audience response systems to be used in classrooms and auditoriums and to implement a system for auto-recording of the audio and data synchronisation of Power-Point presentations by faculty members; files will be automatically transferred by the system. Therefore students can view and listen to lectures on their PDAs, computer and MP3 players (Tawyea 2007). Future use of this equipment could be extended to use in clinical and emergency medicine in the third- and forth-year clerkship (Lopez, Kolecki et al. 2004).

Georgetown University. The Medical School at Georgetown University has currently integrated PDAs for medical students in their pre-clinical- and clinical-year by having students start using PDAs during the last quarter of their second year of medical study (Mays, Boston et al. 2003; Mays and Boston 2004). The early use of PDAs in medical education tends to affects the better use of the software applications especially for medical reference, patient information at POC in order to enhance information management skills for students (Mays, Blumenthal et al. 2002). In addition, the selected software applications to be used for year-2 students are Adobe Acrobat Reader, AvantGo, eMedicine’s Disaster and Trauma e-book, ePocratesRx, ePocratesID, Kaplan-To-Go!, Anatomy Flash Cards, MedCalc, MedMath, Medical Spanish Terminology, PocketPearls and Tarascon ePharmacopeia. Other additional resources for medical related software applications are medical dictionary, differential diagnosis tools, normal lab values, Merck Manual of Diagnosis and Therapy, Griffith’s 5-Minute Consult and class schedule (Mays, Blumenthal et al. 2002). PDA stations are available for students to update and install software applications in both PalmOS and PocketPC platforms. Two types of data transmission are available at PDA stations in both XTND Access infrared PC adapter and a EthIR LAN device without using a PDA cradle (Georgetown 2004). For data security concerns,
Georgetown use data encryption (Secure Sockets/SSL, Secure Shell/SSH, etc.) and user authentication techniques to protect against unauthorised access (Georgetown 2004). The PDA wireless network has been developed based on the IEEE 802.1X protocol which has less electromagnetic radiation than other cell phones, therefore the wireless network that is used with PDA systems does not pose any health risks to healthcare units (Georgetown 2004).

Columbia University. At Columbia University, the medical school and medical education researchers have started to explore the use of PDAs in medical education. They started a pilot project for a students’ log system through the use of PDAs in their third year clerkship in primary care in 2001. The results of this study were that the use of PDAs in tracking patient logs is easier and faster to use than optically scanned cards. The medical school requires students to update their clinical-log data to the university’s database on a weekly basis. With the PDA recording system, students can enter patient data with a lower percentage of missing data (Kurth, Silenzio et al. 2002).

Stanford University. The Stanford University, School of Medicine launched a pilot project in 2002 for a PDA-based audience response system called ‘classroom polling systems’. The purposes of this project were (i) to develop interaction between teacher and students in the lecture class by allowing interactive responses and (ii) to draw attention from students (Menon, Moffett et al. 2004). The major components of these systems include PDA with wireless access, wireless access point, web server, web application, database and multimedia software. The major problem of this project is the cost of distributing Bluetooth or wireless access cards, to the students (Menon, Moffett et al. 2004). Students are able to use PDAs to record patient histories, the results of physical examinations, electronic medical records and laboratory information. The available PDA resources for students to
download in PDA format include drug database, AvantGo, web-clipping service, class announcement and assignments, mobile medical program to convert X-ray, CT scan and other medical images (Stanford 2001).

**Medical College of Wisconsin.** The Medical College of Wisconsin performed a needs assessment in women’s health curriculum in 2000. The study was designed to utilise PDAs to obtain real-time assessment in women’s health teaching during their third year clerkship. The patient log system was installed on a handheld computer. The components of the log system include rotation, clinical setting, gender of teacher and patient, patients’ diagnosis and whether the gender affects the disease of patients. Medical students need to download patient logs to a central computer fortnightly. According to the patient log, the report in the diagnostic categories is supported for the statistical analysis. Most medical students use PDAs to record their activities during their clerkship. Therefore the use of PDAs shows how the medical school monitors students during their clerkship and also conforms to the medical curriculum (Autry, Simpson et al. 2002).

**Wayne State University.** The Wayne State University School of Medicine, Detroit developed an evaluation system to monitor the achievement and equity of students’ clinical experiences at their clinical sites during 1999-2001. This system allows students to provide real-time feedback for the progress of their clerkship via the use of PDAs, Internet and intranet. In the meantime, the students can also monitor their own progress, for instance, interdependent area reports of clinical encounters (Bridge and Ginsburg 2001; Wayne 2002). The clerkship director can also view the reports of all students or specific student at their real-time experiences (Bridge and Ginsburg 2001; Wayne 2002). This system was divided into two subsystems. The front-end systems include the development of a database for the PDA, which the students can transfer the data from remote sites via the PDA
modem to the central server at the medical school. The students are required to send the data back to the School of Medicine’s central server on a weekly basis (Wayne 2005). The back-end systems were composed of remote receiving data, data storage and reporting of data. The back-end technology used Palm Hot Sync software as it allows the database to be downloaded to the clinical students with the Windows NT server. The Oracle database management software and JSP (Java Sever Page) were selected to implement these systems. The problem found while testing the system was the download time --it was time consuming if students wanted to download more than 20 patient records or with a large volume of data. The systems, however, can improve collaboration, support and communication between the teacher and students in order to maintain the quality of medical education. (Bridge and Ginsburg 2001).

PDAs were used as the educational tool for second-year (pre-clinical) students in the medical school in 2002. The teachers were able to monitor student performance via real-time interactive programs with a PDA-based format during class discussion (Wayne 2005). Moreover, PDAs are used to record student clinical experiences, patient contacts and clinical encounters while students are away in their clinical placements, for instance, type of patients, medical conditions and clinical procedures (Wayne 2002; Wayne 2004). The purposes of using PDAs for recording the students’ encounters are (i) to keep track of student experience during their clinical rotations in family medicine, obstetrics/genecology and surgery and (ii) to ensure that the learning objectives are met (Wayne 2002). PDAs are also used extensively during third- and forth-year to carry class schedules, clinical and medical references, patient management, clerkship examination, procedure coding and professional educational development (Wayne 2006; Wayne 2006).
3.7 Issues to consider for PDA use in healthcare and the medical profession

Generally, there are nine major issues to consider before implementing PDAs in the healthcare sector (Table 3.7) (Martins and Jones 2005) besides PDA functionalities (Holubar and Harvey-Banchik 2007).

Table 3.7 Issues to consider before incorporating PDAs in healthcare and the medical profession

<table>
<thead>
<tr>
<th>Issues to consider before incorporating PDA use in healthcare and medical professions</th>
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<tbody>
<tr>
<td>Data security and information privacy</td>
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<tr>
<td>Interoperability of compatibility of PDA platforms and availability of software</td>
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<tr>
<td>applications</td>
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<tr>
<td>PDA functionalities</td>
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<tr>
<td>Network connectivity and scalability</td>
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<tr>
<td>Education and training</td>
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<tr>
<td>Familiarity of using PDAs and ability of using PDA</td>
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<td>EI</td>
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<tr>
<td>Social acceptance</td>
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<td>Maintenance and support</td>
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**Data security and Information Privacy**

Data security and information privacy is a concern in personal digital assistant (PDA) use in medical education and healthcare organisations. Awareness of security and privacy has been emphasised for the incorporation of PDAs not only into healthcare organisations but also in medical education (Alvarez 2002; Jahan, Gretter et al. 2002). Information access, storage and retrieval (Alvarez 2002) and loss of data (Alvarez 2002; Kurth, Silenzi et al. 2002) are major concerns of PDA use in clinical practice. The obvious concern is that data is sensitive, and might be accessed and used by the
wrong people. Data security, therefore, is a significant aspect for the use of health information and PDA applications in healthcare organisations (Alvarez 2002; Buranatrived and Vickers 2002; Jahan, Gretter et al. 2002; Nairn 2005; Peters 2005; Turner, Milne et al. 2005; Jarvenpaa and Lang Fall 2005). Data security and information privacy issues are essential for wireless connectivity. It is necessary to ensure that data being recorded on PDAs is securely protected as there are risks of losing PDAs containing private and confidential data.

**Data security**

*Data security* is an important aspect of medical information. It is necessary to ensure that data being recorded on PDAs is securely protected as there are risks of losing PDAs containing private and confidential data (Martins and Jones 2005). Further, data security also covers other aspects around computer viruses, worms and Trojan horses which may originate and spread from adware, spyware or cybercrime (Hughes and DeLone 2007). These is also computer crime or cybercrime, which users may encounter when using mobile devices, PDAs or computers generally (Hughes and DeLone 2007).

Further, data security is a collection of policies and procedures to safeguard and maintain the integrity, availability and accessibility of information systems (Win 2005). There are three major attributes of information security, these being (i) integrity, (ii) availability and (iii) confidentiality.

*Integrity*. Integrity is the protection of unauthorised access to information. The meaning of *data integrity* for medical information is that an unauthorised person is not allowed to access, modify or track any patient information (Pordesch 1998; Lin and Vassar 2004; Turner, Milne et al. 2005). Therefore, to ensure integrity, *data encryption and decryption* must be applied to any sensitive data, especially transmitting patient information over the Internet (Pordesch 1998; Alvarez 2002; Lin and Vassar 2004; Turner, Milne et al.
Data transmitted over the Internet can be intercepted by any unauthorised user. Using data encryption and a virtual private network (VPN) for data protection, data can be transmitted without risk (Lin and Vassar 2004). The cost of applying data encryption in VPNs is less than private telephone leased-line or frame-relay connections (Lin and Vassar 2004). Using VPN with minimum configuration is an effective network security solution (Turner, Milne et al. 2005). In addition, the selected data encryption technique should at least satisfy the data security requirements and standard (Lu, Xiao et al. 2005). In addition users also need to be aware of sharing data either by beaming to other handheld computers or synchronising to a personal computer (Alvarez 2002). There are various threats of using wireless devices via open networks, including manipulation, interception, interference, unauthorised access of data, potential cost of replacement, ineffective device management, staff misuse and Malware/Worms (Pordesch 1998; James 2004; Miller 2004) (see Table 3.8).

Table 3.8 Wireless Network Threats (Pordesch, 1998; James, 2004)

<table>
<thead>
<tr>
<th>Threats of Wireless Network</th>
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<tbody>
<tr>
<td>Manipulation</td>
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<tr>
<td>Interception</td>
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<tr>
<td>Interference attempts</td>
</tr>
<tr>
<td>Unauthorised access</td>
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<tr>
<td>Potential cost of replacement</td>
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<tr>
<td>Ineffective device management</td>
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<tr>
<td>Staff misuse</td>
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<tr>
<td>Malware/Worms</td>
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</table>

Availability. Availability is protection against the unauthorised withholding of information (Win 2005). Medical data and health information should be accessible anytime for authorized users. However such data and information can be inaccessible due to technical failure. Data backup procedures can be
considered as one option in maintaining data availability (Lin and Vassar 2004).

Confidentiality. Confidentiality is the protection of unauthorised disclosure of information. It also relates to information privacy (Win 2005).

**Device security and data security techniques**

Security of information can be applied in terms of hardware (device or physical security) or software mechanisms (data security techniques).

*Device security.* PDA memory is easily removed, therefore a security policy is compulsory for data protection, for instance, data encryption and anti-virus protection with updated virus signatures (Miller 2004). Device management involves with a data synchronisation process. Data on PDAs will be merged with the management host. PDAs must be securely kept at all times (Holubar and Harvey-Banchik 2007). Therefore data will be moved from the PDA to the host or central computer (Miller 2004).

*Data security techniques.* Data security procedures and techniques are applied to PDAs in order to safeguard information. Data security techniques are very much dependent on the requirements, interests and situation of each organisation. In terms of technical aspects, it is dependent on the availability and suitability of network resources, network infrastructure and other related factors. Possible data security techniques range from authentication with username and password, information access priority, data encryption, unobserved-ability, acknowledgement, services with special package and digital signatures, wireless communication security and wired equivalent privacy (WEP), biometric identification, digital signatures, PKI, symmetric cryptographic algorithms, token-based two-factor authentication, data security for GPRS, GSM or 3G networks and backup procedures (Pordesch 1998; Miller 2004; Turner, Milne et al. 2005; Win 2005). However with
current data security procedures, the majority of medical information is protected by username and password, which may possibly be insufficient in terms of security. Generally, data security also includes security for the mobile device and the network itself (Lin and Vassar 2004).

An information access priority should be applied to different groups of users. In the mean time, information should be backup centrally and individually by central IT unit and individual user (Rotich, Hannan et al. 2003). Further, data security also covers other aspects around computer viruses, worms and Trojan horses which may cause and spread from adware, spyware or cybercrime (Hughes and DeLone 2007). These is also computer crime or cybercrime, which users can encounter when using computers and mobile devices (Hughes and DeLone 2007).

Therefore 4-security techniques are recommended against the threats of wireless devices, these being (i) manual authentication, (ii) data encryption, (iii) securing non-repudiation of connections and (iv) avoiding unnoticed distortion of contents (Pordesch 1998).

**Different security technologies**

In technical term, data security is dependent on the availability and suitability of network resources, network infrastructure and other related factors (Pordesch 1998) Possible data security techniques are data encryption, unobserved-ability, user authentication, acknowledgement, services with special package and digital signatures, wireless communication security, wired equivalent privacy (WEP), device security and device management (Table 3.9) (Pordesch 1998; Miller 2004; Turner, Milne et al. 2005).
Table 3. Possible wireless security techniques (Pordesch, 1998; Miller, 2004)

<table>
<thead>
<tr>
<th>Wireless security techniques</th>
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<tbody>
<tr>
<td>Data encryption</td>
</tr>
<tr>
<td>Unobserved-ability</td>
</tr>
<tr>
<td>User authentication</td>
</tr>
<tr>
<td>Biometrics</td>
</tr>
<tr>
<td>PIN or password</td>
</tr>
<tr>
<td>Token-based two-factor authentication</td>
</tr>
<tr>
<td>Acknowledgement</td>
</tr>
<tr>
<td>Digital signatures</td>
</tr>
<tr>
<td>Wireless communication security</td>
</tr>
<tr>
<td>Wi-Fi</td>
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<tr>
<td>GPRS/GSM</td>
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<tr>
<td>3G Networks</td>
</tr>
<tr>
<td>Wired Equivalent Privacy (WEP)</td>
</tr>
<tr>
<td>Device security</td>
</tr>
<tr>
<td>Device management</td>
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</tbody>
</table>

Public health services are particularly interested in the following security approaches: *data encryption, unobserved-ability, biometric, personal identification numbers (PIN) or password protection, token-based two-factor authentication, acknowledgement, digital signatures, wireless security, data security for GPRS, GSM or 3G networks, WEP for wireless network connectivity, device security and device management.*

*Encryption.* Voice transmission can be encrypted in order to protect from unauthorised access (Pordesch 1998). In order to encrypt voice, it is required to change hardware of mobile devices (Pordesch 1998; Masseroli, Visconti et al. 2006). In addition, Pordesch (1998) recommended that text messages should be applied with a cryptographic mechanism before sending to a third party.

However, newer PDA technologies normally come with the latest security standards for data encryption and authentication (Peters 2005), for instance,
remote access to clinical databases by data encryption with PDAs for wireless data transmission (Wilcox and Tella 2001).

For *PIN or password protection*, this method is a standard authentication level, fast and inexpensive to implement (Miller 2004). This protection method is a simple data protection for any wireless devices, for instance, PocketPC. It may not be sufficient data protection. This is because PIN is firstly readable once registered (James 2004). PIN can be read through other phone’s memory, which any unauthorised user can gain access after device start-up (James 2004).

**Wireless security.** There are a number of technologies being applied to wireless devices and can be categorised into the following groups: WiFi, GPRS/GSM and 3G networks (Table 3.9) (Miller 2004). *Wi-Fi* is simple, short range, easy to implement with a built-in security function (Miller 2004). On one hand, *GPRS/GSM* is a more complex system delivered to existing telephony technology infrastructure. Data communication can be temperamental and extremely slow compared to modern standards. The coverage area is very good (Miller 2004). On the other hand, *3G networks* brings a great change to mobile communications technology, as it provides faster speed and better roaming facilities. However, this technology still depends on the existing network carrier (Miller 2004).

**WEP.** The idea of WEP is to improve wireless network security as WEP uses a data encryption technique for devices to gain wireless network access. The advantage of WEP is that it can communicate among wireless devices. The implementation of WEP can be done within a wireless network card. Such implementation requires no further modification of software, which is protected by WEP (Turner, Milne et al. 2005). However, the weakness of WEP is the ease of the key to be recovered due to weakness cryptographic (Turner, Milne et al. 2005). Turner et al. (2005) indicated that such weakness
can be solved by AirSnort tools. In order to enhance wireless network security, the wireless access points should be directly connected to the VPN via a firewall instead of a direct connection to a wired-network (Turner, Milne et al. 2005).

Other techniques are device security and device management as mentioned earlier. For device management, this technique involves with data synchronisation process. Therefore data will be moved from PDAs to host or central computer. However, the problem of data transmission via data synchronisation may arise especially with sensitive data. For instance, distribution of software or sensitive data via data synchronisation might cause overexposure of sensitive data (Miller 2004). Another issue concern of is keeping PDAs up-to-date, in particular with software applications, operating systems, policies and data (Miller 2004).

Pordesh (1998) indicated that PDAs should have two major security settings, namely (i) global setting and (ii) individual security setting. The global settings are the setting for all PDAs. On the other hand, the individual security setting can be set and defined by each PDA user (Pordesch 1998).

However security requirements are much dependent on the certain situations and each organisation’s interest (Pordesch 1998). Pordesh (1998) recommended that data security should be simple as much as possible, and application oriented. Therefore data security procedures should be integrated into the communication network (Pordesch 1998).

In addition, newer PDA technologies always come with new standards for data encryption and authentication procedures. Another challenge is how to maintain data security with integration between older and newer PDAs (Peters 2005).
Information privacy

In order to maintain information privacy and confidentiality, systems need to be securely protected. It is essential for healthcare providers and stakeholders to maintain and focus on the privacy of information and to protect the data from any unauthorised access (Win and Fulcher 2007). Importantly, healthcare providers and users of health information need to abide by the privacy acts to ensure the patient’s confidentiality (Win 2005; Win and Fulcher 2007). Health privacy legislation exists in various countries. For instance, the United States of America has the HIPAA that emphasises health information. It is essential for all healthcare organisations and providers to follow this legislation. In addition, the HIPAA covers data security and information privacy of patient data in both hard- and soft-copy form (Holubar and Harvey-Banchik 2007).

In Canada, the Personal Information Protection and Electronic Document Act (PIPEDA) was applied to personal health information being used in the public sector. Further, the ACT Health Records (Privacy and Access) Act 1997 emphasises 12 privacy principles. The Health Record Act 2001 and the HRIPA 2002 are used in Victoria and NSW, respectively (Win 2005; Win and Fulcher 2007). The HRIPA comprises 15 Health Privacy Principles (HPPs).
Table 3.10 Fifteen principles of HPPs

<table>
<thead>
<tr>
<th>Collection</th>
<th>1. Lawful. Health information should be corrected for lawful purposes. The collection of health information should be relevant to organisation’s activities.</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>2. Relevant. It is essential to ensure that the collection of health information does not breach individual.</td>
</tr>
<tr>
<td></td>
<td>3. Direct. Only collect information directly from personal concerned.</td>
</tr>
<tr>
<td></td>
<td>4. Open. It is essential to inform the person why health information needs to be collected, for what purposes and who will use the information.</td>
</tr>
<tr>
<td>Storage</td>
<td>5. Secure. Information must be securely kept and protected from unauthorised person.</td>
</tr>
<tr>
<td>Access and</td>
<td>6. Transparent. It is essential to inform the person about what health information to be stored and why it is being accessed and used.</td>
</tr>
<tr>
<td>accuracy</td>
<td>7. Accessible. The health information should be available for accessing without reasonable delay.</td>
</tr>
<tr>
<td></td>
<td>8. Correct. Health information can be updated, corrected and modified if necessary.</td>
</tr>
<tr>
<td></td>
<td>9. Accurate. Health information should be accurate and relevant before using.</td>
</tr>
<tr>
<td>Use</td>
<td>10. Limited. Health information should be used for its purposes, otherwise consent is needed.</td>
</tr>
<tr>
<td>Disclosure</td>
<td>11. Limited. Health information should be used for its purposes, otherwise consent is needed.</td>
</tr>
<tr>
<td>Identifiers</td>
<td>12. Not identified. Unique identifiers must be used to identify people.</td>
</tr>
<tr>
<td>and anonymity</td>
<td>13. Anonymous. Anonymity should be given to people as the option for receiving services.</td>
</tr>
<tr>
<td>Transfer and linkage</td>
<td>14. Controlled. Health information can be transferred outside NSW in accordance with HPP 15. Authorised. People must express their consent to disclose their identifier for the purpose of the health records linkage system.</td>
</tr>
</tbody>
</table>

Table 3.10 illustrates what the NSW public and private sector must abide by when collecting, storing, using and disclosing health information.

Information privacy is an important concern. Privacy protection and security procedures can decrease the gap between users’ expectations and technology performance in mobile computing (Jarvenpaa and Lang Fall 2005). Privacy of patient information is protected by the privacy laws, which cover
unauthorised access to personal data, unauthorised destruction and unauthorised data disclosure (Mole, Fox et al. 2006). Therefore, when disclosing patient information, it is essential to ensure that data is protected.

In regards to PDA use in healthcare and the medical profession PDAs are normally owned by individuals rather than particular units. Therefore transferring data, in particular patient information or EHR, via PDAs could be uncontrollable in terms of patient privacy. It is possible that healthcare providers could limit access to health information or limit the ability to download and transfer patient information to PDAs or any computer (Holubar and Harvey-Banchik 2007).

Data security procedures and techniques being applied to PDAs and allied systems need to safeguard information. There are three simple data security procedures which can be applied to information systems in general, these being (i) username and password protection, (ii) information access priority and (iii) backup procedures. Information access priority should be applied to different groups of users. For backup procedure, the information should be backed up centrally and individually by the central IT unit and individual users, respectively (Rotich, Hannan et al. 2003).

*Privacy protection and security procedures* can decrease the gap between user expectations and technology performance in mobile computing (Jarvenpaa and Lang Fall 2005). However, the privacy of patient’s information is already protected by privacy laws, which covers unauthorised access to personal data, unauthorised destruction and unauthorised data disclosure (Mole, Fox et al. 2006). Therefore, when disclosing any patient information, it is essential to ensure that data is protected. Grandison et al. (2007) introduced the concept of “*Sticky Policy Enforcement*”, which allows data to be disclosed to a third party with less privilege in accessing or viewing data. The third party can access data without having permission to
the original source of data, as the data is already protected by such a policy. Therefore, every time data is transferred and disclosed to the third party, this policy is always attached along with the data. However, data transmission over the Internet can be intercepted by unauthorised users. Using data encryption and virtual private networks (VPN) for data protection, therefore, can ensure data transmission without risk (Lin and Vassar 2004).

**Interoperability (compatibility of PDA platforms)**

Compatibility of PDA platforms is an essential factor to consider before deploying PDAs into healthcare and the medical profession. Compatibility of different PDA platforms not only impacts PDA use within healthcare organisations but also personal use, as it affects the ability to synchronisation data between PDAs and computers, as well as the ability to transfer data among PDAs, computers and other mobile devices over computer networks, cellular networks or the internet (Holubar and Harvey-Banchik 2007). Further, the specific PDA platform also affects the availability of software applications and PDA functionalities relevant to healthcare and the medical profession (Holubar and Harvey-Banchik 2007).

On the other hand, interoperability is a limitation of utilising PDAs in the healthcare sector, as there are various PDA operating systems available in todays market, for instance, PalmOS, PocketPC and Linux; the majority of PDA users are Palm users (70%) while others are PocketPC and other OS (Lin and Vassar 2004). There is no single platform that is suitable for all user and organisational requirements. Therefore encouraging users/organisations to use any particular PDA platform would be impossible if they already have one (Topps, Thomas et al. 2003).
**PDA functionalities**

PDA functionalities for healthcare and the medical profession can be generally categorised into 4-major areas, these being (i) specialty functions for particular professions, (ii) administrative functions, (iii) communication functions and (iv) reference functions. Firstly, specialty functions for particular healthcare and medical professions are available for surgeons, pharmacists, physiologists, pharmacists, radiologist, nutritionists, etc. Such functions are developed and implemented to support the different needs in each particular professional. Secondly, administrative PDA functionalities carry and manage information and work flow within healthcare providers, for instance patient tracking, EHR, etc. Thirdly, communication functions on PDA devices allow healthcare providers, healthcare and medical professionals to communicate, transfer and contact each other using secure network connectivity. Finally, reference functions seem to be the most important PDA functionalities, especially for the medical profession, as they allow physicians to look-up references at the bedside and thus support clinical decision making.

**Scalability and network connectivity**

*Scalability* is essentially emphasized on expanding wireless systems without any system breakdown. Expanding the size of wireless networks is directly related to the number of wireless devices, as well as the system capacity of the network (Lin and Vassar 2004). Network scalability directly depends on various factors, for instance, data transmission load, computation, network size, robustness and memory (Agarwal, Starobinski et al. 2002). All these factors are discussed in the next section regarding data synchronisation protocols. Agarwal et al. (2002) indicated three concerns regarding network scalability with respect to data synchronisation for PDAs, these being (i) the
amount of data to be synchronised between two devices, (ii) the amount of data needed to be stored in the memory in order to maintain data consistency, and (iii) the computation required during data synchronisation (Agarwal, Starobinski et al. 2002).

Network connectivity of PDAs in wireless networks can be categorised in terms of geographic or independent connection. Generally, a common connection of PDAs is through data synchronisation via universal serial bus (USB) port where users can connect to high-speed internet in order to transmit data (Andrade, von Wangenheim et al. 2003a; Lin and Vassar 2004). In addition, there are 6-concerns regarding network connectivity (Figure 3.1), namely network bandwidth, choice of PDA platforms, coverage area, amount of data synchronisation, type of data synchronisation, and type of network connectivity.

![Figure 3.1 Concerns related to connectivity](image)
Bandwidth.

Problems with connectivity and data transmission (Figure 3.1) are related to bandwidth, particularly for wireless connection (e.g. wireless Ethernet, Bluetooth) (Hoffmann, Scott et al. 2001) as wired connections provide higher bandwidth than wireless connections. (Hoffmann, Scott et al. 2001).

Choice of PDA platform and network area coverage

Dyck (2002) indicated that network connectivity is a major problem for mobile developers as there is a variety of platform choices (as stated in section 2.2.3). Network connectivity problems would occur when the devices are not within the coverage areas. Therefore solutions to these problems are (i) to develop the software application to run locally on PDAs and (ii) to use local databases to store the data while not in the coverage area for real-time data synchronisation (Dyck 2002).

Types of network connectivity

Various types of connectivity (Table 3.11) are available for PDAs, for instance, infrared port, Bluetooth radio frequency, cellular digital packet data (CDPD) modem, WLAN, pager transmission and remote data synchronisation (Want and Borriello 2000; Hoffmann, Scott et al. 2001). These days, wireless connectivity for PDAs is affordable as cables are no longer required to connect to PC or notebook computers. Data synchronisation can be done via infrared port or Bluetooth connection instead of synchronising the PDA via a cradle/docking station with cable connection (Want and Borriello 2000).
**Table 3.11** Data synchronisation approaches (Want and Borriello, 2000; Hoffmann, Scott et al., 2001)

<table>
<thead>
<tr>
<th>Wireless connectivity</th>
<th>Wire connectivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infrared port</td>
<td>USB Cradle</td>
</tr>
<tr>
<td>Ethernet</td>
<td></td>
</tr>
<tr>
<td>Bluetooth Radio Frequency</td>
<td></td>
</tr>
<tr>
<td>Cellular Digital Packet Data (CDPD) mod</td>
<td></td>
</tr>
<tr>
<td>WLAN</td>
<td></td>
</tr>
<tr>
<td>Pager Transmission</td>
<td></td>
</tr>
<tr>
<td>Remote data synchronisation</td>
<td></td>
</tr>
</tbody>
</table>

However, wireless technology may create numerous other problems apart from connectivity. Therefore users must carefully consider their needs in order to satisfy a particular service. Various concerns (Table 3.12) for users to consider before start using wireless computing include mobility fulfilment, privacy protection and security, technology competence/incompetence, interface design or technical limitations, cross-platform solutions, compatibility of software application upgrading, uncertainty about long-term stability and viability (Jarvenpaa and Lang Fall 2005).

**Table 3.12** Summary of significant issues for wireless networks

<table>
<thead>
<tr>
<th>Significant issues for wireless networks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobility fulfilment</td>
</tr>
<tr>
<td>Privacy protection and security</td>
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<tr>
<td>Technology competence/incompetence</td>
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<tr>
<td>Interface design or technical limitation</td>
</tr>
<tr>
<td>Cross-platform solution</td>
</tr>
<tr>
<td>Compatibility of software application upgrading</td>
</tr>
<tr>
<td>Uncertainty about long-term stability and viability</td>
</tr>
</tbody>
</table>

*Mobility fulfilment* refers to the ability to do things anywhere and at anytime with mobile technology (Jarvenpaa and Lang Fall 2005), whereas *technology*
competence/incompetence essentially affects ability to do things effectively and efficiently (Jarvenpaa and Lang Fall 2005). Interface design (technical limitation) may effect to users’ self-efficacy. Examples of technical limitations with regard to mobile technology are limited screen size, small input keys, network constraints, poor connectivity and bandwidth limitations (Jarvenpaa and Lang Fall 2005). Therefore software applications that support mobile computing must be well designed and implemented in order to suit user requirements (Jarvenpaa and Lang Fall 2005).

Data synchronisation approach/protocol and size of data to be synchronised

In terms of connectivity, data synchronisation for PDAs should be well defined (Agarwal, Starobinski et al. 2002) regardless wired or wireless data transmission over low bandwidth, central procession unit (CPU) speed, memory capacity, transferring large amount of data and battery power. With remote data synchronisation, PDAs are able to display web-content, e-mail and messages on the PDA screen in real-time (Want and Borriello 2000).

Data synchronisation is essential for maintaining data consistency in PDAs. Therefore data synchronisation must be done periodically while PDAs are connected to a network. In general, PDA becomes one node while connecting to the network whether it connects to PC, laptop computer or desktop at home. For this reason, data synchronisation can be categorised into two groups: single-device and multi-device synchronisation (Agarwal, Starobinski et al. 2002).

The idea of single-device synchronisation is that a PDA synchronises with the same computer all the time. That means the modification flag and time stamps are completed by the FastSync approach of the HotSync synchronisation protocol. Therefore the data modification of single-device
synchronisation is based on the previous synchronisation. In case any conflict occurs regarding data synchronisation of the same record, manual or chronological modification must be determined by the user (Agarwal, Starobinski et al. 2002).

On the other hand, multi-device synchronisation is more complicated than single-device synchronisation, as the PDA is synchronised with different computers at different locations, for instance, workplace desktop, home computer, laptop computer, other PDAs or cell-phones. Therefore maintaining data consistency is essential for different PDA devices (Agarwal, Starobinski et al. 2002).

PDAs can be synchronised using various approaches, including (i) synchronise by time schedule-basis while pending on the queues, (ii) synchronise when PDAs are in coverage areas, or (iii) synchronise when PDAs are on the server request (Dyck 2002).

These days various data synchronisations protocols for PDAs are available, for instance, Palm HotSync synchronisation protocol, Pumatech’s Intellisync synchronisation, the SyncML standard and the CPISync (new scalability-oriented) protocol (Agarwal, Starobinski et al. 2002).

**Education and training**

Education and training on PDA use is an essential aspect to consider before implementing and introducing PDAs to healthcare professionals, in particular providing sufficient training for doctors and patients (Martins and Jones 2005). Providing adequate education and training of PDA use would affect the level of familiarity and the ability to use devices by healthcare and medical professionals (Holubar and Harvey-Banchik 2007).
Familiarity of using technology (Technology Comfort)

Comfort with technology (computer or technology competency) is a concern regarding PDA use in the medical profession and medical education. It is possible that users are afraid of using technology and afraid of breaking or damaging the devices, for instance, fear that a device might be broken if used too often (Lu, Xiao et al. 2005).

In addition, there are several studies which indicate that familiarity with technology and computer technology competence of users are directly associated with sufficient maintenance, support, education and training on PDA and other related technologies (Seago, Schlesinger et al. 2002; Scott, Wilson et al. 2005; Kho, Henderson et al. 2006).

A study on the computer literacy of medical students indicated that the tendency of computer literacy in the 21st century is free of barriers in the use of technology in medical education, as there are a number of medical schools are gradually deployed computer technology into medical education (Seago, Schlesinger et al. 2002). Computer technologies which are used in medical education, range from computers, online learning, computerised examination and PDAs (Seago, Schlesinger et al. 2002).

Kho et al. (2006) indicated that most of medical students are already familiar and comfortable with the use of PDAs in medical education. However, insufficient technical experience seems to be a barrier in using technology. Such a barrier is usually found from all PDA users whether they are already familiar with the technology (Kho, Henderson et al. 2006). Further, students tend to have a high comfort level in using PDAs during clerkship rotations (Baumgart 2005).

Another study indicated that the usage PDAs gradually increases due to the medical faculty and students finding PDAs useful in medical education.
(Stroud, Erkel et al. 2005). Also, both medical faculty and students tend to have high technology comfort in using PDA technology in medical education. Indeed many studies that using PDAs in medical education and during clinical rotation tend to enhance the students’ clinical experiences during clinical rotations (Baumgart 2005; Stroud, Erkel et al. 2005).

**Electromagnetic Interference (EI)**

EI of PDAs is one concern for incorporating such devices into the healthcare sector, as they might interfere with other medical devices, especially in cardiac wards (Lin and Vassar 2004).

Tri et al. (2004) indicated that the EI generated from WLAN technology caused no harm to pacemakers within a WLAN at the Mayo Clinic in Rochester. The connection was established by using a Cisco Aronet WLAN card (IEEE 802.11b standard) in 2.4 MHz band. PDAs were connected to the WLAN either by external or internal WLAN card. Aironet WLAN cards were programmed to generate maximum power. After programming Cisco Aironet WLAN card to generate maximum power, all pacemakers and cardioverter-defibrillators (ICDs) were programmed to various kinds of setting – unipolar, bipolar, sensing and pacing. The results showed that EI did not occur with other medical devices, particularly the ICD ones (Tri, trusty et al. 2004). However, the ICD devices identified the signal that generated from Cisco Aironet WLAN as “noise” (Tri, trusty et al. 2004). As a result, no EI was found from the WLAN by testing with cardio pacemakers and ICDs (Tri, trusty et al. 2004). Van et al. (2005) also indicated that cell phones cause no EI to cardio-pacemakers and other ICDs (again at the Mayo Clinic, Rochester).

Similarly, interference testing with WLAN connection for PDAs in a special unit at a hospital in Edinburgh, UK was conducted (Turner, Milne et al.
2005). The implementation of wireless technology with PDAs was formulated with various choices of software, hardware data security and networks solutions. Dragon Naturally Speaking Software, MySQL, PHP language, PDAs, Cisco Aironet access point and IEEE802.11b standard were selected for this interference testing project. The interference testing was performed against the medical devices in order to ensure that no EI might be caused in the medical devices. IEEE802.11b with 2.4MHz band was used to test for EI of PDAs for distances of 0.5, 1.0, 1.5 and 10.0 meters from wireless access points. The results indicated that no EI was discovered while placing PDAs close to sensitive radio frequency (RF) clinical devices, and none of them caused harm to any other relevant medical equipments (Turner, Milne et al. 2005).

However the use of cell-phones and two-way communication devices such as radios are able to interfere medical devices due to generation of EI from such devices (Jones and Conway 2005; Nairn 2005).

A number of studies indicated that PDA causes no EI with medical equipment (Tri, trusty et al. 2004; Turner, Milne et al. 2005; Scientific 2007). However PDA phones or smartphones to cause EI with medical equipment (e.g. respiratory ventilator, cardio peacemaker) at distances of less than 2 metres. First generation mobile phones are safe to use in hospitals at distances greater than 2-metres away from the medical equipment as they can generate mild signal which would cause malfunction of medical equipment (Gilfor 2001; MayoClinic 2001; Jones and Conway 2005; Young and Fox 2005; BioMedCentral 2007). In addition, second- and third-generation mobile phones still cause EI with medical equipment even though such devices are located 3-metres away from medical equipment (BioMedCentral 2007). Second- and third-generation mobile phones cause strong EI, and
cause the medical equipment to stop or have to be restarted (BioMedCentral 2007).

On the other hand, there are a numbers of hospitals have policies that prohibit the use of mobile phones (Jones and Conway 2005; Morrissey 2007). Even though a number of clinicians, pharmacists or healthcare staff still using these devices for communication besides pagers. Several studies indicated that it is a perception of many hospitals as using mobile phones could annoy patients, however such devices are still effective communication tools for medical professionals in consultations and treatments (Jones and Conway 2005; BMJ-BritishMedicalJournal 2006; YaleUniversity 2006; BioMedCentral 2007; BMJ-BritishMedicalJournal 2007; Scientific 2007).

**Interference between Wi-Fi and Bluetooth devices**

Wi-Fi (Wireless Fidelity) and Bluetooth are communication standards for wireless technology devices, particularly PDAs. Both Wi-Fi and Bluetooth use the same frequency band (between 2.40 and 2.48 GHz), therefore there is an opportunity for interference if the communication channels overlap with one another. In order to reduce interference, Quinnell (2005) introduced three major techniques: non-collaborative, collaborative technique, and other.

Non-collaborative technique which is adaptive packet selection and scheduling (APSS) can reduce the impact of interference in the Bluetooth connection. The idea of this technique is different range of packet length will be provided by Bluetooth connection. The adaptation of packet type and transmission time can reduce interference and data loss (Quinnell 2005).

Collaborative techniques can be performed once there is collaboration between Wi-Fi and Bluetooth communication channels in order to reduce the interference. The collaboration techniques can be controlled from the driver level, hardware level or higher-level software partitioning (Quinnell 2005).
The Driver-level collaboration technique can be controlled by switching between two different devices in order to protect against signal interference. The hardware-level collaboration technique is controllable. The chips are produced from different manufacturers. Therefore there is no opportunity that EI can occur from different chips manufacturers when the communication standard is available (Quinnell 2005).

The Higher-level of software collaboration technique is a simple collaborative technique that uses alternating-wireless-media access (AWMA). With this technique, the WLAN interval will be partitioned by the higher-level software into time segments (Quinnell 2005). However, this collaboration technique is effective when Wi-Fi and Bluetooth are connected into the same physical unit and access points (Quinnell 2005).

Other possible solutions are to control the direction of the antennas or to extend the distance between Wi-Fi and Bluetooth devices in order to protect from interference (Quinnell 2005).

Social acceptance

Although PDAs are widely used in the medical profession, user acceptance is still a barrier. Moreover, culture and social norm still remain when changing to different clinical practice (Lapinsky 2007). For example, patients may not like the doctors using PDAs in the examination room (Lu, Xiao et al. 2005). Therefore it is possible that PDAs will have limited use in front of patients or a certain areas in the hospital.

Maintenance and support

Maintenance and support could be a barrier in using PDAs in the medical profession and education. Maintenance and support can be in terms of PDA devices or certain software applications for medical profession or medical
education. It is possible that PDA software applications are no longer under warranty, therefore maintenance and support for software applications has cost implications (Lu, Xiao et al. 2005).

However Menon (2004) indicated that implementing and supporting any software application which runs on the wireless network is not too complicated, as most of universities have got wireless network infrastructures.

Providing adequate user support is a good foundation for maintenance. This technical support could be provided by a group of experts (Topps, Thomas et al. 2003). Technical support can be provided to users by the expert team in 8 different ways, these being (i) face-to-face contact with experts, (ii) e-mail to experts, (iii) telephone technical support, (iv) web-site information, (v) FAQ, (vi) user tips and discoveries, (vii) e-mail list and (viii) peer group (Topps, Thomas et al. 2003). There are a number of medical and nursing schools that directly provide maintenance and support for PDA applications, which were developed by the school along with the general support from the university (Bakken, Cook et al. 2003; Topps, Thomas et al. 2003). For instance, the use of Palm-based clinical-logs at the University of Columbia Nursing School is partially supported by the Informatics for Evidence-based Nursing Practice and the Columbia Centre for New Media Teaching and Learning, but the design and implementation is directly support by IT staff from the School (Bakken, Cook et al. 2003).

3.8 Medical Education

Medicine is a combination between the art and science as there are the involvement between sensitivity and clinical judgement on patient (Barrows and Tambyn 1980). The principal aim of medicine is to cure the ills, prevent people from illness and provide appropriate medical treatment to patients
(Barrows and Tambyn 1980). Learning medicine, therefore, is essential to have a basic foundation in health and the understanding of disease which would assist doctors to provide any necessary and effective treatment to patients (Barrows and Tambyn 1980). Spencer and Jordan (1999) indicated that medical education is a lifelong (LLL) learning process. This process could be started from pre-clinical experience, undergraduate education, general clinical training, specialty training and continuing medical education, respectively (Spencer and Jordan 1999).

In the old days, medical education was seen as the collaboration between medical schools and teaching hospitals. At present, medical education can be provided by medical practitioners as they can provide both medical and clinical education besides the traditional learning environment (Spencer and Jordan 1999).

To date, the tendency of medical education in the 21st century is essentially focused on the use of problem-based learning (PBL) approach or student centre with the use of information technology (IT) in medical education. The learning tends to be done with curiosity, knowledge exploration and clinical evaluation with the evidence being seen for learning (Corrigan, Reardon et al. 2008). The concept of PBL, context of PBL-approach, benefits and limitations of PBL were reviewed from section 3.8.2 onwards.

**Objective of medical education**

The objective of medical education, which was given by Barrows and Tambyn (1980) indicated that “the medical practitioner should have ability to identify, evaluate and manage patient with clinical problems or medical condition effectively and efficiently as well as humanely”.

Barrows and Tambyn also (1980) indicated that there are six important components in the objective of medical education, including, *evaluate, manage, patient, effectively, efficiently* and *humanely*.

Within medical education sphere, there are number of skills and sub-skills which are compulsory in medical study. These skills are included cognitive skills in clinical reasoning, medical problem solving skills, interviewing skills, physical examination skills and interpersonal skills. Therefore medical practitioner or physical should be able to identify and *evaluate* their patients based on theses skills which they would acquire while studying and learning medicine (Barrows and Tambyn 1980).

*Manage* or management is ability in providing appropriate medical treatment which requires clinical problem solving skills, clinical reasoning skills or clinical judgement skills to patient. Such medical treatment may include medication, surgery, counselling, rehabilitation or patient education in certain medical conditions (Barrows and Tambyn 1980).

*Patient* refers to any individual who ills and needs to have any necessary medical treatment based on the existing and pre-existing medical condition or health problem from the physician (Barrows and Tambyn 1980).

*Medical* is a specific component in healthcare. The physician or doctor is one of medical profession members, which include nurses, rehabilitation therapists, psychologists, nutritionists as well as psychiatry, etc (Barrows and Tambyn 1980).

*Effectively* and *efficiently* refers to speed, accuracy, consistency, reliability and suitability in diagnosing clinical problems and providing treatment and medical care to patients (Barrows and Tambyn 1980).
For humanely, it is essential for doctors and medical profession to diagnosis, provide their best in for clinical treatment based on patient medical condition regardless to race, nationality and social status (Barrows and Tambyn 1980). Importantly, any doctor or physician should be able to accomplish their learning needs in medical education in order to enhance their clinical skills when encounter with any clinical problem (Barrows and Tambyn 1980).

3.8.1 Traditional Medical Curriculum

The traditional learning approach is generally focused on teachers and contents in teaching. On the other hand, student centre-approach is essentially focused on what students learn in medicine. Spencer and Jordan (1999) indicated that student centre approach has changed the role of teachers or educators to mentor or facilitator in the process of learning.

In the traditional learning approach, students seem to spend their time on a particular course in order to accomplish their goal and compete with others during examination rather than trying to understand the subject being learnt (Farrow 1995). Forrow (1995) also indicated that there were number of medical student in the traditional learning approach carried large volume of lectures as receiving and accepting as “facts”. However traditional learning approach seems to be ceased after students graduated from their medical studies (Farrow 1995).

The continuation of learning, therefore, is important in practicing medicine no matter student status has been change to medical practitioners, doctors or medical specialists. As a result, a problem-based learning approach had been introduced in medical education in order to sustain a life-long learning in medical education sphere.
3.8.2 Problem-based Learning

PBL is a learning process which had been firstly formulated and used at McMaster University, Ontario, Canada in 1960s in undergraduate course and the University of Masstricht (Bligh 1995; Prideaux 2002; Smits, Verbeek et al. 2002). Therefore PBL was a brand new medical education at that period. PBL-approach consists of facilitator or tutor. PBL is a self-directed group with a small learning session, which is normally a brainstorming session (professional learning session) rather than teaching session (Smits, Verbeek et al. 2002; Batey 2006).

The tutor and facilitator in PBL-approach generally followed a particular learning sequence, for instance, Maastricht “seven jump” (Spencer and Jordan 1999).

Table 3. 13 Masstricht “seven jump” (Spencer and Jordan 1999)

| Please see print copy for images |

The “seven jump” (Table 3.13) are the learning process which allowed students to identify their individuals learning needs and how to accomplish their learning on particular problems (Spencer and Jordan 1999).
In addition, PBL is a learning method that use problems for students to begin their learning (Bligh 1995; Spencer and Jordan 1999). Such problems are generally the combination of clinical problems, basic science problems or the integration of basic science problems which would facilitate students to develop their critical thinking (Bligh 1995). These problems would assist students in developing their understanding about the concept and principal of each clinical problem in particular (Spencer and Jordan 1999).

Similarly, Maudsley (2002) indicated that PBL is the integration between educational method and philosophy, which focused on both students and problem as learning motivation.

To conclude, PBL-approach is an interactive learning by small group. It is also a self-directed learning which allows students or learners to identify their personal knowledge deficiency. PBL is a basic foundation of adult learning theory which improves students’ knowledge, skill and attitudes toward clinical problems being encountered and also develops a better learning environment (Prideaux 2002; Smits, Verbeek et al. 2002; Sanson-Fisher and Lynagh 2005; Batey 2006; Wood 2008).

Moreover, PBL facilitate a better understanding of the integration between basic science and clinical science with regards to clinical problems being encountered as each clinical attachment allows students to invigorate their knowledge from their learning.

PBL-approach is a life-long learning approach which facilitates students in developing their clinical-reasoning and clinical judgement skills before becoming doctors and also sustains their learning while practicing medicine elsewhere (Sanson-Fisher and Lynagh 2005; Batey 2006).

Defining learning material for PBL-approach must be done by the medical educators to determine which would be the essential elements in practicing
medicine. Firstly the core clinical elements must be identified then, secondly, clinical problems can be formulated and supported for learning activities, for instance, lectures, practicals, workshops, clinical attachments, etc. (Bligh 1995).

**Aim of PBL**

Learning in PBL-approach aims to explore and discover new knowledge and information which is gained by self-directed study with effective and efficient learning (Maudsley 2002). PBL is unlike the traditional learning approach as teachers tended to deliver knowledge and information to students rather than having problems drive students to explore their knowledge (Spencer and Jordan 1999; Maudsley 2002; Smits, Verbeek et al. 2002). Therefore PBL-session is normally concluded by group discussion and evaluation as a process of learning validation, which is normally done with tutor or facilitator (Bligh 1995; Smits, Verbeek et al. 2002).

**3.8.3 Context of Problem-based Learning (PBL)**

PBL-approach is a specific learning education in medicine. PBL is generally supported by particular learning tools that are designed for this particular learning process (Barrows and Tambyn 1980). As a result, PBL-approach is a learning process which tends to intensively use number of learning resources, for instance, video, websites, etc (Tan, Amin et al. 2007).

PBL-approach is not only presenting problems to students as a starting point to their learning but also demonstrated knowledge and experience being learnt from each particular problem (Barrows and Tambyn 1980). It is a basic learning process which allows the learner to explore their experiences and skills on problem being encountered in a particular learning environment (Barrows and Tambyn 1980).
The effectiveness of PBL-approach has been revealed in assisting students to develop their scientific and critical thinking regarding clinical problems with the integration among basic science, medical science and clinical information in real-life clinical experience. This would be beneficial for students when practicing medicine in their future employment (Barrows and Tambyn 1980). Generally, medicine is a profession which requires number of skills and capacity in practicing medicine with ability to work through each medical condition of each particular patient especially. Therefore PBL-approach is an efficient learning method any skill which is compulsory for practicing medicine from general though any specialty area (Barrows and Tambyn 1980).

There are a number of research evidence being proved that PBL-approach has been incorporated in undergraduate medical education and other training programs in various professionals. The use of PBL-approach in medical education tend to rise and increase exponentially (Sanson-Fisher and Lynagh 2005; Batey 2006). In addition, the current Australian medical schools elsewhere are already implemented or will be incorporating PBL-approach to their medical curricula (Sanson-Fisher and Lynagh 2005; Batey 2006). Moreover there are a number of organisations and websites have been promoting PBL-approach to medical education, for instance, the International Virtual Medical Schools (IVIMEDS) (Sanson-Fisher and Lynagh 2005; Batey 2006).

### 3.8.4 Benefits and Limitations of PBL

Several research evidences proved that the use of PBL-approach is beneficial to medical education (Bligh 1995; Farrow 1995; Spencer and Jordan 1999; Sanson-Fisher and Lynagh 2005; Batey 2006; Wood 2008). On the other hand, the limitations of PBL-approach to medical education are more towards
to several implications, including cost, resources and manpower in implementation (Spencer and Jordan 1999; Sanson-Fisher and Lynagh 2005; Batey 2006). The benefits and limitations of PBL-approach in medical education were reviewed in section the following sections.

**Benefits of PBL**

PBL-approach facilitates students in developing their learning strategy which would be beneficial not only their medical study but also their future professional in medical areas. Therefore, students would be able to use their knowledge while studying medicine in their professions without ignoring, instead applying PBL-approach to formulate their individual learning objectives regarding any clinical problem. In PBL-approach, numerous learning resources are used to facilitate in learning, including, textbooks, computerised literature searchers, journals, knowledge exchange by discussion or talking with patients, peers, clinicians, tutors, teaching staff, or family (Farrow 1995). PBL-approach, therefore, has positive effects on students competencies in developing their clinical knowledge and experiences as well as interpersonal and cognitive skills (Farrow 1995; Sanson-Fisher and Lynagh 2005; Wood 2008).

Moreover, PBL-approach also enhances students’ interest in learning, self-directed learning skills (Bligh 1995). PBL-approach would facilitate them to have a better understanding of the relationship and integration basic science in solving clinical problems being encountered.

In addition, PBL-approach also reduced amount of learning courses. On the other hand the clinical knowledge and skills are projected to increased as the learning is occurred in real clinical problems rather than studying from textbooks (Bligh 1995). Table 3.14 summarised the benefits of PBL-approach in medical education.
Table 3.14 Benefits of PBL-approach in medical education (Bligh 1995; Farrow 1995; Spencer and Jordan 1999; Sanson-Fisher and Lynagh 2005; Batey 2006; Wood 2008)

<table>
<thead>
<tr>
<th>Benefits of PBL-Approach in Medical Education</th>
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</thead>
<tbody>
<tr>
<td>1. Promote in-depth understanding in basic science, medical science and clinical problems rather than surface learning</td>
</tr>
<tr>
<td>2. Increase and maintain self-directed learning skills</td>
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<tr>
<td>3. Stimulate learning environment</td>
</tr>
<tr>
<td>4. Support and stimulate the interaction and relationship among students, peers, patient, clinicians, tutors and teaching staff</td>
</tr>
<tr>
<td>5. Enhance the collaboration between basic science and clinical sciences</td>
</tr>
<tr>
<td>6. Promote enjoy learning environment among students, peers, clinicians and teaching staff</td>
</tr>
<tr>
<td>7. Promote life-long learning</td>
</tr>
<tr>
<td>8. Improve students motivation in learning and researching</td>
</tr>
</tbody>
</table>

Limitation of PBL

The limitations of PBL-approach in medical education are more towards cost, resources and manpower implications in implementation. Table 3.15 summarised the limitations of PBL-approach.
### Limitations of PBL-Approach in Medical Education

<table>
<thead>
<tr>
<th>Limitation</th>
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<tbody>
<tr>
<td>1. Relatively high cost in implementation and maintenance</td>
</tr>
<tr>
<td>2. Time consuming for teaching staff in preparing learning resources and materials</td>
</tr>
<tr>
<td>3. Generate stress on students and academic staff</td>
</tr>
<tr>
<td>4. Relative inefficiency in certain learning areas</td>
</tr>
<tr>
<td>5. Decrease knowledge acquisition in basic sciences</td>
</tr>
<tr>
<td>6. Difficult to implement in large class size without motivation in learning</td>
</tr>
</tbody>
</table>

It had been proved that students who studied medicine in PBL-approach graduated with different basic science knowledge from students in traditional learning approach. This is because PBL-approach is effective in particular areas, including behavioural science, psychiatry, etc. The amount of basic science which was acquired during studying medicine in PBL-approach is enough for students to successfully accomplish their undergraduate course and be confident in practicing medicine. However, this amount of basic science and medical science is difficult to determine without a well-designed evaluation research with control groups (Spencer and Jordan 1999; Sanson-Fisher and Lynagh 2005; Batey 2006; Wood 2008).

### 3.8.5 Why PBL is so popular

There are number of reasons why PBL-approach is popular in medical education. Firstly, PBL-approach is relatively beneficial to the current medical practice. Secondly, PBL-approach is compatible with socio-cultural values, past experiences and needs of learners and educators. Thirdly, PBL-approach provides a simple learning process in understanding the
interpretation among basic science, medical science and clinical problems. Fourthly, PBL-approach facilitates the adoption of innovation as it provides opportunity to trial innovation before adopting process occurs. Fifthly, PBL-approach provides observability after adoption process. Lastly, the popularity of PBL-approach is also involved with other factors (Sanson-Fisher and Lynagh 2005; Batey 2006). Table 3.16 summarised various reasons for the popularity of PBL-approach.

Table 3.16 Various reasons for the popularity of PBL-approach in medical education (Sanson-Fisher and Lynagh 2005; Batey 2006)

<table>
<thead>
<tr>
<th>Reasons for the popularity of PBL-approach in medical education</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Relatively beneficial to the current medical practice</td>
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<tr>
<td>2. Compatible with socio-cultural values, past experiences and needs</td>
</tr>
<tr>
<td>3. Simple learning process in understanding the interpretation among basic &amp; medical sciences and clinical problems</td>
</tr>
<tr>
<td>4. Facilitating the adoption of innovation</td>
</tr>
<tr>
<td>5. Enable observability after adoption process</td>
</tr>
<tr>
<td>6. Other factors</td>
</tr>
</tbody>
</table>

3.8.6 Development and Implementation of PBL

Wood (2008) indicated that implementation PBL-approach in medical education is necessary to transform curriculum design, course delivery of educators and assess the curriculum. Students, therefore, should be encountered, obtained and demonstrated with real-life clinical problems and then assisted in exploring any necessary information (Spencer and Jordan 1999). The reason is that PBL is a systematic learning process which the
learners need to apply their cognitive findings to their educational and clinical practice (Spencer and Jordan 1999). These included the foundation of prior knowledge, learning in context, enhancing subsequent knowledge and skills by learning with curiosity (Spencer and Jordan 1999). PBL, consequently, is essentially suitable in developing clinical reasoning, which is a cognitive process in identifying and describing patient’s illness, which is required in learning and practicing medicine (Spencer and Jordan 1999).

On one hand, cost and resource implication in developing and implementing PBL-approach in medical education could be fairy high. On the other hand, PBL-approach has been deployed into medical education in various degrees around the world, for instance, the US medical schools and elsewhere in developing countries.

### 3.8.7 Evolution of PBL in Medical Education

Maudsley (2002) indicated that during 1992-1993 there are number of undergraduate medical curricula have deployed PBL-approach, as a result there were 27-North American medical curricula were using PBL-approach. Moreover the transforming medical curricula were continued since the mid of 1990s, including the first British medical schools, the University of Manchester, University of Liverpool and University of Glasgow. Theses represented the reflection regarding the incorporation of adult learning theory and problem focused on medical education in relation to the recommendations of the General Medical Council and worldwide imperatives (Maudsley 2002).

### 3.8.8 Evidence around PBL

Fisher and Lynagh (2005; Batey 2006) indicated that there are several evidences from medical students’ experience with regards to studying medicine in PBL-approach. Firstly, students are more likely to have better
attitudes, class attendance and fine learning atmosphere than studying medicine in the traditional learning approach. Secondly, students are more enjoyable in learning medicine in PBL-approach and capable to demonstrate their interpersonal skills than students in traditional learning approach. Lastly, students in PBL-approach tend to learn medicine with more productivity and creativity than students in traditional learning approach (Sanson-Fisher and Lynagh 2005; Batey 2006).

In addition, Wood (2008) claimed that studying and learning medicine in PBL-approach with less lectures and small groups learning were rare found in undergraduate medical curriculum but rather postgraduate and continuing medical education (Prideaux 2002). This is because teaching and learning in communication skills and psychosocial domains can be accomplished in number of ways, for instance, working in small groups with productive feedback as PBL-approach does (Wood 2008).

Further, the use of PBL-approach in medical education has been spread to numerous medical schools elsewhere around the world, including, Europe, the Middle East, and the Far East, Australia continents (Bligh 1995). Any new founded medical school is more likely to use PBL-approach as there is a possibility that the transformation within traditional curriculum and existing recourses (Bligh 1995).

3.9 Chapter summary

Four-major PDAs functionalities have been identified as useful functions in healthcare and the medical profession, these being, PIM, references, special functions for administrative and clinical work, and communication functions. Such functions are used while healthcare staff, in particular physicians, are on duty. The benefits of PDA use in these professions enhance a better workflow, improve quality of care and facilitate their daily routines. On the
other hand, limitations of using PDAs are more toward network connectivity and the physical presence of PDAs, from which arise a number of problems regarding data entry, limited screen size, and data security. Moreover, eight possible issues regarding the deployment of PDA use in healthcare and the medical profession are identified, namely: data security and information privacy, interoperability, network connectivity, education and training, familiarity of PDA devices, EI, social acceptance, and maintenance and support.

Therefore the issues found in this literature review could be considered for the incorporation of PDAs into the UOW-PBL medical curriculum, including four PDAs functionalities being used in the medical profession, technical issues (data security and information privacy, interoperability, scalability and network connectivity, EI and maintenance and support) and practical issues (education and training, familiarity of PDA devices and related technology and social acceptance).

Based on what has been found in the literature review of this chapter, it is possible that four PDA functionalities (PIM, reference, special functions in other areas and communication functions) could be deployed and used in medical education, even though several functions are more applicable in a real clinical practice, for instance, ordering clinical tests, PHR, EHR and prescribing drugs functions. However, such PDA functionalities would allow student-doctors to be familiar with their use before becoming a real qualified doctor.

*PIM function* facilitates student-doctors to keep address books, contact information, schedules, to-do lists and reminders, while *reference function* allows students to access medical knowledge from the internet, e-textbook, and handbooks, as PDAs would serve as an information centre. On the other hand, there are various *special software applications* (Table 3.1), which
would be beneficial in medical education, for instance, medical calculators, database programs, student-logs and research tool functions. For *reference function*, having access to relevant information while offsite, not only for accessing general information but also accessing drug databases, updating medical literature, medical references as well as school timetables and university events. Communication seems to be a routine activity in practicing medicine, therefore having a *communication function* on PDAs for both direct and indirect communication would be beneficial for students in studying medicine, particularly while offsite.

Moreover the *technical considerations* regarding the incorporation of PDAs into the UOW-PBL medical curriculum are *data security and information privacy, interoperability, scalability and network connectivity, EI and maintenance and support*, while the *practical considerations* are *education and training, familiarity of technology and PDA devices and social acceptance*.

*Data security and information privacy*. Data security and information privacy are important aspects of incorporating PDAs into the UOW-PBL medical curriculum. Even though the use of PDAs in medical education would contain no patient identifiers and maintain anonymity of patient information, maintaining security and privacy of data on PDA devices is still a top priority in medical education.

PDAs are mobile devices that can be encountered with a number of threats (Table 3.8) over the wireless network. Therefore various wireless security methods (Table 3.9) could be considered based on requirements, purpose of protection, level of data security, applicability in relation to resources, and financial implications. However the most cost-effective and simplest data security techniques are user authentication by WEP, username and password.
In the meantime, security of PDA devices and device management should be introduced to all PDA users.

**Interoperability.** It is possible that a particular PDA platform or a combination of different PDA platforms can be deployed and incorporated into the UOW-PBL medical curriculum. However, the selection of PDA platform(s) would depend on a number of factors, including PDA functionalities, software applications, systems implementation, network connectivity among devices, campus and other network carriers, maintenance and support, and importantly resource and financial implications. Therefore all these factors need to be considered before selecting, introducing and deploying PDAs into the UOW-PBL medical course.

**Scalability and network connectivity.** Scalability and network connectivity are factors to consider before incorporating PDAs into the UOW-PBL medical curriculum, especially if PDAs are planed to be used while offsite. Network connectivity for PDA in medical education is generally divided into two areas, namely on-campus and off-campus. However, consideration regarding network connectivity essentially relates to off-campus rather than on-campus networks. The reasons are that, firstly, computer facilities and network connectivity are already available at various locations around campus; and, secondly, medical students are more likely to be offsite in different clinical placements elsewhere during all four years of medical study. Therefore having adequate off-campus network connectivity is essential for PDA use while being offsite.

**Electromagnetic interference.** This is essential to consider for PDA use in medical education at the UOW. Even though there are a number of mobile technology devices, including mobile phone, PDA, PDA phone, pagers, etc., used in hospital and clinical placements, it is still important that use of these devices should abide by policy and procedures at each hospital and clinical
placement. There is some research evidence that using such devices can generate EI with medical equipment if used closer than the safe (recommended) distance.

*Maintenance and support.* Inadequacy of maintenance and support could become a major barrier to incorporating PDAs into medical education. Therefore it is essential to ensure that sufficient maintenance and support is provided via various channels (e.g. on-campus, off-campus, web-based support) before introducing and deploying PDA devices into medical education. Generally, maintenance and support can be categorised into three groups, these being (i) hardware maintenance, (ii) PDA functionalities and software applications, and (iii) central maintenance and support regarding campus network connectivity. Therefore the level of maintenance and support would depend on the complexity of PDA functionalities, interoperability among various platforms, and technology familiarity of PDA users.

*Education and training and familiarity of technology.* To successfully and effectively deploy PDAs in medical education, it is essential to ensure that both educators and students are informed of the purposes of PDA use, how the devices would assist in both learning and teaching medicine, and how and when they can use these devices in order to facilitate their medical study and daily activities, especially while offsite. Therefore it is important to ensure that medical educators and students have adequate and sufficient training regarding PDA use before/once the devices are introduced and incorporated into medical education.

*Social acceptance.* Even though the incorporation of PDAs has a primary focus on medical education and clinical encounters, skills and practice, the success of using these devices in hospitals and clinical placements would not only depend on their functionalities and technical aspects but also on
acceptance by the community, in particular patients, as PDAs would be intensively used in real clinical placements especially, in hospitals and the community generally. Therefore it is essential to ensure that the patients in the community and hospitals are well informed about the purpose of using PDAs while students have clinical encounters in hospital and clinical placement during their 4-years of medical study.

The motivation for incorporating PDAs into the UOW-PBL medical curriculum is to provide multiple or various PDAs functionalities which can facilitate students in studying medicine while offsite. Therefore students can at least have access to relevant information, clinical material and references, as well as organising their daily activities, recording any necessary information and communicating with others.

In the next chapter, a conceptual framework for incorporating PDAs into medical education –in particular the PBL-based curriculum at UOW –is developed, informed by the findings of the literature review reported in this chapter.
Chapter IV
Conceptual Framework for the Incorporation of PDAs into Medical Education

4.0 Chapter overview

This chapter explores the possible conceptual framework for the incorporation of PDAs into medical education in general. Therefore, the purposes of this chapter are fourfold, these being (i) to introduce the context of a conceptual framework for the incorporation of PDAs into medical education; (ii) to propose possible PDA functionalities for medical education, (iii) to propose relevant aspects to be considered for the incorporation of PDAs into medical education; and (iv) finally, to propose a conceptual framework for the incorporation of PDAs into medical education, based on a reviews of the literature.

Details of each aspect in this framework were derived and formulated based on the literature reviews of Chapters II - III. However, this conceptual framework is yet evaluated.
4.1 Background

The conceptual framework in this chapter has been derived and formulated based on the literature reviews in Chapters II - III (regarding the context of PBL, PDA use in general, and PDA use in the healthcare professions, medical profession and medical education, respectively).

There are four major reasons why this study was conducted at the GSM, UOW. Firstly, PDAs have been used for various purposes and functionalities in different industries. However PDA use depends on a particular job. Therefore, there is an opportunity that a number of PDA functionalities can be applied and used in medical education. Secondly, according to the literature review, there is no comprehensive study of PDA use in medical education regarding technical, ethical, clinical and practical aspects. Thirdly, there are a number of medical schools have already incorporated PDAs into medical education. For instance, PDAs have been used in medical education as a learning tool for delivering and facilitating medical studies, for example, tracking student progress, accessing clinical materials and resources, looking up lab results, using as an electronic organiser or communicating with others. However a study regarding how to enhance PDA use in medical education, in particular a PBL-approach, has yet to be undertaken. Therefore this study is conducted in relation to PDA functionalities and relevant aspects to consider for the incorporation of PDA devices into a PBL-medical curriculum. Finally, in US medical schools with traditional medical curricula, the use of PDAs focuses on internship and clerkship programs when students start having clinical placements. It has been assumed that PDA use in traditional medical curricula differs from PDA use in a PBL-medical curriculum, in particular at the UOW, as students start having clinical encounters and experiences from year-1, and are intended to use PDAs from this time onwards. Therefore, a close look at the use of PDAs in the healthcare profession, medical
profession and medical education reveals many similarities in PDA functionalities, including (i) clinical-log (ii) reference (iii) PIM, (iv) communication and (v) special functions.

Further debate occurs regarding what PDA functionalities are the most suitable and applicable for a PBL-medical curriculum, particularly to the UOW PBL-medical curriculum, whether the use of PDA functionalities in the traditional medical curricula is differ from a PBL-medical curriculum at the UOW, and what aspects to consider before incorporating PDAs into medical education. Therefore, the further contributions in this chapter are a conceptual framework, which consists of prospective PDA functionalities for the UOW PBL-medical curriculum, as well as possible aspects to consider before incorporating PDAs into medical education.

### 4.2 Context of the Framework

According to the literature reviews regarding characteristics of PDAs, PDA use in general and in other industries (Chapter II), PDA use in industry, and the healthcare and medical professions, and PDA use in medical education at various medical schools (Chapter III), there is a considerable opportunity that PDAs could incorporated into the UOW PBL-medical curriculum. Therefore the context of a conceptual framework for the incorporation of PDAs into medical education has been formulated and comprises two major components, including prospective PDA functionalities for medical education, and various factors to be considered before incorporating PDAs into medical education, as shown in Figure 4.1.
4.3 Prospective PDA Functionalities for the PBL-medical Curriculum at UOW

There are a number of PDA functionalities which can possibly be deployed into medical education. Such functionalities are generally categorised into five-major classes, namely electronic clinical-log, reference, communication, PIM and special functions in medical education. Details of each functionality are identified and discussed in the following sections.

4.3.1 Electronic clinical-log in PDA format

Electronic clinical-log is a useful functionality for both students and medical faculty. Generally, a clinical-log has numerous advantages (Section 3.2). Such advantages are beneficial for students, medical faculty and clinical preceptors in terms of self-assessment, monitoring students’ clinical
experiences, future curriculum evaluation and development, and future research in medical education.

There are a number of reasons why an electronic clinical-log is a must have functionality in medical education. Firstly, it facilitates students in recording their clinical skills and experiences anytime when having clinical encounters. It facilitates students to immediately record clinical experiences at patient bedsides or while on wards. Electronic clinical-logs are an effective way to record clinical experience and encounters, as clinical-log data can be easily accessed and retrieved from a central database server. It allows students to identify their learning needs based on their clinical experiences and gaps in their learning. Secondly, an electronic clinical-log enables clinical supervisors, phase directors or medical faculty to monitor students’ progress. Therefore medical faculty, clinical supervisors and phase-directors can have close supervision of students’ clinical competency while students are offsite. Finally, having a record of clinical experiences and reflections in a clinical-log enables the medical school to perform complex data analysis for research and curriculum development.

Further, electronic clinical-logs can be developed and implemented using various methods, including creating spreadsheets, programming (using various programming languages), developing clinical-log systems or web-based clinical-logs. Having a web-based clinical-log is another alternative approach which allows students to access either via PDA or computer. The advantage of a web-based clinical-log is that it provides flexibility of software implementation. This is because web-programming can be run and used with any PDA platform. Students, therefore, would have flexibility in selecting and using any PDA platform, which would accommodate other uses of PDAs besides a clinical-log function. Another advantage is reliability in terms of system maintenance and support.
4.3.2 Reference functionality

Reference functionality would be a large part of PDA use in medical education. The primary purpose of having reference functionality for PDAs is to provide immediate access to clinical resources and materials on hand, anytime and anywhere, particularly when students are offsite, in clinical placements or at the patient’s bedside. The reasons why reference is a compulsory PDA functionality is that, firstly, it provides immediate access to clinical resources. This would be beneficial for students in practicing and studying medicine in their clinical placements. Secondly, with immediate access to relevant resources and materials, students could enhance the development of clinical experiences and skills in relation to clinical decision making, decreasing medical errors and adverse events, clinical procedures, drug interactions, etc.

A number of reference software applications for PDAs has been used in both the medical profession and medical education. A certain range of reference applications, which have been identified through the literature review, are proposed as prospective reference functionality for medical education in a PBL context. These references are categorised into several groups, these being e-textbooks, pharmaceutical databases, clinical guidelines, dictionaries, journal information, disease classification, medical calculators and encyclopaedias (Figure 4.2).
E-References and e-Textbooks
- ABG Pro
- Five Minute Clinical Consultant
- Franklin electronic publishers
- Harrison’s principles of medicine
- Language translator
- MD Consult
- Meck Manual
- NCBI Bookshelf (collection of free online books provided by the US National Centre of Biotechnology Information)
- Redbook
- SkyScape
- StatRef (Medical science textbooks and other resources)
- Taylor and Francis online eBook library

Pharmaceutical Databases
- AZIDrugs
- ABX guide
- AHFS drug information
- Alternative drugs
- Australian medicine handbook
- Australian prescription product guide
- British pharmacopoeia
- Clinical algorithms
- Differential diagnoses
- Drug dosage
- Drug facts and comparisons
- Drug interactions
ePocrates Rx
- LexiDrugs
- Medical rules databases
- MIMS
- Medline Plus (drugs, supplements and herbal information)
- Pocket Pharmacopoeia
- The Lothian Drugs Formulary

Clinical Guidelines
- Clinical information guidelines
- Clinical practice guidelines
- Therapeutic guidelines

Dictionaries
- MEDLINE Plus (Medical Dictionary)
- Online Medical Dictionary
- Dictionary of Public Health

Journal Informations
- NCBI Journal search
- List of journals indexed in index Medicus

Disease Classification
- International Classification of Disease

Medical calculators, scores and algorithms
- Body Mass Index Calculator
- GI Bleed Complication Risk
- Bradycardia Treatment Algorithm

Encyclopaedias and others
- ADAM Medical Encyclopaedias
- Medical directory

Figure 4.2 Prospective reference functionality

**E-reference textbooks.** E-textbooks and e-books are generally available either as resources for downloading in PDA format, or for online access.

**Pharmaceutical databases.** The use of pharmaceutical databases differs from elsewhere in Australia. This is because drugs are named differently in each country. Therefore the pharmaceutical databases are based on Australian drugs basis.

**Clinical guidelines.** Clinical guidelines would be specific guidelines designed for a particular clinical practice. These would be systematic guidelines designed and reviewed for clinical evidence as a primary source for evidence based medicine (EBM). For instance, the use of clinical guidelines in Australia would be based on a consideration of both the Australian National Health and Medical Research Council (NHMRC) and the medical school.

**Dictionaries.** Several medical dictionaries would be useful to have on student PDAs. These recommended dictionaries are MEDLINE Plus medical
dictionary, online medical dictionary, and dictionary of public health. In addition, a translator dictionary could be recommended for international students or any student who deals with multicultural situations.

Journal information. Journal information, journal articles, list of journals indexed and/or journal search in PDA format are recommended as a part of the reference functionality. Reading journal articles on PDAs is possible if Acrobat reader is installed on the PDA device. There is the possibility of having an Internet connection either off- or on-campus. Accessing online journals or any online resource is dependent on the availability of network connectivity in each clinical placement, hospital environment or GP division.

Disease classification. The international classification of diseases (ICD) is issued by the World Health Organisation (WHO), and is available in several languages and formats, including online access, CD-ROM format or PDF version for downloading. ICD provides standard diagnostic classification for all general diseases, all general health situations and other characteristics and circumstances of affected individuals. Therefore ICD is recommended for students to use as part of their medical and clinical reference resources on their PDA.

Medical calculators, scores and algorithms. Medical calculators, scores and algorithms are recommended to have on PDAs for immediate access. Several of them are recommended, these being, body mass index calculator, GI Bleed Complication Risk, and Bradycardia Treatment Algorithm.

Encyclopaedias and others. Medical encyclopaedias can be accessed online as online resources. The recommended encyclopaedias are the ADAM Medical Encyclopaedia, which contain articles about diseases, tests, symptoms, injuries and surgeries with medical illustrations. Other reference resources are also included, EBM, etc.
In addition, the reference resources and materials recommended in this section are generally based on the literature reviews. Such reference resources are prospective PDA reference functionalities for medical education. However, all reference functionality has yet to be evaluated by medical faculty and honorary clinical academics whether they are appropriate and possible to be used in medical education, in particular a PBL-approach.

4.3.3 Personal Information Management

According to the original function of PDAs, they are generally designed to be an electronic organiser, which comes with instant functions, for instance, address book, calendar and personal diary. Therefore such functions are recommended for students to manage their schedules, reminders and school events, personal contacts with peers, medical academics and clinical supervisors.

4.3.4 Communication functionality

Communication is an important functionality, as students can use this function for downloading and uploading their clinical-logs to university servers, sending and receiving e-mails and looking-up clinical resources and materials online. Furthermore, the communication function can be used for socialise between students and their peers. The proposed communication functionalities are e-mail, Internet access, text-message, paging-service, internet telephony and mobile phones.

The communication functionality comprises two categories, namely asynchronous and synchronous. Asynchronous non-real time communication allows students to post their comments on blogs, podcasts, vodcasts, blikis, forums or ‘wiki’ (Choules 2007; Konstantinidis and Bamidis 2007). Therefore asynchronous communication may take longer time to respond than other types of communication.
On the other hand, synchronous data communication could be implemented on PDAs. However, it is dependent on three factors, these being network and Internet connectivity, speed of data transmission and memory capacity of PDAs. Proposed applications for synchronous communication for PDAs in medical education are text-chats, document exchange, voice communication and real-time conference tools (Choules 2007; Konstantinidis and Bamidis 2007). Table 4.1 summarises the proposed communication applications for both asynchronous and synchronous communication (Konstantinidis and Bamidis 2007; Read, Verdejo et al. 2007).

Table 4.1 Proposed PDA applications for asynchronous and synchronous communication functionality

<table>
<thead>
<tr>
<th>PDA Applications for asynchronous and synchronous communication functionalities</th>
<th>Asynchronous Communication</th>
<th>Synchronous Communication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blog</td>
<td>Forum</td>
<td>Text-chats</td>
</tr>
<tr>
<td>Podcast</td>
<td>e-mail</td>
<td>Document exchange function</td>
</tr>
<tr>
<td>Vodcast</td>
<td>Text-message</td>
<td>Voice communication</td>
</tr>
<tr>
<td>Blikis</td>
<td>Any non real-time applications</td>
<td>Real-time conference tool</td>
</tr>
<tr>
<td>Wiki</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Synchronous communication offers just-in-time communication, particularly when students are isolated in different geographical regions in Australia.

4.3.5 Special functions in medical education

Special functions are additional functionalities beside the four basic functionalities described in sections 4.3.1-4.3.4, designed and developed according to the requirements of medical school. Possible functions of these special functionalities, which are useful for a PBL-medical curriculum at the
UOW, including classroom polling systems, teaching and interactive evaluation, evaluation of medical training, monitoring students’ clinical experiences, data collection for medical research, and tracking or accessing medical images.

4.4 Considerable Factors of Incorporating PDAs into Medical Education

The purpose of this section is to address potential concerns which may impact the incorporation of PDAs into medical education, including data security and information privacy, interoperability (compatibility of PDA platforms), scalability and network connectivity, education and training, familiarity of using PDAs (technology comfort), EI, social acceptance, maintenance and support and other relevant aspects.

Now, the evidence in the literature is much less definite as to whether such factors may affect the incorporation of PDAs into medical education. In addition, other aspects need to be further explored, including education and training, financial implications and attitudes of medical faculty and clinicians regarding PDA use in medical education. Details of each concern are discussed in the following sections.

4.4.1 Data security and information privacy

Data security

The proposed data security techniques can be categorised into two strategies. Firstly, the data security strategy is focused on the security of PDA functionalities, in particular clinical-log and communication functions. Secondly, the data security strategy emphasises data security of the PDA device itself, the so called “physical data security of PDA”.
Data security of PDA functionalities. In order to ensure the security of PDA functionality, in particular clinical-log and communication functions, it is necessary to ensure that only authorised users can access their clinical-log either via PDAs or using other pervasive devices. Numerous data security procedures are available for both clinical-log and communication functions, including authentication methods using username and password protection, data encryption methods when sending information over the network, digital signatures, security over a wireless network, and using WEP or WPA.

Generally, the simplest wireless network security for PDA devices is authentication and WPA.

Data encryption methods can be applied and used over the on-campus network. However such data security techniques do not as yet control the user recording patient identification on PDA devices. Therefore information privacy is another important concern, especially for learning, studying and practicing medicine in a professional way. Information privacy is discussed in the following section.

Physical data security of PDAs. The security of the physical device is also important. In order to protect personal and sensitive data in case of PDA loss, it is recommended for users to set and save their username and password, which could present a security risk if PDA is lost or stolen.

Information privacy

Information privacy is a concern for any sensitive data which is recorded using the clinical-log function. Policies, procedures and regulations regarding information privacy, particularly regarding patient clinical information, should be introduced for students to follow and practice for their medical profession. The key element is that any patient information being recorded,
either on clinical-logs or elsewhere, should be recorded without any patient identifier; a information about patients must remain anonymous.

For instance, in both the public and private sectors in NSW, the Health Records and Information Privacy Act 2002 (HRIPA) safeguards the privacy of health information. HRIPA governs organizations that handle any type of health information. HRIPA is concerned about data collection, storage, access, data accuracy, disclosure, data identifiers and anonymity, data transmission and linkage, and data authorisation.

The PDA functionality which directly deals with patient information is the clinical-log function. Therefore the design of data field in this function must omit recording of any personal information, for example, date of birth, social security number or any information that can identify who the patients are. However, the recording of patient information, clinical experiences and personal reflections cannot be controlled if recorded elsewhere. Therefore students should strictly follow professional ethics and conduct on protecting and safeguarding patient information and the privacy of any individual patient.

4.4.2 Interoperability and PDA Platforms

Interoperability

According to Read et. al (2007), interoperability of PDAs refers to the transferability of information among different platforms, devices, functionality and systems. There are three factors which may affect interoperability among systems and different PDA platforms, these being (i) structure of data, (ii) content of data, (iii) protocol and techniques for data transmission (Read, Verdejo et al. 2007).
Interoperability in this conceptual framework essentially focuses on the interoperability of PDAs and other mobile devices (e.g. PDA phones, tabletPCs, Smartphones and laptop computers), as well as the interoperability of reference software applications for medical education.

**Interoperability of PDA functionality on both PDAs and other mobile devices**

According to the literature reviews regarding PDA platforms and interoperability in section 3.2.3 and 4.6 respectively, various authoring tools for developing a particular PDA functionality for medical education are recommended in order to support the interoperability of PDAs and other mobile technologies, including WAP applications on mobile phones, tablet PC and laptop computers.

The incorporation of PDAs and their applications is also dependent on connection mechanisms, courseware import and export, and learning record buffering.

In addition, the use of mobile technology is not only restricted with PDA devices and choices of PDA operating system, Students can also use other mobile devices to facilitate their medical study. Now it is possible that different students may use other mobile devices besides PDAs for accessing online clinical-logs: while one group of students may use PDAs to access online clinical-log, another group of students may use WAP applications on PDA phones to access and record their clinical-logs. Moreover, students may also use smartphones, 3G mobile phones or PC for recording their clinical-log information.
Interoperability of reference software applications in reference functionality

According to the interoperability of reference software applications for reference function, there are a number of software applications, which are available in both PalmOS and Microsoft PocketPC (Appendix A). These are medical link resources, medical databases, medical calculators, drug guidelines, patient information, medical textbooks and journals and EBM applications. On the one hand, such software applications are interoperable with different PDA platforms. On the other hand, there are a certain range of software applications which can be used either on PalmOS or PocketPC. Therefore, the primary consideration of which reference software applications are suitable for medical education or whether each application has interoperability among different platforms is dependent on the final decision of the medical school and clinical academics.

In addition, reference software applications and reference materials are generally available in PalmOS and PocketPC. Therefore it is possible for medical schools to provide such resources in either PDA platform or both. However, in the case of using Smartphones for accessing reference materials, a problem regarding the availability of reference software application could arise.

PDA Platforms

The selection of PDA platform may impact on the interoperability of software applications. Two major PDA platforms were identified based on the literature reviews. However, the selection of which PDA platform to use in medical education is dependent on various factors, such as (i) requirements of the medical school regarding PDA use, (ii) interoperability of PDAs with the university and off-campus networks, (iii) the availability of software
applications for PDAs, in particular software applications in medical education and (iv) maintenance and support of clinical-logs and other functions.

<table>
<thead>
<tr>
<th>PDA Platforms</th>
<th>PalmOS</th>
<th>Pocket PC</th>
<th>PDA phone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost effective than other PDA platforms</td>
<td></td>
<td>Faster processor speed</td>
<td>Available in both PalmOS and PocketPC</td>
</tr>
<tr>
<td>Widely used in medical education</td>
<td>Large number of medical and clinical software application in both freeware and commercialise software</td>
<td>Small number of software availability on clinical and medical software applications</td>
<td>Two in one device: PDA and mobile phone</td>
</tr>
<tr>
<td>Difficulty of interoperability, maintenance and support</td>
<td>Similar interface as Windows operating systems</td>
<td>More expensive than individual PDA</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 4.3** A comparison between three different PDA platforms

There are two reasons why Palm PDAs are used in many medical schools (Figure 4.3). Firstly, Palm is more cost effective than other PDA platforms. Secondly, there are a number of reference software applications and medical resources available for PalmOS. Such software applications are available in both freeware and commercial software form. On the other hand, PalmOS has some drawbacks regarding interoperability, maintenance and support.

PocketPC has similar interface to other Windows operating systems and is interoperable with any Microsoft Application. On the other hand, PocketPC has less of a range of software applications, in particular in the medical area.

Nevertheless developing any particular PDA system in medical education for both PalmOS and PocketPC is feasible. The important concern is to ensure that the systems are capable of network connectivity to PDA servers, as well as data security for different platforms. For instance, the School of Medicine at Columbia University has implemented a PDA-based patient encounter tracking system which consists of a patient-log function. Such a function allows medical students to record patient demographics and diagnostic
information during their clerkship year. The systems were designed to support different PDA platforms and the other mobile technology, including PalmOS, PocketPC and Smartphone, respectively.

Therefore both PalmOS- and WindowsCE-based PDAs can be used together in the same system, which are configured by using J2ME (Java 2 Platform Micro Edition) Wireless Toolkit. J2ME is essentially a software development tool for any resource-constrained device, for instance, PDA, cell phone or smart-phone. J2ME consists of a combination of toolkits that support the Mobile Information Device Profile (MIDP). MIDP provides the core application and necessary functionalities which are required by the mobile application, including user interface, network connectivity, local data storage, and application lifecycle management. J2ME is available for downloading without cost. Having systems which support both PDA operating systems provides flexibility in selecting PDA devices based on user preference. However, the medical software applications must be provided for both platforms, which may increase the software purchase cost.

**Software availability**

The selection of PDA platform is directly affected by the availability of software applications, in particular the reference functionality. As mentioned in the previous section, PalmOS has more medical reference software applications than PocketPC, in both freeware and commercial form.

4.4.3 **Scalability and network connectivity**

*Scalability of PDA use* is a vital factor for the medical school to consider for the future use of software applications and the increase number of medical students in each year. Special software applications such as clinical-log, OSCE and classroom polling systems should be designed and developed for
future expansion with respect to the increasing number of students in each academic year.

For future expansion of network scalability, it is possible to linearly scale the database server to have an unlimited number of identical servers in a cluster represented only by one Internet protocol (IP) address on the network. However the potential number of medical students each year varies in each medical school, for instance, the GSM expects to have no more than 84 students per academic year (including 72-domestic and 12-international students).

Network connectivity and data synchronisation. According to the literature reviews, data can be synchronised to database server(s) using six different techniques, namely HotSync via PDA cradle, Infrared, Bluetooth, remote access via the Internet, Wi-Fi and VPN. The purpose of data synchronisation is threefold, more specifically (i) to backup the data between PDAs to students’ desktop computer; (ii) to install software applications onto PDAs and; (iii) to transfer data to the PDA server on the campus network.

While on-campus, students are able to synchronise data via a PDA cradle (HotSync) or wireless (Wi-Fi) via the campus network. It is recommended that HotSync spots should be provided for students to synchronise data back to the server as not every PDA has Wi-Fi access. HotSync spots should be available at several locations within the university, for instance, in the library, computer laboratory and medical school student lounge. As a result, students could synchronise data to the database server via the campus-network. On the other hand, students can synchronise data from elsewhere to the database server if they can log-on to the campus-network as if they were on-campus. The current standard Wi-Fi connections (wireless local area network or wireless LAN) for PDAs are IEEE 802.11a and IEEE 802.11b, with transmission speeds of 11 MB and 56 MB per second, respectively. The
implementation cost of wireless network connection is inexpensive and convenient for students to transfer and access data. Sending or exchanging data from peer-to-peer can be simply done by Infrared and Bluetooth, via Private Area Network (PAN) data transmission. Infrared and Bluetooth are short-range data transmission channels with less than 10-metres (approximately 30-feet) between devices.

Bluetooth enabled-PCs allow data to be synchronised from PDAs to computers or shared Internet connections. This can be done by having Bluetooth- and Internet-enabled PDAs and computers, respectively. First of all, the computers must be Bluetooth enabled for performing this type of data synchronisation. Before the connection is established, students will be asked to enter their username and password for authentication purposes, then data can be synchronised to the server. Apparently Bluetooth does not have a line-of-sight data transmission problem. However the short range of Bluetooth and high cost create a difficulty in implementing such a connection in a hospital-wide as a data distribution network. Despite this, Bluetooth is highly useful for communication between PDA devices.

Alternatively, off-campus data transmission and synchronisation can be done by remote access over the Internet, Wi-Fi and VPN. However the implementation cost of VPN is quite high. VPN, which is one type of network connectivity for data transmission and synchronisation, is generally used in a small number of medical schools, for instance, Stanford University School of Medicine. Data exchange at the POC service in clinical settings can be done via Infrared or Bluetooth connection.

Further considerations are the possible data synchronisation and network connectivity for on-campus and off-campus environments. Such data synchronisation and network connectivity are reasonable in terms of implementation, maintenance and support aspects. Figure 4.4 summarises the
proposed data synchronisation and network connectivity for on-campus and off-campus.

**Possible data synchronisation and network connectivity for on-campus and off-campus environments**

<table>
<thead>
<tr>
<th>On-campus environments</th>
<th>Data synchronisation</th>
<th>Network connectivity</th>
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<tbody>
<tr>
<td></td>
<td>Wireless data synchronisation</td>
<td>Wi-Fi network connectivity</td>
</tr>
<tr>
<td></td>
<td>Wired data synchronisation via HotSync (PDA cradle)</td>
<td>Inside buildings: IEEE 802.11a (54MB) and IEEE 802.11b (11 MB)</td>
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<tr>
<td></td>
<td></td>
<td>Outside buildings: IEEE 802.11b (11MB)</td>
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<tr>
<th>Off-campus environments</th>
<th>Data synchronisation</th>
<th>Network connectivity</th>
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<tr>
<td></td>
<td>Wireless data synchronisation</td>
<td>Wi-Fi network connectivity</td>
</tr>
<tr>
<td></td>
<td>Wired data synchronisation via HotSync (PDA cradle)</td>
<td>VPN, Internet connectivity via PDA phones or Smartphones from telecommunication company (e.g. Telstra, Vodafone, Optus, etc.)</td>
</tr>
</tbody>
</table>

**Figure 4.** Possible data synchronisation and network connectivity of on- and off-campus networks

**On-Campus wireless network connectivity**

On-campus wireless network connectivity is categorised into two major areas, namely inside and outside buildings. For inside buildings, the wireless network connection standard is IEEE802.11a (54 MB) and IEEE802.11b (11 mb). On the other hand, the wireless network connection standard for outside buildings is IEEE802.11b (11MB). Generally, any student with an active university e-mail account is eligible to gain wireless access to the on-campus environment.

For data security, the WPA standard could be applied for on-campus wireless access, where students are authenticated with username and password protection, and all data is encrypted before transmitting over the wireless network. Therefore it is essential to ensure that PDAs support the WPA standard in order to gain on-campus wireless network connectivity.
Off-campus network connectivity

The proposed network connectivity for off-campus environments can be categorised into three major sources, these being (i) Wi-Fi network connectivity, (ii) VPN and (iii) Internet connectivity via telecommunication companies. Firstly, Wi-Fi network connectivity is generally available in clinical placements, hospitals and general practice. However, using wireless Internet via the available networks in such locations is dependent on agreement between the medical school and the former. There are a number of factors to be considered (Table 4.2) before establishing wireless network connectivity for off-campus environments.

Table 4.2 Considerable factors before establishing wireless network connectivity for off-campus networks (Motorola, 2006)

<table>
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<th>Considerable Factors</th>
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Secondly, while VPN is possible, it is not being considered by the medical school and university for future development and implementation due its high cost. Finally, having an Internet connection via PDA phone or Smartphones
is also possible for students, especially when offsite in rural settings and remote areas. However, the cost of Internet connection via PDA phones and Smartphones is still expensive.

### 4.4.4 Education and training

Providing sufficient education and training regarding PDA use in medical education would impact the adoption of PDAs. Therefore, such education and training should be available for students, medical faculty and clinical academics. However, the purpose of using PDA in medical education while offsite should be informed to the community, especially in hospitals and clinical placements, in order to decrease bias, especially from patients, and healthcare and medical professional.

The purposes of having education and training on PDAs in medical education are threefold. The first purpose is to inform learners, educators and the community regarding PDA use in medical education and how devices can enhance student in learning medicine. Especially, being well informed regarding PDA use in hospitals and clinical placements could reduce bias from patients in the community. The second purpose is to provide education and training for medical educators (e.g. medical faculty and clinical academics) on how PDAs can facilitate them in teaching medicine either in classroom or clinical environments. The final purpose is to provide education and training for students regarding PDA use, in particular how they can facilitate students in learning medicine and enhance their clinical skills while offsite.

### 4.4.5 Technology comfort

Technology comfort of PDA users is generally associated with other factors, including providing sufficient education and training on PDA use and importantly having relevant maintenance and support for PDA users if
necessary. Being comfortable with PDA use would give rise to competency in using PDAs, which would impact on effectiveness and efficiency in learning and practicing medicine.

### 4.4.6 Electromagnetic Interference (EI)

Wireless technologies which are based on radio frequency technology can be susceptible to EI, and can take the form of interference to the wireless link or medical devices. Cellular technology has been shown to cause EI.

Wireless technologies use burst rather than constant transmission, for instance, the IEEE 802.11b wireless Ethernet standard and Bluetooth operate at much lower power levels than cellular technology. Further, wireless technologies also use various methods for data transmission, including Frequency Hopping Spread Spectrum (FHSS) or Direct Sequence Spread Spectrum (DSSS), which would lower the risk of EI. On the other hand, Infrared communication does not carry any risk of interference, but it has a narrow bandwidth and reduces range.

Using PDA with wireless connectivity does not cause any EI with medical equipment, including pacemakers (Turner, Milne et al. 2005). Therefore PDAs could be used in hospital environments. However, it is recommended that wireless data transmission should be done in other area beside patient wards, and keep distance from the medical equipment. However the use of PDAs in clinical settings should be based on the policy and regulation of individual hospitals.

### 4.4.7 Social acceptance

Social acceptance may influence PDA use, particularly in hospitals and clinical placements, even assuming education and training of the community. PDA use could be restricted in certain situations, especially during clinical
attentions, as using PDAs during clinical contacts could interfere with patients.

### 4.4.8 Maintenance and support

Maintenance and support could be a barrier to PDA use in medical education. Therefore it is essential to consider this aspect before incorporating PDAs into medical education. The medical school should consider what type of maintenance and support is appropriate for PDAs in order to support the ease of using devices in medical education and be reachable for any user when needed. Further, such maintenance and support could include hardware, software, systems or network connectivity. Now there are various ways of providing maintenance and support for PDA users, for instance, helpdesk, e-mail support, live chat with technical staff, web-information, FAQ, user tips, peers, troubleshooting page, etc.

### 4.4.9 Other aspects

Finally, there could be other aspects to consider before incorporating PDAs into medical education, such as organisation support from relevant parties, resource and financial implications, and other mobile technology options besides PDA devices.

### 4.5 A Conceptual Framework for the Incorporation of PDAs into Medical Education

An overall conceptual framework for this study (Figure 4.5) was derived from the literature reviews as mentioned at the beginning of this chapter. This conceptual framework is viewed as a future plan for deploying PDA devices into medical education, which aims to facilitate and enhance the quality of learning in a medical education context. There are a number of assumptions in section 4.3 and 4.4 related to this feasibility study. Those assumptions
provide the basic foundations of the conceptual framework, and include prospective functionalities and relevant factors for incorporating PDA devices.

Figure 4. 5 A conceptual framework for incorporating PDAs into the UOW PBL-medical curriculum

The conceptual framework developed in this study incorporates:

(1) an analytical view of prospective PDA functionalities and possible IT aspects that would influence the incorporation of PDAs into a PBL-medical curriculum at UOW;
(2) a solid and practical literature regarding PDAs, PDA use in general, industries, healthcare professionals, medical professions and medical education.

The important aspect of this conceptual framework is to demonstrate the association between incorporating PDAs into medical education and other components in this framework, including (i) medical curriculum, (ii) PDA functionalities and (iii) other relevant aspects that would affect the deployment of PDA technology into medical education.

According to Figure 4.5, there are a number of considerable factors for incorporating PDAs into medical education. To conclude, there are three important factors of this conceptual framework, which would possibly have a great impact to other factors in this framework. Firstly, the significant key factor of incorporating PDAs into medical education is PDA functionalities. Once the prospective PDA functionalities have been identified, then the appropriate PDA platforms and required software applications can be determined, based on the medical school’s requirements. The reason why PDA functionalities must be the first element for the medical school to consider is that any potential PDA functionality would affect the choice of both reference software applications and PDA platforms. Not all reference software applications are available for all PDA platforms. Therefore,

(1) the prospective PDA functionalities could be influenced by the requirements of the medical school and the available software applications in the market;

(2) the prospective PDA functionalities would influence a selection of PDA platforms and software applications (in particular reference software applications).
Secondly, medical curriculum is also an important factor which would impact on the incorporation of PDAs into medical education. It is important to understand the context of medical curriculum in order to best utilise PDA technology in a the learning context. If the incorporation of PDAs into a medical curriculum could be tailor-made for particular needs, then it would be suitable.

Thirdly, other important aspects include data security and information privacy, interoperability, scalability, education and training, technology comfort, EI, social acceptance, and maintenance and support.

This conceptual framework can be used as a general tool to systematically specify and identify a range of relevant aspects in the context being studied. The framework would assist in setting out the priority of each relevant aspect to be considered for the incorporation of PDAs into a medical curriculum. Finally, this framework facilitates in evaluating and identifying the outcomes of this study – i.e. whether the incorporation of PDAs into medical education, in particular the UOW PBL-medical curriculum, is feasible.

4.6 Chapter Summary

PDAs have been incorporated into medical education elsewhere during pre-clinical or clerkship years. Little is known about whether PDAs can be incorporated at the beginning of medical study, what the appropriate PDA functions are, and what factors/aspects should be considered in particular the PBL-medical curriculum at the UOW. Therefore this research sets out to determine whether the use of PDAs is feasible based on the attitudes/perceptions of participants. The next chapter introduces the research methods and research design used in this study in order to answer all three research questions.
Chapter V
Research Methodology

5.1 Introduction
PDAs are widely used in the medical profession, and in various medical schools, particularly in the UK, US and Canada. The majority of medical schools recommend students to use PDAs in their clerkship or internship. Some medical schools encourage students to use PDAs during the last two years of their medical study. However, each medical school has its own medical curriculum, and require 4-, 5- or 6-years of medical study. Some medical schools use a traditional curriculum while others use a cased-based or PBL-medical curriculum. This study aims to determine whether it is feasible to incorporate PDAs into a PBL-approach to medical education, using the UOW GSM as a case study.

There are a number of PDA functionalities for the medical profession and medical education available nowadays. However, the appropriate PDA functionalities and aspects to be considered for the incorporation of PDAs into a PBL-medical curriculum have yet to be identified.

There is much literature that discusses the benefits and constraints of PDA use, PDA applications developed and deployed into the medical professions and medical education, technical aspects, and research findings before and after deploying certain PDA functionalities into medical education. However the literature has yet to propose appropriate PDA functionalities and aspects to consider before introducing PDA technology into a PBL-medical curriculum.
Therefore two major research questions have been proposed for this study in order to determine the feasibility of incorporating PDAs into a PBL-medical curriculum, using the UOW GSM as a case study.

1. What are the appropriate PDAs functionalities for studying medicine using a PBL-approach?

2. What are the factors/aspects which may influence the incorporation of PDAs into such a PBL-approach?

In order to find out the answers to these research questions, three major themes were focused on this study, these being (i) medical education and medical professionals, (ii) IT use in education, and (iii) relevant technical aspects.

The outcomes of this study would be beneficial not only for the PBL-medical curriculum at UOW GSM for the incorporation of PDAs in the future, but also for other medical schools which plan to deploy PDAs into their curriculum.

**Aim of this study**

The aim of this study is to study the feasibility of deploying PDAs into a PBL-approach to medical education at the UOW. A mixed method study was used in this feasibility study. A triangulation mixed method design was used in this study to validate the findings from the different methods. Further, Complementary data being gathered from one method was used to clarify the findings from another method.

In this study, qualitative in-depth interviews were used to explore the attitudes of participants regarding the incorporation of PDAs into the PBL-medical curriculum at the UOW GSM. Concurrently, a web-based survey was used to gather attitudes and experiences of respondents regarding PDA
use in PBL medical curricula elsewhere, and to determine whether the factors for incorporating PDAs would influence the feasibility of incorporating PDAs into the UOW PBL-medical curriculum based on the attitudes/perception of participants. The reasons for collecting both qualitative and quantitative data are to bring together the strengths of both forms of research to compare and validate the results, and to devise a strategy for the incorporation of PDAs into a PBL-medical curriculum.

**Objectives of this study**

In order to answer the two research questions, there are three major objectives in this research. The first objective is to validate the proposed PDA functionalities based on the conceptual framework (Chapter IV) as to whether they are appropriate for the UOW PBL-medical curriculum. The second objective is to validate whether the proposed aspects in the conceptual framework should be considered for the incorporation of PDAs into the UOW PBL medical curriculum. The final objective is to determine whether there is potential for incorporating PDAs into the UOW PBL-medical curriculum.

**5.2 Philosophical approach**

In order to answer all two research questions, it is essential to identify the relevant philosophical approach, and then later determine what research methods are appropriate for this study before conducting the research. The philosophical approach facilitates the researcher’s understanding of the major entities and focus of the research, what contexts need to be explored, and how they relate to each other.

The philosophical approaches for this study are *ontology* and *epistemology*. *Ontology* refers to the nature of reality (Lincoln and Guba 1985; Guba and Lincoln 1998), and the study of what entities exists, what reality is in general,
and how entities can be grouped together (Lincoln and Guba 1985; Guba and Lincoln 1998). Generally, ontology is referred to as “what we believe about the nature of reality” (Lincoln and Guba 1985; Guba and Lincoln 1998; Patton 2002). Mertens (2005) indicated that it is sometimes essential for the researcher to determine reality within the multiple contexts, for instance, cultural, political, economic or historical. The context of this study is focused on PDA use in medical education using a PBL-approach. In present study, PDAs, medical education and a PBL-approach are the existing entities, which can be known about, what they are, how they (PDAs, medical education and PBL-approach) really are and how they really work together in the existing reality. Therefore it is important to understand the nature and characteristics of these entities.

The concept of epistemology refers to the relationship of the knower to the known (Guba and Lincoln 1998). Therefore questions regarding epistemology are about “how do we know what we know? (Patton 2002)”; whether valid knowledge about the reality can be achieved, and how it can be achieved (Patton 2002; Maxcy 2003). The concerns in this research are PDA use in PBL-medical education, the feasibility of such devices being deployed in a PBL-medical curriculum, what they can be used in a PBL-medical curriculum, how they can facilitate medical education using a PBL-approach, etc. In order to identify the outcome of research interests and the findings of this study, interaction between the research and participants is necessary as it facilitates the researcher to understand the latter’s insight, thoughts, attitudes and perceptions in the areas being studied, and being able to justify and evaluate the outcomes and findings concerning the two major research questions.
5.3 Research methodology

*Ethnography* is a methodology commonly used in sociology and psychology research (Rice and Ezzy 1999). However, *ethnography* is also commonly referred to the social studies in cultural study (Patton 1990). The interest of this study is essentially on the cultural perspective of medical education using a PBL-approach, and PDA use in its curriculum. The issue in ethnographic data collection is focused on a mixture of different data sources. As a result, the research methods which were selected for this study focus on *mixed methods research*; such methods are a combination of qualitative and quantitative methods.

5.4 Methods

The goal of this research is to identify the feasibility of PDA use in a PBL-medical curriculum in the UOW Graduate School of Medicine according to the participants’ attitudes. The use of mixed methods aimed to identify and evaluate attitudes, knowledge and experience of participants regarding PDA and IT use in a PBL-medical curriculum, including the UOW GSM and other medical schools.

In addition, the approach being applied to this study emphasised both qualitative and quantitative methods, by using the in-depth interviews and web-based survey. This is because such an approach allowed the researcher to perform both methodological and data triangulations (Denzin and Lincoln 1998; Patton 2002; Teddlie and Tashakkori 2003; Tashakkori and Teddlie 2008).

Further, a combination of qualitative and quantitative methods also provided a better opportunity for the researcher to determine and evaluate the appropriate research outcomes and answers to all research questions (Teddlie and Tashakkori 2003; Teddlie 2003).
Qualitative research essentially focuses on the inductive-subjective contextual approach (Morgan 2007). It facilitates the researcher in gathering in-depth data and explores the area being studied (Teddlie and Tashakkori 2003). Quantitative research, on the other hand, is focused on the deductive-objective-generalising approach (Morgan 2007). A Quantitative research method therefore provides a greater breadth of data being collected (Teddlie and Tashakkori 2003). Therefore applying mixed methods (qualitative and quantitative) to this study allowed the researcher to understand the greater depth and breadth of PDA use in PBL-medical curriculum, and the broad perceptions of various data sources regarding PDA use in PBL-medical curricula elsewhere.

**Rationale of using mixed methods**

Mixed-methods were selected for using in this research because these methods allow the researcher to gain in-depth and breadth understanding of various issues and aspects (Mertens 2005) not only for PDA use in PBL-medical curricula, but also issues to be considered for the incorporation of PDAs into medical education in a PBL-approach than any single research method could provide.

The additional reasons why the mixed method was selected to conduct this study is that, firstly, mixed method research facilitates the researcher in answering research questions that other research methodologies cannot do (Teddlie 2003; Bryman 2006). The qualitative research method (in-depth interviewing) allows the researcher to explore any unknown issue in relation to PDA use in a PBL-approach medical curriculum. Concurrently, the quantitative research method (conducting a web-based survey) facilitates the researcher to capture the broader attitudes, experiences and perceptions of experts from elsewhere regarding PDA use in the medical education sphere. In contrast, applying any single method cannot capture the data in these two
dimensions (breadth and depth). As a result, the benefits of each method have outweighed the disadvantages. Further, the advantage of the mixed method also allows the researcher to evaluate and justify outcomes based on the strength of the two approaches.

Secondly, the mixed method research provides a better and stronger inference than using single method. With qualitative research, the in-depth interviews facilitate the researcher to gather ideas, attitudes and insightful thoughts of the participants regarding PDA use in a PBL-medical curriculum. Moreover, the in-depth interviews allow the researcher to explore any unclear issues regarding PDA use in a PBL-medical curriculum. Therefore the outcomes gathered by the qualitative research method provide data consistency, as the data is directly captured from the participants’ viewpoint rather than that of the researcher. Moreover, conducting in-depth interviews also allows two-way communication and facilitates the researcher to explore aspects in detail.

On the other hand, conducting this study by using one-on-one in-depth interviews with experts in different geographical areas could be time consuming and involve financial implications. Therefore applying quantitative research by using a web-based survey also allows the researcher to capture the attitudes of experts from elsewhere, and to overcome such limitations and constraints. As a result, applying the mixed method provides a stronger outcome to this study as it allows the researcher to justify and evaluate the most accurate answers to the research questions.

Thirdly, the mixed method provides the opportunity for the researcher to present a greater diversity of views (depth and breadth of data). It has been stated in the beginning of this chapter that applying mixed method research to this study facilitates the researcher to explore and capture the participants’ viewpoints of the issues and context being studied. Qualitative research (using in-depth interviews) allows the researcher to deeply understand and
gather insights/thought of the participants, while quantitative research (using the web-based survey) provide ease of capture of the attitudes and experiences of respondents from the medical schools elsewhere.

Finally, the mixed method provides grounds data triangulation; it contains the strength of both method (qualitative and quantitative). As a result, it provides greater strength to this research. The researcher can therefore overcome the weakness and inherent biases from using a mono-research method. Methodological triangulation allows the researcher to use more than one method to perform data collection; the method and data can be triangulated to one another in order to bring out the most accurate findings for this study.

**Design issues in mixed methods**

The design for this study was selected based on the four major classifications of the mixed method design, these being (i) triangulation design, (ii) embedded design, (iii) explanatory design and (iv) exploratory design (Creswell and Clark 2007). *Triangulation design*, which is a one-phase design, was applied to this study, as it allows the researcher to concurrently implement qualitative and quantitative methods at approximately the same time (Creswell and Clark 2007).

For this study, a qualitative approach (in-depth interviews) was used as the dominant approach, while a quantitative approach (web-based survey) was a minor component. This is because the aim of this study is to determine the feasibility of incorporating PDAs into a PBL-medical curriculum by using the GSM at the UOW as a case study. Therefore, it is essential to understand the attitudes, knowledge, experiences and insightful thoughts of participants toward the UOW PBL-curriculum.

On the other hand, the quantitative method is still important, even though such method is a small component in this study. This is because it provides a
better tool to capture the attitudes of respondents in broader perspectives regarding PDA use in medical education as well as medical practice elsewhere. Moreover, it is a fact that PDAs have already been incorporated into medical education elsewhere. The findings based on the quantitative method could be used to compare and validate the similarity and differences of PDA use in a PBL-medical curriculum, both in the UOW GSM and internationally.

There are numerous reasons why triangulation design was applied to this study. Firstly, it allows the researcher to best understand the research questions (Creswell and Clark 2007) with regard to PDA use in a PBL-medical curriculum, and to identify the appropriate outcomes for all two major research questions.

Secondly, triangulation design with the mixed method also allows the researcher to obtain data from different angles under the topic or area being studied (Creswell and Clark 2007). The characteristic of the qualitative and quantitative data is unique by itself. Qualitative data from the in-depth interviews facilitate the researcher to capture and understand the attitudes and insightful thoughts of the participants which quantitative tools cannot provide. The qualitative data therefore allows the researcher to view and understand each aspect regarding PDA use in a PBL-medical curriculum from different perspectives. On the other hand, the quantitative data from the web-based survey also assists the researcher to understand broader perspectives of individuals in each aspect from the participants in the medical educational sphere elsewhere.

Thirdly, the characteristic of triangulation design in mixed methods is that it allows the data to be collected and analysed separately by using appropriate data analysis techniques for each data type (Creswell and Clark 2007). As a result, triangulation design facilitates the researcher to compare, validate and
expand the qualitative (in-depth interviews) and quantitative (web-based survey) results.

Finally, triangulation design allows the researcher to identify with strength and non-overlapping weakness of qualitative and quantitative methods (Creswell and Clark 2007). As a result, it is beneficial for this study in determining the answers to all research questions.

**Figure 5.1** Triangulation design (Creswell and Clark 2007)

Figure 5.1 represents the concurrent triangulation design which the qualitative and quantitative method occurred in the parallel procedures for data collection and analysis. These procedures would facilitate the researcher to better understand the research problem. The results from both the qualitative and quantitative methods, finally, are to be integrated with the separate results together with the interpretation between the qualitative and quantitative findings as the final outcomes for this research. In addition, this design assists the researcher to compare, validate, confirm and integrate the qualitative results with the quantitative findings. The purpose of this model is
to come up with valid and well-substantiated conclusions about a single phenomenon (Creswell and Clark 2007). Figure 5.2 represents the research plan for this study.
Figure 5.2 Research procedures
The research procedures consist of four major steps, namely (i) instrument design, (ii) participant sampling, (iii) data collection procedures, and (iv) data analysis and interpretation. These procedures are explained and discussed in sections 5.4.1 - 5.4.4.

5.4.1 Instrument design

The instrument design for the in-depth interviews and web-based survey were derived from a two phase literature review and a scoping study. The phase-1 literature review was conducted in three major aspects, these being (i) an overview of PDA devices, (ii) PDA use in the medical profession and (ii) PDA use in medical education.

Further, the scoping study was conducted based on the phase-1 literature review by arranging informal interviews with the UOW GSM stakeholders and medical and nursing academics from other universities in NSW and New Zealand. The participants in the scoping study comprised the experts from various fields, including medical and nursing education, educational technology specialists, and IT experts. The reasons for conducting the scoping study were (i) to frame out the boundary of this study and; (ii) to further conduct additional literature reviews based on the research frame.

The comprehensive literature reviews in phase-2 were conducted with additional aspects, including PDAs, PDA use in medical practice and medical education, and IT issues regarding PDA use in other industries. The purposes of conducting the literature reviews in phase-2 were (i) to formulate a conceptual framework regarding the incorporation of PDAs into a PBL-medical curriculum and; (ii) to further design and develop the research.
**Instrument design for interviews**

The semi-structured interview questions were formulated based on the two-phase literature reviews and scoping study. The 37-interview questions (Appendix C) were categorised into three major aspects, these being (i) PDA functionalities, (ii) IT aspects, and (iii) practical aspects towards PDA use in a PBL-medical curriculum at the UOW GSM.

The first section aimed to identify the preferences of the GSM regarding PDA functionalities for the UOW PBL-medical curriculum. Secondly, the questions in the IT aspects section were intended to capture ideas towards the technical considerations with regard to the incorporation of PDAs into the UOW PBL-medical curriculum. This section contains three sub-sections, namely (i) interoperability, (ii) network connectivity, and (iii) data security and privacy.

Thirdly, the practical aspect questions were set to gather the concerns and future plans regarding PDA use in both medical education and clinical placements. This section contains three sub-sections, these being (i) EI, (ii) maintenance and support, and (iii) education and training. Lastly, the questions in the attitude section aimed to gather perceptions of participants regarding PDA use in medical education.

All interview questions were sent to experts in medical education, educational technology and IT for reviewing. The interview questions were reviewed and revised for several rounds to ensure that they were valid and reliable for conducting the interviews.

**Instrument design for the web-based survey**

The web-based survey provides an alternative method to conduct the questionnaire when it is financially unfeasible to access certain populations (Couper 2000; Andrews, Nonnecke et al. 2003) in different geographical
areas. Therefore incorporating a web-based survey into this study is a most cost effective (Couper 2000) data collection method. There are several reasons why the web-based survey was incorporated into this study.

Firstly, web-based surveys provide faster speed of data collection than paper-based surveys (Couper 2000; Adams and White 2008). Moreover, there are a number of software products available for conducting web-based survey research, and which are a self-administered application (Couper 2000; Mertens 2005), for instance, Survey Monkey, Zoomerang, and Survey Wiz (Andrews, Nonnecke et al. 2003). Such applications include useful functionalities for distribution of an e-mail cover letter, some built-in statistical analysis, reporting capabilities, auto tracking respondents, and HTML tag editors for developing and formatting the questions and response fields, etc (Mertens 2005). Secondly, web-based surveys provide low-cost data collection and data entry (Couper 2000; Adams and White 2008). Thirdly, using a web-based survey provides ease of data collection in terms of maintaining anonymity of respondents (Adams and White 2008). Finally, web-based surveys facilitate the researcher in increasing the number of potential respondents who are widely dispersed elsewhere.

However, there are two limitations of conducting such the web-based survey in this study. Firstly, there is a limitation in calculating the response rate (Adams and White 2008). Secondly, the respondents are automatically required to have Internet access and computer skills to complete the survey (Couper 2000; Adams and White 2008).

For this study, the 31 web-based survey questions with 48 closed-end items (Appendix C) were derived from the literature reviews and scoping study, and were organised into 5-parts, namely (i) PDAs functionalities, (ii) IT aspects, (iii) practical aspects, (iv) attitudes towards PDA use in PBL-medical curricula and (v) demographics. The organisation of the web-based survey
questions was similar to that used in the interview questions with all questions in three major aspects: (i) PDA functionalities, (ii) IT aspects (interoperability, network connectivity, data security and privacy protection), and practical aspects (electromagnetic interference, education and training, maintenance and support) and (iii) additional sections for attitudes towards PDA use in PBL-medical curricula, demographics and computer skills. The 5-Likert scale was applied to the majority of questions in all major aspects. In addition, open-ended questions were included in each section, which allows the researchers to seek additional comments and facilitates respondents to answer in their own words in each individual aspect.

Before launching the web-based survey, all survey questions were reviewed and revised by experts from three areas, namely (i) medical education, (ii) educational technology specialists, and (iii) IT specialists, in order to ensure validity of the questions.

5.4.2 Participants sampling and selection

The sample selection can be based on either probability design (random) or non-probability design (deliberate) (Burns, Duffett et al. 2008). Probability designs consist of simple random sampling, systematic random sampling, stratified random sampling and cluster sampling (Mertens 2005; Burns, Duffett et al. 2008). On the other hand, non-probability designs include purposive sampling, quota sampling, chunk sampling and snowball sampling (Mertens 2005; Burns, Duffett et al. 2008).

Purposive sampling or theoretical sampling (Mertens 2005; Burns, Duffett et al. 2008), which is the non-probability sampling, was applied to both the qualitative (in-depth interviews) and quantitative (web-based survey) data collection. This is because this sampling technique is suitable for the aim, objective, budget and timeframe of this study.
Participants sampling and selection for interviews

*Purposive sampling or theoretical sampling,* in the form of a criterion sampling strategy, was used in selecting interview participants. As previously mentioned, the aim of this study is to determine the feasibility of incorporating PDAs into a PBL-medical curriculum at the UOW GSM. Therefore the researcher specified the characteristics of the population of interest into three major groups, namely (i) the GSM faculty, (ii) clinical academics and (iii) educational technology specialists.

There are several reasons why the interview participants were drawn from these three groups of experts. Firstly, the medical faculty are the primary group of experts who have direct contact with students throughout their 4-years of medical study. Therefore it is essential to determine their attitudes, perceptions and experiences regarding PDA and technology use in medical education with respect to the UOW PBL-medical curriculum.

Secondly, the clinical academics are also a group of experts who play an important role in educating and supervising clinical skills and practice to students while being dispersed in clinical placements elsewhere. Their attitudes, ideas, perceptions and experiences towards technology and PDA use are not only valuable for the incorporation of PDAs into the UOW PBL-medical curriculum, but also in a real clinical practice.

Lastly, the educational technology specialists are a group of experts who directly deal with all technical issues. Therefore it is important to identify their attitudes, knowledge, perceptions and experience in designing, developing, implementing, maintaining and supporting technology and PDA use in the educational sphere.

Further, a list of participant contacts was obtained from the GSM, based on such criteria and recommendations from the GSM stakeholders. The criteria
for participant selection were defined. Participation in this study was based on the initial permission and volunteering of each individual interview participant. As a result, 15 participants were selected based on such criteria. The participants comprised medical faculty from the UOW GSM (n = 8), Honorary Clinical Academics from Wollongong Hospital (n = 3), and Educational Technology Specialists (n = 4). The participants were scheduled for one-on-one interviews. A summary of the interview participants is provided in Table 5.1.

Table 5.1 Summary of interview Participants

<table>
<thead>
<tr>
<th>Participants position</th>
<th>Number of Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical Faculty</td>
<td>8</td>
</tr>
<tr>
<td>Honorary Clinical Academics</td>
<td>3</td>
</tr>
<tr>
<td>Educational Technology Specialists</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>15</strong></td>
</tr>
</tbody>
</table>

Even though the sample for the interviews is relatively small, it is acceptable sample size in qualitative research (Bertaux 1981). The in-depth information was planned to gather from the individual experts in each area. These groups of participants represented the population of experts in the areas regardless how many participants were required for the interviews (Guest, Bunce et al. 2006). Details of the data gathering procedure and data analysis are discussed in the following sections.

**Participant sampling and selection for the web-based survey**

The purpose of conducting the web-based survey is to determine the attitudes, experiences and perceptions of experts regarding PDA use in the
PBL-medical curricula elsewhere. Therefore the strategy for participant sampling and selection for the web-based survey is *purposive sampling*, which is a *non-probability type of sampling*. The population of interest for the web-based survey is similar to the interview participants sampling, namely medical faculty, clinical academics or clinicians, and educational technology specialists or IT experts. The researcher invited web-based survey respondents via the educational working group mailing list from the American Medical Informatics Association (AMIA). However, participation in the web-based survey data collection is based on volunteers (Couper 2000) from this mailing list. This approach created volunteer respondents from the letter of invitation through the mailing list, which is embedded in the survey website. Therefore, the non-probability surveys with volunteer-based respondents is significantly different from the probability-based method for participants sampling and selection as the response rate can be determined based on statistical principles (Couper 2000; Andrews, Nonnecke et al. 2003).

In total, 45-participants responded to this survey. Due to the small number of web-based respondents, the survey data was used for supporting the interview findings and to better understand the use of PDAs in PBL-medical education from respondents elsewhere. Table 5.2 summarises the survey participants by country.

**Country**

**Table 5.2 Web-based survey participants by country**

<table>
<thead>
<tr>
<th>Country</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>US and Canada</td>
<td>32</td>
<td>71.1</td>
</tr>
<tr>
<td>Europe</td>
<td>3</td>
<td>6.7</td>
</tr>
<tr>
<td>Others</td>
<td>10</td>
<td>22.2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>45</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>
The reason for having different response rates from different countries is possibly because of the survey distribution to particular mailing lists and the participants’ degree of interest. Finally, participation in this survey is on a voluntary basis.

**Gender and age**

The participants were male and female (Table 5.3), and including age 45 and under and over 45 (Table 5.4). It is important to note that due to the small number of the survey responses; the four-rages of participants’ age groups from the survey were collapsed into two-groups, these being (i) 45 and over and (ii) over 45, in order to best utilise the data for survey analysis.

**Table 5.3 Web-based survey participants by gender**

<table>
<thead>
<tr>
<th>Gender</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>33</td>
<td>73.3</td>
</tr>
<tr>
<td>Female</td>
<td>11</td>
<td>24.4</td>
</tr>
<tr>
<td>No response</td>
<td>1</td>
<td>2.2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>45</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

**Table 5.4 Web-based survey participants by age**

<table>
<thead>
<tr>
<th>Age</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>45 and under</td>
<td>16</td>
<td>35.6</td>
</tr>
<tr>
<td>Over 45</td>
<td>25</td>
<td>62.2</td>
</tr>
<tr>
<td>No response</td>
<td>1</td>
<td>2.2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>45</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

**Position**

The survey questionnaire originally asked about the knowledge, experiences and attitudes from medical faculty members elsewhere. However responses were received from various positions from the AMIA education working
group. Moreover the majority of respondents already have experience in the field. Table 5.5 summarises the various positions of the survey respondents.

Table 5.5 Web-based survey participants by position

<table>
<thead>
<tr>
<th>Position</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical faculty</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Professor</td>
<td>7</td>
<td>15.6</td>
</tr>
<tr>
<td>Associate professor</td>
<td>17</td>
<td>37.8</td>
</tr>
<tr>
<td>(Senior lecturer)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assistant professor</td>
<td>10</td>
<td>22.2</td>
</tr>
<tr>
<td>(Lecturer)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IT specialists</td>
<td>2</td>
<td>4.4</td>
</tr>
<tr>
<td>Healthcare professions</td>
<td>7</td>
<td>15.6</td>
</tr>
<tr>
<td>Others</td>
<td>2</td>
<td>4.4</td>
</tr>
<tr>
<td>Total</td>
<td>45</td>
<td>100.0</td>
</tr>
</tbody>
</table>

5.4.3 Data collection procedures

The data collection procedures for both interviews and web-based survey were planned to concurrently occur approximately at the same time as presented in Figure 5.2.

Interview data collection procedures

After obtaining the list of interview participants with permission from the GSM, the procedures to contact potential participants consisted of 3 steps. Firstly, invitation letters were sent to selected participants individually via e-mail in order to inform the background, intention and purpose of this study, then their permission requested to conduct the interviews. Secondly, the appointment time and venue for the interview were arranged, together with permission to use a voice recorder while conducting interviews. Thirdly, letters, participant information sheets, and consent forms were given to the participants directly. Before interviewing, the participants were asked whether they agreed to be interviewed before signing the informed consent form. It was agreed that the participants be interviewed on a voluntary-basis.
The participants were informed that they have the right not to answer any questions and/or to withdraw from the interview at any time. Such refusal or withdrawal had no affect; and they were able to withdraw their data if they withdraw their consent. The participants were also informed that the given information was to be kept strictly confidential and not be indentified in any report or publication.

The in-depth interviews were conducted (during September – October, 2007) at the office of participants according to location and time, including the GSM, Wollongong Hospital, Illawarra Area Health Service, etc. All interview questions were presented to all participants. The interviews were tape-recorded for subsequent data transcription. The interviews took approximately 30-45 minutes. The follow-up e-mail and second visits were sent out for transcribe checking purposes.

**Web-based survey data collection procedures**

The 31-questions with 48-items questionnaire was converted to a web-based survey and posted on the Survey Monkey web pages. The web-based survey had a simple layout with a straightforward navigation strategy and limited graphics and colour to minimise download time. The software applications support multiple platforms and web browsers. The web-based survey applications also provided automatic saving of respondents’ answers for both closed- and open-ended questions. Such feature facilitates data loss in case of network connection error while answering survey questions. Further, the ‘thank-you’ page for participation in this survey was immediately displayed once the respondents completed the survey.

The e-mail invitation letter about the aim and objectives in conducting the web-based survey was sent to survey participants via the mailing list of the AMIA educational working group. The participant information sheet was
also embedded within the invitation letter, including that participation in the web-based survey was voluntary. The participants were free to withdraw from the survey at any time. All answers to the survey remained anonymous, kept strictly confidential and not identified in any subsequent reports or publications. The survey took approximately 10-minutes to complete. The web-based survey was live for data collection between March and April 2008 (approximately 30 days). Respondents with the same internet protocol (IP) address as the previous response submitted the survey were accepted, however, they were assumed to be duplicates and excluded from the data analysis.

5.4.4 Data analysis and interpretation

Mixed method data analysis and interpretation facilitates the researcher to bring out the strengths of both qualitative and quantitative data analysis techniques in order to better understand the area being studied, and to utilise and interpret quality data to answer the research questions (Onwuegbuzie and Teddlie 2003).

Caracelli and Greene (1993) indicated that the purpose of mixed-method data analysis is to accomplish mixed-method evaluation, including triangulation, complementarity, development, initiation and expansion. The triangulation design of mixed methods was selected for this study.

The mixed-method data analysis and interpretation was categorised into four major types, these being (i) non integration, analyses and interpretation of qualitative and quantitative data conducted separately; (ii) analyses separate but some integration during interpretation; (iii) integration during both analyses and interpretation; and (iv) analysis procedures not reported (Caracelli and Greene 1993). Data analysis within the mixed-method for this study falls into type-2 where the data are separately analysed within both
qualitative and quantitative approaches and integrated with those approaches (Caracelli and Greene 1993; Creswell 2003; Johnson and Christensen 2004).

**Interview data analysis**

All 15-interviews were transcribed into 15-document cases and analysed using thematic analysis. A computer-assisted qualitative data analysis with Nvivo software version 7 was used for data analysis. The strategies in analysing the interview data were segment coded with references to their original verbatim sources (Lee and Fielding 2004), sorted, organised, categorised into themes and sub-themes (Appendix G), then annotated, noted in memo form (Bazeley and Richards 2000; Lee and Fielding 2004), discussed and reflected to the literature and conceptual framework. The following procedures were derived during the interview data analysis.

Firstly, the researcher began exploring the interview data based on the three major research questions. Secondly, the data was gathered and coded in each aspect. The codes were sorted, organised and stored in nodes, then categorised according to themes and sub-themes (Bazeley and Richards 2000; Lee and Fielding 2004). Time was taken to reflect on what had been learned from the data sources, themes and sub-themes in each aspect. During this step, the coding sometimes leads to new categories. Further, more data from the interview transcription were collected, coded and stored on the developing themes and sub-themes.

Thirdly, knowledge of the data was built through the coding structure, represented into themes and sub-themes (Bazeley and Richards 2000; Lee and Fielding 2004) in each aspect. Time was taken to reflect on what had been learned from the data sources, themes and sub-themes in each aspect. During this step, the coding sometimes leads to new categories. Further, more data from the interview transcription were collected, coded and stored on the developing themes and sub-themes.

Fourthly, relationships were determined and examined on how each node, theme or sub-theme might associate among each other (Bazeley and Richards 2000). At this stage, the nodes and free-nodes were re-organised into proper locations. Fifthly, the *coding reference* was determined from Nvivo for
indentifying which items in each aspect were most to least important for the incorporation (Bazeley and Richards 2000) of PDAs into a PBL-medical curriculum.

Sixthly, themes and sub-themes in each aspect were compared individually. The demographic information of participants was brought into the data analysis by using Matrix query (Miles and Huberman 1994; Bazeley and Richards 2000; Lee and Fielding 2004) in Nvivo. Further, memos were written about the researcher’s idea and reflection towards themes and sub-themes in each aspect. Lastly, the literature and conceptual framework were frequently revisited in order to emerge and revise the answers to the three research questions.

**Web-based survey data analysis**

After the data collection period was over, the survey data was downloaded from the survey web-site and imported into SPSS (version 15). The variables of the survey data were defined. Further, the data were screened, checked, cleaned and corrected for any error in the data file. The reason for performing an inspection of the data file was to check the readiness of data before conducting the specific statistical function to further address the answers to the research questions. Three major statistical analysis were performed in this web-based survey, namely (i) the reliability test, (ii) descriptive statistics (iii) Mann-Whitney U Test, and (iv) correlation matrix.

There were 48-items in this survey, which were grouped into three aspects, these being (i) PDA functionalities and its benefits and constraints, (ii) technical, and (iii) practical. A reliability test was performed on each aspect in order to find reliable scales for the attitudes measurement (5-Likert scales) of each aspect (Appendix D). The common use indicator to identify the reliability of the survey questions was Cronbach’s alpha coefficient (Pallant
The Cronbach alpha should generally be above .7 (Pallant 2007). Ideally, Cronbach’s alpha is preferable if its values are above .8 (Pallant 2007). Several double negative questions in the survey were reversed before performing the reliability test in order to avoid a negative value on Alpha scale. The Alpha values in each aspect are displayed in Table 5.6.

Table 5.6 Cronbach alpha of responses to PDAs functionalities, benefits and constraints to medical education using a PBL-approach

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Cronbach's Alpha</th>
<th>Cronbach's Alpha Based on Standardized Items</th>
<th>N of Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>PDA functionalities, benefits and constraints</td>
<td>.831</td>
<td>.861</td>
<td>22</td>
</tr>
<tr>
<td>Technical aspect</td>
<td>.721</td>
<td>.730</td>
<td>11</td>
</tr>
<tr>
<td>Practical (EI, education, maintenance and attitudes towards the incorporation of PDAs into a PBL-approach)</td>
<td>.757</td>
<td>.775</td>
<td>14</td>
</tr>
</tbody>
</table>

However, one item was deleted from the technical aspect, as the Cronbach Alpha was considered too low (.693) for the item to be considered on the scale. Therefore, dropping SQ 15.1a from the technical aspects (11-items) leads to a Cronbach Alpha of .721, which provided a more desirable Cronbach Alpha value.

Further, descriptive statistical analysis was performed on each aspect against the demographic information (country, academic position, gender and age) in identifying the attitudes of respondents on PDA use in PBL-medical curricula. The web-based survey findings in each aspect were compared with the interview findings to see whether there was any convergence, inconsistency or contradiction in the findings. This is because it is essential to
ensure trustworthy findings, accurate conclusions and the strategies for the incorporation of PDAs into a PBL-medical curriculum.

5.5 Validity

The Validity or Legitimation (Onwuegbuzie and Johnson 2006) issue is important in research, as its results verify whether or not it has quality and reliable outcomes (Onwuegbuzie and Johnson 2006). The validity of research results for the mixed method is different from other studies which use qualitative or quantitative research methods. The validity approaches in qualitative research are (i) descriptive validity, (ii) interpretative validity, and (iii) theoretical validity (Johnson and Christensen 2004). Validity approaches in quantitative research comprise the following four different strategies, (i) internal validity, (ii) external validity, (iii) construct validity, and (iv) statistical conclusion validity (Johnson and Christensen 2004). Therefore the different validity approaches have been applied to validate mixed method research for both internal and external standards (Johnson and Christensen 2004; Onwuegbuzie and Johnson 2006). This is because each study may have various ranges of quality for certain aims and objectives than others (Johnson and Christensen 2004; Onwuegbuzie and Johnson 2006).

Validity of mixed-method study can be categorised into four-approaches, namely (i) data triangulation (cross-validate, corroborate findings), (ii) investigator triangulation, (iii) theory triangulation, and (iv) method triangulation (Onwuegbuzie and Johnson 2006). Such approaches facilitate the researcher in establishing the credibility of mixed data (Johnson and Christensen 2004; Onwuegbuzie and Johnson 2006). Further, method and data triangulation were applied for internal validity for this study, while generalisation was applied for external validity. Finally, a correlation matrix was generated in order to identify the relationships among all three major
aspects, these being (i) PDA functionalities, (ii) IT aspect and (iii) practical aspects.

5.5.1 Internal validity

Method triangulation and data triangulation were used for internal validity in this study. This is because, firstly, two different data collection methods were used, these being the in-depth interviews and the web-based survey; secondly, multiple data sets were obtained using two different data collection methods (Johnson and Christensen 2004). In short, when mixing the method and data, it allows the researcher to use the mixed method by minimising the weakness of each method so does minimise the weakness of data from another method (Johnson and Christensen 2004).

Method triangulation

According to method triangulation, different data collection methods, which are interview and web-based survey, were used in this research for obtaining data. The interview allows the researcher to gather attitudes, knowledge and experiences of participants with inner-depth perspective while the web-based survey facilitates the researcher to understand the area being studied in broader-breadth dimension.

Therefore, it allows the researcher to use the strength of data collection and bring out quality data, which each method can provide to better answer the research questions than using any single data collection method (Johnson and Christensen 2004). As a result, there is better evidence for determining answers to the three major research questions.

Data triangulation

Data from multiple sources were used in data analysis and interpretation (Johnson and Christensen 2004). Such data came from the in-depth
interviews and web-based survey. Further, such data not only came from different data collection methods, but also from different time, places and people. Data triangulation facilitated the researcher to identify the convergence, consistency, inconsistency and contradiction (Johnson and Christensen 2004) of attitudes, knowledge, experiences and opinion of respondents towards PDA use in a PBL-medical curriculum. As a result, it facilitated the researcher to bring out rigorous research findings than using any single data source for one particular data collection method (Johnson and Christensen 2004).

5.5.2 External validity

According to naturalistic generalisation (Johnson and Christensen 2004), it is possible that the results and findings of this study can be simply applied to medical schools elsewhere based on their basic similarity, including the context of PBL-medical curriculum, learning requirements, learning environments and settings. On the other hand, the incorporation of PDAs into a PBL-medical curriculum can also be applied and used in other medical schools with the basic functionalities, major aspects for incorporating PDA use and strategies for incorporating PDAs into PBL-medical curricula, even though the context and focus on each function, aspect and model or approach to incorporate PDA use may vary in each medical school.

The external validity can also be determined by replication logic (Johnson and Christensen 2004) where similar findings regarding attitudes toward the incorporation of PDAs into a PBL-medical curriculum simply occur from different participants in the same or different settings. As a result, the results and findings from this study can be broadly applied into medical schools elsewhere.
5.6 Ethical issues

Before conducting this study, approval was granted from the Human Research Ethics Committee at the University of Wollongong. Consents were obtained from all participants before data collection (see Appendix B for the consent form).

The ethical issues were essentially focused on consent, privacy and confidentiality of data. For interviewing, permission had been granted from the GSM for the data collection. On the other hand, e-mail invitation letters were sent to the AMIA educational working group regarding the intention of conducting the web-based survey.

The participations in this study were completely voluntary; they had their rights and freedom to withdraw from the study at any time. Therefore whether they chose to take part in this study, both interview participants and web-based survey respondents experienced no risk or harm.

For interview data collection, all answers and discussions were emphasised on participants’ attitudes, knowledge, experiences and perceptions regarding medical education, IT and PDA use in learning medicine. All interview participants’ names were coded and used throughout the data analysis and thesis write-up (e.g. IV01, IV02, etc.). Their names were de-identified in reports and published results for privacy and confidentiality of participants and respondents. The interviews were conducted in private and the audio records were securely stored in a safe place without participants’ identification. On the other hand, no identification was required or given on any web-based survey data collection. However the respondents’ comments and opinions were represented as respondent number (e.g. Web-based Survey Respondent #1, etc.). All data were remained anonymous and were securely kept for the required period (5 years) before being disposed of.
5.7 Limitations

There were several limitations to this study. Firstly, the interviews were conducted with medical faculty, honorary clinical academic and educational technology specialists using the GSM UOW as a case study. Therefore the purposive sampling design may not represent the general population of other medical schools using PBL-medical curricula. However, the findings from this study can be used as a guideline for the incorporation of PDAs into PBL-medical curriculum in the future.

Secondly, this study was conducted at the very beginning of the GSM, therefore medical students were excluded from the participant sampling. A Qualitative research method has been adopted for this study. However, the findings in each aspect need to be validated by international medical academics, clinicians and IT specialists.

Thirdly, a number of the web-based survey respondents were a small group of experts in IT, as a result the data from the web-based survey was unsuitable for performing other statistical analysis, for instance, factor-analysis.

Lastly, the study is based on the perception of three groups of experts. These cannot be tested with the actual usage of PDAs in medical education as there was no actual use of PDAs at the GSM at the time of study.

5.8 Chapter Summary

In summary, the mixed-method research with concurrent-design and data analyses was used in this study, as it facilitates the researcher to bring out data in both depth and breadth from experts in medical education and educational technology. Data collection included the in-depth interviews and a web-based survey questionnaire. Internal and external validations were used to validate the data being collected from both interviews and the web-
based survey. Data analysis for this study included thematic analysis (Lee and Fielding 2004), induction and deduction, correlation, comparison and integration (Teddlie 2003).
Chapter VI
An Overview of the UOW PBL-Medical Curriculum

6.0 Chapter Overview

The objective of this chapter is to review the contents, context and structure of the UOW PBL-curriculum. This review assists the researcher to better understand the curriculum design and educational methods, which include both learning methods and specific instructional methods.

Secondly, this review of the UOW PBL-medical curriculum also enhances an understanding of student responsibility for learning and the learning outcomes during their 4-years of medical study.

Further, the curriculum structure also assists the researcher to understand the learning context in each stage during the program. Moreover the review in this chapter also enhances the researcher in identifying opportunities for incorporating PDAs use into the PBL-approach at the UOW GSM.
6.1 A PBL-Medical Curriculum at the University of Wollongong Graduate School of Medicine

The UOW GSM PBL-medical curriculum was developed and formulated based on three different sources, these being the University of Sheffield (UK), the Peninsula Medical School (UK), and the Flinders Rural Parallel Community Curriculum. The curriculum focuses on various aspects, for instance, the clinical problems normally found in community-based practice, the required clinical competencies for internship, and flexibility of curriculum structure in delivery in teaching and learning strategies.

The medical curriculum was designed to use 93-clinical problems. Each clinical problem addresses the knowledge and skills which medical students must have, based on the learning outcome and learning assessments. For the core strategy of delivery, the learning is case-based by monitoring the students’ progress through the whole course as an independent learning exercise. The use of IT is also integrated into the course in order to assist in course delivery.

The primary focus of the medical school is to produce internships to practice in regional, rural and remote areas with skill competence. The students start practicing in a regional area from phase-1, and are required to practice in clinical placements in a rural setting for a 40-week period.

6.2 Curriculum design and educational methods

The entire GSM curriculum is learnt in a clinical focus. The multiple methods of flexible learning (Figure 6.1) include large group lectures, video-cast lectures, small-group project, online study, clinical demonstrations and anatomy laboratory. The first half of the course is to increase the involvement in clinical placement in both regional and rural areas.
Case-based learning and active learning approaches are applied to the program at the beginning of the clinical contact. A combination of learning approaches, however, would be varied to suit the progress of students throughout the course. The purpose of the learning methods is to meet the students’ learning, wherever and whenever this is needed. Therefore such an approach would assist students to learn and understand the real task of doctors through the learning activities.

The clinical placement activities are practiced in the clinical skills centre during phase-1 and phase-2, where students can learn and develop the clinical
skills. During these phases, students learn different issues in population health, the behavioural and social sciences, and personal and professional development.

An online learning environment has been integrated into the curriculum while students are located in different clinical placements, especially during phase 3 and 4.

An e-portfolio or student log is used to monitor student progress while they are away in clinical placements. The e-portfolio is an approach to foster and reflect the students’ practice. Besides monitoring the students’ progress, the medical school is able to assess their learning needs, any gaps in their learning, and how to fill these gaps via the e-portfolio.

Specific instructional methods

Various instructional methods are used in medical education at the GSM, including integrated learning activities (ILA), anatomy laboratory sessions, lectures, small group project work, guided independent learning, clinical demonstrations and workshops, online learning activities, clinical skills sessions and clinical placement in different clinical environments (Figure 6.2).
Figure 6.2 Instructional Methods

*Interactive Learning Activity (ILA)* is a modification of PBL, which would be done in phase-1 as a group of lecture theatre then students would be assigned to work in a small group. The case scenario would be given to the students. The purpose of these activities is to encourage students to define the problem, clarify unfamiliar terms, brainstorm and define possible solutions. ILA would be conducted online through the end of each 2-week cycle. At the beginning, ILA would essentially focus on medical sciences, clinical sciences, ethics and management skills. The case scenarios would be delivered to students in different styles; however the majority of case delivery would be focused on online learning environment. Students are expected to work as a group, pair
or individual, and to work independently or together with their supervisor in phase-4.

*Lectures* would be held during phase-1 and phase-2. The purpose of lectures is to address the study topic in basic, medical, population health and behavioural sciences. The focus of each lecture is to define the learning guide.

*Clinical presentations and demonstration* would be occurred either in small or large learning group during each 2-week. These learning methods are essentially focused on the body systems, history taking, physical examination and clinical signs.

*Human anatomy sessions* would be occurred in phase-1. The instructional methods would be anatomy computer image and anatomical models.

*Clinical skills centre* would allow the students to develop the clinical skills and competencies in a structured educational environment. The various skills are included in this session, these being, communication skills, medical interview, physical examination skills, basic practical procedures, resuscitation skills and health and safety skills. In this session, the students are allowed to visit and revisit the clinical skills centre to learn and develop the skill in the clinical placement.

*Clinical placement* would be held between phase-2 and phase-4 with certain clinical areas, including, medicine, surgery, general practice, mental health, women’ and children’s health, ambulatory acute and critical care. During these phases students would have opportunity to make physical contacts with patients by taking patients’ history, examine patients, diagnosis the patients and manage a plan to their clinical supervisors.

*Online learning opportunities* would be occurred in every phase of the medical curriculum. Different activities are planned to conduct to online
learning, for instance, practical exercise in histology, pathology, physiology by using computer-based interactive learning materials.

*Guide independent learning* is planned to develop students’ self-directed learning. The self-learning project would be assigned to the students during phase-1 and phase-3.

*Reflective journal* would be maintained in order to keep track with the student progress through the entire program. Students are required to record their progress in the e-portfolio and the patients that they have seen on clinical-log from the beginning of phase-1 throughout phase-4.

Different instructional strategies would be used throughout the program as the student learning progresses.

**6.3 Student responsibility for learning**

Student responsibility for learning is developed from the beginning of the program via clinical contact, learning method and course content. The aims of the instructional design are, firstly, to develop the ability to ask and answer questions; secondly, to gather and evaluate the data in order to answer questions; thirdly, to apply to the evidence, the capacity in order to reflect upon the experiences and; finally, to identify their own learning needs.

In addition, there are other tools which help the students in facilitating their learning needs and also accessing various learning resources, these being e-learning package, online versions of traditional Clinical-Pathologic Conferences, and e-portfolio. Students are required to record their clinical encounters, to identify their shortcomings and to record in their personal portfolio. During the course students are required to work in a small group in order to find solutions to problems in their learning activities, research and other projects. Students are also encouraged to spend their remaining time for
independent learning with online access learning activities, and to be responsible for their own learning needs.

### 6.4 Learning outcomes

The GSM PBL-medical curriculum comprises three basic foundations, namely scientific method evidence-based practice, analytical skills and critical thinking skills. Therefore three learning outcomes are addressed. The first learning outcome is referred to as the ability to address and access relevant clinical information, evaluate problems and seek solutions to problems. The second learning outcome is the ability to continuously seek solutions as they gradually change in social and cultural terms. The final learning outcome is the ability to respond to changes in science, healthcare and policy.

In order to achieve the first learning outcome, phase-1 students are expected to have the ability to gather and understand medical articles from a clinical medicine perspective. Students are required to identify the current literature and review the information of approved drugs on a scientific basis. According to their evidence-based investigation, students are also required to construct questions based on their patient encounters and to indicate possible answers to such questions.

To accomplish the second learning outcome, students are arranged to conduct a practice audit during their 40-week clinical placement. This practice audit is supervised by a general practitioner (GP). Students are required to identify their clinical involvement based on root-cause analysis, in order to indicate any factors relevant to the clinical incident.

The third outcome can be achieved indirectly via group discussion regarding scientific-based medical practice. Students are expected to have a good
understanding of the scientific process with critical analysis skills in advanced clinical medicine.

6.5 Curriculum structure

The curriculum structure (Table 6.1) was derived from the content, context and sequencing that guides faculty and students for knowledge, understanding, skills and attitudes at each stage of the course. The curriculum assists students to learn by doing, see the issues where they encounter them, and to identify related resources from different aspects. Each phase of the curriculum is constructed with the content, context, extent and sequencing of learning, learning activities in each fortnight and the scope of the assessments in each phase.
### Table 6.1 Curriculum structure

<table>
<thead>
<tr>
<th>Year</th>
<th>Phase 1: Medical Science/Introductory Clinical Competence (57-weeks)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Introductory, Cardiovascular/Respiratory, Intensive Clinical Experience, Gastrointestinal/Liver, Skin/Genitourinary/Genetics/Endocrine/Reproductive, Introductory Clinical Competence, Community Clinical Placement, Research &amp; Critical Analysis, and Personal &amp; Professional Development,</td>
</tr>
<tr>
<td>Year-1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Haemopoietic/Immune, Neurosciences/Musculoskeletal, Medical Science, Research &amp; Critical Analysis, Personal &amp; Professional Development</td>
</tr>
<tr>
<td>Year-2</td>
<td>Phase 2: Basic Clinical Competency (20-weeks)</td>
</tr>
<tr>
<td></td>
<td>Wollongong Hospital Rotation, Other Illawarra/Shoalhaven Rotation, Medical Science, Research &amp; Critical Analysis, Personal &amp; Professional Development</td>
</tr>
<tr>
<td>Year-3</td>
<td>Phase 3: Extended Clinical Competence/Medical Science (58-weeks)</td>
</tr>
<tr>
<td></td>
<td>Clinical Elective or Medical Science Directive, Extended Clinical Competence, Ambulatory Care, Acute &amp; Critical Care, Maternal &amp; Paediatrics, Medical Sciences (Women’ and Child’s Health), Research &amp; Critical Analysis, Personal &amp; Professional Development</td>
</tr>
<tr>
<td>Year-4</td>
<td>Phase 4: Advanced Clinical Competence (12-Weeks)</td>
</tr>
<tr>
<td></td>
<td>Advanced Clinical Competence, Hospital Student Internship Rotation, Clinical Elective Rotation, Personal &amp; Professional Development</td>
</tr>
</tbody>
</table>
6.6 Chapter summary

From the preceding literature review, almost all medical schools have already applied a PBL-approach to their medical curricula. The difference, however, is how early students in each medical school start having clinical encounters in a real clinical setting. In a traditional learning medical curriculum, students start having clinical attachments, encounters and rotations during year-3 or year-4.

However, other medical schools, which already incorporate a PBL-approach into their curricula, start having clinical attachments from year-2 onwards. For instance, medical students in US medical schools start having their clinical attachment, encounters and rotation during their clerkship year. For medical schools in NSW, most start having their clinical attachment from year-2 or in the following years. Therefore, the difference between the UOW-PBL medical curriculum and other medical schools is that students start learning medical science and have clinical encounters at the very beginning of year-1. As a result, PDAs facilitate students in studying medicine, especially while located offsite.

Therefore, there is an opportunity that PDA devices could be incorporated into the UOW-PBL-medical curriculum, for instance in classroom learning, clinical skills practice and clinical attachments while offsite. PDAs are a learning tool which students could use for accessing and gathering information, as well as for communicating with others while offsite. The findings in this feasibility study are reported and discussed in the following chapters (Chapters VII – IX).
Chapter VII
Results and analysis

7.0 Introduction-overview

The purpose of this research is to study the appropriateness and feasibility of incorporating PDAs into a PBL-approach to medical education at the University of Wollongong based on participants’ perceptions. The major research questions that guide this study are:

(1) What are the PDA appropriate functionalities for a PBL-medical curriculum?;

(2) What are the factors or aspects that may influence the incorporation of PDAs into the UOW PBL-medical curriculum?

A conceptual framework was formulated based on the scoping study as mentioned in the methodology chapter, to frame out this study. There are various issues to be considered for incorporating PDAs into the PBL-medical curriculum at UOW, including:

- PDA functionalities,
- Software and hardware requirements
- PDA platforms
- Data synchronisation
- Network connectivity
- Scalability
- Electromagnetic interference
- Data security
These concerns are the important considerations for incorporating PDAs into medical education, not only in traditional classroom learning, but also using a PBL-approach.

In order to answer all three research questions, interview and web-based survey questions were set up and categorised into the following nine sections (Appendix C):

**Section A:** Medical School preference (Preferred PDA functionalities).

**Section B:** PDA Platform (Interoperability)

**Section C:** Data synchronization

**Section D:** Data transmission and network connectivity

**Section E:** Data security and protection

**Section F:** Interference

**Section G:** Education and training

**Section H:** Maintenance and support

**Section I:** Attitudes toward the use of PDAs in medical education in PBL

Results and findings are reported and discussed in three separate chapters, namely how PDAs can assist PBL-medical curriculum (Chapter VII), technical aspects (Chapter VIII) and practical aspects (Chapter IX).

In this chapter, the results of this study are presented in themes and sub-themes, which were derived from the research questions. The results of this study came from interviews (Section 7.1) and a web-based survey (Section 7.2).

Answers to the three research questions are discussed in Chapters VIII - IX.
7.1 Interview Findings: How PDAs assist a PBL-approach

PDAs could assist/facilitate students in learning medicine in four major aspects. Firstly, they facilitate students in recording clinical experiences while having encounters in clinical placements. Secondly, they facilitate students in having immediate access to reference information while in these clinical placements or at the bedside. Thirdly, they are a useful tool for keeping interactions and sharing information among faculty, clinical preceptors and peers. Finally, they are a useful tool as PIM tool for keeping contacts, reminders, to-do-lists, organising daily activities, and updating school events. Therefore there are 4-major PDA functionalities found from this study.

According to the 15-interviews with medical faculty, honorary clinicians and IT experts at the GSM and Wollongong Hospital, the results of medical school preferences regarding PDA functionalities are a combination of four different functions (Figure 7.1) these being clinical-log or tracking clinical experience-log, reference, communication, and PIM functions. Table 7.1 shows the ranks of PDA functionalities which interview participants prefer to have on students’ PDAs.
Table 7.1 Rank of PDA functionalities by number of coding references from Nvivo

<table>
<thead>
<tr>
<th>PDA functionalities</th>
<th>Number of coding references from Nvivo</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Honorary academic</td>
</tr>
<tr>
<td>Clinical-log</td>
<td>4</td>
</tr>
<tr>
<td>Reference function</td>
<td>2</td>
</tr>
<tr>
<td>Communication function</td>
<td>1</td>
</tr>
<tr>
<td>PIM</td>
<td>1</td>
</tr>
</tbody>
</table>

According to Table 7.1, the interview participants gave the greatest support to the clinical-log function as the first and most important one for student PDAs. Having a clinical-log function on the PDA would facilitate students in recording their clinical experiences. The second most important function is the reference function. Having a reference function would provide an opportunity for students to access information and reference materials while in the clinical settings. The other two recommended functions are communications and PIM, which would facilitate students to communicate and share information with medical faculty and peers, and to organise their daily activities.
7.1.1 Clinical-log

The honorary clinical academics, the GSM faculty members and educational technology specialists have similar perceptions that clinical-log would be the first and the most important PDA functionality for the UOW PBL-medical curriculum.

A Clinical-log is a record of students’ clinical experiences encountered in clinical settings during their 4-years of medical study. According to the interviews, having a clinical-log function on PDAs would facilitate students in studying medicine in a PBL-medical curriculum and also assist the medical faculty in monitoring students’ progress. The effective ways of using the PDA-based clinical-log in a PBL-approach are categorised into four major aspects, these being: (i) recording clinical experiences, (ii) reflecting on clinical-experiences, (iii) mapping clinical experiences to learning objectives and (iv) cross referencing for the medical faculty in monitoring students’ progress while away from the campus.
Recording clinical experiences

*Recording clinical experiences* is the primary purpose of using a PDA-based clinical-log function. It is a record of what students have seen during encounters in clinical placements. The first three elements that the interview participants want students to record on their log are patient characteristics, clinical problems and medical errors, adverse events or near miss events (if any). These factors are the basic information which would later facilitate students in learning medicine when they start to reflect on their clinical experiences.

**Patient characteristics**

*Patient’s characteristics* is the first element to be recorded on a clinical-log once students see a patient, as indicated by the medical faculty and medical education technology specialists. The medical faculty and educational technology specialists pointed out that only ‘general characteristics’ of patients are allowed to be recorded on a clinical-log. This information includes age, gender, sign and symptoms, medical conditions, chronic pain, and excluded any patient identifier. Generally, the expectation of the medical school is to have students record their clinical experiences on a PDA-based clinical-log every time they have seen a patient, and to record data which summarises patient characteristics. This is similar to other medical schools elsewhere (section 3.2). The reason behind this aspect is that, firstly, patient privacy is an important aspect in practicing medicine and; secondly, the patient privacy aspect relates to the HRIPA. Therefore recording identified information about patients is prohibited. As a result, a clinical-log is used for educational purposes only.
Clinical problems

Clinical problems range from signs and symptoms that can physically be seen from patients, their pre-existing medical conditions, chronic pain, diseases or clinical problems which students may gather from an interview with patients. This aspect was indicated among three groups of interview participants regarding recording clinical problems being encountered on clinical-log.

Further, clinical problem is information that should be recorded on a clinical-log (section 3.2). According to the UOW PBL medical curriculum (Chapter VI), it is essential for students to record clinical problems being encountered on their clinical-log. This information would then be useful for students to practice, reflect and formulate their clinical reasoning skills in a PBL-approach before diagnosing any patient.

"...to take the history from the patients, examine the patients and write up, as called ‘clinical-log’...”
IV15 (15.09.2007)

"...the key things are the clinical problems...”
IV10 (12.09.2007)

Medical errors, adverse events or near miss (if any)

Generally, medical errors range from minor to major errors which may be caused from small injuries to unnecessary death. The causes of medical errors vary from lack of experience, poor communication, improper handwriting, misjudgements of doctors or patients, drug interactions, etc. A similar perception was found among three groups of the interview participants regarding how the GSM suggest students to record medical errors. However, in terms of medical education, in case any student encounters any medical error, such errors should be recorded in the reflective portfolio.

In the literature (section 3.2), recording medical errors/adverse events on clinical-log for medical education has not been mentioned elsewhere at other
medical schools. Rather it was mentioned by the National Patient Safety Education Framework and Charting the Safety and Quality of Health Care in Australia (section 3.2). Following on from the fact that the interview participants have a similar perception on recording medical errors/adverse events, such information should be recorded in students’ reflection on the clinical-log function. This implies that medical errors should be clearly reported to either the preceptors or the medical school. Therefore students should be able to identify the errors, report and learn from medical errors, including rational judgement to support those errors.

"...the reflections would be very personal...medical errors or adverse events should be recorded and reflected on because self-disclosure is a highly professional activity....we need that at the very beginning. ...we should encourage them to admit uncertainty“ IV12 (07.09.2007)

It is stressed that students can only record and reflect on their own errors rather than someone else’s.

“I don’t think the students should record the medical errors by other people. It is not their responsibility... they should be able to record their mistake or their action...”

IV15 (15.09.2007)

In summary, recording all relevant clinical experiences being encountered in clinical settings would facilitate students to practice and develop their skills on history taking, which would allow them to do clinical reflection at a later stage. It would facilitate students in learning medicine in a PBL-approach, as students get to see all different problems and having a variety of clinical experiences during their 4-years of medical study.

**Reflection on clinical experiences**

Reflection on clinical experience is the second aspect of using a PDA-based clinical-log. This aspect would facilitate students in learning medicine in the PBL-approach, as it allows them to reflect upon their clinical experiences that
they have gained in their clinical placements, based on their knowledge and attitudes toward the clinical encounters. According to the interviews, the participants indicated three components that would assist students in identifying their clinical experiences during their 4-years of encounters in clinical placements, these being (i) clinical experience rating, (ii) confidence rating and (iii) level of involvement. Such components also allow students to monitor the growth of their clinical skills over time.

**Clinical experience rating**

Honorary clinical academics, GSM faculty and educational technology specialists have a similar perception that clinical experience and experience rating should be recorded in clinical-logs for self-assessment purposes.

Even though the general strategies of recording log and reflecting on clinical experiences being encountered are similar to the use of clinical-log elsewhere (section 3.2), the finding is significantly different from the literature that students rate their clinical experiences and skills being encountered by recording on their clinical-log. Therefore this strategy would assist students to perform self-learning and self-monitoring while being supervised by clinical supervisors and GSM faculty members. As a result, the medical schools can monitor and evaluate the growth of students’ clinical skills and experiences over time.

“I’m more interested in their interpretation of the problem... what would show progression would be their ability to construct their problem... ability to make the diagnosis...ability to actually make plan of what the patient needs. ...we will see the difference between the first and the third, and the forth year would be the ability to interpret the information, not just record it.” IV09 (22.09.2007)
Confidence rating

Confidence rating is information that the medical faculty and the educational technology specialists would like students to record on their clinical-log. However, confidence rating on a clinical-log has not been found in the literature (section 3.2). From interviewing, recording the confidence-rating on a clinical-log would assist students to identify their level of confidence on each particular clinical problem being encountered during their 4-years of medical study. Therefore students can realise what particular clinical skills they need to work on or what clinical knowledge they need to learn more. As a result, students can pay particular attention to what they have learned in their clinical encounters. It facilitates students in developing a framework of their learning.

"...they get through the involvement with the patient. That would be very important to have confidence rating...once they have done their examination into their log...how confident did you feel undertaking is the procedure or their history or the examination...they can self-rate... They can track that confidence and their experience."

IV03 (24.09.2007)

"...and how they feel about those skills..."

IV08 (16.09.2007)

Level of involvement

Recording the level of involvement in each particular clinical problem on clinical-log is essential for students in learning and practicing medicine in a PBL-approach. The reason is that it would assist them in identifying their current clinical skills based on the required clinical skills in the UOW PBL-medical curriculum. Further, it also facilitates students in identifying their level of participation during their clinical encounter at that period. Students, therefore, will realise how much more they have to work on each particular clinical problem in order to have sufficient clinical skills and confidence.
This aspect is reflected by the honorary clinical academic and educational technology specialist.

"...getting involved in a set of experiences. ...the level of involvement ...what we would like to see there is a growth of their level of involvement and in their confidence... "

IV10 (12.09.2007)

It is essential for students when they become a mature clinician that they should be able to reflect and think through in each clinical problem being encountered. Therefore having students reflect on their own clinical experiences would assist them in a process of self-learning and work out on their own in order to achieve the learning objectives in a PBL-medical curriculum.

**Map experience to learning objectives**

*Mapping experience to learning objectives* is the third aspect of a clinical-log function. This feature allows students to map their clinical experiences to the learning objectives in a PBL-medical curriculum. It is an ongoing process after recording clinical experiences and reflecting on their clinical experiences. In order to best utilise the PDA-based clinical-log for a PBL-medical education, *mapping clinical experiences* to the learning objectives are threefold. Firstly, it facilitates students in identifying learning gaps. Secondly, it facilitates students as a self-assessment tool in determining their learning needs. Finally, it facilitates students in identifying their learning outcomes.

*Facilitate students in identifying the learning gap*

Based on their clinical experiences being recorded (on the PDA-based clinical-log) in the previous processes of recording information on (the PDA-based) clinical-log, the use of a clinical-log facilitates students in identifying their learning gaps by allowing students to map their actual clinical
experiences and knowledge back to the learning objectives. This is how a PDA-based clinical-log facilitates the medical study in a PBL-approach.

The finding is similar to the literature in section 3.2. Using a clinical-log facilitates students as a self-assessment tool, whether using pen-and-paper or an electronic one. This is because the clinical-log function allows students to react and reflect upon their clinical experiences being encountered, determine their learning gap and identify their learning outcomes and learning needs.

Three GSM faculty members have a similar perception that the primary advantage of a clinical-log is to assist students in assessing their individual learning experiences. Therefore using a clinical-log would be of benefit to students in studying medicine in a PBL-approach.

“…to make sure…tracking patients...range of experiences... identify where some of the gaps in their experiences... throughout the year, they can try to make sure that they go through the programs. ...able to assess the information.” IV03 (24.09.2007)

Facilitate students as a self-assessment tool in determining their learning needs and identifying a learning strategy in order to fill the gap

One feature of a clinical-log regarding mapping clinical experiences to the learning objectives is that it facilitates students as a self-assessment tool in determining their learning needs and identifying a learning strategy in order to fill the gap.

Self-assessment tool is an important component that three groups of interview participants would like to have in the clinical-log functionality. This is because this component would allow students to monitor themselves by reflecting on their performance based on their learning framework which is required by the GSM. According to Epstein (2007), a number of skills are required to be competent in medicine, these being communication, knowledge, technical skills, clinical judgement and reasoning, mental, and
reflection upon daily clinical encounters. Therefore using the clinical-log function as a self-assessment tool would facilitate students to practice those skills. It allows students to reflect on what they have known from the clinical settings, what they do not know, what they feel comfortable with, and then what additional aspects they need to learn. Finally, this component would facilitate students in identifying a certain plan that they need to address to accomplish their learning needs. Therefore self-assessment is an individual activity, individual responsibility for themselves to monitor their own learning, to adapt and to be able to guide their own learning and find the resources to accomplish their learning.

"what I would like to see them develop is a process of self-reflection and self-assessment... at the earliest stages, ...because as we become more mature clinicians we need to have that process intuitively and innately within ourselves. We do our own reflection and self-assessment and work-out a learning plan of what we need to learn now from this experience...”  IV14 (18.10.2007)

Facilitate students in identifying their learning outcomes

Three groups of interview participants have similar perceptions on the use of a clinical-log as a tool in assisting students to reflect on their clinical experiences. As a result, the use of a clinical-log would facilitate students in identifying their learning outcomes. Therefore the learning outcomes is the final component after recording and reflecting the clinical experiences that they have encountered from the clinical placements. It is essential information, which the medical faculty members can directly monitor and to see what students have gone through during their clinical encounters, what they have learned, what their learning gaps are, and how students can bridge their gaps. It is a learning process which the PDA-based clinical-log could possibly facilitate while students are off-campus.

In addition, this finding is similar to the literature (section 3.2).
"...the learning outcomes of their selection...with the learning outcome...they are...involved with the set of experiences. ...the quality of the students’ reflection about their learning needs and their actions for those learning needs."

IV10 (12.09.2007)

Cross-reference (Facilitate medical faculty in monitoring students’ clinical experiences)

Generally, a cross-reference is one feature in a PDA accessible clinical-log, which allows the GSM faculty to track and monitor students’ progress and clinical performance while they are in clinical placements. It allows the GSM faculty to identify any related information, clinical information or clinical experiences among students in order to make a cross-reference or cross-connection in each particular clinical problem in relation to the 93-case based PBL-medical curriculum.

The finding is similar to the literature (section 3.2), namely that PDAs facilitate medical school faculty in tracking students’ clinical experiences. However, the difference from other medical schools (section 3.6) is that the PDA accessible clinical-logs are used during clinical rotation in the clerkship/internship year, while the GSM prefers to incorporate PDAs from the beginning of year-1 throughout the 4-years of medical study. Therefore using a PDA accessible clinical-log would provide a great benefit, not only for the GSM faculty in tracking students’ progress, but also students. As a result, students are able to have close supervision by medical faculty at a distance.

“It is also going to help us (i.e. GSM faculty members) to demonstrate the range of illnesses and the range of experiences and encounters that students have had.”

IV03 (24.09.2007)
Benefits and limitations of PDA-based/web-based clinical-logs in a PBL-approach

Five benefits and four limitations of using a PDA accessible clinical-log in a PBL-approach were found in this study. The benefits of using a clinical-log function on PDA devices are (i) it provides an efficient way of recording clinical experiences; (ii) it acts as a self-assessment tool for students; (iii) it allows students to share information among the medical faculty and peers; (iv) students do not need to memorize what they have encountered as they can immediately record onto the device at the bedside; and (v) it is valuable for students’ future employment.

On the other hand, the limitations of using PDA accessible clinical-log are, (i) difficulty of the data entry method; (ii) the possibility of formulating a habit of recording experience by using abbreviations or shortcuts; (iii) no equity of learning medicine with and without PDA technology; and (iv) difficulty in gaining social acceptance. These findings are discussed in the follow sections.

Benefits

Provide an efficient way of recording clinical experiences

Using a PDA-based clinical-log would be an efficient method for recording clinical experiences encountered during the day. Students can possibly record what they have encountered immediately at the bedside without memorizing what to record on their log after they come home or do it at the end of the day. This finding is similar to the literature (section 3.3). On the other hand, recording clinical experiences later once students are back at base, their fresh experience and encounter at the beginning of that day may probably fade off. Further, having access to a ‘web-based clinical-log’ can be done via a PDA, PDA phone or even mobile phone available in PDA format with a wireless
Internet connectivity. Therefore a PDA accessible clinical-log provides flexibility for students in tracking their clinical experience log.

“...it is a very efficient way of recording information rather than having to come home and write it down at the end of the day. It is a great long-term record of what you have done. ...it needs to be very efficient so it does not take lots of time and distract them from a major agenda of their being in the clinical placement is to learn from real patients and experience, ...rather than...having a system that is efficient so they can maximize their time in the clinical settings and minimize their time recording it.”

IV12 (07.09.2007)

“...it is very critical for the student to have the ability to enter all that data straight away at the encounter as the cause of the clinical experiences as possible because if there is something that they need to do at the end of the week or even at the end of the day. ...to be able to do it through a PDA. ...we are to provide the admin for them to make it easier for them to use the clinical-log. ...that is the first functionality”

IV10 (12.09.2007)

Self-assessment tool for students

Using a clinical-log is also beneficial for students in studying medicine as a self-assessment tool. It allows students to reflect on their clinical experiences and assist them to come up with their learning plan. It facilitates students to become an active learner as they can always monitor their learning, identify their learning gaps, determine the learning needs and design their own learning plan in order to achieve the learning objectives. A Clinical-log also assists students to practice the life-long learning.

Portability, information at hand

Portability is a common advantage of the PDA device which adds value to the use of a PDA accessible clinical-log. It allows students to easily carry the device with them at all times while they are in clinical placements. As a result, PDA portability provides ease of recording information into their clinical-log.
This finding is similar to other researchers, in that PDAs gradually provide portability in accessing clinical data and immediate access to clinical-logs (Day and Fox 2007). It is a fact that students at the GSM will be in remote areas for most of the time. That is the reason why the PDA accessible clinical-log functionality provides the advantage of portability for students in recording data. It allows students to record their clinical encounters at any time without noting on paper. The GSM faculty and educational technology specialists have similar perceptions on this aspect.

“It is very portable.” IV12 (07.09.2007)

Sharing information (between students and medical faculty)

Sharing information is a benefit of using a PDA accessible clinical-log, in that it allows students to share their clinical experiences among their peers, clinical preceptors and especially the medical faculty while they are away in their clinical placements. The use of a clinical-log on PDA-based technology would allow this to happen at a distance with proper internet connectivity as a communication channel.

“...the main components of that are sharing information and allocating tasks to different members to come back and share things together. ...the moment of the problem-based learning program will happen with groups come together and meet in a schedule time. ...the technology of the PDA would help, keep interaction that coordinate the PBL process.” IV07 (03.09.2007)

Provide capability for instant recording without recall

For students, having the ability to memorise what they have gone through during the day, what clinical experiences they have encountered and what other relevant issues they need to take note at each particular event during the day seems to be a simple task, as the PDA accessible clinical-log provides an easy way to record clinical experiences, reflection and personal notes at any time on their PDAs.
Therefore a PDA accessible clinical-log would assist students to learn medicine in a PBL-approach more effectively. This is not because students do not need to memorize what they have done in their clinical placement, but because students have a tool to facilitate them in their medical study. Definitely, students are required to reflect upon their clinical experiences and encounters then discuss and share such experiences with peers, preceptors and the medical faculty as a part of the learning process in a PBL-approach. A PDA accessible clinical-log can facilitate students in learning medicine. However, students need to accomplish learning objectives and fulfil their learning gap in a PBL-medical curriculum.

“... a lot of information in a medical degree to remember. Being able to have it at hand when you need it, where you need it. That would be a big advantage.”

IV02 (28.09.2007)

Value for future employment

One benefit of a clinical-log is that it is valuable for students’ future careers, as mentioned earlier in the literature (section 3.2). The clinical-log not only facilitates students in learning medicine during their 4-years of medical study, but also assists them to have a two-way interaction with the medical faculty while being in remote areas. Further, a clinical-log is also a students’ portfolio, showing what they have done and seen during their medical study. Therefore it is a portfolio which would be beneficial for their future career after finish their study.

“... they can use when they come into the end of the program for a future employer.”

IV03 (24.09.2007)

Limitations

Two major limitations were found, from both interviews and the web-based survey, regarding a PDA accessible clinical-log. These limitations are the difficulty of data entry methods, and using abbreviations for recording data.
on PDAs. These limitations are essential elements for incorporating PDAs as a recording tool to facilitate medical study in a PBL-approach.

Data entry methods

PDAs are not particularly useful to write/record a lot of data. Generally PDAs are useful for capturing data. As mentioned in section 2.1.1, several methods are available for data entry on a PDA. Consequently, lengthy entering of data into a PDA can be inconvenient according to the literature (section 2.3.2). However, this does not apply to recording data via voice recording on PDAs.

“...writing that up by hand is difficult so having PDA and quickly recording it. So, the log that you are having on the PDA is a very efficient way to do it and maximize their time to practice.”  

IV12 (07.09.2007)

In addition, using a voice recording mechanism may not always be the best data entry method in all cases, particularly when dealing with patient privacy.

“...You cannot easily do it in front of the patient. ...it depends on how the consultation is planned to flow. Dictating always means that information is available to everybody who can hear it and that is a drawback. ...voice input is difficult.”  

IV01 (21.09.2007)

Generally, the honorary clinical academics and the GSM faculty have a similar perception that a PDA has its limitations on data entry method, whereas the educational technology specialists did not mention this aspect.

“...the barriers are largely in the design of PDAs...I am a person who does not find them easy for inputting information. PDAs are being used by doctors, junior doctors...they don’t use it very much for inputting information. They are really used them just for downloading the information.”  

IV06 (30.09.2007)

Using shortcuts, SMS or abbreviations to record logs

There have been a number of studies (section 3.2) into the use of abbreviated words for recording clinical experiences and prescribing medication. The
finding in this aspect is directly related to medical errors, adverse events, or near miss aspects. A number of medical errors are generated from different causes, but one of them was from using abbreviations for history taking or prescribing medications.

This aspect was raised from the honorary clinical academic regarding using abbreviated language to record information on a clinical-log. It would particularly affect the clinical preceptors or the medical faculty who are directly sharing information and interacting with students for monitoring or tracking students’ clinical experiences. It increases the difficulty of medical faculty understanding and interpreting the information being recorded by students. It is an essential aspect to consider at the beginning when students start recording information on their log.

“... the fact that people will perhaps tend to take notes in an abbreviated language ... students would be tempted to use shortcuts... shortcuts are bad.” IV01 (21.09.2007)

In summary, a clinical-log functionality is an important function that the interview participants would like to have on students’ PDAs. A PDA accessible clinical-log functionality would be a useful tool that facilitates students in learning medicine in a PBL-medical curriculum. This is because the clinical-log function would develope to support the UOW PBL-medical curriculum. The clinical-log function would be an initial tool which students could use to monitor themselves as to whether they have met the learning objectives of each clinical problem before discussing with their preceptors or medical faculty members.

7.1.2 Reference function

Reference function is the second most important functionality besides clinical-log (Table 7.1). The GSM faculty indicated that a PDA would be a
useful tool for information access besides recording into a clinical experience log.

“Information, delivery of information, having e-text book in PDA…”
IV05 (30.09.2007)

What references facilitate medical study in a PBL-approach

A broad category of reference materials, as indicated by the interview participants, is shown in Table 7.2. Text-book, e-book, e-reading, third party software and evidence-based medicine (EBM) materials tend to be the most important reference resources mentioned during the interviews. On the other hand, having access to online-journals, learning environments and handbooks were the least mentioned. This is because of the difficulty in reading clinical references via a PDA screen. However having access to handbooks or clinical-guidelines is possible, as students can immediately access these while they are on wards. It provides convenience in accessing references resource wherever they are.

Table 7.2 A broad category of medical resources for reference functionality on PDAs

<table>
<thead>
<tr>
<th>Clinical references for the GSM recommended by the interview participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>e-reading, classic textbooks</td>
</tr>
<tr>
<td>Evidence-based medicine</td>
</tr>
<tr>
<td>Online references including Online databases and online journals</td>
</tr>
<tr>
<td>Oxford Handbook of Medicine, Harrison, etc.</td>
</tr>
<tr>
<td>e.g. Australian Drug databases, MIMS, British Medical Journal (BMJ), etc.</td>
</tr>
</tbody>
</table>

E-reading and classic textbooks

E-reading and classic textbooks are electronic reference materials which students can download or acquire from libraries, learning centres or any available website, then directly install on their PDAs. Having these kinds of
references on hand would be beneficial for students in having accessibility to the resource at any time.

The honorary clinical academic, GSM faculty and educational technology members have similar perceptions about having e-textbook, e-book or e-reading resources as reference resources on student PDAs. They can immediately look up while they are off-campus. This finding is similar to the literature (section 3.2), in that PDA has been used as information accessing device in other medical schools. Therefore students would be able to access information while in clinical-placements or whenever they have difficulty getting computer access.

“...beyond that later in the course we would be wanting to upload on the PDAs a lot of resources such as pharmacopoeia...they can look up drugs, drug dosages and; there are a lot of others. ...information would be a large part ...over time, more and more material would be available, will be specifically written for PDAs. ...if they had a patient, they can immediately look up information on that condition on the PDA. ...textbooks, pharmacopoeia databases ...”

IV06 (30.09.2007)

Evidence-based medicine (EBM)

EBM is the use of current and best available research evidence with clinical expertise in making clinical judgements in order to treat each particular patient based on their current medical condition. The purposes of using EBM for students in learning medicine at the GSM are (i) to formulate questions based on the clinical problem being encountered; (ii) to be able to identify the best medical evidence from the available resources for particular clinical problems based on the patient’s condition; (iii) to be able to apply the evidence with clinical skills to the actual patient problem; and (iv) to be able to evaluate and make a clinical judgement for effective and efficient of EBM to be used for further clinical encounters. Therefore, using EBM as a clinical reference, which students can access via PDAs, would be beneficial for
students in learning medicine, because they can access the most up-to-date EBM resources while offsite, especially in clinical placements or at the patient bedsides.

Honorary clinical academics and the GSM faculty have a similar perception about having EBM and third party reference software on students' PDA. This finding is similar to the literature in section 3.2 regarding medical reference for PDAs. According to the interviews, PDAs have the potential to incorporate EBM resources for students.

“It would be very useful for them to have access to the evidence-based medicine ...” IV14 (18.10.2007)

It allows students to access quality of medical information and also facilitates them in making clinical decisions based on the information at hand.

“...having access to evidence-based materials when they are with the patients or when they are on the ward...that would be useful....” IV15 (15.09.2007)

Using EBM can enhance students in practicing clinical judgment and developing their self efficacy. Therefore EBM is one medical resource that supports self-learning/life-long learning (LLL), which would assist students in learning medicine in a complex clinical situation.

“...looking at third party software, many texts that may be good. ...the Oxford Handbook of Medicine, which have CDs that you can pop-on and then use those that would be good as a reference guide. ...the evidence-based medicine tools as well would be really good.” IV03 (24.09.2007)

“The evidence-based for what they have just seen in the patients, the latest things -that sort of option.” IV12 (07.09.2007)

Online references

Online references include databases (e.g. Cochrane, Pubmed, MIMS, etc.), drug databases, journals, clinical guidelines and other references in PDA format. The GSM faculty and the educational technology specialists have a
similar perception regarding accessing online references via PDAs. However, in order to access online reference, it is necessary to have an Internet connection. Therefore the communication function is also necessary, along with having access to online resources, clinical materials or even access to online clinical-log.

“...depending on what we are looking at, fixed-software or looking at software that is going online. It will be good for them to be wireless...” IV03 (24.09.2007)

“We want them to have access to some databases...Australian Medicine Handbook, which is a very good source of information about medications. ... It is provided by a group of professionals. ...that is a very good source if they want to prescribe something or learn about something. They have seen prescription that they could do immediately. Not to say they couldn’t have really downloaded it on the PDA if we didn’t have the wireless access for the students. We...have...’HotSync’ that you would link it at the end of the day to your computer.” IV12 (07.09.2007)

“The other use of PDAs...is reference material. They are very keen to have many e-book and reference databases on PDA or when they are away on the placement. ...if they have wireless Internet access on PDA...online learning environment...online forums, access e-readings...” IV10 (12.09.2007)

In summary, it is essential to have clinical reference materials on PDAs for students to access at anytime, especially while they are on wards or in clinical placements. PDAs would be a great tool which students could use in accessing information remotely. This finding is slightly different from the literature (section 3.2) regarding drug databases and/or pharmacopoeia. The Australian drug databases were recommended rather than using others. This is because the names of drugs are different in each country. Therefore students should rely on the Australian drug databases and their interactions. Even though, students are yet to prescribe any medication it would be necessary for them to know the drugs being used in Australia and their
interactions while having encounters in their clinical placements. Therefore using a proper drug database would help students to become familiar with a number of drugs being used for a certain medical treatment and also preventing medical errors as some drugs’ names may be similar but their interactions definitely different.

All online resources could not be accessed via PDAs without Internet connectivity. In the case of using PDAs without wireless connectivity, using the reference function is possible with any third-party application or reference resource, which is already installed on PDAs, for instance, handbooks, clinical-guidelines, etc. The next section discusses results regarding PDA resources on-campus and online reference resources.

**Where to access reference resources**

A number of PDA resources was mentioned regarding the plan for downloading and updating PDA resources, these being the Internet, Podcast, sync operation, learning centre and other sources. The GSM faculty and educational technology specialists pointed out a number of possible PDA resources which students could download to their PDAs. These being the internet, learning centre, Podcast and Syncing operation.

The GSM faculty (n = 3) and educational technology specialists (n = 3) have a similar perception that the major source for accessing PDA resources is via websites. This finding is similar to the literature (section 3.2) regarding medical references for PDAs. There are several reasons why the *Internet* becomes the primary medical resources - firstly, the majority of references are located on the internet both free-download websites and commercial websites. Secondly, the most up-to-date medical references are located on the internet; these include online databases, drug information, etc. Finally,
internet access not only be used for accessing medical references, but also to access online clinical-logs.

"...if students have got the wireless access then they will be able to access the university library remotely and have access to databases that they have got rather than having to download them. ...The easiest way would be wireless, then it would just be web-based so it will happen automatically rather than to sync it. ...(students) can get from most of (available) web-site as well as a numerous things that you can download to your PDA..."

IV03 (24.09.2007)

"... online...all the information is online on the web-site. "

IV15 (15.09.2007)

"...the preference would be wireless access to the Internet."  

IV08 (16.09.2007)

"...many people will be done through the web...It is up to the students to collect resources from here and there."  

IV10 (12.09.2007)

Podcast is one resource which provides a lecture stream for students to download for their medical lessons. Students and the GSM faculty can share information at any time. It also allows students to catch up with their lectures when they are absent from class, or to review their lesson being learned at their own pace.

Only the GSM faculty (n = 2) suggested using Podcast as an additional reference resource for students to access via their PDAs. This finding is similar to the conceptual framework (section 4.3.4). Having PDA access to Podcasts also requires internet or wireless access. Other alternatives besides Podcast are Vodcast, web blog, Blikis, etc. Providing Podcasts as a medical resource for PDAs is particularly beneficial for students, especially having medical education in two different campuses (Wollongong and Shoalhaven). Therefore Podcasts are one PDA resource that facilitates students’ learning experiences in an e-learning environment.
The *Syncing operation* is another method to access medical resources and materials. When wireless connectivity is unavailable, the *syncing operation* is one strategy to download and upload resources. This strategy of accessing to PDA resources was mentioned by the educational technology specialists (n = 2). This finding is similar to the literature (sections 3.7) – namely that the *syncing operation* or *data synchronisation* via a PDA cradle can be done for backing up, transferring and updating data between PDAs and desktop/laptop computers. One concern mentioned in the literature (section 3.7) is that using the syncing operation might not be secure for patient privacy. However, this problem would not arise if syncing operation is used for transferring medical references to PDAs and no identified information was recorded on their clinical-logs. Therefore the syncing operation would be an alternative method for downloading medical references to PDAs where no wireless connectivity is available.

"...syncing operations...there needs to be some understanding of what possibly can be done and what are the cost implications for that." IV08 (16.09.2007)

In addition, students are free to gather reference information from any source besides the references provided by the university, online library or learning centre at the medical school. This finding is slightly different from the literature (section 3.2) regarding resources for medical reference. It is a fact that students should perform self-learning and self-searching because each student has a different background, learning needs and learning styles. The medical school can provide core resource materials and relevant resources as basic learning needs. However, students can learn at their own pace. Therefore seeking additional medical resources to support individual learning...
is significantly dependent on individual preferences. As a result, students are able to maintain their lifelong learning.

"In the future...finding all those resources is in occasional procedure. Secondly, people have different learning styles, different needs ...the students should be doing it themselves." IV11 (09.09.2007)

The interview participants also indicated that the learning centre is also another location where students could access medical references and resources besides online resources. The Learning centre is located at the medical school. At this learning centre, the GSM provides a number of medical resources and computer facilities for students to use. This finding is similar to the literature (section 3.6) regarding the use of PDAs in various medical schools. However, students are free to do their own research using additional or other resources. This is because different students may have different levels of learning needs and preferences of using resources. Therefore the number of resources which students could access would be based on their preferences.

"...there may be some core materials that we want to direct them to. ...not just give them a handbook, we are giving something to be more flexible." IV11 (09.09.2007)

"...we have provided the students with a learning centre in each of these sites or...computer access." IV12 (07.09.2007)

In summary, various strategies for downloading and updating medical references were mentioned in the interviews, and; are projected to be available for students upon their preferences, based on the availability of facilities at each learning environment. The medical school focuses on providing as many reference resources as possible, especially EBM for students in having access via reference functionality on their PDAs. It is a fact that such resources would be beneficial for students to make their own clinical judgements. As a result, it is essential to provide the most up-to-date
medical resources. However, having access to references provided by the GSM does not limit students to perform their self-learning and self-researching to other medical materials which are available elsewhere.

**Benefits and limitations of reference functionality on PDAs**

The benefits and limitations of using a reference function on PDAs were found from the interviews. The benefits are the accessibility and portability of information at hand. On the other hand, the limitations are the difficulty of reading information via a PDA screen, equity of accessing information among students with and without PDA technology, and difficulty in finding software to support learning in a PBL-medical curriculum.

**Benefits**

The benefits of reference functions, which were mentioned in the previous section, are *portability* and *information sharing*. Moreover, other benefits of having a reference function on PDAs *are accessibility to information*. This finding is reported and discussed in the follow section.

*Accessibility of information at hand*

The benefit of using PDAs in medical study is accessibility and portability in accessing information. However, students still have to understand, extract and apply information to facilitate their medical study as much as possible. Three groups of interview participants had a similar perception that having reference materials available on PDAs would enhance the opportunity for students to access relevant clinical information anywhere, particularly when students are in their clinical placements. This finding is similar to the literature regarding the advantages of using PDAs (section 2.3 and section 3.3).
“...timely access to information ...the quality of experience of what you do with that information depends on the individuals.”  
IV14 (18.10.2007)

“...in problem-based learning...It is enquiry-based but you need to be motivated by something you don’t know or learning. ...you need to seek and answer to that learning issue and then apply that knowledge. ...having immediate access when you have a question, can be very useful to solve it and apply it straight away...you can get the solution on the spot with technology being available wherever you are and move on instead of having to go back to the library and lookup books...”  
IV12 (07.09.2007)

Accessibility to information at hand via PDA devices would assist students in acquiring knowledge and feedback at clinical placements, or offsite elsewhere. It is very important that all the expected references can be accessed via students’ PDAs at the point of care or elsewhere. These expected references must support the learning objectives of the UOW PBL-medical curriculum. Otherwise the utilisation of PDAs into medical education would be as a general data gathering tool, which has been widely used elsewhere.

Limitations

Difficult to read via small screen

Three groups of interview participants had a similar perception about the difficulty in reading information via PDA screens. However, some participants indicated that using PDAs in accessing information would be easier than recoding information on PDAs. This finding is similar to the literature (section 2.3 and section 3.4) regarding the disadvantages of PDAs due to the physical presence of the device.

“It is possible to use it for looking up the material on the Internet...but it is quite slow (for accessing information) on the small screen, certainly it is...not that practical for
In summary, the purpose of having reference functionality on PDA devices is to provide an alternative tool for information access. Studying medicine not only relies on lectures but also searching for other relevant information from other resources. This is how PDA technology can facilitate medical study while students are dispersed into their clinical placements. The technology enhances the opportunity to access information while away from the library.

7.1.3 Communication function

Communication functionality is one PDA functionality that the interview participants prefer to have on students' PDAs (Table 8.1). The primary purpose of having a communication function is for email and internet connectivity. Moreover, it was found that having this function facilitates students in using other functionalities, such as clinical-log/online-log and access to reference materials.

Three groups of interview participants had a similar perception about having a communication function on student PDAs. The use of the communication function is twofold. Firstly, it would facilitate students in *accessing information, resources and other PDA functions through the network connectivity*. The use of a communication function on PDAs facilitates students in accessing published journal articles, web databases, courseware, Podcasts, audio stream lectures, school events, timetables, clinical guidelines and policies, library resources, PDA-based instructional tools and any additional technological simulation for medical and clinical studies. For timetables, the communication function also allows students to have the opportunity to access the school timetable, which would be beneficial for students in organising their time and realising what they need to do during their encounters in their clinical placements.
Secondly, a communication function is essentially used for facilitating interpersonal communication among peers, clinicians and the GSM faculty, in particular when students are offsite. The communication function also facilitates students in using other PDA functionalities at their optimum. From the interview participants’ perspectives, a communication function intends to facilitate and improve feedback and comments from their PDA accessible clinical-log from the medical faculty. It also allows the GSM faculty to directly monitor students’ clinical experiences and clinical judgements via the central database. Further, authorised GSM faculty could view clinical problems which students encounter from their clinical placements, in order to discuss with them based on the real-clinical problem rather than what has been told in the medical textbooks. Moreover a communication function allows students to have online group discussions and communication with others by using all kind of medium, for instance, email, text messaging, etc.

The use of a communication function allows students to have just-in-time medical education with Internet access and network connectivity. Therefore the essential element of the communication function is to have internet connectivity with the PDA device. This connectivity may include both wired and wireless connectivity. Having PDAs connect to the internet wirelessly would be more convenient in uploading and downloading information.

Data synchronisation can be done by a syncing operation via PDA cradle. Using wireless internet connectivity may be preferred, particularly in the regional area where no wireless internet signals available. Therefore using the synching operation is always possible in any case for transferring data from PDAs to computers, then uploading/downloading data can be done at a later stage. The findings on data transmission and network connectivity for PDAs are reported and discussed in section 8.1.2. The findings are generally similar to the literature (section 3.2).
“...there would be the thing (device) as simple for them to communicate with...as the time tabling. ...on our website, on our learning environment... let them know by PDA if there have been changes in time tabling”  
IV06 (30.09.2007)

“...the mail also, if they have wireless Internet access on PDA...they would be able to access online learning environment...”  
IV10 (12.09.2007)

The GSM faculty and educational technology members have a similar perception that PDAs should be able to access reference information both online and off-line. The use of a communication function would support three other functionalities, including reference, online clinical-log, and PIM.

“...to upload on the PDAs with a lot of resources such as pharmacopoeia...they can look up drugs, drug dosages and; there are a lot of others.”  
IV06 (30.09.2007)

“...they are required to start some online journaling and online logs of their experiences...that should be able to be linked (connect) from. They could do that on their PDA, linked (connect) to the online systems ...”  
IV07 (03.09.2007)

“At the moment, it is just a web-based form application that students can enter through the Internet. ...the mail also, if they have wireless Internet access on PDA...they would be able to access an online learning environment...it really helps to use online forums, access e-readings and so on from that.”  
IV10 (12.09.2007)

This finding is similar to the literature (section 3.6) regarding the use of PDAs at other universities –for instance, the Indiana University School of Medicine –namely that the devices are able to connect the wireless Internet for similar purposes, including e-mail, Internet access, log-transfer, access to reference resources, etc (Engum 2003). Methods of transferring clinical-logs may be different in each medical school. One may use e-mail transfer (Engum 2003), while others use web-based clinical-logs. However, both methods of updating clinical-logs need network connectivity as part of the communication functionality on PDAs.
In summary, the purpose of having communication functionality as one of the basic requirements on PDAs are, firstly to access information, resources and references through available network connectivity; secondly, to provide interpersonal communication among students, peers, clinical preceptors and the GSM faculty while offsite.

As a result, the use of a communication function also provides an opportunity for students to maximise the use of each function at its capacity. In addition, a communication function can accommodate other functions besides clinical-log, references and PIM, for example evaluation of medical training, audience response systems or Podcasts (referred to in the literature section 3.2 and the initial conceptual framework in Chapter IV).

**Benefits and limitations of communication functionality on PDAs**

The benefits and limitation of a communication function on PDAs were found from the interviews. The benefits of having a communication function on PDAs are the ability to communicate with the medical faculty and peers, and flexibility in accessing information while in clinical placements. On the other hand, limitations are a difficulty in gaining network connectivity in regional areas and incompatibility among PDAs and network connectivity.

**Benefits**

*Being able to communicate with the medical school and peers while away from campus*

Having a communication function on student PDAs provides a supportive mechanism between students and the GSM faculty or clinical preceptors. This function is particularly important, especially while students are dispersed into the clinical placement elsewhere. It allows interaction among students and the faculty to occur in a timely manner across distance. Three
groups of interview participants have a similar perception on this aspect namely that, the communication function would really facilitate in learning medicine in a PBL-approach.

"...we are going to disperse...students population having a means of communication between students and other staff, which may be another GP in another town. ...for example, if someone is at Leeton and the supervising GP is at Griffith, the possibility exists for that communication to exist between the student and the GP as a mechanism of support between the student and the supervising GP at Leeton as...I’m saying there is a good patient in the venal unit at the hospital, I’ll see you there or I’ll doing delivery in 10-minutes, would you like to be there? That ongoing communication really makes general practice live certainly...Being able to be where the patient is very good that keeps you in touch, attention-ally you are in touch with the staff in the hospital.” IV01 (21.09.2007)

"...sharing information and allocating tasks to different members to come back and share things together. ...PDA can speed that up, make it easier. ...it can allow that process in that interaction to happen across distance. ...problem-based learning program will happen with groups come together and meet in a schedule time. PDA, the technology of the PDA would help keep that interaction that coordinates the PBL process...” IV07 (03.09.2007)

**Being able to access information while in the clinical placements**

The GSM faculty and the educational technology specialists have a similar perception about having a communication function on PDA would facilitate students in accessing information anywhere and anytime particularly having access to online resources. This finding is similar to the literature (section 2.3.1 and section 3.2).

"...the PDAs will be able to do (facilitate students) more in accessing information they need at the time...in different formats, in different areas to relate back to what they need to know at that time, knowing the drugs and knowing the information about the diseases process or give them an access in their hand to and computer facilities so they should improve the learning but as yet to be proved.” IV13 (13.09.2007)
On the other hand, the authorised GSM faculty can directly monitor and review what clinical-problems students have encountered while in their clinical placements once students record their clinical encounters on a PDA-accessible clinical-log. This is because the clinical-log data will be directly stored on the database every time when students directly access their online clinical-log. Therefore it is convenient for the medical faculty to review students’ clinical experiences, even though students are offsite.

**Limitation**

*Network connectivity-uncovered network area*

The GSM faculty and the educational technology specialists have a similar perception that network connectivity could become a limitation for using a communication function on PDAs, particularly when using PDAs in rural areas where there might be difficulty in having wireless internet connectivity. The interview participants are also aware that some PDAs cannot be connected to the university network. This finding is similar to the literature (section 3.7).

“It has got to be able to speak (connect) to the university systems because at the moment we have not really found a PDA that it does...for example...just the connectivity with the university ...the timetables. It just does not speak (connect) to...university one. ...all other things have got to be work out.”

IV06 (30.09.2007)

“the Internet access, wireless-access, is not equitable. That is a big issue...in the current protocol, environment that they are talking about, the equity of access for regional rural people the same as in city. ...We need to make sure that the PDA can talk (connect) to our home-based systems, university systems without massive complications...require so much maintenance, like support (IT support) that is inefficient and frustrating.”

IV12 (07.09.2007)
In summary, the communication function would enhance the opportunity for students to access resources and communicate with medical faculty and peers more direct to their actual setting of learning.

In industry, there are a number of PDA applications in relation to a communication function which physicians often use while in hospitals. For instance, PDAs can replace the paging mechanism as it allows them to instantly communicate between medical professionals and students. Moreover, they can quickly download specific information, for instance, allergy information or lab-test results. It also allows doctors to order-tests, prescribe or check X-ray images, distribute files, etc.

A communication function would emerge between the place of learning – university – and their actual place of learning in their clinical placements. Therefore students can look up for reference information or relevant information for their learning at the level that each clinical placement can provide. Moreover the communication functionality facilitates students to look up information more directly like they were having access to while on-campus.

7.1.4 Personal information management (PIM)

The honorary clinical academic, the GSM faculty and educational technology specialist have a similar opinion about using PDAs as a PIM tool as a basic function of all PDA devices. It is a fact that PDAs originated as an electronic organiser composed of standard applications, including calendar, address book, memo, to do list, etc. (referred to in the literature sections 2.1, 3.2 and 3.6). This could be the reason why these standard functions were rarely mentioned during the interviews.

“...the PDA is an organiser and it is a self-based organizer”

IV01 (21.09.2007)
In summary, the use of a PIM functionality on PDAs is more related to self-organising in relation to the school timetable. Use of this function would facilitate students in managing their time, keep records of important contacts, to-do-list and reminders for their medical study. Moreover, there are a number of applications in relation to PIM that have been used in the medical profession, including organiser to hold appointments, access and manage clinical information and timetable organisation.

In conclusion, regarding how PDAs would facilitate medical study in a PBL-approach, the findings agree that the use of PDAs could facilitate students in learning medicine in four major respects: clinical-log, reference, communication and PIM functions.
7.2 Web-based Survey Findings: How PDAs assist a PBL-approach

The objective of the web-based survey questions in Section B (Appendix C), was to identify the PDA functionalities that might be useful for medical curricula using a PBL approach, including reference, PIM, clinical-log, and communication functions. The following hypotheses were set out to determine attitudes towards each aspect.

**Hypothesis 1:** Respondents will have positive attitudes toward PDA functionalities (reference, PIM, clinical-log and communication functions) for the use of PDAs in PBL-medical curricula.

**Hypothesis 2:** There will be a significant difference in the attitudes toward the use of PDA functionalities in PBL-medical curricula, between respondents with different backgrounds regarding country, gender, age and position.

**Hypothesis 3:** Respondents will have positive attitudes that technical aspects (data security and information privacy, data transmission and network connectivity, maintenance and support, and interoperability) would affect the use of PDAs in a PBL-medical curricula.

**Hypothesis 4:** There will be a significant difference in attitudes toward technical aspects for the incorporation of PDAs into a PBL-medical curricula, between respondents with different backgrounds regarding country, gender, age and position.

**Hypothesis 5:** Respondents will have positive attitudes that practical aspects (education and training, and EI) would affect the use of PDAs in PBL-medical curricula.
Hypothesis 6: There will be a significant difference in attitudes toward practical aspects for the incorporation of PDAs into PBL-medical curricula, between respondents with different backgrounds regarding country, gender, age and position.

Hypothesis 7: There will be a significantly positive relationship between PDA functionalities, technical aspect, and practical aspect.

Hypothesis 1: The respondents will have positive attitudes toward PDA functionalities (reference, PIM, clinical-log and communication functions) for the use of PDAs in PBL-medical curricula.

Data from the web-based survey were analysed using SPSS Version 15.0 for Windows. Data were analysed using descriptive statistics. Table 7.3 represents the attitudes of respondents regarding the four basic PDA functionalities in PBL-medical education.

**Table 7.3 PDA functionalities in PBL-medical curricula**

<table>
<thead>
<tr>
<th>PDA function</th>
<th>Mean</th>
<th>S.D.</th>
<th>SD (%)</th>
<th>D (%)</th>
<th>N (%)</th>
<th>A (%)</th>
<th>SA (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SQ 4.2</td>
<td>4.40</td>
<td>0.837</td>
<td>2.2</td>
<td>0</td>
<td>8.9</td>
<td>33.3</td>
<td>55.6</td>
</tr>
<tr>
<td>SQ 4.1</td>
<td>4.33</td>
<td>0.739</td>
<td>0</td>
<td>2.2</td>
<td>8.9</td>
<td>42.2</td>
<td>46.7</td>
</tr>
<tr>
<td>SQ 4.4</td>
<td>4.02</td>
<td>0.892</td>
<td>4.4</td>
<td>0</td>
<td>11.1</td>
<td>57.8</td>
<td>26.7</td>
</tr>
<tr>
<td>SQ 4.3</td>
<td>3.98</td>
<td>0.892</td>
<td>2.2</td>
<td>2.2</td>
<td>10.0</td>
<td>46.7</td>
<td>28.9</td>
</tr>
</tbody>
</table>

*Note.* Value labels for 5 Likert scale: SD = Strongly Disagree; D = Disagree; N = Neutral; A = Agree; SA = Strongly Agree. (n= 45)

The majority of survey respondents agreed that four functionalities (Table 7.3) should be incorporated on student PDAs. These findings also gave the greatest support to reference, PIM, special and communication functions. The
reference and PIM seem to be the important PDA functionalities for medical schools elsewhere. This supports the interview results; firstly, PDAs provide portability and mobility while students are having encounters in clinical placements. There is a limited number of software applications available to support a PBL-medical curriculum in each medical school. The majority of respondents had positive attitudes about PDA functionalities for the use of PDAs in PBL-medical curricula. Therefore hypothesis 1 was accepted.

The only difference between these results on the interview findings is that the interview participants provided the greatest support to clinical-log, reference, communication and PIM functions, respectively. This is probably because the learning context and medical curriculum varied in medical schools elsewhere.

### 7.2.1 Reference function

The majority of respondents agreed (n = 40, 88.9%) that a reference function should be incorporated on students’ PDAs (Table 7.3, SQ 4.2). This finding is generally similar to the interview results, namely that having a reference function on PDAs would be beneficial for students in accessing useful resources and facilitating students in enhancing their knowledge, especially while offsite.

One web-based survey respondent #11 noted:

"The students are the ones who should download and develop these resources on their own PDAs—it should be part of the learning process so that it is truly their 'personal' digital assistant. It will enable them to continue using them after they have left our institution."

This finding provided positive support to the interview finding regarding where to access reference resources (section 7.1.2). Responsibility for downloading, searching or recommending reference resources should be part of learning and studying medicine, even though the medical school also provides support in acquiring medical references for all students. This would
assist students in developing their learning and research skills. Moreover, it is also beneficial for students in developing their LLL skills.

**Benefits and limitations of a reference function on PDAs**

Three benefits and limitations of a reference function for PDAs have been found from the web-based survey. These findings are generally similar to the interview findings. The findings provide positive support to the benefits of incorporating a reference function on PDAs for a PBL-medical curricula.

**Benefits**

Several benefits of a reference function on PDAs were found from the web-based survey. Theses benefits were (i) providing immediate access to information, (ii) facilitating interactions with relevant clinical resources, and (iii) providing alternative ways for looking up references.

**Table 7.4 Benefits of reference function**

<table>
<thead>
<tr>
<th>Benefits of Reference Function</th>
<th>Mean</th>
<th>S.D.</th>
<th>SD (%)</th>
<th>D (%)</th>
<th>N (%)</th>
<th>A (%)</th>
<th>SA (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SQ 2.1</td>
<td>4.22</td>
<td>0.704</td>
<td>0</td>
<td>4.4</td>
<td>2.2</td>
<td>60.0</td>
<td>33.3</td>
</tr>
<tr>
<td>SQ 2.4</td>
<td>3.96</td>
<td>0.903</td>
<td>2.2</td>
<td>4.4</td>
<td>15.6</td>
<td>51.1</td>
<td>26.7</td>
</tr>
<tr>
<td>SQ 2.6</td>
<td>4.09</td>
<td>0.733</td>
<td>0</td>
<td>4.4</td>
<td>8.9</td>
<td>60.0</td>
<td>26.7</td>
</tr>
</tbody>
</table>

*Note. Value labels for 5 Likert scale: SD = Strongly Disagree; D = Disagree; N = Neutral; A = Agree; SA = Strongly Agree. (n= 45)*

**Accessibility of information at hand**

In the web-based survey, the majority of respondents also agreed (n = 42, 93.3%) that the benefit of incorporating PDAs into a PBL-medical curriculum would enhance student learning by providing immediate access to
accurate clinical knowledge (Table 7.4, SQ 2.1). There is no significant
difference among the attitudes of respondents with respect to their
demographic information (e.g. age, gender, position and country). This
finding provides positive support for the interview finding.

Facilitate interactions with relevant clinical resources

The respondents also agreed that PDAs facilitate interaction with other
related clinical resources for medical education, particularly for a PBL-
medical curriculum (Table 7.4, SQ2.4). Further, the majority of respondents
agreed (n = 35, 77.8%) with this aspect.

Web-based survey respondent #14 mentioned:

"*Very useful for well designed medical knowledge
resources;
* Very useful for quick calculators;
* (the benefits of incorporating PDAs into a PBL-medical
curriculum are) ...Not yet effective at integrating
resources and tasks..."

This survey finding generally supports the interview findings regarding the
benefit of a reference function.

Provide alternative ways for looking up references

The majority of respondents agreed (n = 39, 86.7%) that PDA use is
beneficial for students in learning medicine, as it provides alternative ways
for looking up references (Table 7.4, SQ 2.6). This finding provides support
for the interview finding in relation to accessibility to information at hand.

Limitation

The limitation in relation to a reference function for PDAs is the difficulty in
reading via a small screen.
Difficult to read via a small screen

In the open-ended question of Section A (Appendix C), the respondents provided comments in relation to the difficulty in reading information via a PDA screen.

Web-based survey respondent #26 commented:

“Performance and screen size is limiting for multimedia rich content.”

Web-based survey respondent #34 commented:

“Difficult and cumbersome to use. Frequent data loss.”

These comments are similar to the interview finding in this regard.

On the other hand, the attitudes of the respondents towards SQ 3.2 regarding “the difficulty in finding software applications to support a learning in PBL-medical curriculum” have no significant difference among respondents, as the respondents either disagreed or agreed (n = 14, 31.1%) while other respondents disagreed (n = 10, 22.2%) and agreed (n = 11, 24.4%) with this aspect (Table 7.5, SQ 3.2). Therefore the difficulty in finding relevant software applications to support learning in a PBL-medical curriculum may not be a constraint for incorporating reference functions on PDAs.
Table 7.5 Limitations of reference function

<table>
<thead>
<tr>
<th>Limitations of Reference Function</th>
<th>Mean</th>
<th>S.D.</th>
<th>SD (%)</th>
<th>D (%)</th>
<th>N (%)</th>
<th>A (%)</th>
<th>SA (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SQ 3.2</td>
<td>3.20</td>
<td>1.160</td>
<td>6.7</td>
<td>22.2</td>
<td>31.1</td>
<td>24.4</td>
<td>15.6</td>
</tr>
<tr>
<td>SQ 3.3</td>
<td>3.29</td>
<td>1.100</td>
<td>2.2</td>
<td>26.7</td>
<td>26.7</td>
<td>28.9</td>
<td>15.5</td>
</tr>
</tbody>
</table>

*Note. Value labels for 5 Likert scale: SD = Strongly Disagree; D = Disagree; N = Neutral; A = Agree; SA = Strongly Agree. (n= 45)*

Further, the majority of respondents agreed (n = 20, 44.4%) that standard software applications do not match the needs and learning objectives of a PBL-curricula. However there are respondents who disagreed (n = 12, 26.7%) and were neutral (n = 12, 26.7%) with this aspect (Table 7.5, SQ 3.3). This is probably because there are a variety of software applications which are already available and capable of supporting different needs of both educators and learners. On the other hand, it could be possible that these software applications could rarely meet the specific needs and requirements of a particular objective in PBL-medical education.

Therefore Hypothesis 1, that the respondents had positive attitudes toward a reference function for the incorporation of PDA use in a PBL-approach, was accepted.

### 7.2.2 General function (PIM)

The majority of the respondents gave positive support to a *PIM function* (Table 7.3, SQ 4.1) as being one PDA functionality to incorporate into PDAs with a PBL-medical curricula. The majority of respondents agreed (n = 40, 88.9%) about this aspect (Table 7.3, SQ 4.1). This finding generally supports the interview findings.
Web-based survey respondent #27 noted:

“I depend on its PIM functions very heavily.”

On the other hand, the comment on this aspect was different from the interview finding.

### 7.2.3 Clinical-log function

According to survey question SQ 4.4 (Appendix C) regarding attitudes towards special functions (e.g. clinical-log, classroom interaction, classroom resources, etc.), the majority of respondents agreed (n = 38, 84.5%) that special functions, particularly clinical-log, should also be considered to facilitate medical study in a PBL-medical curriculum (Table 7.3, SQ 4.4). Further, the web-based survey respondents also recommended a clinical-log function on PDAs for facilitating medical study in a PBL-medical curriculum. The respondents were also aware that patient privacy regarding information being recorded on a PDA-based clinical-log may contain personal information, and were thus concerned about confidentiality.

Web-based survey respondent #9 noted:

“Patient-log on PDA brings up critically important patient confidentiality issues.”

Therefore information being recorded on a clinical-log must be de-identified. This finding is generally similar to the interview results regarding ‘recording clinical experiences’ on a clinical-log.

### Benefits of a clinical-log function

Four-benefits of clinical-log function were found from the web-based survey, these being, (i) convenient and efficient in tracking students’ progress and providing a self-assessment tool for students, (ii) ability in sharing information between learners and educators, (iii) enhancing students’ LLL, and (iv) providing the capability for instant recording without recall. These
findings essentially provide positive support for the interview findings regarding benefits of incorporating a clinical-log for a PBL-medical curricula.

**Tracking students’ progress (assessment purposes)**

The majority of respondents agreed (n = 33, 73.4%) that recording all clinical encounters on a clinical-log would be beneficial for both students and medical faculty in tracking students’ progress (Table 7.6, SQ 5). Further, a clinical-log assists students in identifying their learning needs in a PBL-medical curricula (Table 7.6, SQ 7). The majority of respondents agreed (n = 33, 73.4%) on this aspect.

Further, the majority of respondents agreed (n = 34, 75.6%) that PDAs have the potential to achieve different learning needs and learning objectives in a PBL-medical curricula (Table 7.6, SQ 24).

**Table 7.6 The benefits of clinical-log function in tracking students’ progress**

<table>
<thead>
<tr>
<th>Benefits of Clinical-log Function</th>
<th>Mean</th>
<th>S.D.</th>
<th>SD (%)</th>
<th>D (%)</th>
<th>N (%)</th>
<th>A (%)</th>
<th>SA (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SQ 5</td>
<td>3.87</td>
<td>0.991</td>
<td>2.2</td>
<td>8.9</td>
<td>15.5</td>
<td>46.7</td>
<td>26.7</td>
</tr>
<tr>
<td>SQ 7</td>
<td>3.82</td>
<td>0.806</td>
<td>2.2</td>
<td>2.2</td>
<td>22.2</td>
<td>57.8</td>
<td>15.6</td>
</tr>
<tr>
<td>SQ 24</td>
<td>3.91</td>
<td>0.763</td>
<td>0</td>
<td>4.4</td>
<td>20</td>
<td>55.6</td>
<td>20</td>
</tr>
</tbody>
</table>

*Note.* Value labels for 5 Likert scale: SD = Strongly Disagree; D = Disagree; N = Neutral; A = Agree; SA = Strongly Agree. (n= 45)

These survey findings are similar to the interview findings regarding PDA use in medical education, namely facilitating students as a self-assessment tool in determining their learning needs and identifying a learning strategy in order to fill the learning gap.
Sharing information between learners and educators

SQ 6 reflected the respondents’ attitudes about an interactive clinical-log which assists students in presenting their clinical reports to the medical faculty (e.g. clinical encounters report, patient problems reports, consultation reports, medications and allergies reports) irrespective of the clinical location, and assists faculty in providing individual student feedback based on the student entries. The majority of respondents agreed (n = 33, 73.3%) with this aspect (Table 7.7, SQ 6). This finding provides support for the interview finding regarding the benefit of using a clinical-log in terms of sharing information between students and medical faculty while offsite.

Table 7.7 The benefits of clinical-log in sharing information between learners and educators

<table>
<thead>
<tr>
<th>Benefits of Clinical-log Function</th>
<th>Mean</th>
<th>S.D.</th>
<th>SD (%)</th>
<th>D (%)</th>
<th>N (%)</th>
<th>A (%)</th>
<th>SA (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SQ 6</td>
<td>3.80</td>
<td>0.968</td>
<td>4.4</td>
<td>4.4</td>
<td>17.8</td>
<td>53.3</td>
<td>20</td>
</tr>
<tr>
<td>SQ 2.3</td>
<td>4.02</td>
<td>0.723</td>
<td>0</td>
<td>2.2</td>
<td>17.8</td>
<td>55.6</td>
<td>24.4</td>
</tr>
</tbody>
</table>

*Note. Value labels for 5 Likert scale: SD = Strongly Disagree; D = Disagree; N = Neutral; A = Agree; SA = Strongly Agree. (n= 45)*

Further, the majority of respondents agreed (n = 36, 81%) that PDAs provide flexibility and adaptability for exchanging clinical-log information records between peers and faculty members (Table 7.7, SQ 2.3). These findings regarding the benefits of clinical-log function for PDAs are consistent with the interview findings.
Enhancing students’ life-long learning

The majority of respondents also agreed (n = 37, 82.3%) that PDA use in medical education could enhance self-learning and LLL (Table 7.8, SQ 2.2).

Table 7.8 The benefits of a clinical-log in enhancing student self-learning and LLL

<table>
<thead>
<tr>
<th>Benefits of Clinical-log Function</th>
<th>Mean</th>
<th>S.D.</th>
<th>SD (%)</th>
<th>D (%)</th>
<th>N (%)</th>
<th>A (%)</th>
<th>SA (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SQ 2.2</td>
<td>4.04</td>
<td>0.767</td>
<td>0</td>
<td>4.4</td>
<td>13.3</td>
<td>55.6</td>
<td>26.7</td>
</tr>
</tbody>
</table>

*Note. Value labels for 5 Likert scale: SD = Strongly Disagree; D = Disagree; N = Neutral; A = Agree; SA = Strongly Agree. (n= 45)*

This finding provides positive support for the interview finding regarding the benefits of a clinical-log.

Providing capability for instant recording without recall

PDAs provide convenience in obtaining data and feedback during clinical rotations (Table 7.9, SQ 2.5), in particular when incorporated with a clinical-log function.
The majority of respondents agreed (n = 38, 84.57%) that the benefits of incorporating PDAs into a PBL-medical curriculum make it convenient to obtain data and feedback during clinical rotations (Table 7.9, SQ 2.5). This survey finding provides positive support for the interview finding in relation to the benefit of using a clinical-log in medical education.

Further, the respondents also provided positive support for using the classroom interaction function (Table 7.9, SQ 8), which allows medical faculty to monitor students’ access to classroom resources (e.g. taking quizzes, looking up references and performing online class-evaluation). The majority of respondents agreed (n = 21, 46.7%) about using PDAs as a classroom interaction function. On the other hand, some respondents disagreed (n = 5, 11.1%) about using this function, while the remainder either agreed or disagreed about using this function in medical education.

In comparison with the web-based survey finding, the classroom interaction function was rarely mentioned during the interview. This is possibly because the emphasis of PDA use in the UOW PBL-medical curriculum is on the four basic functions (clinical-log, reference, PIM and communication). As a result, the survey finding in this aspect is generally inconsistent with the
interview finding regarding use of classroom interaction function for PDAs in medical education.

**Limitation**

**Inconvenient data entry methods**

The majority of respondents agreed (n = 33, 73.4%) that a constraint of incorporating PDAs into a PBL medical curricula is an inconvenient data entry method (Table, SQ 3.1).

**Table 7.10 Inconvenience of PDAs data entry method**

<table>
<thead>
<tr>
<th>Limitation of Clinical-log Function</th>
<th>Mean</th>
<th>S.D.</th>
<th>SD (%)</th>
<th>D (%)</th>
<th>N (%)</th>
<th>A (%)</th>
<th>SA (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SQ 3.1</td>
<td>3.71</td>
<td>0.968</td>
<td>2.2</td>
<td>13.3</td>
<td>11.1</td>
<td>57.8</td>
<td>15.6</td>
</tr>
</tbody>
</table>

*Note. Value labels for 5 Likert scale: SD = Strongly Disagree; D = Disagree; N = Neutral; A = Agree; SA = Strongly Agree. (n= 45)*

This constraint affects the use of PDA functions, in particular clinical-log. This is because students need to record their clinical experiences and encounters on their log while offsite. The respondents also commented on this aspect.

Web-based survey respondent #27

“I find students spend too much time on working with the PDA, rather than actually looking up data (which takes half the time via the web) or laying hands on patients.”

Web-based survey respondent #26

“We have a PDA-based clinical-log with six questions/fields. Many students still find it faster to jot notes on paper and then use the web interface at the end of the day.”
It is seen that inconvenience of data entry and look up are concerns in both the web-based survey and the interview findings.

### 7.2.4 Communication

The majority of respondents agreed (n = 34, 75.6%) with the use of this function regarding PDAs in medical education (Table 7.3, SQ 4.4).

Moreover, the majority of respondents also agreed (n = 34, 75.5%) that PDAs can be used as a learning tool in PBL-based medical education to communicate with medical schools and peers while students have in the clinical placements (Table 7.11, SQ 25).

#### Table 7.11 Communication function for PDA use in medical education

<table>
<thead>
<tr>
<th>Limitation of Clinical-log Function</th>
<th>Mean</th>
<th>S.D.</th>
<th>SD (%)</th>
<th>D (%)</th>
<th>N (%)</th>
<th>A (%)</th>
<th>SA (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SQ25</td>
<td>3.87</td>
<td>0.661</td>
<td>0</td>
<td>2.2</td>
<td>22.2</td>
<td>62.2</td>
<td>13.3</td>
</tr>
</tbody>
</table>

*Note. Value labels for 5 Likert scale: SD = Strongly Disagree; D = Disagree; N = Neutral; A = Agree; SA = Strongly Agree. (n= 45)*

Generally, the finding in this aspect is similar to the interview findings.

### Benefit

**Providing flexibility and adaptability for information exchange (communication) with medical faculty and peers**

The majority of respondents agreed (n = 36, 80%) that a communication function would provide ability and flexibility to communicate with medical faculty and peers (Table 7.7, SQ 2.3) while offsite, as PDAs can provide
alternative ways for communicating wirelessly. This finding is similar to the interview finding.

**Limitation**

**Network connectivity in uncovered network areas**

The web-based survey respondents commented that a constraint of the communication function could be a limitation of network connectivity for PDAs, in particular in uncovered network areas.

Web-based survey respondent #26 commented:

“Limited Wi-Fi access in clinics and remote sites limits usefulness for live data exchange.”

This finding is similarly to the interview findings regarding the constraint of a communication function.

In conclusion, the majority of respondents agreed (n = 36, 81%) that PDA functionalities for PBL-medical education should be highly self-directed with content, learning methods and learning resources selected specifically to maintain and improve the knowledge, skills and attitudes needed daily in both medical study and clinical practice (Table 7.12, SQ 9).

Most respondents also agreed (n = 41, 91.1%) that providing necessary resources in electronic format for students to access, via PDAs or web-based, would assist in ease of use (Table 7.12, SQ 10).

The majority of respondents agreed (n = 31, 68.9%) that PDA functionalities in PBL-medical education would encourage students to create and manage their own learning (Table 7.12, SQ 11). The respondents mostly agreed (n = 29, 64.4%) and strongly agreed (n = 5, 11.1%) that PDA functionalities in a PBL-medical curricula are different from traditional medical curricula and learning environments (Table 7.12, SQ 12).
### Table 7.12 The use of PDA functionalities in PBL-medical curricula

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>S.D.</th>
<th>SD (%)</th>
<th>D (%)</th>
<th>N (%)</th>
<th>A (%)</th>
<th>SA (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SQ 9</td>
<td>4.02</td>
<td>0.723</td>
<td>0</td>
<td>2.2</td>
<td>17.8</td>
<td>55.6</td>
<td>24.4</td>
</tr>
<tr>
<td>SQ 10</td>
<td>4.27</td>
<td>0.837</td>
<td>2.2</td>
<td>2.2</td>
<td>4.4</td>
<td>48.9</td>
<td>42.2</td>
</tr>
<tr>
<td>SQ 11</td>
<td>3.78</td>
<td>0.927</td>
<td>2.2</td>
<td>6.7</td>
<td>22.2</td>
<td>48.9</td>
<td>20</td>
</tr>
<tr>
<td>SQ 12</td>
<td>3.69</td>
<td>0.763</td>
<td>0</td>
<td>6.7</td>
<td>28.9</td>
<td>53.3</td>
<td>11.1</td>
</tr>
</tbody>
</table>

*Note. Value labels for 5 Likert scale: SD = Strongly Disagree; D = Disagree; N = Neutral; A = Agree; SA = Strongly Agree. (n= 45)*

In addition, the majority of respondents agreed (n = 32, 71.1%) that the adoption of PDAs and its functionalities would be different in each year of a 4-year program which uses a PBL-based medical curriculum (Table 7.13, SQ 26), while only one respondent disagreed. This finding was supported by the interview finding that the basic PDA functionalities should be first introduced to students from year-1. Such functionalities can be changed and adjusted based on students’ learning needs. It would be beneficial for students to justify their needs based on their learning experiences rather than being told by the medical school about what they need to use or learn. The strategy of introducing PDAs and their functionalities should be a pull rather than a push strategy.

### Table 7.13 The adoption of PDA use and its functionalities into a PBL-medical curricula

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>S.D.</th>
<th>SD (%)</th>
<th>D (%)</th>
<th>N (%)</th>
<th>A (%)</th>
<th>SA (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SQ 26</td>
<td>3.89</td>
<td>0.745</td>
<td>0</td>
<td>2.2</td>
<td>26.7</td>
<td>51.1</td>
<td>20.0</td>
</tr>
</tbody>
</table>

*Note. Value labels for 5 Likert scale: SD = Strongly Disagree; D = Disagree; N = Neutral; A = Agree; SA = Strongly Agree. (n= 45)*
The following hypothesis set out to determine whether the demographics of respondents (e.g. country, age, gender or position) influence their attitudes toward PDA use in these aspects (SQ 9, SQ 10, SQ 11 and SQ 12).

**Hypothesis 2:** There will be a significant difference in attitudes towards the use of PDA functionalities in a PBL-medical curricula, between respondents with different backgrounds regarding country, gender, age and position.

The PDA functionalities were categorised into four groups, these being (i) reference, (ii) PIM, (iii) clinical-log and (iv) communication functions. Before testing this hypothesis, a normality assumption was tested for each group in order to identify an appropriate statistical analysis. This was tested using the Kolmogorov-Smirnov and Shapiro-Wilk tests. This finding revealed that four groups of PDA functionalities were not normally distributed ($p < 0.05$), with respect to country, age, gender and position (Appendix F). This suggested that the normality assumption was violated. Therefore the Man-Whitney U test - a non-parametric equivalent to independent sample t-test (Allen and Bennett 2008; Coakes, Steed et al. 2008) - was conducted to test this hypothesis. To control type I error, Bonferroni adjustment of 0.0125 was used to determine a significant level (Brown 2008).

There was no significant difference for the follow-up scores of PDA functionalities, between respondents with different demographics regarding country, age, gender and position. The findings of the Mann-Whitney U test (Table 7.14) indicated that there was no difference at the 0.0125 significance level. This suggested that despite a difference in country, age, gender and position, the respondents had similar attitudes towards the use of the four basic PDA functionalities in a PBL-medical curricula. Therefore, the hypothesis that there was a significant difference of the attitudes towards the use of PDA functionalities in PBL-medical curricula was rejected.
Table 7.14 Mean ranks of demographic groups for follow-up scores of PDA functionalities

<table>
<thead>
<tr>
<th>Demographics</th>
<th>PDA Functions</th>
<th>Groups</th>
<th>N</th>
<th>Mean Rank</th>
<th>Sum of Rank</th>
<th>U</th>
<th>Z</th>
<th>p</th>
</tr>
</thead>
<tbody>
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7.3 Chapter Summary

Learning medicine is a combination of art and sciences. Culture of learning medicine not only comprises of sharing understandings and perspective of medical profession (Becker, Geer et al. 1977) but also using the technology to facilitate in learning, practicing, diagnosing and treating patients. These
four major PDA functionalities were identified to facilitate medical study in PBL-approach based on the attitudes, knowledge and experiences of the participants.

In conclusion, the similarity between PDA use in the medical profession and medical education centres around the use of reference, communication and PIM functions. However the differences between the use of PDAs in these two areas are dependent on the purposes of using these devices and area being used, for instance, administrative purposes (e.g. ordering clinical tests, patient management, etc.), physiotherapy, dietary management, etc.

The findings regarding PDA functionalities are similar to the proposed PDA functionalities in the conceptual framework (Chapter IV). However, the preference of using additional PDA function is directly dependent on the learning needs of individuals after deploying a PDA.

In conclusion, the answers to the first research question, “What are the PDA appropriate functionalities for a PBL-medical curriculum?”, were reported and discussed in sections 7.1-7.2.

Four-basic PDA functionalities were identified based on the 15 in-depth interviews and web-based survey with medical faculty, honorary clinical academics, educational technology specialists and healthcare professionals, these being clinical-log, reference, communication and PIM functions.

According to the findings from both interviews and web-based survey, these are the PDA functions, which should be recommended for students in order to facilitate their medical study in a PBL-medical curricula, based on the experts’ knowledge, attitudes and experiences.

However, based on the interviews and web-based survey findings, the importance of each function depends on the purpose, objectives, context and structure of medical curriculum. As a result, the primary focus of PDA
functionalities at the UOW GSM is on clinical-log, reference, communication and PIM functions, respectively.

Moreover, association between the four basic PDA functionalities and the UOW PBL-medical curriculum (Figure 7.2) becomes readily apparent.
The association of the four-basic PDA functionalities with the UOW PBL-medical curriculum

**Figure 7.2**
1. **Clinical-log function:** What makes this function the most important is the context of the UOW PBL-medical curriculum. According to the GSM, the curriculum facilitates students in having clinical encounters and clinical skill attachment from year-1. Students then gradually disperse into clinical placements elsewhere from year-3 throughout their final year. In addition, the UOW PBL-medical curriculum is essentially focused on 93-clinical problems, therefore a clinical-log function is important for students in capturing and recording their clinical experiences and encounters based on these problems during their 4-years of medical study. The reasons for introducing/recommending a clinical-log as a basic PDA function for medical study in PBL-approach are threefold.

Firstly, students can use the clinical-log to record their clinical experience and encounters, and to reflect upon and identify their learning needs. Incorporating this function on PDAs also encourages students to practice LLL. This would be beneficial for students, not only during their medical study, but also for their medical career in the future. Secondly, a clinical-log function also facilitates students to upload and transfer their log data back to the medical school for educational purposes, for instance, supervision, monitoring learning groups and learning progress, designing learning needs, etc. Finally, a clinical-log function facilitates students in learning medicine using a PBL-approach, especially while offsite.

2. **Reference function:** The findings also indicated that a reference function is an appropriate PDA functionality for studying medicine in a PBL-medical curriculum. The reason why the reference function is the second most important PDA functionality is that the UOW PBL-curriculum has no basic science subjects. Students start having clinical experiences and encounters from year-1, and learn basic science based on real clinical experiences. Therefore, having access to reference material while offsite is important for
students, not only having access to information at hand, but also supporting their clinical reasoning, personal reflections based on problems being encounter, and decision making, etc.

Further, incorporating PDAs with the ability to access reference resources could be more effective and efficient for studying medicine using a PBL-approach. Students can at least access resources while offsite without waiting to come back to base. This would save time in accessing information and also encourage students to sustain their learning which is not only limited to classroom, library or on-campus environments. In addition, the recommended reference materials were also identified in section 7.2.1.

3. **Communication function:** The reasons for incorporating a communication function with PDA use in the UOW PBL-medical curriculum (Figure 7.2) are threefold. Firstly, this function provides a communication channel between students and the medical faculty for individual guidance. Secondly, this function also facilitates communication between students and the clinical preceptor for individual guidance and supervision on clinical skills and experiences. Finally, the function also assists students in communicating with peers for group work and discussion. Therefore this would encourage students to focus on the context of learning with faculty, clinical preceptors and peers, no matter where they are during their clinical skills attachments.

4. **PIM function:** The reasons for incorporating a PIM function on PDA devices to the UOW PBL-medical curriculum (Figure 7.2) are twofold. Firstly, this function facilitates students in organising their contacts, daily activities, etc. Secondly, it also assists students in accessing school timetables. Students, therefore, can organise their school timetable and clinical attachments while offsite.
Chapter VIII
Technical Aspects

8.0 Chapter overview

The aim of this chapter is to determine what technical aspects should be considered for the incorporation of PDAs into PBL-medical curricula, based on the interviews and web-based survey findings. There are three objectives in this chapter, namely (i) to report and discuss the findings from both the interviews and web-based survey; (ii) to evaluate the findings from both interview and web-based survey results and; (iii) to identify the important technical aspects for incorporating PDAs into medical education.
8.1 Interview findings: Technical issues

Interview participants were asked a number of questions regarding technical aspects which need to be considered before incorporating PDAs into the UOW PBL-medical curriculum, these being interoperability between different PDA platforms, data transmission and network connectivity, data security and information privacy, and maintenance and support.

The findings were coded into relevant nodes in each aspect and analysed with NVivo (Figure 8.1).

![Hierarchical categorization of technical aspects for the incorporation of PDAs into PBL-medical curriculum (Note. * represents most important function/aspect)](image)

According to Table 8.1, the interview participants gave greatest support to data security and information privacy as the most important technical aspect to consider before incorporating PDAs into the UOW PBL-curriculum. The second most to the least important technical aspects are data transmission and network connectivity, maintenance and support, and interoperability, respectively.
Table 8.1 Rank of technical issues to consider by number of coding references from Nvivo

<table>
<thead>
<tr>
<th>No.</th>
<th>PDA functionalities</th>
<th>Number of coding references from Nvivo</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Honorary academic</td>
</tr>
<tr>
<td>1</td>
<td>Data security and information privacy</td>
<td>24</td>
</tr>
<tr>
<td>2</td>
<td>Data transmission and network connectivity</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>Maintenance and support</td>
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</tr>
<tr>
<td>4</td>
<td>Interoperability between different PDA platforms</td>
<td>0</td>
</tr>
</tbody>
</table>

Detailed findings from both interviews and the web-based survey are reported and discussed in sections 8.1.1-8.1.4

8.1.1 Data security and information privacy

Data security and information privacy is the most essential technical aspect for incorporating PDAs into the UOW PBL-medical curriculum. The findings on this aspect are directly relevant to data being recorded on a PDA accessible clinical-log and personal data being stored on PDA devices. This section reports and discusses the findings from the interviews in relation to data security and information privacy of clinical-log data.

The honorary clinical academics (n = 3), the GSM faculty members (n = 8) and educational technology specialists (n = 3), voiced concerns regarding the data security and information privacy of clinical-log data. These concerns can be categorised into four groups, including (i) privacy and anonymity of data, (ii) data security and security of PDA device, (iii) professional conduct on practicing medicine and (iv) duration of keeping clinical-log data. Table 8.2 reports the most to the least concerns regarding the HRIPA. Generally, these
four groups are concerns that relate to the HRIPA. They were prioritised into four separate groups that determine what the interview participants’ perceptions were regarding different aspects around the acts.

Table 8.2 Concerns regarding HRIPA, ranked by number of coding references in each aspect from Nvivo

<table>
<thead>
<tr>
<th>Group</th>
<th>Concern aspects regarding HRIPA</th>
<th>Number of coding references in Nvivo</th>
</tr>
</thead>
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<td></td>
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<td></td>
<td>Anonymity</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>Security of data</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>Security of PDAs</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Professional practice and conduct</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>Duration of keeping clinical-log data</td>
<td>1</td>
</tr>
</tbody>
</table>

Firstly, the findings regarding data security emphasise (i) data security and security of PDA devices, (ii) information privacy based on the seven categories of 15 principles of HPPs, (iii) data disposal and (iv) professional conduct, in practicing medicine.

Data security and security of PDA devices

According to Table 8.2, data and PDA device security are the second highest concern regarding the HRIPA. Ten interview participants had a strong concern about data security when dealing with patient information. On the other hand, the honorary clinical academics (n = 2) and educational technology specialist (n = 1) have a great concern regarding the security of the PDA device.
In this case, the security of data regarding the HRIPA or any health information and privacy act elsewhere emphasises data being recorded on the clinical-log function, and reflective e-portfolios or heath information of patients being discussed with peers, the clinical preceptor or the GSM faculty members.

In terms of clinical-log function, there are a number of data security procedures that can be applied, including access restrictions and access protection on recording patient information. Firstly, the clinical-log function can have access restrictions only for students and a small number of nominated members in the medical school. Secondly, accessing a web-based clinical-log is protected by a traditional data security procedure with username and password for login. Finally, the majority of data entered on a clinical-log is already prevented from recording any patient identifier (excluding free-text box).

The security and access protection of a PDA can be done by using password protection. It is possible that a user may leave a PDA unattended, then someone else can access data on that PDA. In case a PDA is lost or stolen, the password protection on the PDA can prevent the device from unauthorised access.

Therefore, in terms of technical aspect, the security of data and the PDA device can be protected by a software mechanism. Besides these mechanisms, the security of data would rely on policy, regulations, guidelines, professional conduct and any health information and privacy act (e.g. the HRIPA for NSW or the HIPAA in the U.S.). For example, in recording clinical experiences, students are instructed not to record any information that would directly or indirectly identify the patient. On the other hand, a reflection on clinical experiences with any written information or verbal communication must be done without specifying who the patient is. It
is essential to ensure that disclosing information about health information on specific health records is not allowed.

“Transmission can be by other means...you can transmit information, for example, by the web, by a WAN, by means of Microwave, landline, all sorts of mechanisms. ...no need to physically move from point A to point B. ...(data) security would sit around the fact that you could download the stuff from the GP surgery, it will be picked up somewhere else, dump somewhere else. What is the security out there? That would be my preference. ...each of the students may have their own web-page or something that they can download data in the GP surgery....then they will create of their own device and it will never leave the surgery in the physical form. That is one approach to security.”  

IV01 (21.09.2007)

“It would be good if all those things (procedures, regulations, data security, data collection, data storage, data access, data accuracy, data usage, data disclosure, identifier and anonymity, data transfer and linkage while using PDAs in medical studies) are in keeping with it.”  

IV02 (28.09.2007)

“...it is the biggest concern ...students should not be having any electronic access to medical records...the information that dealt with needs to be as unidentifiable as possible and secure as possible.”  

IV08 (16.09.2007)

These findings are similar to the literature regarding the security of data and PDA devices (section 3.7). However, there are a number of security mechanisms which can be applied in order to protect data and prevent PDAs from unauthorised access.

**Information privacy**

The honorary clinical academics (n = 2), the GSM faculty (n = 6) and educational technology specialists (n = 2) are totally comfortable and familiar with the HRIPA.
The educational technology specialists realised that there will be no data filed on the PDA accessible clinical-log function. As a result, it only allows students to record general patient characteristics.

“The patient confidentiality would be absolutely critical.”
IV06 (30.09.2007)

“...we have been careful not to record any data that would identify any individual...we have stressed that to the students that this is not meant to be a health record of their patients.”
IV10 (12.09.2007)

Generally, recording clinical encounters on a clinical-log would contain no patient identification in any way, for example, names, initials, etc. As being discussed in section 7.1.1, the primary purposes of using a clinical-log are for recording clinical encounters, including major clinical problems found, and for physical diagnosis and then later discussion with the clinical preceptors. It is possible to use clinical-log data for discussing clinical cases, seeking feedback and using this for self-directed learning. Therefore the most important aspect besides using clinical-log data for medical study is to maintain patient privacy, whether or not students know the details of the HRIPA. However, knowing and understanding the primary concern of the HRIPA would give students more confidence in practicing their medical profession.

Collection and use: What information they can access

The interview participants had a particular concern regarding the information they can access on clinical-logs, namely clinical experiences, reflections on clinical experiences and learning outcomes without patient identifiers, as previously mentioned in sections 7.1.1 and 8.1.1.

“...it is not information that refers to individual information as such. It is general information (e.g. age, gender), what the problem was, what the key learning features are, the problems and learning outcomes that
In terms of security procedures, the finding regarding data security techniques has been emphasised on PDA accessible clinical-log function because clinical-log is a compulsory function that students are required to record their clinical experiences and reflections toward what they have learned from the clinical placements. Therefore access restrictions must be applied with this function.

“...by username and password. That is a traditional model.”

In comparison to other functionalities, which more involve referencing, information access and PIM, these functions require less data security procedures as such. However, these functions may also require access protection on the device, because it is possible that students may record their clinical experiences and personal reflections elsewhere on their PDAs. This is not secure in case PDAs are accessed by unauthorised persons when the devices are unattended, lost or stolen. Therefore it is more secure for data if a device protection scheme can be applied for PDAs, for instance, password protection, after they are unattended for certain period.

There are a number of data security techniques that have been reviewed in the literature (section 3.7). It is possible that the medical school can apply other security procedures, especially for wireless devices and wireless connectivity.

Another concern regarding data security is identity fraud and security of PDA devices, as the device could be accessed by anyone in the case of losing a PDA. There are a number of techniques that can be used to obtain personal information in identity theft or identity fraud to access information on mobile devices, for example, stealing devices, hacking data from database, etc. Moreover, PDAs may contain a rich amount of personal information, which thieves or hackers can use for unethical purposes, for instance, obtaining
personal identifiable information to impersonate the owner of such information.

This could happen when unauthorised persons want to access students’ clinical-logs. Students can access their clinical-log remotely while having clinical encounters. Therefore it is possible for hackers to access online clinical-log functions from different devices, for instance, public dumpsites. As a result it is possible that clinical-log databases can be stolen from a computer database. Therefore, in order to protect against identity theft, security procedures must be applied.

The possible data security techniques for a PDA accessible clinical-log function include using adequate network security with strong data encryption, as reviewed in Section 3.7. In addition, the highest level of data security and protection is to ensure that any information being stored on a clinical-log cannot be reused to impersonate any individual. That is why this procedure was stressed by the interview participants.

Besides having data security for accessing web-based clinical-logs, it is also possible to apply an additional security procedure before students start using their PDAs. Such access protection of the PDA device would safeguard students’ from crackers. Even though students are not allowed to record any patient identifier, they could nevertheless safeguard their personal information stored on such devices.

Storage

Where and how to store clinical-log information

The GSM faculty (n = 4) and educational technology specialists (n = 3) commented on where and how to store clinical-log data in a similar manner. The majority of participants indicated that clinical-log data should be stored on the university’s database server and maintained by the central IT unit
rather than storing at the medical school. This is because the university central IT unit has a secure database server room. However the data is directly supported and maintained by the GSM educational technology specialists. It has been stressed that clinical-log data should not be primarily stored on student PDAs or personal computers but rather on the university’s databases. Clinical-log data would be directly and automatically stored on the university’s database once students record their clinical experiences on their PDA accessible clinical-logs. In this case, students record their clinical experiences on a given spreadsheet form, and their data will be stored on the university’s database once students upload this spreadsheet file to their online clinical-log.

"...this is going to be on a secured server. That is up for ITS\(^1\) to provide us with the secure data set, which is only for the students, academic members and staff to have access to."

IV03 (24.09.2007)

"...there is a database that stores all of the information on the server and on the PDA is subset of information relative to the students."

IV08 (16.09.2007)

“The clinical-log is stored at the ITS secure room. ...the data in the clinical-log is stored on the server in the secure room...data is not meant to be kept in the students’ PDA.”

IV10 (12.09.2007)

There is a similarity with other findings reported in the literature (section 3.6), in that students are required to update and synchronise their clinical-log data to the university’ server regularly. Further, there are possible reasons why the clinical-log data must be stored on the university’s server. The primary reason is for security purposes. Any authorised user can access the

\(^1\) Information technology service (ITS) supports IT infrastructure (e.g. computers, network and communication services) to the UOW for academic teaching, research and general administrative activities.
data once they are logged in and verified as an authorised user. Generally, the authorised user will be given a different priority for accessing data. Secondly, the medical school prefers students to store their clinical-log data on the university’s database server rather than storing on their PDA or elsewhere for data management and security purposes. It would be easy for the university’s IT staff to maintain data in a centralised manner. Thirdly, storing clinical-log data on the university’s server is secure, as data is already protected in case students lose their PDAs or run out of battery. Finally, the medical faculty can easily access and monitor students’ clinical-logs for assessment purposes via online access.

Therefore both students and nominated medical faculty members would be able to access the same data source over time. This would provide speed, accuracy and reliability in information accessing. Furthermore, both students and the GSM can also maintain the communication and interaction based on the recent update information, especially when students are away in the clinical placements elsewhere.

Duration of data storage

The honorary clinical academics (n = 1), medical faculty (n = 5) and the educational technology specialists (n = 2) reflected differently on the duration of storing clinical-log data. The interview participants had different opinions about this aspect.

The participants’ perceptions toward duration of storing clinical-log data in the database can be categorised into two major timeframes. Firstly, data can be stored on a database equivalent to the academic timeframe. Secondly, data can be kept for a longer period for future use. Generally, data being recorded on a clinical-log is generally used for academic purposes - one is for assessment, and the other is for future research, curriculum evaluation and medical students’ profile for their future employment.
“...With respect to the student information, I would presume for a relevant time frame.” IV14 (18.10.2007)

“...it needs to be kept for a duration of the students (minimum 4 years), terms of the students (4 years) and official data then it would be subject to the health act as well as in terms of keeping confidential data.”

IV13 (13.09.2007)

“...it will be kept up to four years.” IV08 (16.09.2007)

“...students only have access to their data for four years of their course...a minimum four years. ...whether we want to keep that data beyond the students’ course....it may be helpful for research and comparing from cohort to cohort.” IV10 (12.09.2007)

On the other hand, since clinical-log data is a record without identified information about patients, then there should be no issue regarding how long information should be stored on the databases, as long as the medical school can manage and maintain it. As previously mentioned, clinical-log data would be useful for future use, for instance, for high level reporting and for future curriculum evaluation and development.

“...ideally would like to keep it for very long time because.... it is valuable for the students to keep a record of what they have seen and to keep them ...to think about and learn from...for the medical school...apart from being a fabulous research tool because we know exactly what else students have seen. ...in the long-term, it gives us the ability to evaluate a curriculum much better.”

IV09 (22.09.2007)

In the case, where clinical-log data were a EHR then the timeframe to store this record would be based on the HRIPA. On the other hand, a clinical-log is not an actual EHR, as it contains no patient identification. Therefore an appropriate timeframe could be applied which would depend on the purpose of using such clinical-log data in the future.

“...for a clinician, I have to maintain records for seven years legally. It is information that has been gathering in order to assist the patient or treating the patient...information is not only for your academic knowledge... It is to assist the patient in the work you
This finding is similar to the literature (section 3.6), i.e. that a clinical-log is kept and used for reviewing students’ progress during their clinical rotations and self-assessment during their medical study. To date, little has been mentioned in the literature regarding having medical schools store clinical-log data for future use. In addition, there are a number of medical schools (section 3.6) that recommend students keep their own copy of clinical-log data for future employment. Therefore, medical schools could possibly keep students’ clinical-log data for future use, for students’ future employment, evaluation and future research.

**Duration of storing clinical-log data**

Duration of storing health information on the university’s database server is of least concern regarding the HRIPA. This is possibly because, firstly, a record of clinical-log is not an actual EHR; secondly, there is no patient identifier recorded on a clinical-log. Therefore the GSM needs to follow the university procedures regarding the duration for storing students’ clinical-log data, which will satisfy the acts. On the other hand, in the case of storing EHRs, the health information must be stored for a certain timeframe as specified in the acts.

“For medical practitioners, that is seven years....the kids, for newborn kids, it is 25-years. That is a long period of time.”

The literature regarding the HRIPA indicated that there is a specific timeframe for storing EHRs, these being at least 7-years for adult patients and longer than 7-years for newborn babies or kids. However, clinical-log data is not a patient health record as such but the purpose for keeping this data is for future use, for instance, students’ future employment, etc.
Access and accuracy: How to safeguard information and who can access the information

The interview findings regarding data security and access plan reported the most to the least important aspects shown in Table 8.3, these being data accessibility and access authority, who can access data, how long to keep clinical-log data and where and how to store clinical-log information, respectively. The honorary clinical academic (n = 1) only commented on the duration of storing data on the university’s database server. This is possibly because other aspects were more toward a potential plan within the university and GSM rather than the clinical aspect. Therefore the participant only commented on duration for storing clinical-log data based on their perspectives and clinical experiences.

Table 8. 3 Data security and access plan ranked by number of coding references in each aspect from Nvivo

<table>
<thead>
<tr>
<th>Data security and access plan</th>
<th>Number coding references in Nvivo</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Honorary clinical academic</td>
</tr>
<tr>
<td>Data accessibility and access authority</td>
<td>0</td>
</tr>
<tr>
<td>Who can access data</td>
<td>0</td>
</tr>
<tr>
<td>How long to keep data on the database</td>
<td>2</td>
</tr>
<tr>
<td>where and how to store clinical-log information</td>
<td>0</td>
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</tbody>
</table>

The findings in each aspect are reported and discussed in the following sections.
Data security and access plan

The GSM faculty (n = 4) have definite ideas regarding data security protection (data security and access plan), namely that access restrictions must be applied by providing authority only for students and several medical faculty members and educational technology specialists (n = 3).

“...some people can access and compile data so it is not identified by the students’ name. ...we can look at a growth confident (of students’ clinical experience)... for research purposes ... a few people have an access to it via technology wired...by username and password. That is a traditional model. ...then managed by an educational technology team to ensure that system they have put in...does not allow any security break and that no one is accessing it.” IV12 (07.09.2007)

“...we have got quite strict protocols and access limitations for people who have access to information ...certain people are credited with an ability to enter this information. ...that limits the mistakes and accuracy. For example...the exam questions or test questions that they have throughout the course are provided by the staff and given to one person to enter into the system and that one person correlates all of the data from the students. They have a secure password access to participate in the testing and give their responses ... we have quite strict protocols.” IV13 (13.09.2007)

This finding is similar to the literature (section 3.2 and 3.7), i.e. that accessibility to the clinical-log is eligible for the log owners and authorised persons. These authorised people may be named or called differently by each medical school, for instance, tutor, preceptor, clerkship director, etc. However, the data security techniques and procedures vary at each medical school, and would directly depend on what technique is applied to the clinical-log functionality.

Besides having limited access only for authorised persons, it is possible to apply relevant security techniques to enhance the security of PDAs in order to protect from interception or hackers. These security strategies include the
use of password protection, data encryption, virus protection software, identification and frequent backing up of data.

**Data accessibility and access authority**

The GSM faculty (n = 4) and educational technology specialists (n = 3) indicated what measures the GSM have to protect health information in relation to data accessibility and access authority in the clinical-log function. In terms of data accessibility, three major groups of people in the medical school are eligible to access the clinical-log data, these being (i) the logs’ owner, (ii) a group of nominated faculty members, and (iii) the educational technology specialists.

However, the participants stressed that there is limited access to clinical-log data. Firstly, students can only access their own clinical-log. Secondly, the nominated faculty members can access certain levels of clinical-log data for assessment purposes. Finally, the educational technology specialists are able to gain access to clinical-log data for maintenance and support.

“They shouldn’t access the others (others’ data) than…personal reflections. …there will still be de-identified…there should be no issue breach of privacy.”

IV03 (24.09.2007)

“…as they need to access the students’ progress and experiences in their clinical placements.”

IV10 (12.09.2007)

This finding is similar to the literature (section 3.2), in that only a group of the medical faculty, clerkship director or tutor are able to access students’ clinical-log data for assessment purposes. This authorised access allows them to monitor, investigate, comment and feedback on individual students’ experiences during their clinical rotations. It is essential for students to maintain security of their clinical-logs by not letting any unauthorised person access, complete or fill-out any data.
The security of using PDAs in the UOW PBL-medical curriculum is limited to a certain number of authorised people in accessing the online clinical-logs. Therefore password protection is the first and most essential security technique to protect the clinical-log function against unauthorised access.

**Who can access data**

The medical faculty (n = 4) and the educational technology specialists (n = 2) have a similar perception regarding information access to clinical-log data (who has access to clinical-log data, why and what data they can access).

“...only the students, academic members and staff have access to. ...nominating numbers of the faculty ...the clinical skill director ...the phase director ...senior academics and the school for the direct teaching, system director teaching. ...it is a well defined group of people.”

IV03 (24.09.2007)

There are three major reasons why the GSM faculty and the educational technology specialists are eligible to access the clinical-log data. Firstly, the GSM faculty need to access clinical-log data for monitoring students’ clinical experiences and skills for assessment purposes. Students would benefit by having the medical faculty or clinical preceptor provide feedback on their log. Secondly, clinical-log data would be valuable for further research (e.g. future evaluation and development of the curriculum). Therefore, the GSM is able to generate a high level report which summarises what clinical experiences and encounters were gained during their 4-years of medical study. Lastly, it is essential for the educational technology specialists to access both online clinical-logs for maintenance and support purposes, in case, students encounter technical difficulties. In addition, this group of educational technology specialists comes from the GSM rather than the central IT support unit. Therefore they know the requirements and concerns regarding the clinical-log function, as well as security and privacy concerns. Further they will also maintain patient confidentiality. Importantly, students
will be dispersed into clinical placements elsewhere in rural and regional areas, therefore it is essential to ensure that any problem that arises in relation to the PDA accessible clinical-log function should be solved with full maintenance and support from the GSM educational technology specialists. However, the primary purpose of having access authority to clinical-log data is essentially for assessment.

“...the students they have to have access to their own and obviously within the school. We do need to have the ability to have some levels of access. ...the faculty need to but somebody within the school may need to have the top level access.” IV09 (22.09.2007)

"...the students and a limited people have access to it. ...this will be secure and it need to be available to those who have granted to access.” IV12 (07.09.2007)

“The clinical-log is purely for the students…it is only need to be kept while the students are still a student at university ...some examples or some selected samples would need to be kept in case Australian Medical Council wanted to see what our students have been doing...” IV15 (15.09.2007)

“...the students and the relevant academics in the medical school and people who are access, have clinical assessment responsibility for the students, the educational technology people and the school and the assessment and data analysis within the school.” IV08 (16.09.2007)

This finding is similar to the literature (section 3.6) regarding the accessibility of clinical-logs whether there be paper-based or electronic. Different users –the clinical-log owner, the clinical preceptors and medical faculty members –would have different priorities in accessing students’ clinical-log for assessment purposes. However, other medical schools allow interns to access health information. It was stressed that a clinical-log is not a personal health record. It serves students for educational purposes rather than as a treatment record of patient.

Providing accessibility and authority for a particular group of faculty and educational technology team members would be beneficial for students in
learning medicine in a PBL-approach. Firstly, students are able to receive close supervision from the GSM faculty besides their clinical preceptors, even when they are away in the clinical placements from year-2 onwards. Secondly, it facilitates the development of competency-based outcomes in each clinical problem being encountered. Finally, students are able to receive appropriate maintenance and support if they have difficulty in using the clinical-log function from the GSM educational technology specialists. However, any technical support from the GSM educational technology specialists centres around the clinical-log function rather than hardware or software support for PDAs. On the other hand, one potential drawback is that students might feel reluctant to record their clinical experiences and reflections on their clinical-log if they know that the medical faculty would monitor them at all times.

**Disclosure: Data disclosure after graduation**

There were a small number of GSM faculty and educational technology specialists with concerns about methods of data disclosure after graduation, transfer and linkage of data after the disclosure process, and the accuracy of the data disclosure process. Table 8.4 summarises the number of the interview participants who commented on these three aspects.
Table 8.4 Number of cases coded regarding data disclosure after graduation from Nvivo

<table>
<thead>
<tr>
<th>Data disclosure after graduation</th>
<th>Number of case coded by cases in Nvivo</th>
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<tbody>
<tr>
<td></td>
<td>Honorary clinical academic</td>
</tr>
<tr>
<td>Methods of data disclosure</td>
<td>0</td>
</tr>
<tr>
<td>Transferring data between two locations</td>
<td>0</td>
</tr>
<tr>
<td>Accuracy of data disclosure process</td>
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</table>

Method of data disclosure after graduation

The GSM faculty (n = 3) and educational technology specialists (n = 2) commented on the method of data disclosure after graduation. The participants had a similar perception regarding data disclosure, which can be categorised into three general opinions.

Firstly, clinical-log data can be generally released by students without patient identifiers. For instance, students can release their clinical-log of experiences for future employment. Secondly, the medical school cannot disclose clinical-log information, which belongs to students without student consent. However, the medical school is allowed to use clinical-log information for research and evaluation of the medical curriculum for future development. Finally, it is possible to disclose clinical-log data in a high-level report rather than a detail report for the Australian Medical Council or the medical school research and evaluation purposes. This type of research would contain no specific information about patient records.

"…the GSM wouldn’t be distributing information … without our student consent. It may be distributed as a part of research… it will be de-identified the information from the students as well as from the individual. …information will be released by the student.” IV03 (24.09.2007)

"…if they disclose, it would be at the highest level aggregation. …no identification of individual patients …
The process of data disclosure essentially emphasises disclosing clinical-log information to anyone who is excluded from the process of medical education during 4-years of medical study. As a result, clinical-log data can be shared and discussed among peers, clinical preceptors and medical faculty members regarding the clinical experiences and encounters during the 4-years of medical study as part of the learning process.

“...the key policy is that no individual patient is kept in those ...even if some of the data would disclose to someone outside the organization, that person would not be able to identify who the actual patient was because the data that are kept are general...students may from time to time share some of the experiences with their clinical supervisors on placements, a typically clinical academics who are members of the university community and who need to abide by university’s policies...”

IV10 (12.09.2007)

These findings are similar to the literature (section 3.7) in that data can be disclosed only with the consent of an authorised person. Therefore, in order to disclose the data on students’ clinical-logs, it is necessary to seek student consent.

Accuracy of the data disclosure process

Only the GSM faculty (n = 1) commented on the accuracy of the data disclosure process. Data accuracy from the medical school’s perspective is to ensure that clinical-log data contains no patient’s identifiable information. Generally, the participant indicated that the clinical-log function has no data filed which would allow students to record patient identifiers. Therefore there are two issues regarding the accuracy of disclosing clinical-log data. Firstly,
data must contain no patient identifiable data. Secondly, the data must be up-to-date before disclosed.

In the case of recording data via online clinical-log, the data is automatically updated to the university’s database. On the other hand, if students record on the spreadsheet template, their clinical-log will be updated once the spreadsheet is uploaded to the university’s database.

"...any information that store is de-identified, therefore any release of that information to anyone contains no identify material. ...If the data fields don’t have any privacy data, there is no privacy data to hand-on (no health information)..." IV03 (24.09.2007)

This finding is similar to the literature (section 3.6) regarding data disclosure by maintaining data privacy. The accuracy of clinical-log data is ensured by students’ clinical-log on PDAs being synchronised back to the central server within an appropriate timeframe.

**Identifiers and anonymity: Privacy and anonymity of data**

In this aspect, the honorary clinical academics (n = 2), the GSM faculty (n = 6) and educational technology specialists (n = 3) strongly supported maintaining privacy of patient information. Also, the honorary clinical academics (n = 2), the GSM faculty (n = 3) and educational technology specialists (n = 3) indicated that anonymity is essential when dealing with patients, particularly when recording patient characteristics and clinical problems encountered.

The HRIPA generally focuses on who can access data in the case of recording identified data on clinical-logs or elsewhere. Using a clinical-log to record and reflect on clinical experiences being encountered for self-assessment and cross-reference, the data being recorded on clinical-log function must be de-identified. On the other hand, if any patient identifier is recorded on any part of the clinical-log or elsewhere, then students, the GSM
and the university would need to directly involve the HRIPA act. Therefore in this case, patients are able to view their data. As a result, students have to obtain consent from patients before recording or using such data in any way and for any purpose.

Thus, privacy and anonymity of data essentially emphasises that any data being recorded on a clinical-log or elsewhere must not be identifiable by any means (section 7.1.1).

“...it is a whole awareness upon what confidentiality and how that is protected on all sort of levels, whether it is a verbal communication or written communication or electronic communication.” IV14 (18.10.2007)

Further, de-identified data can easily become identified information without recording any patient identifier. For example, in recording a rare medical condition found in particular areas with particular patient characteristics, it would be easy to identify who the patient is. In such cases, it is important for students to make a judgement whether recording patient characteristics is compulsory for their self-assessment, whether it would be possible to omit some general characteristics by not recording them, but still reflect on their clinical experiences. Data security techniques and programming techniques can be applied when developing and implementing the data field and user interface of a PDA accessible clinical-log particularly for a technical prevention. However it needs to practice with professional practice and conduct, otherwise this aspect would be an ideal solution.

“...it is identified data or unidentified data. ...If you are nearly a hundred years old... If you are in Coniston, who are males...ethnic background...Macedonians?” ...it is not possible to be de-identified that kind of data.... That is not anonymous.” IV01 (21.09.2007)

The findings on privacy and anonymity generally agree with the literature (section 3.6). Using a clinical-log to recorded clinical experiences and encounters is essentially similar to other medical schools, whether using
paper-based or electronic-logs. Therefore any information being recorded or discussed must remain anonymous.

**Transfer and linkage: Transferring information between two locations**

Transfer and linkage of data to other locations (after graduation), the GSM faculty (n = 1) and the educational technology specialist (n = 1) indicated that it is the responsibility of students for their data and usage. In addition, the students’ clinical-log data contains no identifiable information of patients, therefore there should be no issues related to the privacy legislation.

“... they can have the ability to print that off... transfer to Excel spreadsheet, which have no privacy information so they must be the students’ responsibility to distribute it.”

IV03 (24.09.2007)

This finding is similar to the literature (section 3.7) with regard to privacy of patient information, namely that clinical-log data must only contain de-identified patient information. However it is possible to attach the policy of using clinical-log information every time when data is transferred to a third-party elsewhere. This allows the third-party to be aware of what they can or cannot make use of with such clinical-log data. In case of transferring any sensitive data, additional data security approaches can be applied when transmitting data, for instance, data encryption techniques, WEP, etc. This allows clinical-log data to have less privileges when being transferred to other users.

**Data disposal**

The participants had a similar perception on data disposal. The data disposal includes both paper-based and electronic information on the clinical-log. Therefore in order to dispose of any unused clinical-log data, it is essential to ensure that data is disposed in a safe bin or completely deleted from computers or PDAs without resurrection.
“...if it is paper-based, throw to a secured document disposal facility that the university provides. ...As well as electronic information goes...until something is overwritten or all the disks is formatted.”

IV13 (13.09.2007)

Generally, clinical-log data is a valuable asset for both students and the medical school for future use whether for students’ future employment, further research, curriculum evaluation and development, as discussed earlier. If the medical school wants to remove any electronic data from the university database, it must be completely removed from the system.

“...they would keep it longer. ...there might be a reason to keep it indefinitely.  

IV08 (16.09.2007)

“Currently, we haven’t disposed of any. It would need to be done in a way that didn’t leave anything behind...that would be really up to ITS to do and for us to supervise. ...ITS would have processes in place...”

IV10 (12.09.2007)

This finding differs slightly from the literature, as students are free to edit, append or modify their clinical-log contents into multiple versions. As a result, the clinical-log function would not allow students to remove or delete any existing data in the log. From a researchers’ perspective, any unwanted data on the clinical-log must be disposed for information privacy purposes, even though it contains no identified information, but just a record of students’ clinical experiences. Therefore data needs to be disposed of properly. On the other hand, in terms of storing clinical-log data on the university’s database server over a long period for future use, secure data storage becomes an issue.

The literature regarding data disposal of clinical-log records (section 3.2) indicates that clinical-log data has to be stored in the system for a minimum 5-years before being disposed of. However, this regulation would depend on each medical school and the purpose of using clinical-log data. Further, it has been mentioned in the literature (section 3.2) that it is possible to apply the
use of a PDA accessible clinical-log at the GSM so that students have the right to modify their clinical-log data, and their modifications will be recorded in different versions on the database server. It is possible that students not be allowed to directly delete their clinical-log data. On the other hand, all clinical-log records are maintained by the university’s IT unit. In case the university wants to dispose clinical-log data, this can be done by the IT unit.

**Professional conduct on practicing medicine**

According to Table 8.2, three groups of interview participants have a similar perception that professional conduct on practicing medicine in one is another concern regarding the HRIPA. Within this aspect, the GSM faculty members (n = 4) strongly supported that a professional conduct can be put into practice whether learning medicine with or without using IT to facilitate medical study. Having a good foundation in learning medicine would lead to a good medical practitioner.

"You shouldn’t talk about the patient or enter the data into the keyboard about the patient (patient’s identifiers), then walk away with that data from the practice without the practice knowing is that what’s going on."

IV01 (21.09.2007)

"...it is a whole awareness upon what confidentiality and how that is protected on all sort of levels whether it is a verbal communication or written communication or electronic communication...never viewing a confidential information about somebody else. ...aware at every moment that you are dealing with personal and confidential information and respect that."

IV14 (18.10.2007)

During their 4-years program, it is essential for students to demonstrate responsibility on patient information and have a good discipline in ethical principles. In professional practice and conduct, students should be able to demonstrate ongoing professional development, including history taking,
physical examination, maintaining professional ethics on privacy, and confidentiality of patient information. The aspect on professional practice and conduct are embedded in clinical activities that students encounter in the clinical placements, whether online, offline, verbal, non-verbal, direct or indirect communication.

These findings are similar to the literature (section 3.7), as medicine cannot be practiced without having a good foundation of professional conduct. It cannot instantly be gained from the use of technology, but rather from personal development in the medical profession.

In summary, a PDA accessible clinical-log can be used in any clinical placement where a network connection is available. In this way, a clinical-log function can be provided in a common web browser without installing an additional software application on the PDA. This enables high portability and direct deployment of the clinical-log function for all students only with an implementation on security and privacy protection for accessing this function.

Therefore, it is essential for each user to have a unique identifier and level of data access based on the individual’s authorisation in different groups, including students, the GSM faculty and educational technology specialists. Therefore each user needs to log-on and log-off when starting or terminating their clinical-log session.

In order to protect clinical-log data against unauthorised access, data security protocols with data encryption and decryption should be applied. There are five aspects to be considered in order to secure PDA devices and data privacy. Theses aspects are (i) do not leave PDAs unattended; (ii) apply password protection for PDA devices; (iii) data encryption techniques are recommend in case of storing or transmitting sensitive data; (iv) carefully use wireless connectivity as unauthorised people can access PDAs via wireless
connectivity; and (v) be careful on downloading software or resources, as the software applications might be hidden with viruses or programs that intend to steal users’ personal information or password.

These data security mechanisms not only assist in protecting data from unauthorised access, but also in providing confidentiality and privacy of data. Therefore, the use of a PDA accessible clinical-log on web-based technology with data security and privacy protection would ensure security in recording, storing and accessing clinical-log data to all students and any authorised users from the medical school.

8.1.2 Data transmission and network connectivity

Data transmission and network connectivity are the second most important aspect besides data security and information privacy, as it facilitates students in successfully using the four-basic functions, in particular the clinical-log function. Therefore an appropriate type of data transmission and network connectivity for each particular area must be considered before incorporating PDAs into the UOW PBL-medical curriculum.

The findings on data transmission and network connectivity essentially focus on two major aspects, these being (i) how data can be transmitted on web-based clinical-log on a PDA; and (ii) how often students have to update their clinical-log data.

How data can be transmitted to PDA accessible clinical-log

The participants reflected on what possible network connectivity can be used in both covered- and uncovered-networks. Two possible communication channels were mentioned, including wired- and wireless-medium for covered-network. Wired-communication channels are preferred for uncovered-networks. Table 8.5 reports the preferences of using particular
network connectivity for each area, which were ranked based on *coding references* from Nvivo.

**Table 8. 5** Number of *coding references* regarding network connectivity for ‘on-campus’ and ‘off-campus’ from Nvivo

<table>
<thead>
<tr>
<th>Network connectivity</th>
<th>Number of coding references in Nvivo</th>
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<tbody>
<tr>
<td></td>
<td>Honorary clinical academic</td>
</tr>
<tr>
<td>On-campus</td>
<td></td>
</tr>
<tr>
<td>Wi-Fi</td>
<td>0</td>
</tr>
<tr>
<td>Bluetooth</td>
<td>0</td>
</tr>
<tr>
<td>Off-campus</td>
<td></td>
</tr>
<tr>
<td>Wi-Fi</td>
<td>0</td>
</tr>
<tr>
<td>connect via docking station</td>
<td>0</td>
</tr>
<tr>
<td>Uncovered-network</td>
<td>0</td>
</tr>
</tbody>
</table>

The findings indicate that Wi-Fi is the preferable network connectivity for on-campus and off-campus environments. On one hand, Bluetooth could be used only on-campus due to the strength of its signal, while connectivity via a docking station is preferred in off-campus environments. The detailed findings are reported and discussed in the follow sections.

**Data transmission for ‘covered-network’**

**On-campus environment**

The GSM faculty (n = 3) and educational technology specialist (n = 2) commented on the appropriate *network connectivity* to transmit information (e.g. class-material) to students’ PDAs that provides ease of maintaining and implementing while other interview participants commented on other aspects as they were aware that they were unqualified to comment on technical
aspects. There are two-types of network connectivity for students to use PDAs when on-campus, these being Wi-Fi and Bluetooth.

**Wi-Fi**

The GSM faculty (n = 3) and educational technology specialists (n = 2) indicated that they preferred students to use Wi-Fi rather than Bluetooth or infrared connectivity. The reason is that the Wi-Fi signal is much stronger than other types of connectivity. Moreover it allows PDAs to access information easier than other connectivity. There are a number of hotspots where students can use PDAs around the campus.

“...Wi-Fi would be the better way to go. ...Both infrared and Bluetooth have range problems...how close you should be. ...some of the new PDAs don’t have infrared ...some of them are using Wi-Fi only rather than Bluetooth.” IV09 (22.09.2007)

“...Bluetooth and Infrared might be problematic. ...Wi-Fi would probably be the easiest ...because we just provide everything through the web ...the students can look at stuff from the desktop, laptop or the PDA. It doesn’t matter we are just providing the same thing, the same way.” IV10 (12.09.2007)

This finding is similar to the literature (section 3.6) regarding using Wi-Fi for on-campus environments. Wireless access with Wi-Fi and wireless access points should been incorporated in the campus environment, which would allow students to access resources and participate in classroom activities via PDAs. This would provide students with an alternative in accessing information and resources on-campus besides using computers or laptops.

Moreover, it is possible to develop relevant software applications that would facilitate students in learning medicine in the UOW PBL-medical curriculum. Therefore PDAs can be utilised to their optimum in a PBL-medical curriculum.
Bluetooth

The Educational technology specialist indicated that Bluetooth connectivity is applicable to use only in classroom environments where the medical faculty and students can share information together over a short distance.

“Bluetooth might be an option in a sense that we could use within the room. We could have at the lecture theatre or tutorial room that might work.” IV10 (12.09.2007)

In comparison to the literature (section 3.6 and section 3.7), Bluetooth has been used with PDAs for sending and receiving appointments, reminders and personal contacts. To date there is no literature that indicates that Bluetooth can be used for accessing information and resources in medical education. However, other wireless connectivity, for instance, Infrared and EthIR LAN, which is independent of PDA hardware and software platform, has been incorporated as network connectivity in classroom environments. Using other wireless connectivity besides Wi-Fi would be less convenient due to the short-range of signals. Further there are three major-criteria to be considered for selecting appropriate network connectivity for on-campus environments, namely (i) security, (ii) simplicity in terms of implementation and (iii) speed of data transmission. On the other hand, syncing PDAs with a wired connection or PDA docking station would be an alternative connectivity that students could use for their personal purpose, as different students may use different models of PDA. As a result, it may not be possible that the medical school could provide a synching operation for all types of PDAs.

Off-campus

For appropriate data transmission methods in different environments, in particular off-campus, clinical settings, hospitals in both urban and city areas, the GSM faculty (n = 5) and educational technology specialists (n = 2) have two distinct perceptions regarding this aspect. They commented on using (i)
Wi-Fi and (ii) syncing operation via a docking station for off-campus network connectivity.

Wi-Fi
The GSM faculty (n = 3) and educational technology specialist (n = 1) had a similar perception that wireless connectivity with Wi-Fi would be more applicable for off-campus environments, in particular clinical placements, while other types of network connectivity could be applied in case of encountering difficulties in connecting to wireless networks or wireless access points.

"In hospital, I would be careful about doing any data transmission because the number of other resources that could be interfered with. ...if you won’t have a PDA, you could put into fly-mode that actually takes-off to switch-off from the transmission. ...primarily one, Wi-Fi is going to be the better way to go. ...Wi-Fi is much better in my understanding for broad log-in and transmission with Bluetooth is more on one-on-one log-in to a laptop kind of thing. ...”

IV09 (22.09.2007)

"...it would be good if it had wireless access but it adds costs to buying it and we do need to appreciate that we will be working in rural settings in Australia, where the Internet access, wireless-access, is not equitable. That is a big issue...in the current protocol, environment that they are talking about, the equity of access for regional rural people, same as in city.”

IV12 (07.09.2007)

This finding is similar to the literature (section 3.6), in that there are a number of medical schools that use Wi-Fi as a wireless network connection for off-campus environments, in particular in hospitals and clinical settings.

Having Internet connectivity while offsite is an essential element for the incorporation of PDAs into the UOW PBL-medical curriculum. This is because all four-basic PDA functionalities cannot be used to their optimum without having Internet connectivity.
As a result, wireless network connectivity via Wi-Fi becomes preferable for connecting PDAs to the Internet. There are a number of reasons why Wi-Fi is preferred for the network connectivity whether students use PDAs on-campus or off-campus. Firstly, it provides convenience for accessing data anywhere and anytime where wireless access points are available. Secondly, using Wi-Fi allows students to immediately record their clinical-log online without having to record on a spreadsheet template and upload it later after connecting to the Internet. Thirdly, using Wi-Fi also provides students with a convenient way of accessing online references, school timetables and other relevant information while offsite or in clinical placements. Finally, it provides an opportunity for students to communicate by paging, emailing, web-blogs or other communication tools with peers, clinical preceptors or the GSM faculty. However using Wi-Fi in off-campus environments is only applicable where there is a wireless access point available. Therefore wired connectivity (docking station) is also compulsory for off-campus connectivity.

**Network connectivity via a docking station**

The other GSM faculty (n = 2) indicated that using a docking station as an alternative tool for network connectivity is still recommended in case Wi-Fi connectivity is unavailable.

“...the simplest is the computers where the students are working... need to give them access to the server and the Internet ... if the PDA just plugs into that computer, if that is already a network then they will be automatically network (connection). ...if we are not going wireless, we need to make sure that they have access to a network computer and then simply put in the PDA into that. I am not convince yet that all of Australia, rural area has a reliable network.”  

IV12 (07.09.2007)

This finding is similar to the literature (section 3.6) in terms of off-campus network connectivity. There are a number of medical schools that use both
wired and wireless connectivity for data synchronisation and data transmission while students are off- or on-campus.

According to this study, having network connectivity through a PDA docking station would be beneficial for students to upload their clinical-log data onto the web, as students may record on a spreadsheet template in case wireless internet connectivity is unavailable. On the other hand, students cannot immediately access online resources via their PDAs at the bedside.

However, there are a number of possible reasons why a PDA docking station could be used as an alternative for network connectivity. Firstly, Wi-Fi connectivity may not be available at all places while off-campus. Secondly, it is also possible that there is a restriction on using Wi-Fi at a certain area in the hospital or clinical placement, therefore transferring clinical-log data to online clinical-logs could be done via the PDA docking station. Finally, using hotspot for Wi-Fi connectivity is not always free of charge in some places, therefore HotSync would be an alternative to transfer data over the Internet via a network computer. However, the students would not have the benefits on this type of network connectivity if they need to immediately access online resources while in clinical placements. Moreover, they can use HotSync via a PDA docking station for back up purposes and transfer data between PDA and a computer.

**Data transmission for ‘uncovered-network’**

For the appropriate type of network connectivity between wired or wireless connectivity for PDA use in *un-covered network areas*, the GSM faculty (n = 2) and educational technology specialist (n = 1) had a similar perception about acquiring either wired or wireless connectivity (or both), if applicable.

"...that will have to be just over the Internet...either wirelessly. ...if it is ‘un-covered’ by the university network off-site, then that would have to be Internet...Telstra or
“you couldn’t have wireless connectivity in an area without coverage. we are hoping to have (wireless connectivity) when students are away on placements. we are hoping to have hubs linking...with general practice divisions that students can from time to time coming and we would hope that we can have some reasonable network connectivity to provide them there. ...even though, they cannot access a wireless network like NextG from Telstra, they can at least come here every now and then and have some access there.”  

IV10 (12.09.2007)

Generally, other medical schools use either wired or wireless connectivity while offsite or during clinical rotation, for instance, Wi-Fi, wireless LAN, Ethernet Infrared or VPN. However the cost of implementing and establishing a VPN in a number of clinical placements would be very high. As a result it may not be possible to implement for all locations as students will be dispersed into different clinical placements in various locations.

However, in case students use a PDA phone, they can connect to the Internet via their mobile phone connectivity. This would allow them to have online access to PDA accessible clinical-logs and other online resources, even though there is no Wi-Fi connectivity.

On the other hand, if using PDAs without a mobile phone function, then it is possible for students to have Internet connectivity via the internet connection in a GP’s office. Otherwise, students would need to use their PDA docking station for data transmission, as previously mentioned.

**Strategy for network connectivity in uncovered-network areas**

The GSM faculty (n = 4) and educational technology specialist (n = 1) reflected on the strategy for connecting PDAs in *uncovered-network areas* with different perceptions for the possible alternatives of using PDAs in the clinical placement elsewhere in regional areas.
“If they are not using Wi-Fi, you can always go through mobile Internet. ...it would be important to have PDA that had 3G connectivity as a Internet and mobile phone as well so they could do that. If all those fail, waits til we get back. ... If they are away.”  IV09 (22.09.2007)

“...it would have to be completely wireless-based ...it would be certainly in a hospital, automatically they would have a wireless connectivity there. ...certainly any of the hospital, they should be able to get wireless connection ...as many places as possible. Wherever this is not possible, obviously you have to get some sort of hooking to ISDN or cables or something.”  IV11 (09.09.2007)

This finding is similar to the literature (section 3.6) regarding other types of network connectivity besides Wi-Fi or HotSync. To date, the literature rarely mentions using 3G technology via mobile devices as the Internet connectivity for PDA use in medical education.

Generally, in using PDAs without mobile phone technology it is possible to establish network connectivity via four types of connectivity, namely Wi-Fi, HotSync, Bluetooth and Infrared connection. In the case of uncovered-network areas, students would need to rely on syncing operations via a PDA docking station that would allow them to transfer data from PDAs to computers and also upload or download data over the Internet.

On the other hand, using PDAs with mobile phone capacity or 3G technology is beneficial for students in connecting to the Internet via these technologies. However, the worst case is that students may have clinical encounters in regional or rural areas where 3G or mobile phone coverage is unavailable. Then they need to have Internet connectivity via HotSync or PDA docking station.

The educational technology specialist (n = 1) raised one aspect regarding other critical/significant technical considerations for the incorporation of PDAs into the UOW PBL-medical curriculum. They stressed that students
may prefer to use laptop computers rather than PDAs, as the majority of students already own laptop computers.

“...they (students) may use their laptop to access resources then they synchronize with their PDA, they might do it through there.”

The finding indicated that the GSM faculty and educational technology specialists have different attitudes toward PDA use. It is possibly because of the culture of using technology is perceived differently in these two groups. The GSM faculty would like the students use PDAs for recording and accessing information at anywhere and anytime. On the other hand, the other group aware that the students can use the alternative devices (besides PDAs) for such activities. However they might not gain the absolute just-in-time for information access especially while they are in the clinical placements.

To date the medical school has yet to introduce or incorporate PDAs into the UOW PBL medical curriculum. Therefore there are a number of students who currently use laptop computers. Generally, laptop or desktop computers are widely used around campus by all students in any faculty. In the future, if the GSM formally introduces the actual use of PDAs in the UOW PBL-medical curriculum, then it is possible that a number of students would use PDAs as an alternative learning tool to facilitate their medical study. To date there are not many PDA functionalities which directly support medical education using the UOW PBL-approach besides an information access function.

However, there is the potential that students may prefer to use PDAs or equivalent mobile technology devices if there are sufficient resources for them to use for a PBL-medical curriculum, for instance, whether for class activities, taking tests or accessing information in on- or off-campus environments.
How often do students update their clinical-log?

The following sections report and discuss the interview findings regarding how often clinical-log data needs to be updated to the university’s server, what the appropriate strategies for updating data from students’ PDAs to the university’s database server, how it is possible to have PDA-based real-time data collection, and what factors the medical school needs to consider for PDA-based real-time data collection.

How often to update clinical-log data

The honorary clinical academics (n = 1), the GSM faculty members (n = 4) and educational technology specialists (n = 4) had different viewpoints regarding how often the data on PDAs needs to be synchronised to the university’s database server after students record onto their clinical-log. The perceptions and opinions of the interview participants reflected their experiences and position towards medical education. Three groups of participants commented on this aspect in a similar manner.

The honorary clinical academics indicated that the frequency of synchronising clinical-log data to the university’s database server would directly depend on how often the medical school wants to track students’ clinical experiences and encounters.

“If there is an arrangement that their log is going to be viewed by their teacher, perhaps to have it synchronised in real time for that to take place but I don’t think they are going to update on a daily basis. Twice a term...the frequency of data synchronization depends upon why that needs to happen.” IV05 (30.09.2007)

On the other hand, the GSM faculty and educational technology specialists stressed that clinical-log data should be updated to the university’s database server as often as it can be. Clinical-log data should be updated on a daily or weekly basis in order to prevent any loss, damage or technical failure of data.
“...that will depend on which model of synchronization we are going with. ...it will be updated and synched once a day at the end of the day. Again, if it is a wireless sync, it does the issue (job). You load it and press enter”

IV03 (24.09.2007)

“...when we get to the point where the students are on the clinical placement everyday...they (students) are required to review and report the next day of what happened this day...it needs to happen daily. Depending on what years it is, it could be different. If there is something that happened automatically then I would say it should happen daily.”

IV07 (03.09.2007)

The findings are partly similar to the literature (section 3.6), as there are some factors which would affect how often clinical-log data needs to be updated to the university’s database. There are a number of medical schools that use real-time updating of data on clinical-log, while other medical schools encourage students to update data on a weekly basis. These would directly depend on what tool that clinical-log was developed and implemented.

In terms of the UOW PDA accessible clinical-log, the medical school plans to implement clinical-logs on web-based technology that does not require data synchronisation if students can connect to the Internet while recording their clinical experiences onto their log. On the other hand, working on clinical-logs in uncovered-network areas, students would need to record their clinical experiences on the spreadsheet template file and then later upload this file to their online clinical-log at the end of the day.

The idea of using online clinical-logs are, firstly, to protect students from storing clinical-log data on PDA devices in order to prevent the loss of data; and, secondly, the GSM faculty can keep track and monitor students’ progress at any time, as all clinical-log data are kept, managed and maintained on the central database server at the university.
Possible and appropriate strategies for data synchronisation

The GSM faculty (n = 3) and educational technology specialists (n = 3) reflected on the appropriate data synchronisation strategies for the clinical-log function between real-time and non real-time data synchronisation with similar perceptions.

“...wireless would be much easier. Certainly, we have got wireless support here (Shoalhaven campus) and Wollongong and students are currently using wireless for the laptops. ...the docking station is too hard because you need to have something with consistence for all PDAs. ...wireless is a better way to go.” IV09 (22.09.2007)

“...real-time would be good. Wireless real-time update.” IV02 (28.09.2007)

This finding is slightly similar to the literature (section 3.6); a number of medical schools elsewhere use either wired or wireless data synchronisation, or both. Appropriate strategies for data synchronisation would directly depend on two factors, namely (i) the availability of network connectivity and (ii) the characteristics of the clinical-log function on PDAs.

For the GSM, a PDA-based clinical-log is not a system which is directly designed and implemented to be installed and run on PDAs. On the other hand, a clinical-log is a function which would be developed and implemented by using web-programming and then used on a web-based interface. Therefore clinical-log data would be directly updated and recorded on the university’s database once students logon to their online clinical-log. In order to perform this function effectively, PDAs need to wirelessly connect to online clinical-logs.

Aspects to be considered for PDA-based real-time data collection

In terms of how it is possible to implement PDA-based real-time data collection, the honorary clinical academic (n = 1), GSM faculty (n = 5) and educational technology specialists (n = 3) indicated a number of factors that
need to be considered. Each aspect is coded and prioritised by number of coding references (Table 8.6).

Table 8.6 Number of coding references regarding aspects to be considered for PDA-based real-time data collection from Nvivo

<table>
<thead>
<tr>
<th>Aspects to be considered for PDA-based real-time data collection</th>
<th>Number of coding references by cases in Nvivo</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Honorary clinical academic</td>
</tr>
<tr>
<td>Reflection period</td>
<td>0</td>
</tr>
<tr>
<td>Cost</td>
<td>0</td>
</tr>
<tr>
<td>Acceptance of community</td>
<td>1</td>
</tr>
<tr>
<td>Network coverage</td>
<td>0</td>
</tr>
</tbody>
</table>

The three most important concerns are time spent for reflection, cost of implementing real-time data collection, and community acceptance. Details are reported below.

Reflection period (time spent for reflection period)

According to the interview participants, the reflection period is an appropriate duration that allows students to record and reflect upon clinical experiences they encounter. The GSM faculty (n = 3) and educational technology specialist (n = 1) were concerned that real-time data collection would only allow students to record and reflect on their clinical experiences in very short periods. In addition, real-time data collection might obstruct communication between students and patients, as well as ability to synthesise clinical problems being encountered.

“...the biggest issue is getting them to record that data because we cannot evaluate the use of data, evaluate the activity unless it is complete. ...they must have a way to
quickly record what they. We need to allow time at the end of the placement where they can do that as part of the placement and not do it in their own time, at the end of the day. ...we need to decide if we want them to do evidence-based practice or to reflect on what they find immediately, like in real-time but not later on, so reflection in action rather than after action. We should get the access either on the PDA, where the log is collected to data sources or access to the Internet so they can look that up.”

IV12 (07.09.2007)

"...real-time is important because I’m a bit concerned if the students don’t try to collect information as close to the actual patient encounter as possible, they may forget or not have time to transcribe a written note into a PDA. ...it needs to happen as closely as possible, not during the patient encounter but at least immediately following.”

IV08 (16.09.2007)

This finding is different from the literature (section 3.6), as there are a number of medical schools use non real-time for clinical-log function. However, there are some medical schools, which use a real-time data collection for certain functions on PDA, for instance, real-time assessment for classroom teaching and real-time feedback for PDA-based clinical-log. It is the fact that PDA-based clinical-logs from the literature allow students to update their clinical-log data to central database server at the university in weekly basis. Once students logon to the online clinical-log, they are able to provide real-time feedback for the progress of clerkship via PDA devices.

Therefore having PDA-based real-time data collection for the clinical-log function would be an ideal function if students have to immediately record and reflect on their clinical experiences without carefully thinking through, as personal reflection is an important element in learning medicine in a PBL-approach. It allows students to make a clinical judgement based on what they have learned in real clinical problems they encounter.

However, PDA-based real-time data collection could be applicable and appropriate only if working on PDA-function which requires an immediate
response or feedback from students, for instance, classroom interaction or taking-tests.

Cost

The GSM faculty (n = 2) and educational technology specialist (n = 1) had a similar perception that cost and financial implications would be factors to consider for implementing PDA-based real-time data collection for the clinical-log function.

“...to make sure that IT is in place. ...then we are going to have wireless connections and then there is a whole cost issue. Is it going to be part of the course?, Shouldn’t we ask students to buy it? Should we provide it? So, it is a whole funding thing.”

IV03 (24.09.2007)

“...there are a couple of things we need to consider. ...obviously the cost of the device, the functionalities of the device we use and the acceptability of the students. We have to find the balance between what the best machine is and what is the one that students can afford.”

IV09 (22.09.2007)

This finding is similar to the literature (section 3.3, 3.4 and 3.6-3.8) regarding cost of developing, implementing and deploying PDAs into medical education. The cost of establishing real-time data collection would involve the development and implementation of the right systems which support real-time data collection, then the cost of the network facility to keep the systems alive.

Therefore, real-time data collection for clinical-log function may be unnecessary for three major reasons. Firstly, students have access to online clinical-logs via their PDA. This feature of online clinical-log allows students to directly record, update and reflect to clinical experiences on their clinical-log. Secondly, students can record their personal reflections regarding clinical experiences and encounters at any time when logged onto their web-based clinical-log via their PDA. Lastly, their reflections on clinical
experiences would be more effective if an appropriate reflection timeframe is available for students to think through and reflect upon.

**Acceptance by the community**

The honorary clinical academic (n = 1) and the GSM faculty (n = 2) worried that using PDAs in clinical placement may distract patient consultation and patients’ rest time.

“...we also have got to make sure that it (PDA) does not actually distract the students from the clinical experience. ... if you don’t do it well, it can actually really take away from the communication (between student and patient). ...we need to teach the students to use PDAs so they are not intrusive and they don’t take away from the students that they are communicating with the patient...”

IV09 (22.09.2007)

This finding is similar to the literature (section 3.7) regarding social acceptance about using PDAs in clinical placements. However, using PDA-based real-time data collection would directly affect the acceptance of patients in the clinical placements.

A PDA accessible clinical-log function is a tool to facilitate students in capturing their clinical experiences. However the most important part of having clinical encounters is the ability of students to synthesise, contextualise and reflect upon the clinical experiences they encountered. Therefore this process does not need to be real-time in front of the patient if it distracts students from communicating with patients.

**Network coverage**

The educational technology specialist (n = 1) indicated that having PDA-based real-time data collection is necessary to ensure that there is always network-coverage at every clinical placement.
The finding is similar to the literature (section 3.6), namely that PDA-based real-time data collection could be done unless there is no network connectivity available (especially wireless). This would lead to cost implications.

8.1.3 Systems maintenance and support for PDA and its functions

Maintenance and support for PDAs and their four-basic functionalities, particularly the clinical-log, is the third most important aspect to be considered before incorporating PDAs into the UOW PBL-medical curriculum. Table 8.7 reports the number of coding references based on 15-interviews. The GSM faculty and educational technology specialists are the major groups who reflected on this aspect. On the other hand, only a small number of honorary clinical academic reflected on this aspect, as maintenance and support are more the concern of the medical school and the university.
Table 8.7 Number of coding references regarding maintenance and support from Nvivo

<table>
<thead>
<tr>
<th>Maintenance and support for PDA and its functions</th>
<th>Number of coding references by cases in Nvivo</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Honorary clinical academic</td>
</tr>
<tr>
<td>Maintenance and support for PDA</td>
<td>0</td>
</tr>
<tr>
<td>In-house support</td>
<td>0</td>
</tr>
<tr>
<td>Central support</td>
<td>0</td>
</tr>
<tr>
<td>Hardware support</td>
<td>0</td>
</tr>
<tr>
<td>Software support</td>
<td>0</td>
</tr>
<tr>
<td>Maintenance and problem solving with clinical-log function PDA and database server</td>
<td>1</td>
</tr>
<tr>
<td>PDA applications and troubleshooting</td>
<td>0</td>
</tr>
<tr>
<td>Backup and recovery plan</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>0</td>
</tr>
</tbody>
</table>

The findings reported on several aspects in relation to maintenance and support, including how the GSM plans maintenance and support for PDA functionalities, who maintains the PDA server and database server for the PDA accessible clinical-log function, troubleshooting regarding PDA functionalities, and backup plan for clinical-log data.

**How the GSM plans for systems maintenance and support, in particular for PDAs**

The GSM faculty (n = 4) and educational technology specialists (n = 3) reflected on how the medical school plans to provide technical support for solving problems related to clinical-logs and other related software applications for PDAs. The maintenance and support plan for PDA devices and their functionalities can be categorised into three major aspects, these being (i) *internal support by the GSM* and (ii) *central support by the*
university’s central IT unit, and (iii) the Centre for Education Development and Interactive Resources (CEDIR), while there would be limited and restricted maintenance and support of hardware-software for each student’s PDA. This is because different students may use different types of PDAs for their medical study. Further, the participants had a similar perception regarding these three aspects.

In-house support

The GSM (n = 3) and educational technology specialists (n = 2) had a similar perception, namely that certain maintenance and support regarding specific PDA applications and database management for the clinical-log function should be provided by in-house support within the GSM.

However, such maintenance and support is still a collaboration between the GSM and the university IT units. For instance, the maintenance and support for general software applications and specific software applications for PDAs in medical education are collaborations between the university’s central IT unit and the GSM.

“...we really need to provide direct support for the interfacing and any support with respect to the PDA itself...that would be only in terms of instructions on how to use the particular programs that we are asking them to use. ...The servers themselves will be managed and maintained by IT Services within the university.”

IV13 (13.09.2007)

“...those decisions about how to set up a team or how to set up a support system need to involve the people that understand the technology, understand the uses.”

IV07 (03.09.2007)

“...if it is a software issue, it would be the school or university who is responsible for that. If the school puts some kind of programs and provides the students with PDAs then there has to be some kind of a service agreement. I don’t think that the university staff or GSM staff are in a position to provide the maintenance and
This finding is similar to the literature (section 3.7) in terms of providing maintenance and support by experts in a particular area.

For the GSM, in-house maintenance and support are essentially for the four basic PDA functionalities in relation to medical education, and tend to be directly provided for students and medical faculty by the in-house educational technology specialists rather than the university’s central IT staff. This is because the educational technology specialists are a group of people who will collaborate with CEDIR in developing and implementing the PDA accessible clinical-log function. Therefore technical support from in-house experts is especially important, as they are keen with (i) the use of this function, (ii) basic requirements, (iii) security and privacy protection, and (iv) flow of information within this functionality.

**Hardware-software support**

The GSM faculty (n = 3) and educational technology specialists (n = 3) indicated that the medical school would provide no maintenance for PDA devices, and limited support for problems in relation to software applications for PDAs. This is because the medical school would not require students to use a certain type or model of PDA for their PBL-medical education. As a result, it is possible that a number of students may use different types of PDAs. Therefore providing direct maintenance and support for all students’ PDAs is not possible for the GSM. On the other hand, the hardware support for PDAs should be directly served by the PDA manufacturers.

In terms of software support, the university has a central IT unit and several local IT units which are located in several schools - including the GSM - in the university. Therefore the support for software applications will be provided by both in-house IT unit on behalf of the university’s central IT
unit, for instance, software installation, any problems with software installation or license renewal. In addition, the GSM in-house IT unit can only provide maintenance, support and training on any application which is developed and implemented by the GSM, but not for other commercial software applications for medical education. Therefore support of medical software applications would depend on contracts or agreements between the software vendors and the university.

“...servers and the software that we are using will be supported by our own technical staff and then the GSM.”
IV13 (13.09.2007)

“...it is up to the students to choose to have and therefore we couldn’t provide direct support for all of our students. ...we would want to fix it then we aren’t be able to provide direct access, direct support to all of our students with all the different PDA devices that they may have.”
IV10 (12.09.2007)

This finding is similar to the literature (section 3.7) in relation to the maintenance and support given by local experts within medical schools in terms of resources, information and guidelines - related to custom PDA functionalities for medical education, for both students and faculty members. It is also possible for the GSM and educational technology specialists to provide a PDA resources web-portal for a PBL-medical education, and other useful software applications on the schools websites. This would facilitate students in acquiring self-support besides the direct support which would be provided by the GSM.

Central support

The GSM faculty (n = 2) and educational technology specialist (n = 1) indicated that central support would be served by the university’s central IT unit. The maintenance and support which would be provided by the university’s central IT unit is database server for PDA accessible clinical-log, software application distribution and management, data transmission, and
network connectivity. As mentioned in the previous sections (9.1.1 and 8.1.2), the university’s central IT unit would provide network facilities and database servers for storing clinical-log data. All clinical-log data would be stored on the central IT unit; however, database management and support of clinical-log data would be directly maintained by the authorised educational technology specialists from the GSM only.

“That would be ITS (the university’s central IT unit). …we need to see how big the need is. If they can be managed in-house then…moving over to ITS as part of their services to us.”

IV03 (24.09.2007)

This finding is somewhat similar to the literature (section 3.7), in that the PDA functions and applications developed by the schools can be maintained and supported by either in-house or central supported from the universities. Generally, maintenance and support are collaborations from different departments or units within the university. For instance, there are a number of medical and nursing schools which provide direct maintenance and support by themselves, in the case where the PDA applications or functions were directly developed and implemented by the schools. However, other supports in relation to database servers, network connectivity or security are collaborations among other IT units within the university. For the GSM, maintenance and support will come from three major units, namely (i) the in-house support by the educational technology specialists, (ii) CEDIR and (iii) the university’s central IT unit, as previously mentioned.

**Who maintains the PDA servers and PDA database server?**

**Maintenance and support for PDA accessible clinical-logs**

The honorary clinical academic (n = 1), the GSM faculty (n = 5) and educational technology specialists (n = 4) reflected on the issue of who provides maintenance and support, especially problem solving associated,
with PDA accessible clinical-logs. The findings indicated that maintenance and support for the clinical-log function should be given by IT experts who understand and are familiar with all features of this function. It is a fact that the development and implementation of PDA accessible clinical-logs is a collaboration among three different units within the university\(^2\). However, particular support for clinical-logs will be served by educational technology specialists from the GSM in-house IT unit.

"...the education technology group needs to provide that. ...the university often centralize IT and approach (distribute) to local. ...they often take longer to get help with problem-solving. ...being a school level so it is more valuable to staff and students and we do not have to go to the whole university system. ...it is cost-effective for the university. It often takes longer and is frustrating and people say that I cannot get help and I will not use this technology." IV12 (07.09.2007)

"...the GSM provides that source of information for the technology that we are using like computers...we have to have a centralised support-service, for the PDA. But...with respect to the interfacing and making sure the centralised server is working properly and if there are technology issues where anybody’s individual PDAs, then that is the responsibility of the student and the supplier of the PDA” IV13 (13.09.2007)

"...that will be a combination of the technical, the educational technology people in the school and the university...” IV08 (16.09.2007)

This finding is similar to the literature (section 3.7), in that maintenance and support should be provided by local experts in case any particular application or system is developed and implemented by the school.

As mentioned, the PDA accessible clinical-log function is developed and implemented by collaborations between CEDIR and the GSM in-house

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\(^2\) Three major units are (i) in-house support by the educational technology specialists, (ii) CEDIR and (iii) the university’s central IT unit.
educational technology specialists. In this case, the in-house educational technology specialists would be local experts who directly provide support for clinical-log functions. Therefore students and the medical faculty can receive optimal service and support in a timely manner from the expertise in this area. Therefore they can use PDA accessible clinical-log function and related software applications in an efficient way.

**Maintenance and support for database server for PDAs**

The GSM faculty (n = 2) reflected on this aspect regarding maintenance of the database server for clinical-logs with a similar perception. The university’s central IT unit would provide database server space, a secure server room and any necessary network facility for the GSM to store students’ clinical-log data. However, the database will be managed and maintained by the GSM in-house educational technology specialists.

“The servers themselves will be managed and maintained by IT Service within the university, but the structure and how the data is kept on those servers and the software that we are using will be supported by our own technical staff and then the GSM.”

IV13 (13.09.2007)

This finding is similar to the literature (section 3.7). It is a fact that the clinical-log function and its database can be partially maintained and supported by different units or IT departments within the university. For instance, some medical schools let the university’s IT unit fully maintain and support the clinical-log database.

For the GSM, the PDA accessible clinical-log database is directly maintained and supported by the GSM in-house educational technology specialists. Maintenance and support for the clinical-log database server is a collaboration between the GSM in-house IT unit and the university’s central IT unit. The in-house educational technology specialists are fully authorised.
to manage and maintain the clinical-log database, whereas the university’s central IT unit provides data storage on the university’s database server.

**Troubleshooting regarding PDA applications**

The GSM faculty (n = 3) reflected on troubleshooting plans for problems associated with PDA applications. The interview participants had different perceptions on this aspect. Troubleshooting for PDAs and their applications can be provided in numerous ways. However, the GSM is unable to provide any troubleshooting of PDA devices, as different students may use different PDA types, models and platforms. Therefore the GSM would rather provide troubleshooting in relation to PDA applications and their functionalities which are recommended by the medical school, for instance, in particular the PDA accessible clinical-log function.

The findings indicated that this troubleshooting can be provided in both direct and indirect support. Direct support for troubleshooting PDA accessible clinical-logs can be given in person by the educational technology specialists. On the other hand, indirect support for troubleshooting can be provided on the GSM website via information pages, useful links, resource pages, etc.

“...basically, there will be troubleshooting pages and information. ...the team will be the IT team but if this is a significant issue then it is ITS (the university’s central IT unit).”

IV03 (24.09.2007)

“...just providing adequate support as well as facility. For student reporting any difficulties, we will have people who can determine whether that difficulty is a software problem or a user interface problem and if it is a problem with the actual device, it is somebody else.”

IV13 (13.09.2007)

This finding is similar to the literature (section 3.7) regarding procedures for troubleshooting at various medical schools. It is possible for the GSM to provide both direct and indirect maintenance, support and troubleshooting
regarding the four-basic PDA functionalities and other related software applications for medical education.

Enquiries regarding troubleshooting can be made in person with the in-house educational technology specialists. On the other hand, the medical school can also establish and provide guidelines, procedures, FAQ and other relevant PDA resources on the school websites ready for students and medical faculty to access in case they are away from the campus.

**How the GSM plans for backing up data if students lose PDAs or anything damages their data**

The GSM faculty (n = 5) reflected on this aspect with various perceptions regarding how the GSM plans for backing up students’ clinical-log data if students lose their PDAs or anything damages their data. Generally, the data from any PDA device can be backed up by a syncing operation. In case students have direct access to a web-based clinical-log function for recording their clinical experiences and encounters, the data will be automatically stored on the university’s central database server once students connect and logon to their clinical-log. However they can also record their clinical-log data on a spreadsheet template which is provided by the medical school. In such cases, students would need to upload this template to their online clinical-log later once Internet connectivity is available. Therefore in the latter case, students are recommended to back-up their data by a syncing operation at the end of the day in order to prevent from data lost. This is not only recommended for clinical-log data, but also for other data.

The interview findings indicated that there are two major aspects regarding backing up clinical-log data. Firstly, students must have direct responsibility to backup their clinical-log data in uncovered-network areas where they cannot access web-based the clinical-log function through their PDAs.
Secondly, the backup procedures for clinical-log data will be directly maintained and supported by the university and in-house support in case clinical-log data is already stored on the university’s database server.

“...storing material primarily on the university server because we have sophisticated backup systems. That is why the student has responsibility for whatever is on the PDA. That is where they should be storing it and that solve that problem in a way.”  
IV09 (22.09.2007)

“...it is the responsibility of students to back up the information that they need for themselves just the same as it is when there are at their home computer. Any information that they store, they need to provide their own system backup and anything that is downloaded or uploaded from a PDA will be backed up to normal university systems.”  
IV13 (13.09.2007)

This finding is similar to the literature (section 3.7) regarding backup procedures for clinical-log data. However, the frequency in performing backup procedures would directly depend on how often the medical school requires this, and how often the data has been updated. For the GSM, these two aspects have been reported and discussed in section 8.1.2. It is possible for the medical school to back up clinical-log data on a regular basis, for instance, weekly or fortnightly. On the other hand, students should backup their clinical-log data at the end of the day when using PDA accessible clinical-log in uncovered-network areas. In the case of using clinical-log functions in a campus environment or anywhere with available network connectivity, it is not necessary to backup their clinical-log data as the data being entered via the online clinical-log is automatically stored on the university’s central database server. If students use PDAs without Wi-Fi connectivity then it is essential to backup their clinical-log data and then daily upload to online clinical-logs or as soon as network connectivity is available.
In summary, maintenance and support regarding the four-basic functionalities, especially the clinical-log function, can be provided in different ways, including direct and indirect support. Direct maintenance and support can be provided by in-house educational technology specialists within the GSM in person, telephone or email. For indirect maintenance and support, this can be provided for both students and the medical faculty in various channels, including an information resource page on the GSM websites, FAQ, peer group, user tips, and guidelines, procedures and troubleshooting information.

8.1.4 Interoperability (between different PDA platforms)

Interoperability among different PDA platforms is an important aspect to be considered before incorporating PDAs into a PBL-medical education, especially when the medical school has the potential to introduce four-basic PDA functionalities (section 7.1) for students to use and facilitate their medical study while in the clinical placements.

The purpose of using these four-basic PDA functionalities in medical education are for capturing, recording, organising, accessing and synthesising information, communicating with peers and others. Therefore it is necessary for the medical school to ensure that PDAs are able to perform these functions. That is why PDA platforms and their interoperability becomes a technical consideration in this study.

The GSM faculty (n = 7) and educational technology specialists (n = 3) suggested several possible strategies for the medical school in preparing the future use of PDAs in medical education, either using a particular PDA platform or a combination of different PDA platforms, or other possible systems (Q8).
There are several reasons why interoperability is an important technical issues for incorporating PDAs into medical education at the UOW. Firstly, it is essential to provide flexibility for students in selecting and using PDAs which suit their needs and budget. Secondly, some students already have PDAs or other mobile devices, including PDA phone, smartphone or TabletPC, therefore the likelihood of acquiring additional mobile devices with a particular platform is very slim in terms of financial implications. Lastly, technology is rapidly changing, therefore it is important to use a simple technology which is less dependent on fashion.

The interview findings indicated that there are several strategies regarding PDA platform and the interoperability of different PDA platforms, there being Open-standard PDA platform, Windows-based PDA platform and function-oriented PDA-platform.

**Open-standard PDA platform**

An open-standard PDA platform would potentially work well with the PDA accessible clinical-log function. Five interview participants –including the GSM faculty and educational technology specialists– have a similar view about incorporating an open-standard PDA platform that supports all four-basic PDA functionalities (section 7.1) in a PBL-approach. The open-standard PDA platform also includes a cross-platform which allows interoperability between different PDA platforms.

“...we have got to make sure that it is cross-platform because some students already have Palms but it is interesting that just the latest Palm Treo is Windows-based. ...the priority would be Windows-based, Pocket-PC, whatever but we have to look at Palm as well. But if it is web-based, that would be an issue because it would be just on the PDA browser. We should make life easier.”

IV03 (24.09.2007)

“...the difficulties that are already existing between different platforms and ensuring that the service can be
provided or in even just interacting with the corporate time diary systems. ...different PDA seem to work better than others...the right platform has to be made available because students already have the PDAs but at the same time we would probably have to limit what we can guarantee to provide a certain support for because a students who has a PDA doesn’t work with the system, can’t guarantee to make everybody work with the system. ...they might have to change their PDAs rather than us upgrading the systems. ....more than one platform would be value because the platforms are changed all the time...”

IV13 (13.09.2007)

“I much prefer to use open-standards like ‘html’ and ‘web-pages’. ...the idea is to let students access through web-based, through handheld device.”

IV10 (12.09.2007)

This finding is similar to the literature regarding use of PDAs at a particular medical school which deploy a certain PDA function for their medical study (section 3.6).

The advantage of using an open-standard PDA platform is that it provides flexibility and affordability for students in selecting PDAs based on their preference and budget. For instance, students may want to use a PDA phone which can be used as a mobile phone and supports all four basic functions. This is because some students may want to carry only one device. On the other hand, others may not mind how many devices they have. Some students, therefore, may prefer to have both PDA and mobile phone devices. In addition, a rule-of-thumb for selecting and determining which PDA is a standard PDA is that it must not obstruct students in using the four-basic functions, as stressed above.

The second advantage of using a open-standard PDA is the ease of maintaining the clinical-log function and its data, as the function is independently developed therefore it can be used among different PDA platforms. This would provide flexibility not only for maintenance and support, but also for future development of the clinical-log function.
However, providing maintenance and support for other functions, especially
the reference functions, is inflexible as this may vary with different PDA
models, because not all reference software applications are available for all
PDA platforms (particularly smartphone). Students can possibly find
reference software for both Palm and PocketPC or similar platform, but not
for a smartphone. Therefore this is an issue to be considered before selecting
a particular PDA for medical study.

**Windows-based PDA**

Two GSM faculty members have a similar perception about introducing a
Windows-based PDA platform because of familiarity with Windows
operating system interface. The issue around Windows-based PDAs becomes
an important aspect among the familiarity of its interface, the availability of
reference software in medical education, and the interoperability of PDA
platforms.

“...most people use Windows...Windows would be
something that most people are familiar with. Though we
do have MAC people but I think with MAC and Windows
talk to each other ...”                    IV12 (07.09.2007)

“...it would have to be Windows-based...it would have to
be a PocketPC or mobile Windows. ...I had a Palm before,
it is always difficult. ...having a Windows-based platform
means that you can have more interaction and the other
thing is that everything else is Windows-based. ...we need
to be consistent. ...that would be PocketPC.”

IV09 (22.09.2007)

This finding is similar to the literature as various PDA platforms (section 3.6)
have been introduced and incorporated into medical education.

**Function-oriented PDA platform**

The GSM faculty and the web-based survey respondents have a similar
perception about introducing a particular PDA-platform, which should be
based on the aims and purposes of using PDAs in a PBL-medical education. Therefore once defining what PDA functionalities are to be used in a PBL-medical education, then the medical school can easily identify which particular PDA platform would suite the objectives of deploying PDAs into a PBL-medical education.

Further, the interoperability of PDA platforms may also affect other functionalities, including reference and communication functions. This is because there are a certain number of reference software applications available on a particular PDA platform compared with other platforms. Therefore the selection of PDA platform would directly depend on the purpose and functionalities of its use.

This finding is potentially different from the use of PDAs in various medical schools according to the literature (section 3.6), because the PDA technology has yet to incorporated into the PBL-medical curriculum at UOW. Therefore, currently, there is no preference for introducing any particular PDA platform to a PBL-curriculum. Rather the focus is on using open-standard PDA platforms as there are a number of students who already own PDAs. Another reason is that a PDA accessible clinical-log can be simply used with any PDA platform with a web-based interface; strategy provides freedom for students in selecting a PDA. Further, there is no commitment for students to have and use a PDA in facilitating their medical study. At the same time, the medical school can easily provide maintenance and support for the clinical-log function which can be used on any device via such a web-based interface.

**Benefits and limitations of using interoperable PDA platforms**

There are two major benefits of using a cross-PDA platform. One is in terms of affordability in acquiring PDA devices and maintainability of a particular functionality PDA functionality which can run on the cross-PDA platform. It
is also beneficial for students in that they have freedom in selecting and using PDAs based on their affordability and personal preference.

There is another benefit regarding PDA platform interoperability. A Cross PDA-platform provides flexibility with the rapid change of technology, particularly the clinical-log functionality, as this is developed and run under the web-based interface. On the other hand, the reference functionality would directly depend on the availability of software for a particular PDA platform. There might be some criticisms’ of this flexibility, including reference software availability from PDA users that some necessary reference software should be added to the list.

Therefore it is essential to deploy PDA technology into medical education in terms of function-oriented rather than technology-oriented. In this way, the aims and objectives of medical education would drive the use of technology rather than having technology leading the medical education in the information age.

“...many students already have the PDA and they already bought...they have already spent a good money to buy the PDA and if they just have to buy their own one, that would be very unfair to expect them to buy a new one. ...this technology stack where we have a hardware, the operating systems, the browser even...any of those can change.”

IV10 (12.09.2007)

As a result, the open-standard PDA platform, Windows-based PDA platform and function-oriented PDA-platform are the most attractive from the point of view of the medical school.
8.2 Web-based Survey Findings: Technical Aspects

The web-based survey findings are reported and discussed below regarding the respondents’ knowledge, experiences and attitudes toward technical aspects for the incorporation of PDAs into medical education. These technical aspects are data security and information privacy, data transmission and network connectivity, systems maintenance and support, and interoperability among different PDA platforms.

**Hypothesis 3:** The respondents will have positive attitudes that technical aspects would affect the use of PDAs in PBL-medical curricula.

Data from the web-based survey were analysed by SPSS version 15.0 for Windows, using descriptive statistics. The findings are reported and discussed in Sections 8.2.1-8.2.4 accordingly.

8.2.1 Data security and information privacy

The majority of web-based survey respondents agreed (n = 43, 95.6%) that data security and information privacy of clinical-logs is a concern, as per the HRIPA (Table 8.8, SQ16).

<table>
<thead>
<tr>
<th>Data Security and Information Privacy</th>
<th>Mean</th>
<th>S.D.</th>
<th>SD (%)</th>
<th>D (%)</th>
<th>N (%)</th>
<th>A (%)</th>
<th>SA (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SQ16.1</td>
<td>4.69</td>
<td>0.557</td>
<td>0</td>
<td>0</td>
<td>4.4</td>
<td>22.2</td>
<td>73.3</td>
</tr>
</tbody>
</table>

*Note.* Value labels for 5 Likert scale: SD = Strongly Disagree; D = Disagree; N = Neutral; A = Agree; SA = Strongly Agree. (n= 45)
This finding is inconsistent with the interview findings, as clinical-logs are not actual health records. The information being recorded on the clinical-log does not contain any patient identifier. Therefore the issue around the act may not be a major concern for the clinical-log function according to the interviewees’ perception. In case, the information being recorded on clinical-log contains patient identifier then the HRIPA would be considered in such case. However, the issue around data security and information privacy is of most concern for the incorporation of PDAs into medical education. This is because this aspect not only relates to the clinical-log function but also to other PDA functionalities.

Web-based survey respondent #22 noted:

“PDAs are easily misplaced, so patient-specific information must be highly protected. But this does not apply to non-patient specific material, such as references, compendia, and curricula.”

This comment from web-based survey respondent provided positive support to the interview finding regarding data security and information privacy (section 8.1.1).

8.2.2 Data transmission and network connectivity

On-campus

Wi-Fi network connectivity for on-campus environments was supported by the majority of respondents (n = 35, 77.8%) (Table 8.9, SQ15.1c). Wi-Fi signals are much stronger than Bluetooth and more applicable and flexible for use anywhere on-campus under network coverage.
Table 8.9 Data transmission and network connectivity for on-campus environment

<table>
<thead>
<tr>
<th>Data Transmission and Network Connectivity for on-campus environment</th>
<th>Mean</th>
<th>S.D.</th>
<th>SD (%)</th>
<th>D (%)</th>
<th>N (%)</th>
<th>A (%)</th>
<th>SA (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SQ15.1(c)</td>
<td>4.11</td>
<td>0.935</td>
<td>2.2</td>
<td>2.2</td>
<td>17.8</td>
<td>37.8</td>
<td>40.0</td>
</tr>
<tr>
<td>SQ 15.1(b)</td>
<td>3.33</td>
<td>0.977</td>
<td>4.4</td>
<td>11.1</td>
<td>42.2</td>
<td>31.1</td>
<td>11.1</td>
</tr>
</tbody>
</table>

Note. Value labels for 5 Likert scale: SD = Strongly Disagree; D = Disagree; N = Neutral; A = Agree; SA = Strongly Agree. (n= 45)

On the other hand, when asked about the attitudes, knowledge and experiences of respondents regarding the appropriate type of network connectivity for on-campus environment, the respondents also agreed (n = 19, 42.2%) to use Bluetooth as the data transmission medium (Table 8.10, SQ15.1a).

In addition both Bluetooth and Wi-Fi are applicable for use as on-campus network connectivity. The decision on which type of connectivity is more appropriate for medical education is dependent on the purpose of its use for data transmission. Bluetooth is suitable for short-range data transmission as its limitation is the signal's range, while Wi-Fi does not have limitations on strength of signal. Therefore Bluetooth can be used in classroom environments, while Wi-Fi can be used anywhere within the campus network. Further, the respondents strongly supported using Wi-Fi for on-campus network connectivity, while Bluetooth seems to be their second preference.

Web-survey respondent #14 stressed:

"...depends on the campus. Needs to be 1) secured; 2) mindlessly simple; and 3) fast, in that order."
Web-survey respondent #19 noted:

“…(Wi-Fi and Bluetooth are)...secured connections for identifiable data…”

This finding lends positive support to the interview finding regarding on-campus network connectivity (section 8.1.2). Using Wi-Fi for on-campus network connectivity is more practical than Bluetooth.

**Off-campus**

The majority of respondents agreed (n = 36, 80.0%) that PDAs should have the capability of accessing remote clinical databases wirelessly, especially while students are in clinical placements (Table 8.10, SQ15.2). Further, the majority of respondents agreed (n = 36, 80.0%) that students should have wireless network connectivity for off-campus environments including clinical settings and hospitals in both urban and city areas in order to keep the information up-to-date and provide student access to medical knowledge (Table 8.10, SQ15.3).

**Table 8.10 Network connectivity for off-campus environments**

<table>
<thead>
<tr>
<th>Data Transmission and Network Connectivity for off-campus environment</th>
<th>Mean</th>
<th>S.D.</th>
<th>SD (%)</th>
<th>D (%)</th>
<th>N (%)</th>
<th>A (%)</th>
<th>SA (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SQ15.2</td>
<td>4.07</td>
<td>0.809</td>
<td>0</td>
<td>4.4</td>
<td>15.6</td>
<td>48.9</td>
<td>31.1</td>
</tr>
<tr>
<td>SQ15.3</td>
<td>3.96</td>
<td>0.878</td>
<td>2.2</td>
<td>4.4</td>
<td>13.3</td>
<td>55.6</td>
<td>24.4</td>
</tr>
</tbody>
</table>

*Note. Value labels for 5 Likert scale: SD = Strongly Disagree; D = Disagree; N = Neutral; A = Agree; SA = Strongly Agree. (n= 45)*

In addition, another respondent also provided an additional comment on this aspect.
Web-based survey respondent #19 noted that:

“...not for patient identifiable data!!...but for medical education databases. Most of those do not require constant internet access.”

These findings provide positive support to the interview finding regarding off-campus network connectivity (section 8.1.2). Having internet connectivity for off-campus environments is important for accessing relevant information while offsite. Internet connectivity is not only important for information access and retrieval, but also for communication with medical faculty, clinical preceptors and peers. Students, therefore, can use PDAs at their optimum capacity.

**Data synchronisation**

The majority of respondents agreed (n = 36, 80.0%) that PDAs should support both wired and wireless data synchronisation (Table 8.11, SQ14.1). This finding is similar to the interview finding in terms of wired data synchronisation (HotSync) from PDAs to laptop or desktop computers. However, HotSync could be generally used for backup purposes and software installation. On the other hand, wireless data synchronisation can be done via web-based environments, as the clinical-log function is to be implemented by using web-based programming rather than developing a system for PDA-based clinical-logs. Therefore there would be no wireless data synchronisation for the PDA accessible clinical-log function.
Table 8.11 Data synchronisation

<table>
<thead>
<tr>
<th>Data Synchronisation</th>
<th>Mean</th>
<th>S.D.</th>
<th>SD (%)</th>
<th>D (%)</th>
<th>N (%)</th>
<th>A (%)</th>
<th>SA (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SQ14.1</td>
<td>4.02</td>
<td>0.965</td>
<td>2.2</td>
<td>6.7</td>
<td>11.1</td>
<td>46.7</td>
<td>33.3</td>
</tr>
<tr>
<td>SQ14.2</td>
<td>4.16</td>
<td>0.706</td>
<td>0</td>
<td>2.2</td>
<td>11.1</td>
<td>55.6</td>
<td>31.1</td>
</tr>
</tbody>
</table>

Note. Value labels for 5 Likert scale: SD = Strongly Disagree; D = Disagree; N = Neutral; A = Agree; SA = Strongly Agree. (n= 45)

Further, the majority of respondents also agreed (n = 39, 86.7%) that students should be able to synchronise data back to the central database server regularly for assessment purposes (Table 8.11, SQ14.2).

Web-survey respondent #24 noted:

“synch with wired connection is available alternative”

Web-survey respondent #27 noted:

“Some places also use cradles scattered around the hospital.”

This finding lends positive support to the interview finding that students should transfer data to the central database server on a regular basis (section 8.1.2). This procedure would be applicable either using PDAs in covered- or uncovered network areas. Uploading information to a central database server regularly is compulsory for students and medical faculty for assessing students’ clinical encounters and experience. On the other hand, recording to online web-based clinical-logs, the data will be automatically recorded and stored on the central database. As a result, data synchronisation for covered network areas might not be compulsory in this case.

8.2.3 Systems maintenance and support

The majority of respondents agreed (n = 41, 91.1%) that the technical support team should be available upon request to provide relevant support regarding
the clinical-log function and other related software applications for PDAs, regardless of where students are located (Table 8.12, SQ19.1).

<table>
<thead>
<tr>
<th>Systems Maintenance and Support</th>
<th>Mean</th>
<th>S.D.</th>
<th>SD (%)</th>
<th>D (%)</th>
<th>N (%)</th>
<th>A (%)</th>
<th>SA (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SQ19.1</td>
<td>4.33</td>
<td>0.707</td>
<td>0</td>
<td>2.2</td>
<td>6.7</td>
<td>46.7</td>
<td>44.4</td>
</tr>
</tbody>
</table>

*Note. Value labels for 5 Likert scale: SD = Strongly Disagree; D = Disagree; N = Neutral; A = Agree; SA = Strongly Agree. (n= 45)*

In addition, other respondents also commented on this aspect.

Web-based survey respondent #14 commented:

"healthcare is a 24x7 activity. ... Any device used in healthcare needs 24x7 support."

Web-based survey respondent #26 commented:

"Students need to learn how to use the computer technology the same way they learn about other medical technologies."

This illustrates that the GSM and the university should provide strong maintenance and support for students in case of encountering any difficulty in using PDAs and their functionalities, in particular the clinical-log and reference functions. Maintenance and support for PDA use in medical education may be available in various formats, as discussed in section 8.1.3.

This finding lends positive support to the interview finding. An appropriate level of maintenance and support should be available for PDA use, especially while offsite. Particular maintenance and support is essential for the clinical-log function, as this function is designed and developed for particular needs and requirements of each medical school. On the other hand, maintenance
and support of reference software applications can be provided directly via
the software vendors. However, the medical school or university can provide
support in relation to software installation, troubleshooting, etc.

8.2.4 Interoperability (PDA platforms)

The majority of respondents agreed (n = 36, 80.0%) that the PDA platform
directly affects PDA functionalities and the availability of software
applications for medical education, in particular PBL-medical education
(Table 8.13, SQ13.1). This finding provides a positive support to the
interview finding regarding this aspect (section 8.1.4). Even though there are
a number of reference software applications which are compatible for various
PDA platforms, the selection of PDA platform still affect PDA use in
medical education, especially any custom PDA functionalities, for instance,
the clinical-log.

Further, the majority of respondents agreed (n = 33, 73.3%) that the selection
of PDA platform should reflect the major PDA functionalities and software
applications that support a PBL-medical curricula (Table 8.13, SQ13.3).

The Clinical-log function can be either developed to run on a certain PDA
platform or any platform. As a result PDA platform still affect PDA use and
its functionalities.

Web-based survey respondent #14 noted:

"First choose the function, then find (or create) software
that provides it, then use the device that runs that
software."

From the web-based survey, the majority of respondents agreed that the PDA
platform directly affects the PDA functionalities and the availability of
software applications for medical education, particularly in a PBL medical
curricula (Table 8.13, SQ13.1 and SQ13.3).
Table 8.13 PDA platforms

<table>
<thead>
<tr>
<th>Interoperability</th>
<th>Mean</th>
<th>S.D.</th>
<th>SD (%)</th>
<th>D (%)</th>
<th>N (%)</th>
<th>A (%)</th>
<th>SA (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SQ13.1</td>
<td>3.96</td>
<td>0.796</td>
<td>0</td>
<td>6.7</td>
<td>13.3</td>
<td>57.8</td>
<td>22.2</td>
</tr>
<tr>
<td>SQ13.3</td>
<td>3.87</td>
<td>0.815</td>
<td>0</td>
<td>6.7</td>
<td>20.0</td>
<td>53.3</td>
<td>20.0</td>
</tr>
</tbody>
</table>

Note. Value labels for 5 Likert scale: SD = Strongly Disagree; D = Disagree; N = Neutral; A = Agree; SA = Strongly Agree. (n= 45)

In addition, another respondent commented on a standard-PDA platform in relation to maintenance and support, education and training.

Web-based survey respondent #26 noted:

"A standard device facilitates support, development and training. A standard device is politically unpopular."

The benefit of using a standard PDA platform is that it provides ease of selecting software applications, developing and implementing PDA systems or functions. On the other hand, the advantage of using an open-standard PDA platform is that it provides flexibility for users, in particular students, when choosing a PDA device for their needs. However using an open-standard PDA platform may not always be difficult in maintaining and supporting PDAs and their functions. This is because there are a number of programming languages which can be used for developing and implementing particular PDA functionalities to run on any platform.

The majority of respondents agreed (n = 33, 73.3%) that the selection of PDA platform should reflect the aims, objectives and requirements of the medical school in order to incorporate PDA devices into medical education (Table 8.14, SQ13.2).
Table 8. 14 The selection of PDA platforms for medical education

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>S.D.</th>
<th>SD (%)</th>
<th>D (%)</th>
<th>N (%)</th>
<th>A (%)</th>
<th>SA (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SQ13.2</td>
<td>3.91</td>
<td>0.668</td>
<td>0</td>
<td>0</td>
<td>26.7</td>
<td>55.6</td>
<td>17.8</td>
</tr>
</tbody>
</table>

*Note.* Value labels for 5 Likert scale: SD = Strongly Disagree; D = Disagree; N = Neutral; A = Agree; SA = Strongly Agree. (n= 45)

These findings are slightly different from the interview finding. This is because a number of medical reference software applications are already available on various PDA platforms. Moreover, a particular PDA functionality can be designed, developed and implemented to be installed and run on different PDA platforms. For instance, the web-based clinical-log function can be used on PDAs as well as laptop or desktop computers.

In summary, the web-based survey findings regarding technical aspects provided positive support for the interview findings. Even though the respondents may have different perceptions in certain aspects, for instance, concern regarding the clinical-log function in relation to the privacy acts. However, the majority of respondents agreed that all technical aspects should be considered before incorporating PDAs into medical education, including data security and information privacy, data transmission and network connectivity, systems maintenance and support, and interoperability among different PDA platforms. Therefore hypothesis 3 was accepted.

**Hypothesis 4:** There will be a significant difference of the attitudes towards technical aspects regarding the incorporation of PDAs into PBL-medical curricula, between respondents with different backgrounds regarding country, gender, age and position.

The technical aspects comprised four-major components, these being (i) data security and information privacy, (ii) data transmission and network
connectivity, (iii) maintenance and support, and (iv) interoperability. For the expectation of this hypothesis, the country, age, gender and position of respondents would influence their attitudes toward these technical aspects for the use of PDAs in PBL-medical curricula. Before testing this hypothesis, a normality assumption was tested for each group in order to identify an appropriate statistical analysis. This was tested using Kolmogorov-Smirnov and Shapiro-Wilk tests. The finding revealed that four components of technical aspects were not normally distributed (p < 0.05), with respect to country, age, gender and position (Appendix F). This suggested that the normality assumption was violated. Therefore the Man-Whitney U test (which is a non-parametric equivalent to independent sample t-test (Allen and Bennett 2008; Coakes, Steed et al. 2008)) was conducted to test this hypothesis. To control type I error, Bonferroni adjustment of 0.0125 was used to determine a significant level (Brown 2008).

There was no significant difference for the follow-up scores on technical aspects, between respondents with different demographics regarding country, age, gender and position. The findings of the Mann-Whitney U test (Table 8.15) indicated that there was no difference at the 0.0125 significance level. This suggested that despite a difference of country, age, gender and position, the respondents had similar attitudes towards the technical aspects regarding the incorporation of PDAs into a PBL-medical curricula. Therefore, the hypothesis that there was a significant difference of the attitudes towards the technical aspects for the incorporation of PDAs into PBL-medical curricula was rejected.
Table 8.15 Mean ranks of demographic groups for follow-up scores of technical aspects

<table>
<thead>
<tr>
<th>Demographics</th>
<th>Technical Aspects</th>
<th>Groups</th>
<th>N</th>
<th>Mean Rank</th>
<th>Sum of Rank</th>
<th>U</th>
<th>Z</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Country</td>
<td>Data security and information privacy</td>
<td>US</td>
<td>31</td>
<td>22.56</td>
<td>699.50</td>
<td>203.500</td>
<td>-.429</td>
<td>.668</td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td>US</td>
<td>14</td>
<td>23.96</td>
<td>335.50</td>
<td>213.500</td>
<td>-.087</td>
<td>.931</td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td>US</td>
<td>31</td>
<td>23.11</td>
<td>716.50</td>
<td>203.500</td>
<td>-.429</td>
<td>.668</td>
</tr>
<tr>
<td>Maintenance and support</td>
<td>Data transmission and network connectivity</td>
<td>US</td>
<td>31</td>
<td>24.81</td>
<td>769.00</td>
<td>161.000</td>
<td>-1.525</td>
<td>.127</td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td>US</td>
<td>14</td>
<td>19.00</td>
<td>266.00</td>
<td>217.000</td>
<td>.000</td>
<td>1.00</td>
</tr>
<tr>
<td>Interoperability</td>
<td>Others</td>
<td>US</td>
<td>31</td>
<td>23.00</td>
<td>322.00</td>
<td>207.500</td>
<td>-.606</td>
<td>.545</td>
</tr>
<tr>
<td>Age</td>
<td>Data security and information privacy</td>
<td>45 and under</td>
<td>16</td>
<td>21.91</td>
<td>350.50</td>
<td>214.500</td>
<td>-.538</td>
<td>.591</td>
</tr>
<tr>
<td></td>
<td>Over 45</td>
<td>29</td>
<td>23.60</td>
<td>684.50</td>
<td>214.500</td>
<td>-.419</td>
<td>.675</td>
<td></td>
</tr>
<tr>
<td></td>
<td>45 and under</td>
<td>16</td>
<td>21.91</td>
<td>350.50</td>
<td>214.500</td>
<td>-.538</td>
<td>.591</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Data transmission and network connectivity</td>
<td>Over 45</td>
<td>29</td>
<td>23.60</td>
<td>684.50</td>
<td>209.500</td>
<td>-.593</td>
<td>.533</td>
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<tr>
<td></td>
<td>45 and under</td>
<td>16</td>
<td>21.59</td>
<td>345.50</td>
<td>207.500</td>
<td>-.606</td>
<td>.545</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Maintenance and support</td>
<td>Over 45</td>
<td>29</td>
<td>23.78</td>
<td>689.50</td>
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<td>.545</td>
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<tr>
<td></td>
<td>45 and under</td>
<td>16</td>
<td>24.53</td>
<td>392.50</td>
<td>207.500</td>
<td>-.606</td>
<td>.545</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Interoperability</td>
<td>Over 45</td>
<td>29</td>
<td>22.16</td>
<td>642.50</td>
<td>207.500</td>
<td>-.606</td>
<td>.545</td>
</tr>
<tr>
<td>Gender</td>
<td>Data security and information privacy</td>
<td>M</td>
<td>34</td>
<td>24.40</td>
<td>829.50</td>
<td>139.500</td>
<td>-1.627</td>
<td>.104</td>
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<tr>
<td></td>
<td>F</td>
<td>11</td>
<td>18.68</td>
<td>205.50</td>
<td>155.000</td>
<td>-.853</td>
<td>.394</td>
<td></td>
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<tr>
<td></td>
<td>M</td>
<td>34</td>
<td>22.06</td>
<td>750.00</td>
<td>167.000</td>
<td>-.587</td>
<td>.557</td>
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<tr>
<td></td>
<td>Maintenance and support</td>
<td>F</td>
<td>11</td>
<td>21.18</td>
<td>233.00</td>
<td>154.000</td>
<td>-.909</td>
<td>.363</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>34</td>
<td>23.97</td>
<td>815.00</td>
<td>154.000</td>
<td>-.909</td>
<td>.363</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Interoperability</td>
<td>F</td>
<td>11</td>
<td>20.00</td>
<td>220.00</td>
<td>167.000</td>
<td>-.685</td>
<td>.493</td>
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<tr>
<td></td>
<td>M</td>
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<td>22.65</td>
<td>770.00</td>
<td>175.000</td>
<td>-.685</td>
<td>.493</td>
<td></td>
</tr>
<tr>
<td>Position</td>
<td>Data security and information privacy</td>
<td>Academics</td>
<td>34</td>
<td>23.59</td>
<td>802.00</td>
<td>167.000</td>
<td>-.685</td>
<td>.493</td>
</tr>
<tr>
<td></td>
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<td>21.18</td>
<td>233.00</td>
<td>175.000</td>
<td>-.320</td>
<td>.749</td>
<td></td>
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</table>
### Table: Mann-Whitney U Test

<table>
<thead>
<tr>
<th>Groups</th>
<th>N</th>
<th>Mean Rank</th>
<th>Sum of Rank</th>
<th>U</th>
<th>Z</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Others</td>
<td>11</td>
<td>24.09</td>
<td>265.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Academics</td>
<td>34</td>
<td>23.53</td>
<td>800.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td>11</td>
<td>21.36</td>
<td>235.00</td>
<td>169.00</td>
<td>-.528</td>
<td>.598</td>
</tr>
<tr>
<td>Academics</td>
<td>34</td>
<td>22.94</td>
<td>780.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td>11</td>
<td>23.18</td>
<td>255.00</td>
<td>185.00</td>
<td>-.055</td>
<td>.956</td>
</tr>
</tbody>
</table>

**8.3 Chapter summary**

In conclusion, the findings are similar to the conceptual framework (Chapter IV) regarding to factors consider regarding IT aspects. In addition, the important of each aspect has been prioritised based on the findings.

The answers to the second research question, “what are the influence factors of incorporating PDAs into the UOW PBL-medical curriculum?,” are reported and discussed within this chapter in terms of technical issues.

The technical issues comprise four major aspects, namely data security and information privacy, data transmission and network connectivity, maintenance and support, and interoperability among different PDA platforms. These aspects were confirmed by the medical faculty, clinicians, educational technology specialists and healthcare professionals via in-depth interviews and a web-base survey with the UOW GSM and other medical schools.

*Data security and information privacy.* Data security and information privacy is the most important aspect in learning and practicing medicine. This aspect not only emphasises storing data in a safe place and securing data from unauthorised persons, but also focuses on ethical and privacy issues when dealing with patient information. Even though no patient identifier is allowed
to be recorded on PDAs, especially on the clinical-log function, having good conduct in information privacy is still essential in learning and practicing medicine. From a technical perspective, the success of data security depends on the security technique being applied. On the other hand, the success of information privacy cannot be accomplished without applying data security techniques and professional practice.

Data transmission and network connectivity. The usefulness of PDAs in medical education is having the opportunity to access, store and retrieve information and communicate with others wirelessly, anywhere and anytime, especially while offsite. Therefore, data transmission and network connectivity is an important technical aspect. Without data transmission and network connectivity, PDAs would be only an electronic organiser with software applications and offline reference software.

Maintenance and support. The reason why maintenance and support is important for PDA use in a PBL-medical curriculum is that PDAs are to be used while offsite. The objectives of using PDAs offsite are (i) to record logs of clinical experiences and encounters; (ii) to access relevant medical references and information; (iii) to communicate with others via available network connectivity; and (iv) to organise daily schedules and personal information. Therefore having reliable PDA devices is essential. Sufficient maintenance and support should be available anytime when users encounter technology difficulties. However, such maintenance and support should be available via various channels in order to satisfy different needs, for instance, online troubleshooting, FAQ, onsite support, etc.

Interoperability. Interoperability among different PDA platforms seems to be an issue for developing, implementing, and incorporating PDAs into medical education in PBL-medical curricula. It is a fact that PDA technology and its software applications have dramatically changed and moved beyond this
issue. Therefore a number of programming techniques and software applications are currently compatible and support any PDA platform. The issue around which PDA platform is appropriate for medical education, in particular the UOW PBL-medical curriculum, is no longer a critical aspect.

However, technical aspects are not the only aspect which the medical school needs to consider for the incorporation of PDAs into a PBL-medical education. The primary issue of PDA use in medical education centres more on PDA functionalities, technical aspects and other relevant aspect, which are reported and discussed in the following chapter.
Chapter IX
Practical Aspects

9.0 Chapter Overview

The aim of this chapter is to identify what practical aspects should be considered for the incorporation of PDAs into PBL-medical education, based on the interviews and web-based survey findings. The objectives of this chapter are threefold: (i) to report and discuss the interview findings; (ii) to report and discuss the web-based survey findings; and importantly (iii) to identify the importance of each practical aspect for the incorporation of PDAs into PBL-medical education.
9.1 Interview findings: Practical Issues

Practical issues are another aspect to consider before incorporating PDAs into the UOW-PBL medical education. The first part of this section reports and discusses the concerns for incorporating PDAs into a PBL medical curriculum based on the interview findings. Table 9.1 summarises six issues and three strategies to overcome all concerns.

<table>
<thead>
<tr>
<th>Concerns</th>
<th>Strategies</th>
</tr>
</thead>
</table>
| 1. Technology comfort  
  • IT in daily life  
  • IT in medical education  
  2. Nervousness about using IT in medical education  
  3. Electromagnetic interference (EI)  
  4. Resource implications  
  5. Uncertainty about the differences between studying medicine with and without PDAs  
  6. Equity of learning medicine with and without PDAs/Equity of accessing information with and without PDAs | 1. Education  
  • Preparation for technology familiarity  
  • Inform the faculty staff/teaching academics  
  • Train students  
  • Inform community  
  2. University support and needs accomplishment  
  3. Technology options  
  • Laptop computers  
  • TabletPC  
  • iPod |

According to the interviews, six concerns were identified for the incorporation of PDAs into the UOW-PBL medical curriculum. The most to
least important concerns were ranked based on coding references from Nvivo, these being (i) technology comfort, (ii) EI, (iii) resource implications, (iv) uncertainty about the difference with PDAs, (v) equity of learning medicine and accessing information with and without PDAs, and (vi) social acceptance, respectively.

Theses concerns can be overcome by three major strategies, namely (i) preparation for technology familiarity (education and training), (ii) university support and needs accomplishments, and (iii) technology options besides PDAs.

**Concerns for the incorporation of PDAs into UOW PBL-medical education**

The most to least important concerns in practical aspects (Figure 9.1) were ranked based on coding references from Nvivo (Table 9.2). Each issue was reported and discussed in the following sections.

![Diagram](#)

**Figure 9. 1** Hierarchical categorisation of practical aspects for the incorporation of PDAs into PBL-medical curriculum (Note. * represents most important function/aspect)
Table 9. 2 Number of *coding references* regarding practical issues for incorporating PDAs to the UOW PBL-medical curriculum from Nvivo

<table>
<thead>
<tr>
<th>Concerns regarding practical aspects for incorporating PDAs into the UOW PBL-medical curriculum</th>
<th>Number of <em>coding references</em> in Nvivo</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Honorary clinical academic</td>
</tr>
<tr>
<td>Technology comfort</td>
<td>14</td>
</tr>
<tr>
<td>EI</td>
<td>1</td>
</tr>
<tr>
<td>Resource implications</td>
<td>0</td>
</tr>
<tr>
<td>Unsure about the difference with PDAs</td>
<td>1</td>
</tr>
<tr>
<td>Equity of learning medicine and accessing information with and without PDAs</td>
<td>0</td>
</tr>
<tr>
<td>Social acceptance</td>
<td>1</td>
</tr>
</tbody>
</table>

**Technology comfort (Computer literacy) of students and medical faculty**

The purpose of the interview questions regarding technology comfort was to identify the medical faculty’s and students’ knowledge, skills and experiences with the use of IT in both daily life and medical education. The findings would be a useful guide in preparing the instructional services regarding the use of PDAs, IT facilities and other related resources in the future.

**Technology comfort (computer literacy) of students**

The honorary clinical academics (n = 2), the GSM faculty (n = 6) and educational technology specialists (n = 3) reflected on technology comfort...
with a similar perception. The participants indicated that a number of students are likely to be comfortable with using technology in their study for several reasons. Firstly, all students have already done their undergraduate degree, therefore they are already familiar with the use of technology as such. Secondly, the GSM intensively uses technology in delivering courses and lectures between two campuses in both Wollongong and Shoalhaven. Finally, students normally use online learning resources to accompany their study. However the participants indicated that there are only a small number of students who feel less confident in using technology.

"Technology has been around long enough in all our life... It is just your own insecurity about your lack of knowledge and skills but if it is something you feel you need to learn and then you will certainly take it up."

IV14 (18.10.2007)

"...80% or more are very comfortable with the computer technology. ...there is a small group that are not, but we are working on them. By the time we get to second or third year, all of our students should be very comfortable with the software packages that we are using and with the university interface. ... the majority of them will (feel comfortable). It is just an extension of it. ...there is a very small percentage that are resistant always."

IV09 (22.09.2007)

"...generally they feel comfortable for using technology if there is an obvious purpose for it and they can see if it is going to help them in their learning. ...generally if it is well explained to them, how it works and they can see that it can help them."

IV08 (16.09.2007)

"...we surveyed the students at the start of the course on their level of confidence with technology in general. The results were that overall there were very confident. There was a minority of people that were not confident, ...that comes back to us, supporting (in terms of education and training)."

IV10 (12.09.2007)

This finding is similar to the literature (section 3.7), as there is evidence that most medical students are likely to be familiar with the use of technology in
medical education in the 21st century, for instance, online resources, email, software applications which can run on computers and mobile devices, etc.

The GSM internal survey indicated that the students’ computer literacy and confidence in using technology in general are very high. The medical school accepts students for only graduate entry. Therefore there are a number of students who are already familiar and competent with using technology, as a number of undergraduate courses require students to use computers, online assessment, online resources, online databases and other internet technologies as part of their courses.

**Technology comfort (Computer literacy) of the medical faculty**

Technology comfort of the GSM medical faculty is generally focused on their comfort of using technology in daily life and medical education. The technology comfort of the medical faculty indicates their perceptions towards the use of technology in both general and medical education sphere.

*IT in daily life*

The honorary clinical academic (n = 1), GSM faculty (n = 7) and educational technology specialists (n = 4) reflected on the *degree of technology comfort in general*: technology comfort and computer competency varied with each person. Their levels of technology comfort ranged from low to high. One reason is because the majority of clinicians are busy in their clinical placements. The second reason is that some honorary clinical academics are already very competent and comfortable in using technology for their work, including emailing, referencing, scheduling, etc. Finally, the honorary clinical academics realised that there are a number of technologies available to accommodate their daily life and work; however they would rather choose any available technology which suits their personal needs. Therefore the technology comfort levels of honorary clinical academics are mostly based
on personal interest. On the other hand, the GSM faculty and educational technology specialists are highly comfortable with the use of technology in both personal daily life and works as they have to use the technology at all times for socialising and normal working days.

“...my comfort level would be low but my enthusiasm and interest in learning would be high and as the two went along. I am sure they will meet at some stage.”

IV14 (18.10.2007)

“...high level support is critical but actually if you solve it yourself, you will learn a lot from it. .... everyone has basic skill. ...there is a huge range of comfort.”

IV12 (07.09.2007)

“If it is referred to medical faculty who are a sort of full- or part-time academics in the school…at least 70% feel comfortable with the technology. If you are talking about clinicians who are in hospitals or surgeries, it would be less than that.”

IV08 (16.09.2007)

This finding is similar to the literature (section 3.7), in that technology comfort is directly dependent on sufficient maintenance, support, education and training regarding the technology being used. The technology comfort of honorary clinical academics could be improved if sufficient training and support is available on site. There are some studies that indicate that the comfort of technology will increase in parallel with the level of maintenance and support, education and training that are available for clinicians. In addition, the technology familiarity of honorary clinical academics can be gradually increased if they deploy the technology to accommodate their daily activity. The GSM faculty and educational technology specialists have high technology comfort as they have already intensively used technology for their everyday work.

For the role of IT in daily life, the honorary clinical academics (n = 3), GSM faculty (n = 7) and educational technology specialists (n = 4) indicated that they generally use technology in their daily life for both personal use and
daily work. The honorary clinical academics are more likely to pick and choose the technology that suits their needs rather than using the technology all the time. The majority of honorary clinical academics use mobile phone as a telephone for communication but are unlikely to use such device for sending short messages or other functions. On other hand, the GSM faculty and educational technology specialists use most of available technologies a lot in their daily life, including their personal daily activities and for their daily work. The technologies which the GSM faculty and educational technology specialists normally use include basic software applications, mobile technologies, online resources, online services (e-mail, web-messaging, podcast, MP3, video conference), etc.

“It is very important; I use the computer routinely for communication, for socialising, ... for reporting my cases, with pathologists. ...to take photographs, to create teaching materials. I use the computer all the times so I am familiar with the basic functions.”

IV11 (09.09.2007)

This finding is similar to the literature (section 3.7), in that familiarity and comfort in using technology will increase if the technology is frequently used. However, the familiarity and comfort in using technology may drop in cases where users encounter technical difficulties. Therefore it is necessary that sufficient maintenance and support are available in case problems occur.

**IT in medical education**

The honorary clinical academics (n = 3), GSM faculty (n = 7) and educational technology specialists (n = 3) identified their technology comfortability and reflected on the use of IT in medical education aspect with different perceptions. The purpose of seeking technology comfort in medical education is to identify the personal perception of each interview participant towards the use of IT in medical education.
The findings indicated that the GSM faculty and educational technology specialists are highly comfortable with the use of technology in medical education, as the medical school intensively uses various technologies to deliver medical courses across two campuses. Therefore they are competent with the use of technology in medical education. On the other hand, the honorary clinical academics are aware that the use of IT in medical education could possibly replace human contact, relationships and communication between patients and doctors. Therefore fear of using IT would be a factor, which could affect the use of IT in both medical education and clinical skills, in particular the incorporation of PDAs into clinical practice.

“I don’t think teaching medicine or learning medicine can be done without one-on-one or small group activities where you have human contact with your teacher or your patient or whatever. …technology has a place and it can be used well but it is in a supportive role...the prime experience is human contact.” IV14 (18.10.2007)

This interview finding contrasts with the literature (section 3.7) regarding technology comfort with the use of technology in medical education and patient care. There are a number of physicians who feel uneasy and are unlikely to use the technology for their work and patient care; their perceptions towards the use of technology would gradually change once they start learning and using the technology to accommodate and facilitate their daily activities and clinical work. At a later stage, most physicians would enjoy using technology once they found it useful for patient care. In addition, the technology comfort of the physicians would gradually increase if there is sufficient maintenance and support in case of encountering technical problems, as well as providing education and training for the particular technology being introduced.

Therefore the attitudes towards the use of PDA technology in medical education would gradually change if the medical school introduces the
purpose of using PDAs in a PBL-medical education with the appropriate functionalities, maintenance, support, education and training for its usage.

The honorary clinical academics (n = 3), GSM faculty (n = 7) and educational technology specialists (n = 4) reflected on the role of IT in medical education. The perceptions of the honorary clinical academics differ from the GSM faculty and educational technology specialists, while the GSM faculty and educational technology specialists have similar perceptions on this aspect.

The perceptions of honorary clinical academics towards the use of IT in medical education centre around three major aspects, these being (i) resources and infrastructure, (ii) information overload and (iii) IT replacing interactions between doctor and patient. On the other hand, the GSM faculty and educational technology specialists have a similar perception that IT would play an important role in the UOW PBL-medical education, as the curriculum was essentially designed for students in long clinical placements while being dispersed elsewhere in regional areas. Therefore IT would be used extensively during the course for delivering information, resources, online assessment, accessing information, etc.

It is noticeable that the medical culture is varied by the different groups (Becker, Geer et al. 1977), these being honorary clinical academics and the GSM faculty. The honorary clinical academics are the physicians who practice elsewhere in the hospital or private practice. They occasionally gave lectures or participated students’ group discussion. Their attitudes, therefore, are more toward maintaining contacts between the student-doctor and patients which students would later gain the clinical experiences (e.g. performing minor diagnosis, physical examination and therapeutic procedures, interpreting signs and symptoms of disease, taking medical history, etc.) from the placements. The GSM faculty, on the other hand, are
the full-time faculty who spend most of their time with the students, academic activities and medical curriculum. This is probably why the intensive use of IT is important throughout the course especially while offsite.

“...it is vital and particularly for us because we are introducing quite a lot of new concepts of having students in long placements in rural and remote areas without much direct contact with the medical school and because it’s all dependent on IT and information systems. ...it is vital for our medical school.” IV15 (15.09.2007)

This finding differs from the literature (section 3.7) regarding the role of IT use in medical education. There are studies that prove that physicians and clinical preceptors who have already used IT and PDA technology in their work found it useful for patient care, clerkship and internship. However, the effectiveness and efficiency of using IT in both the medical profession and medical education would depend on three major factors. Firstly, appropriate technology and PDA functionalities should be properly introduced to both the medical profession and medical education. Secondly, pre-education and training should be provided before incorporating IT and PDA use in the medical profession and medical education. Finally, sufficient maintenance and support should be provided in case of encountering technical difficulty, as there is evidence that proved that user would normally stop using the technology if the problems remain unsolved.

However the GSM faculty’s and educational technology specialists’ perceptions are similar to the literature, in that IT would be an important medium in delivering, accessing, communicating and sharing information across regions. Moreover, the tendency of using IT in medical education in the 21st century would gradually increase for two reasons. Firstly, IT becomes a strong foundation in practicing medicine, not only for medical treatment and patient care, but also for information management, patient
education, patient support in making decisions for their treatment, and developing and maintaining lifelong learning. Therefore it is less likely they will practice medicine without using any technology. Secondly, a number of students are highly competent with the use of technology, therefore it is easy for the medical school to introduce additional technology to accommodate students in learning medicine.

In summary, even though IT has been intensively used in both medical education and patient care, the important aspect for learning and practicing medicine is to maintain a professional relationship between doctor and patient, which the technology cannot replace.

**Nervous about using technology**

The honorary clinical academic (n = 1), GSM faculty (n = 4) and educational technology specialists (n = 2) reflected on their nervousness or lack of comfort regarding technology use in medical education with different perceptions.

For the honorary clinical academic, nervousness about using technology in the UOW PBL-medical education is that the use of technology might replace human skills, especially clinical skills which students need to learn and practice while dispersed into different clinical placements. The clinician reflected that there would be no concern if the technologies are intensively used for delivering medical courses within the school, but using technology may replace students’ clinical skills.

This demonstrated that their perception may possible be dominated from the medical culture in the hospital environment (Becker, Geer et al. 1977) especially the interaction between patient and doctor while practicing medicine. However, there should be no affect to the capability of students in learning medicine with the use of IT.
On the one hand the malfunction of technology and improper backup of clinical-log data are the most concerning aspects according to the GSM faculty. The GSM uses a number of technologies for delivering courses between the two campuses. For instance, there are a number of courses that are delivered by using video conferencing between two campuses. Several courses are suitable for paper-based/traditional classroom instruction, but they do not integrate well when using IT in delivering such courses.

On the other hand, there are three aspects that the educational technology specialists are concerned about when using IT in medical education, these being (i) maintenance and support, (ii) pushing technology to the GSM faculty and students, and (iii) the impact of using technology in medical education at the GSM.

“I’m not comfortable. It is a very easy way to substitute clinical teaching. I don’t know the idea of web-based teaching. ...it is very easy to substitute the lesson because it is less than intensive. For clinical education (in my opinion), it is looking at doing their works with patients. In my theory, we go off, running the technology, (some users but my fear), what I have been uncomfortable, is substituting for what seeing the clinicians working with the students.” IV05 (30.09.2007)

“My most nervousness is with respect to backing up and potential loss of data, particularly when the students are keeping their records and that they may need to reflect back on over a period of a year or more. You need to be confident that is not going to be lost.” IV13 (13.09.2007)

“I feel nervous about security of the information ...there is some concerns around issues like that without the people associated with the GSM. ...some concerns with privacy. It depends on the nature of information. Clinical-log is not so much because the actual patient information is de-identified, but some of the assignments and work that students do in regards to their experiences in the field that they record. They are the reflection (personal reflection) on it, personally, professionally behaviour out of the field that dealing with. There are some concerns about privacy of that information.” IV02 (28.09.2007)
"...we need to support our students and our faculty in the use of technology. ...to be careful that I don’t push people too hard, too fast and then just leave them there. ...to be careful that I don’t just throw technology to people and...leave them to themselves. ...technology is always risky in its implementing and developing its applications so that is something that I try to highlight to people that we don’t get too enthusiasm... we don’t just hold and chasing around (technology)...but we think how it is going to impact us...there is a risk of new technologies”

IV10 (12.09.2007)

This finding is similar to the literature (section 3.7) regarding discomfort of using technology either in the medical profession or medical education. It is possible that the users might be reluctant and afraid of using technology as it may cause malfunctions. While others might be afraid, discomforted and not confident in using technology, if there is insufficient maintenance and support in case of encountering technical difficulties.

Using technology in the medical profession and medical education could impossibly replace human clinical skills as there is research evidence that proves that IT provides numerous benefits among the medical profession, medical education and patient care. IT allows communication and professional relationships to become established between a mentor and the students regardless of distance. Mentors can be in different towns and students can still practice their clinical skills. It allows communication to occur among tutors, lecturers and students. IT nowadays enables medical educators to tailor education generally to students’ performance in a particular circumstance. There are a number of medical applications which assist students in learning medicine by incorporating IT into medical education. For instance, the simulation of heart murmurs would enhance students to learn different types of abnormal heart rhythms which are hardly seen or experienced in clinical rotations.
Moreover, being able to access the most up-to-date medical references, in particular the EBM, at bedsides would support physicians in decision making for appropriate treatment. Incorporating PDAs into medical education would accommodate and facilitate students in their medical study, including note-taking, accessing references, organising their clinical activities, and communicating with peers, clinical preceptors and the GSM faculty while offsite.

Therefore anxiety, fear, not feeling confident and discomfort in using technology would gradually disappear once pre-education and training are fully provided, not only for students, but also for educators and educational technology specialists. Whist sufficient maintenance and support should be provided both on-campus and onsite at clinical placements if necessary.

**Resource implications (financial implications)**

The GSM faculty (n = 5) and educational technology specialists (n = 4) had a similar perception that resource implications are another concern for the incorporation of PDAs into the UOW PBL-medical curriculum. Resource implications are essentially focused on infrastructure investment, including cost of developing, and implementing PDA functions and its resources, (e.g. peopleware, software, hardware, network facilities, network accessibilities, pre-education and training, maintenance and support).

“...the main problem would be the expense and actually getting it to work, getting the technology to work. If it could be done, it wouldn’t be the problem. But what I have mentioned (financial implications) is problem...it might turn up to be very difficult.”  

IV11 (09.09.2007)

This finding is similar to the literature (section 3.5 and section 3.7) regarding resource and financial implications for developing and implementing PDA applications and their functionalities, the cost of network devices and network accessibility, the cost of education and training, and also the cost of
maintenance and support. There is some research evidence that proves that the resource and financial implications for incorporating PDAs into either the medical profession or medical education are very high on two major aspects, namely (i) providing maintenance and support (e.g. developing and implementing PDA applications and their functionalities, the cost of network devices, network accessibility, the cost of education and training, and also the cost of maintenance and support), and (ii) pre-education and training on the use of PDA functionalities.

However, the major concern of the GSM is more towards the cost of providing PDAs for students, as the school has yet to decide on which alternative would be suited for students. The reason is that the GSM has yet to incorporate the use of PDAs into its curriculum. The strategy for acquiring PDAs for medical education should be a win-win strategy between students and the medical school.

For the GSM, the development and implementation of PDA functionalities, particularly the PDA accessible clinical-log function, would be a collaboration among three different units. Therefore the cost of development and implementation would not be as much of a concern as the cost of providing PDA devices. Maintenance and support for hardware (PDA devices) and software for PDAs has already been reported and discussed in section 8.1.3.

**Electromagnetic interference (EI)**

EI is one of many concerns to be considered for incorporating PDAs into the UOW PBL-medical education - namely safety using these devices in clinical placements and hospitals. Therefore the findings reported and discussed

3 There three units are (i) the GSM, (ii) CEDIR and (iii) the university’s central IT unit.
several aspects regarding EI among PDAs, PDA phones, smartphones and medical equipment. These aspects included (i) whether such devices affect the use of medical devices; (ii) what the preferences of using PDAs or mobile devices in hospitals and clinical placement are; and (iii) what appropriate future plans should be regarding the use of PDAs or other mobile devices in hospitals and clinical placements (Table 9.3).

Table 9.3 Number of coding references regarding electromagnetic interference from Nvivo

<table>
<thead>
<tr>
<th>Electromagnetic interference</th>
<th>Number of coding references in Nvivo</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Honorary clinical academic</td>
</tr>
<tr>
<td>EI</td>
<td>1</td>
</tr>
<tr>
<td>Whether PDAs have EI to medical equipments</td>
<td>0</td>
</tr>
<tr>
<td>Preference of using PDAs in hospital and clinical placement</td>
<td>1</td>
</tr>
<tr>
<td>Plan regarding the use of PDAs in hospital and clinical placement</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 9.3 reports the coding references based on the 15-interview participants regarding EI and the three aspects being reported and discussed within this section.

Concerns regarding EI with medical equipment while using PDAs in hospitals and clinical placements

Whether PDA use in hospitals and clinical placements can interfere with medical equipment becomes a concern for incorporating PDAs into the UOW PBL-medical curriculum. The GSM faculty (n = 3) and educational technology specialist (n = 1) reflected on this aspect in a similar manner. EI
is always a concern when PDAs, PDA phones or smartphones are used in clinical placements, even though there are a number of studies that support the use of these devices in such environments. It is essential to ensure that such devices could cause no harm to patient treatment and medical equipment in clinical settings.

The interview findings indicated that using PDAs/PDA phones would have no EI with medical equipment. However, what the interview participants are concerned about is the use of PDAs in particular units, for instance, the intensive care unit (ICU), cardiac-care unit (CCU), etc.

“...it probably cannot. They have this thing about mobile phones but the hospital actually gives the junior doctors mobile phones. ...The only places where I am a little more curious about electronic devices are the intensive care unit and in the cardio-care unit and all other environment...”

IV15 (15.09.2007)

This finding is partially similar to the literature (section 3.7), in that mobile phones do not cause EI with medical equipment in hospitals if they are used at least 2-metres away from medical equipment. However, this would apply only for the first generation mobile phones. In case of using second and third generation (2G and 3G) mobile phones or smartphones, such devices would need to be used at greater distances than first generation mobile phones/PDA phones, as 2G and 3G mobile phones exhibit stronger EI. However, any general PDAs without mobile phone function do not interfere with any medical equipment.

On the other hand, if students use PDA phones or smartphones, it is essential to inform them regarding the safety distance of using these devices. The safest solution to use PDAs in such environments is to turn-off the connectivity if students have clinical encounters near patient bedsides or any medical equipment, especially cardio pacemakers, respiratory ventilators, etc.
Preference of using PDAs in hospitals and clinical placements

PDA use in hospitals and clinical placements become a concern as the device may generate EI with medical equipment; or their usage could interfere with patients during medical consultations, medical treatment or patients’ rest time. The honorary clinical academic (n = 1), GSM faculty (n = 3) and educational technology specialists (n = 3) reflected on the preference of using PDAs in hospitals and clinical placements with differing perceptions. There are several aspects which lead to the preference of using PDAs in both hospitals and clinical placements, namely (i) social acceptance in terms of doctor-patient interaction, (ii) EI with medical devices, and (iii) interference in terms of social norms.

The interview findings indicated that what the honorary clinical academics are concerned about with using PDAs, PDA phones or smartphones in a hospital environment is more about social aspects. On the other hand, the GSM faculty and educational technology specialists are concerned about using PDAs or other mobile technology devices in ICU, and the policy of using mobile phones or mobile devices in each hospital.

"...certainly when you come into any hospital or ward, they said 'no mobile phone, it interferes whatever'. The question is ‘do they really interfere?’ or whether it is just nicer to keep everybody quite and mobile phone is off all the time. ...it is a social aspect of social control. And there is a real aspect of what it is really technical hasn’t had an impact.” IV14 (18.10.2007)

This finding is similar to the literature (section 3.7) regarding the use of mobile phones, PDAs or PDA phones in hospital environments. However, using PDAs with Wi-Fi connectivity, PDA phones or smartphones (2G and 3G mobile phones) may generate EI with medical devices at a certain distances, as mentioned previously. Therefore the concern of using such devices focuses on particular areas in hospitals, for instance, CCU, ICU, etc.
However, the doctors and healthcare professions intensively use pagers and mobile phones in the hospital for transmitting medical information and communication, consultations within the hospital or across distances elsewhere. The reason is that there are a number of mobile phone manufacturers, medical device manufacturers and hospitals have abided with international standards and guidelines. Such standards and guidelines identify the EI that may generate from any device. Those standards include the International Standard Organisation ISO TR #21730, the Association for the Advancement of Medical Instrumentation AAMI TIR 18, IEEE 11073-00101, IEEE 821.15 and ZigBee Alliance.

On the other hand, a concern is that the use of PDAs may disturb patients. Therefore there are a number of hospitals that have policies and regulations regarding the use of mobile phones, PDA phones or any mobile device in patient rooms, ICU, CCU or near critical life support medical equipment.

For the GSM, the use of PDAs in any clinical placement or hospital should abide with local policies and regulations in each area while having clinical encounters. Special care should be taken if using PDAs near any medical device, especially respiratory ventilator, cardio pacemaker, telemetry, or any critical life support device, as not every hospital uses modern medical devices shielded from EI; and PDA phones or mobile phones’ signals could trigger the medical devices if being used less than the safe distance (less than 2-metres for first generation mobile phones).

**Future plans regarding the use of PDAs in hospitals and clinical placements**

The honorary clinical academic (n = 1), GSM faculty (n = 5) and educational technology specialists (n = 1) reflected on possible plans and strategies for PDA use in clinical placements regarding this EI aspect.
As mentioned in the previous section, three major areas were considered, these being (i) interactions between doctor-patient, (ii) social norms, and (iii) EI with medical devices. Of most concern are the first two, while the latter aspect is protected by the hospital policy and procedures. It is a fact that studying medicine cannot be done without having interactions between patient and doctor. Therefore it is important to ensure that both doctor and patient understand the purpose of using PDAs, not only for medical study, but also for medical practice.

The interview findings indicate that there are three aspects to be considered for the future use of PDAs in clinical placements and hospitals, namely (i) the policies of each hospital, (ii) the areas using PDA devices, and (iii) the social aspect.

“...we actually need to talk to the rural community that we are using it to make sure that the choice has been informed by this ability. ...the plan would be to engage the community on what we use and then we need to get the community and the school to make sure that the students understand the use, ... not interfere with...whether the community is appropriate in some settings. Cost, comfort in educational technology, interfering with the clinical experience, communication when you are moving around. There is a lot of stuff to carry. That is more portable than books, than etc. obviously...we need to educate students and all the communities where they go and (they may) lack of technical support. Technical support is another barrier that we need to make sure resources are provided so they receive adequate support.”

IV12 (07.09.2007)

This finding is similar to the literature (section 3.7) regarding using PDAs, mobile phones or mobile devices in clinical settings. However, this strategy may not be applicable for all hospitals or clinical environments for three major reasons. Firstly, there are a number of hospitals that have policies and restrictions regarding the use of mobile phones. Most hospitals prohibit the use of mobile phones in certain areas. Secondly, the reason behind the restriction of using mobile phones in hospitals and clinical placements is that
they are tied with the social aspect, as using such devices in patient rooms or patient bedsides may be a nuisance in their rest time. Finally, not all modern medical devices are used in clinical placements, hospitals or even modern hospitals, as traditional medical devices have no electromagnetic shielding from the interference which could be generated from mobile devices (PDA phones, 2G and 3G mobile phones). As a result, it is necessary to maintain an appropriate distance when using mobile devices near medical devices.

Therefore the strategy of using PDA devices in clinical placements and hospitals for the GSM to consider is composed of three golden rules.

Firstly, the use of PDAs in any clinical placement or hospital should abide with the policies and regulations regarding the use of mobile devices in each hospital. These mobile devices include general PDAs, PDAs with wireless connectivity (Infrared, Bluetooth and Wi-Fi), PDA phones, smartphones, laptop and TabletPC).

Secondly, using PDAs and mobile devices in clinical placements and hospitals focuses on certain areas and interference with particular medical equipment, for instance respiratory ventilators, cardio pacemakers, telemetry, or using such devices in ICU or CCU.

Thirdly, using PDAs or other mobile devices should cause no harm to patients with beeping or ringing sounds of such devices. Therefore it is essential to inform and educate the community and hospital about the purposes and benefits of using PDAs or mobile devices for medical study. There are a number of studies that prove that using such devices for medical information transmission, communication and consultation can reduce a number of medical errors and gain faster treatments.

Finally, it is important to maintain a safe distance if using PDAs or mobile devices near any medical device. 2G or 3G mobile phone users must be
aware that signals may be generated from their devices and can easily trigger medical devices, in particular telemetry. Therefore the safest strategy is to turn-off the transmission mode if using PDAs or mobile devices near any sensitive medical device.

In summary, using PDAs with Wi-Fi connectivity or mobile phones would cause no EI and be harmless to patients if used at appropriate distances. However the aspects to consider regarding the use of mobile devices for medical education either in clinical placements or hospitals centre around (i) the policies, regulations and guidelines of each hospital, (ii) safety of patients in special care units, and (iii) social acceptance. Therefore any strategy for using PDAs in clinical placements and hospital should be aware of these aspects.

Unsure about the difference between using and not using PDAs in medical education

The honorary clinical academic (n = 1), GSM faculty (n = 4) and educational technology specialist (n = 1) reflected on the uncertainty regarding the difference between studying medicine with and without PDA technology. The majority of the interview participants did not expect any difference between studying medicine with and without PDA technology, while a small number thought there would be a huge difference. Most participants are not experienced in incorporating and using PDAs in a PBL-medical curriculum, therefore it is not possible to distinguish between using and not using PDAs for medical study.

“I don’t think there is a great difference. It is just for the access of information and much of information will be carried by the doctor. I read a book about PDA, it is more convenient to have a PDA...so very little would be known about them.”

IV05 (30.09.2007)
“...PDA doesn’t make much difference. The reason’s in a sort of a tutorial setting, you don’t have access to anything because your tutor is asking you a question or explaining things so you will have to do some preliminary reading or something ...in which case you would have access to a computer really, not just a PDA.” IV15 (15.09.2007)

“In one sense, I wouldn’t expect to see a lot of difference just because the use of other device of a particular technology shouldn’t dictate too much; it helps students learn. That would be my goal that technology supports learning but doesn’t become a dictator. ...the students are meant to be self-directed learners and they are able to go out there and search for resources themselves...not just limit themselves to the resources that they are given...PDA would enhance them to look for resources. ...it would enhance their access to resources and it would do that in a manner that is more direct to their actual setting of learning. ...they may be emerging between the place of learning (the university) and the places (the clinical placements). Hopefully, they would be able to look up resources...a place of a clinical placement. ...they are looking at resources becomes more direct thing, ...it is not something that they just do at uni, like they can do that at their placements.” IV10 (12.09.2007)

This finding is slightly different from the literature (section 3.7). Before incorporating and using PDAs either into the medical profession or medical education, a number of physicians generally ignore using PDAs as it is time consuming to learn how to use the device and become familiar with it, its functionalities and software applications. However a number of users prefer to use PDAs in the medical profession and medical education once they become familiar with it and know how to deal with technical problems which may occur with either its software or hardware.

In addition, the honorary clinical academics, the GSM faculty and educational technology specialists expect students to equally receive medical knowledge and clinical experiences whether studying medicine with or without PDA technology. However, the differences of studying medicine with and without PDA technology more involve speed, accuracy, consistency
and reliability in accessing information, sharing information among peers, clinical preceptors and the GSM faculty while offsite. Having an opportunity to access references, online resources, and up-to-date EBM is important for studying and practicing medicine, as it facilitates and supports students in clinical decision making, clinical judgement and patient care, in order to provide appropriate treatment for patients even though they have yet to become a real doctor.

**Equity of learning with and without PDAs**

Equity of learning medicine with and without PDA technology could become a limitation of incorporating PDAs into a PBL-approach, as either student or clinician prefers not to use this device. This limitation becomes a concern to carefully consider and ensure that students would receive equivalent knowledge in learning medicine with or without using PDAs. It is a fact that PDA technology could possibly enhance their learning more effectively in a particular environment, especially in clinical placements without information access points like they do on the campus.

“...one of the other issues may be in the way our students are using PDAs. PDAs are still very limited in using by other doctors so certainly in the US doctors use more but in Australia, I don’t think it is really broadly used. ...the students may find that they are more advanced than their teachers and how do we manage that? And that may be the education that we are offering our students, we need to offer them the same education if they choose to on how to use PDA and how it helps them.” IV09 (22.09.2007)

This finding is similar to the literatures (section 3.5) regarding equity of accessing medical resources whether using PDAs, computers or any mobile computing device.

It is a fact that clinical and medical information, online resources, and reference materials can be accessed from the Internet via PDA devices. A number of resources are available in both online and physical resources.
Therefore there would be equity in accessing information whether using PDAs or other devices. The GSM intends to provide optimal learning resources for all students as much as they can, whether using PDAs or any mobile technology. However, the difference would be dependent on network availability, whether they can access resources in a timely manner, especially while offsite or in uncovered network areas.

**Equity of accessing information with and without using PDAs**

The GSM and educational technology specialists have a similar concern regarding the equity of accessing information between students who study medicine with and without using PDA technology. This aspect is not particularly mentioned in the literature. However, it is important for the medical school to ensure that students have equal access to medical resources, which are provided by the school and university, whether students use or do not use PDAs to facilitate their medical study.

"Ideally, it would be good if we had wireless access but it adds costs to buying it and we do need to appreciate that we will be working in rural settings in Australia, where the Internet access, wireless-access, is not equitable. That is a big issue in the current protocol, environment that they are talking about, the equity of access for regional and rural people the same as in the city. If you want to send the students into different sites, it is obvious you have access that you can support them and you can deliver the equity of access to the curriculum."  

IV12 (07.09.2007)

“...people should be aware of when you are introducing something...you need it to be equitable...you need to ensure that all students and staff have accesses...to comparable all the same technology...how the faculty or school would go about insuring that. ...there is a lot to do in different ways...the resource and financial implications...having something that would have the resources that the school’s going into it to make a good educational tool. It’s important that equity of access for everyone is there and also investigating...but one of the things the you need to make sure is its compatibility without the system so with university system and hospital
This finding is similar to the literature (section 3.5), as regards equity of accessing information being directly dependent on where students have their clinical encounters. Students who have clinical encounters in the community seem to have no difficulty in accessing medical resources via the Internet. On the other hand, students who have clinical encounters in remote or regional areas might have problems in accessing the Internet if they are in uncovered network areas. However, strategies to access online resources have already been reported and discussed in section 8.1.2 (Data transmission and network connectivity, Chapter VIII). In this case, students may have to wait until come back to base for information accessing. Fore recording information on clinical-log, it is possible to record clinical experience and encounters on the spreadsheet template and then later uploaded to systems when the internet connection is available. Therefore students would receive and distribute their learning materials and resources equally whether they use PDAs, computers or mobile computers.

**Social acceptance**

The honorary clinical academic (n = 1) and educational technology specialist (n = 1) had a similar perception that *social acceptance* could be a potential limitation of incorporating PDA technology into the UOW PBL-medical curriculum, especially using the PDA accessible clinical-log function for recording clinical experiences and encounters in clinical placements. It is essential that the use of PDAs is well informed and the community educated regarding the purpose of using PDAs in medical education and how the PDA technology would facilitate medical study and patient care.

“...It is obvious while you are inputting data into a PDA or any other devices, your attention is distracted. Patients...
don’t like that. Doctors don’t like it. Doctors don’t necessary like using computers. Some could argue that there is reliance on the machine and not to acquire knowledge yourself and acknowledge is much better and broker it by using a mechanism such as PDA.”

IV01 (21.09.2007)

This finding is similar to the literature (section 3.7), namely that patients are uncomfortable when doctors use PDAs while having physical examinations. On the other hand, doctors might not like using PDAs if they have to learn how to use this device and its applications. However, doctors’ and patients’ attitudes could be changed if appropriate education and training on the use of PDAs is introduced to both medical education and the medical profession. Patients could become comfortable once they were informed and educated on the purpose of using PDAs in the medical profession and the benefits of using PDAs for improving patient care. Therefore having the community informed and educated for the purpose of using PDAs is essential before students start having their clinical encounters and clinical experiences elsewhere in the Illawarra.

**Strategies for overcoming concerns about incorporating PDAs into medical education**

Three major strategies to overcome concerns regarding the practical issues for incorporating PDAs into the UOW PBL-medical education were identified. These three strategies were (i) providing technology options besides PDAs, (ii) providing appropriate education and training to enhance technology familiarity, and; (ii) providing university support and solutions to accommodate needs accomplishment, respectively. Table 9.4 shows the coding references regarding these three strategies. In terms of technology options, the interview findings indicated several mobile devices which students could use for their medical study. Secondly, becoming familiar with the technology became the second priority to overcome the technology
comfort, which was the first concern in practical issue (Table 9.1) for the incorporation of PDAs at the GSM. This is because the majority of the GSM faculty and students are highly competent with technology use in teaching and learning. A majority of students were already competent in using technology from their previous degrees, while a small number still need additional training in using technology. Therefore this concern could be overcome by providing adequate training. Detailed findings are reported and discussed in the following sections.

Table 9.4 Number of coding references regarding strategies to overcome concerns about incorporating PDAs into the UOW PBL-medical curriculum from Nvivo

| Strategies to overcome the concerns of incorporating PDAs to medical education | Number of coding references in Nvivo |
|---|---|---|---|---|
| Preparation to technology familiarity | Honorary clinical academic | Medical faculty | Educational technology member | Total |
| University supports and needs accomplishment | 0 | 6 | 3 | 9 |
| Technology options | 6 | 10 | 5 | 21 |

**Preparation to technology familiarity**

The honorary clinical academic (n = 1), GSM faculty (n = 7) and educational technology specialists (n = 3) reflected on how to prepare medical students to become familiar with handheld computer technology.

The findings indicated that pre-education and training regarding PDA use is essential and important for everyone involved in the use of PDAs in medical education at the UOW. Therefore pre-education and training should be
provided at an early stage, prior to students dispersing into clinical placements elsewhere. The community should be informed about the aims and objectives for students in using PDAs in their medical study.

Therefore education and training to become familiar with PDA technology is emphasised, not only for providing adequate education and training for learners, but also educators and the community at large.

**Training for the medical faculty**

Education and training regarding the four-basic PDA functionalities, in particular the PDA accessible clinical-log, should be provided for the GSM faculty and honorary clinical academics even though the majority of them are highly competent and comfortable with the use of technology. Pre-education and training on PDA use and ongoing training would allow them to have a clear understanding of the purpose of using PDAs in a PBL-medical curriculum.

The findings indicated that education and training for the medical faculty could decrease technology resistance from educators and increase a positive perception regarding the use of mobile technologies in medical education. The four-purposes of having education and training for medical faculty and honorary clinical academics are (i) to ensure that the GSM faculty, honorary clinical academics and students have a clear understanding of how PDA use can facilitate students in both medical study and clinical practice; (ii) to improve the quality of using PDAs in a PBL-approach to their optimum; (iii) to ensure that students would receive equal information during their medical study; and (iv) to ensure that the GSM faculty and honorary clinical academics would receive and access the same information, in particular PDA accessible clinical-logs, while students are offsite.
This finding is similar to the literature (section 3.7) regarding training the trainer or teaching staff. It is important to ensure that medical faculty and clinicians have minimum resistance to using technology and PDAs in medical education. Adequate training should be provided for all teaching staff and relevant members of the GSM, as it will allow them to have a clear understanding for the purposes of using PDAs in PBL-medical education, and also how the PDA functionalities could be used effectively. Such devices would be a gadget which allows interactions, feedback and communication regarding clinical experiences and encounters to occur among students, the GSM faculty and clinical preceptors across distance while students are offsite.

**Training for medical students**

The honorary clinical academic (n = 1), the GSM faculty (n = 5) and educational technology specialists (n = 2) had a similar perception about providing pre-education and training for medical students on the use of PDAs in the UOW medical curriculum, as well as facilitating ongoing training, maintenance and support. It is important to ensure that pre-education and training are available while students are on-campus before being dispersed into clinical placements elsewhere. This would give an opportunity for students to learn and become familiar with PDAs and their functionalities.

“Just give them training session and; we already put FAQ and information sheet upon Vista for any value material so that we do some distance learning module...we can even pledge a reusable learning object in terms of how to use the material and how to do it so that wouldn’t be the problem.”

IV03 (24.09.2007)

This finding is similar to the literature (section 3.7) with respect to providing sufficient training on communication and information technology as the technology becomes part of all education, and in particular medical education. Even though the majority of students at the GSM have a high level
of computer literacy and technology comfort, it is still essential to ensure that students have informatics skills as well as clinical skills and medical knowledge during their medical study. Providing adequate training of PDA use and its functionalities would allow students to access and transfer information in a timely manner.

**Inform the community**

The GSM faculty (n = 1) and educational technology specialist (n = 1) indicated that education and training not only provide technical knowledge and informatics skills regarding the benefits and use of PDAs in medical education, but also how the device should be used in clinical settings in the community. Therefore the GSM intends to provide the basic knowledge and purpose of using PDAs part of medical education at the UOW to the community. As a result, clinicians and patients in community clinical placements would have a basic idea about the use of PDAs during the years of clinical skills.

“...that is a consideration and if we are going to do that we need to educate the community where they are, what the students are doing and how to inform practice so they don’t think that they are fitting around the machine.”

IV12 (07.09.2007)

This finding is similar to the literature (section 3.7), namely that the clinical settings should be informed about the use of PDAs in order to decrease resistance from doctors and patients in the community. This is because there is a possibility that patients might feel discomfort if they see their doctors or students using computers or small gadgets during physical examinations or history taking. On the other hand, practicing medicine in the 21st century relies very much on EBM, which is IT driven. Therefore patients in the community should be informed and educated on how technology and small gadgets can play an important role in most medical treatments.
University support and how to accomplish needs

The GSM faculty (n = 6) and educational technology specialists (n = 3) had various perceptions regarding needs accomplishment from the university or PDA functionality developers, in particular a PDA accessible clinical-log for the incorporation of PDAs into a PBL-medical curriculum.

There are four-basic PDA functionalities which the medical school plans to have on student PDAs. However the focus of developing such functionalities stresses a PDA accessible clinical-log function, which would be a customised function, suitable for the context of the UOW PBL-medical curriculum. However development and implementation of this function would be a collaboration among three different units within the university. The option would be whether the university and the GSM prefer outsourcers to implement such a function. This would have financial implications and require a long-term agreement/contract. On the other hand, awareness by the GSM about deploying ICT into medical education ensures that students would drive and pull the use of technology in medical education rather than pushing the technology onto students and teaching staff (even though the GSM has intensively used technologies in assessments, basic clinical skills, as well as delivering courses between the two campuses).

“...the PDA company should fund the trial (to get more PDA usage). They should have a pilot that where the students volunteer to use the PDA and the staff who want to introduce it and use it...work with the company and developing something. That already have been done and may be that all we need to do is buy that technology.”

IV15 (15.09.2007)

This finding is similar to the literature (section 3.7) regarding PDA systems and functionality development and implementation in terms of university support, as a number of medical schools have already developed and implemented most of the PDA functionalities required by the medical school
rather than hiring outsourcers. However the technology being used for developing any customised function, in particular the clinical-log function, is different from other medical schools. On the other hand, other functionalities including reference, communication and PIM generally come from software-houses, online databases, the university, and library subscriptions. Having in-house developers is beneficial for the medical school in terms of flexibility of user requirements, additional features, future maintenance, support, education and training. To date the university and the medical school have yet to incorporate PDAs as compulsory learning tools in medical education and its curriculum. However there is a potential that PDAs can be incorporated into the UOW PBL-medical curriculum given these concerns (e.g. technology comfort, resources and financial implications, EI, equity of learning and accessing information with and without PDAs and social acceptance) which report and discuss within the section of strategies for overcoming the concerns and in the latter of this chapter.

**Technology options**

The honorary clinical academics (n = 2), the GSM faculty (n = 6) and educational technology specialists (n = 4) had various perceptions regarding technology options and other learning tools which could assist students in learning medicine besides PDAs. There are two reasons why this aspect has been considered, these being (i) student financial implications and (ii) owning existing mobile devices. Many of them use mobile phones, smartphones and iPods. Having or acquiring another gadget would lead to financial implications for each student. Therefore the GSM considered additional alternatives which would not affect students’ financially in using mobile technology in their medical study.

A number of participants indicated that there is no other technology they would consider for students’ learning besides PDA devices. On the other
hand, other participants recommended other gadgets as options based on students’ preferences. In addition, the primary focus of GSM is PDAs while the other devices are the alternatives.

The coding references reported the rate of technology options besides PDA technology (Table 9.5). The results indicated that laptops are the most preferred option, this is because the majority of students already own and use laptops in their study.

Table 9.5 Number of coding references regarding technology options besides PDAs from Nvivo

<table>
<thead>
<tr>
<th>Technology options</th>
<th>Number of coding references in Nvivo</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Honorary clinical academic</td>
</tr>
<tr>
<td>Laptop</td>
<td>2</td>
</tr>
<tr>
<td>TabletPC</td>
<td>1</td>
</tr>
<tr>
<td>iPod</td>
<td>0</td>
</tr>
</tbody>
</table>

**Laptop**

The honorary clinical academic (n = 1), GSM faculty (n = 4) and educational technology specialist (n = 1) had a similar perception that laptops would be another technology option besides PDAs, as there are a number of students who already have and own laptop computers. However the limitation of using laptops while having clinical encounters is their size and weight, making them difficult to carry around in clinical placements. Further, students may also have difficulty in accessing resources and information at the bedside.

“Potentially...a laptop, really. It is just not quite compatible with the development. ...I would like a device that is small and it does everything as a laptop does. Now it may be that those will come online quite soon but I
would like something that has Internet access that is fully compatible with, let’s say “Microsoft-Doctor Professional”- most people use, that can read PDF files...allow you to work essentially as you work with your own laptop on-site and with the Internet access and access to the university network. That is what I would like. I don’t know whether the new PDA can do that or not.”

IV15 (15.09.2007)

“...laptops are quite popular with our students...they would be very helpful. ...the merging of PDAs and the mobile phones is going to be very helpful for our students.”

IV10 (12.09.2007)

This finding is similar to the literature (section 3.6) regarding the incorporation of mobile learning technology as a part of medical education in a PBL-approach that uses various mobile computing technologies and mobile devices, including PDA phones, mobile phones, smartphones, etc. However laptop computers are one of many mobile computing devices which allow students to learn medicine anywhere and anytime. On the one hand, learning medicine and practicing clinical skills while in clinical placements/hospitals would require a lot of mobility in moving around clinical units, wards, patient besides, and inpatient and outpatient units. On the other hand, the use of laptop computer could not achieve independence on just-in-time in accessing information, taking notes or looking EBM at point of care due to its size and portability (in comparison with PDAs). Therefore the use of laptop computers could be an option where absolute just-in-time accessing of information becomes a secondary priority in learning and practicing medicine while offsite.

**TabletPC**

The honorary clinical academic (n = 1), GSM faculty (n = 1) and educational technology specialist (n = 1) recommended that TabletPCs could be another option. However the medical school would not be able to supply this device for students as its cost is still fairly high. Therefore TabletPC is another
gadget for students to consider if they prefer to use another technology besides PDAs.

“I see only one student is using a tablet PC and it is quite interesting to watch someone who knows how to use it because they do write a lot. I’m not saying that this one student used to use the tabletPC all the time. He was going to tutorial and being writing on the tablet PC. ...that is much intensive than typing but it is just information capture.”

IV05 (30.09.2007)

This finding is similar to the literature (section 3.6) regarding the use of mobile technology as a learning tool in medical education. Generally, there is no difference between using TabletPC and laptop computers in terms of information access and retrieval, but TablePCs record information differently, as students are less dependent on using keyboard for data entry. However the limitation of using a TabletPC is the same as laptop computers in terms of location dependency, especially while being used offsite (e.g. in clinical placements, patient bedsides, wards, etc.). It would be more convenient if using such devices in lecture theatre, online assessment, or after daily clinical skills activities.

iPod

The GSM faculty (n = 1) indicated that iPods would be another technology option besides PDAs. Students can use iPods for downloading their video lectures and audio streams for daily review.

“I would like to see if making more use of iPod, MP3 player. We have a lot of materials in MP3 but it will be very valuable for the students to be able to actually download lectures and materials in that format. Most of the students have iPods. It is something that becomes standard, part of their feature...to be able to get lecture material either in audio or video format that they could download and look at another time...it would be incredibly valuable. ...that would be something that they should be using.”

IV09 (22.09.2007)
This finding is similar to the literature (section 3.6) regarding mobile technology in medical education, even though there are a number of computing technologies and mobile devices that can facilitate medical education. Podcasts are one mobile computing technology which would allow students to download stream video lectures and classroom presentations for daily revision. In terms of clinical skills, iPods could play an important role in mobile medical media in presenting streaming video in clinical skills, for instance, anatomy, pathologies, ultrasound guidance, and procedures in emergency medicine.

iPods could be a supplementary device in learning medicine in the 21st century at the GSM as they become a generic device which a number of medical students already have for their personal use. Therefore it would be a beneficial option that they could use as supplement to classroom teaching or clinical skills tutorials. In additional, there was no iPhone technology at the time of conducting this study. However, such devices could be considered as the alternative learning tool in the future.

**Possibility for incorporating PDAs into the UOW PBL-medical curriculum**

The honorary clinical academic (n = 1), GSM faculty (n = 8) and educational technology specialists (n = 2) had different perceptions regarding the possibility of incorporating PDAs into the UOW PBL-medical curriculum. Their concerns centred around resourcing and financial implications; although there is a strategy to partially overcome this aspect by introducing alternative mobile technology options. On the other hand, the remainder of resources and financial implications cover the cost of development, implementation, maintenance, support, and ongoing education and training. However, awareness of resourcing and financial implications is one reason
why the medical school has yet to introduce or incorporate this device into its curriculum.

The perception towards the possibility of incorporating PDAs into the UOW medical curriculum can be categorised into two groups, namely (i) highly possible and (ii) not possible to be done in the short term (Table 9.6). However the perceptions of the interview participants indicated that there is a potential to incorporate PDAs into the UOW medical curriculum if their use is directly dependent on students’ preferences.

Table 9.6 Number of coding references regarding the possibility of incorporating PDAs into the UOW PBL-medical curriculum based on interview participants’ perceptions from Nvivo

<table>
<thead>
<tr>
<th>Possibility of incorporating PDAs</th>
<th>Number of coding references in Nvivo</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Honorary clinical academic</td>
</tr>
<tr>
<td>Possible</td>
<td>1</td>
</tr>
<tr>
<td>Not possible in short term</td>
<td>0</td>
</tr>
</tbody>
</table>

The honorary clinical academic (n = 1), GSM faculty (n = 7) and educational technology specialists (n = 2) had a similar perception, namely that it is highly possible to incorporate PDAs into the UOW PBL-medical curriculum. Currently, the mobile computing technology has dramatically changed as a number of mobile technology applications including laptop, PocketPC, PalmOS or smartphones can be used and run independently regardless of platform and operating system.

Therefore regardless of resourcing and financial implications, it is likely that PDAs could be incorporated into the UOW medical curriculum, as such
devices could provide flexibility in accessing information anywhere and anytime while offsite especially, in clinical placements.

“...it is highly portable... to use as diary...doing things that I used to have to carry a PC or a laptop around for, it is just much more convenient. ...it is convenience factor, will make it very very useful. It should be useful.”

IV13 (13.09.2007)

“In the short term...it is possible. In a trial situation, probably in a small scale. It is possible to give the students the options of doing it in terms of there being no funding available, across the board for the students; and the students need to provide their own technology and their own connectivity...you can give them the options...”

IV08 (16.09.2007)

There are a number of medical schools that have already incorporated PDAs into their medical education, especially during clerkship years, including John Hopkins School of Medicine, Stanford University School of Medicine, etc. (as mentioned in the literature Chapter 3). Strategies for incorporating PDA devices vary with each medical school. On the other hand, other medical schools introduce the use of PDAs into medical education and recommend minimum specifications of PDAs for students’. Finally, some medical schools have collaborations with PDA manufacturers, and medical software vendors for research and development in a specific area in medical education.

The GSM faculty (n = 1) and educational technology specialist (n = 1) had a similar perception that it could be difficult to take action in the short term due to resource and financial implications. This is because the GSM is a new medical school and first accepted students for graduate entry in 2007. The university has invested and established infrastructure for the medical school in two campuses, including buildings, learning equipment, resources and technology.
However, there is the potential that PDAs or other mobile technology devices could be incorporated into PBL-medical education as long as they still provide speed, consistency and accuracy, not only in accessing information, but also in learning medicine and enhancing clinical skills, especially while offsite.

“...imagine that would be fairly low in the short-term. Simply because we have just established first year; expecting students to have provide their own would be a big ask and I don’t think the school has enough funding to buy a whole stack of PDAs...there will be 140 sets that would be a full set...that would not be any time soon and then suddenly throw several million dollars at the University of Wollongong for the Medical School.”

IV02 (28.09.2007)

Generally, it is possible for the medical school to run a pilot project for the use of PDAs in medical education at the GSM, especially from the first or second year while students start dispersing into clinical placements. However, resource and financial implications may not always be a barrier for incorporating PDAs into medical education. For the GSM, generally, the incorporation of PDAs into the UOW PBL-medical curriculum would be dependent on a number of factors, including technical considerations, ethical and clinical issues, and practical aspects in education and training.

**Future plans for incorporating PDAs into the UOW PBL-medical curriculum**

The honorary clinical academic (n = 1), GSM faculty (n = 7) and educational technology specialists (n = 3) reflected differently on future plans for incorporating PDAs into the UOW PBL-medical education.

Generally, having an appropriate and possible plan for incorporating or deploying PDAs into a PBL-medical curriculum at the GSM would be a good start. The perceptions of the interview participants towards such a plan
consisted of five-components, these being (i) identify a specific plan in both incorporating PDAs into the UOW PBL-medical curriculum and possible financial support from the university or elsewhere; (ii) determine specific PDA functionalities for the UOW PBL-medical curriculum that need to be compatible with other mobile technology; (iii) introduce and launch PDAs into the curriculum, as well as other mobile technology options; (iv) observe feedback after PDA use, and; (v) gradually add other PDA functionalities based on what is necessary for a PBL-medical curriculum at the UOW.

“…the functional capacity, the utility of that but if it is hard to use and go to the PDA phone, which would be a next generation. …you have to be accessed and engaged as you go along with its use... For a clinician point of view, what you want to see is that tool is being used frequently. The tool is being used effectively and the user is comfortable and adept at using the tool. ...start with reasonably based model tools and then go with the super deluxe as functionality is proven otherwise it is a lot of money being thrown at something that may not be used.”

IV14 (18.10.2007)

It is essential to identify the four-basic PDA functionalities, which are suitable for the UOW PBL-medical curriculum, then gradually consider other technical issues, including data security and information privacy, ethical and clinical aspects, data transmission and network connectivity, systems maintenance and support, and interoperability of different PDA platforms and other mobile technology devices.

Another important aspect for incorporating PDAs into the UOW PBL-medical curriculum is practical issues in education and training. This aspect not only focuses on providing adequate training for students and teaching staff, but also on informing the community regarding PDA use in clinical environments and emphasising a strategy for the university and the medical school to overcome concerns regarding resources and financial implications in acquiring PDAs for students.
Even though PDAs have yet to be incorporated into the UOW PBL-medical curriculum, there is a tendency that students may prefer to use these devices or equivalent mobile technology devices to facilitate their 4-years of medical study.

This is because, firstly, PDAs enable students to have immediate access to clinical resources and information on-the-spot while offsite. Secondly, PDAs enable students to record and update their clinical experiences and encounters via a PDA-based/web-based clinical-log function, which allows them to update their experiences while offsite. Thirdly, PDAs enable them to communicate among peers, clinical preceptors, the GSM faculty while offsite. Lastly, PDAs enable students to organise and manage their daily activities based on the school timetable which can be immediately accessed while offsite. The primary benefits of PDAs are (i) the accessibility of resources, (ii) the ability to track students’ clinical experiences by the clinical preceptors and the GSM faculty, (iii) the ability to communicate while offsite, and (iv) convenience in carrying such devices while having clinical encounters that other computer technology or mobile technology (e.g. laptop computers) can rarely provide due to their lack of mobility.

**Best year to introduce PDAs**

The honorary clinical academics (n = 2), the GSM faculty (n = 8) and educational technology specialists (n = 4) reflected on the best year to introduce PDAs to students at the GSM for their medical study.

Generally, the honorary clinical academics, the GSM faculty and educational technology specialists preferred to incorporate PDAs at the beginning of medical study if possible, as this would allow students to develop familiarity with the use of PDAs before dispersing into clinical placements elsewhere from year-2 onwards. At a minimum, PDAs should be introduced before
students leave the campus and before having clinical encounters. In practice, PDAs would be more useful while they are in the clinical placements, as PDA devices provide convenience in accessing information and recording clinical encounters while on-the-fly.

"...the earliest as they get introduced, the more familiar...the more comfortable that they will become. ...the role of the PDA will change as they evolve with medical school and the clinical years...it is a balance between the technology, how it dates and how extensive of difficulties of this tool to keep up with the technological changes of the PDAs versions. ...if it is cost to give them for familiarization...at the earliest stage. You might want to introduce it later in their training where as if the cost effect is minimal or can be absorbed then 'the sooner the better', because...with the technology in particular is the generic straight statement. ...the more familiarity they are,, the greater of its use easily so they are not feeling too threaten by all the technology or feeling overwhelmed then they can become familiar and they can become more mature use of that technology when they...mature in their clinical learning and medical training."

IV14 (18.10.2007)

"...it will be very important for third year but I would actually like to see them start using it in second year...second year or third year. ...we had talked about having PDAs in first year but we were not confident yet with the software ready for what we want it to do so that is why we held off...we need to be sure that this is going to be a useful tool ...

IV09 (22.09.2007)

"...if they are going to have a PDA, they probably should have it either from the start or from the start of the 2nd year, which they may have more clinical placements. ...it would be of more value during the clinical placements so they can have access to the determinations."

IV15 (15.09.2007)

"...it should be encouraged from the very start. ...it is a technology that used in the profession of medicine and healthcare ... make much sense to use in year one. They should start using it and encourage to use it...to the best use of it...as well as other technology’s going to be. ...It is no good to introduce it later in the course if they haven’t have a chance to practice."

IV07 (03.09.2007)
“...the most appropriate year is year 3 and year 4 of study when they are away from campus as a significant time in clinical practices...it would be the best place in the program for it.” IV08 (16.09.2007)

For other medical schools, PDAs are generally incorporated and used during clerkship or internship years, in particular the medical schools in the US, while others incorporate PDAs at the beginning of medical study. The issue around when PDAs should be incorporated into medical education may not be associated with which year of medical study, but rather depend on what PDA functionality is being introduced and used during medical studies.

According to the four-basic PDA functionalities from both interviews and web-based survey findings, it would be useful for students if PDAs could be introduced and incorporated at the beginning of medical study. In addition, it would be more useful if additional functionality could also be introduced and used in a PBL-approach, as it would allow students and teaching staff to use either in classroom environments or offsite for assessment, reference and communication purposes.
9.2 Web-based survey findings: Practical Aspects

The web-based survey findings on practical aspects, which include education and training, EI and attitudes towards PDA use in PBL medical education, are reported and discussed in the following sections.

**Hypothesis 5:** The respondents will have positive attitudes that practical aspects (education and training, and EI) would affect the use of PDAs in PBL-medical curricula.

Data from the web-based survey were analysed using descriptive statistics (SPSS version 15.0 for Windows). The findings are reported and discussed in Sections 9.2.1-9.2.2.

9.2.1 Education and training

The purpose of providing education and training are threefold. Firstly, to ensure that there is no resistance in using PDAs as an educational tool in medical education (SQ18.1). The majority of respondents agreed (n = 30, 66.7%) on this aspect (Table 9.7, SQ18.1). In addition, this finding provides positive support to the interview finding with regard to providing sufficient education and training on PDA use in medical education for medical faculty, honorary clinical academics and students.

Table 9.7 Education and training

<table>
<thead>
<tr>
<th>Education and Training</th>
<th>Mean</th>
<th>S.D.</th>
<th>SD (%)</th>
<th>D (%)</th>
<th>N (%)</th>
<th>A (%)</th>
<th>SA (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SQ18.1</td>
<td>3.56</td>
<td>0.967</td>
<td>4.4</td>
<td>11.1</td>
<td>17.8</td>
<td>57.8</td>
<td>8.9</td>
</tr>
<tr>
<td>SQ18.2</td>
<td>4.09</td>
<td>0.701</td>
<td>0</td>
<td>2.2</td>
<td>13.3</td>
<td>57.8</td>
<td>26.7</td>
</tr>
<tr>
<td>SQ18.3</td>
<td>4.38</td>
<td>0.535</td>
<td>0</td>
<td>0</td>
<td>2.2</td>
<td>57.8</td>
<td>40.0</td>
</tr>
</tbody>
</table>

*Note.* Value labels for 5 Likert scale: SD = Strongly Disagree; D = Disagree; N = Neutral; A = Agree; SA = Strongly Agree. (n= 45)
Secondly, the objective of providing education and training is to maximise familiarity with the technology (SQ18.2). The majority of respondents agreed (n = 38, 84.5%) with this aspect (Table 9.7, SQ18.2). This finding supports the interview finding regarding enhancing the comfort of technology use for the medical faculty and students.

Finally, another objective of providing education and training regarding PDA use in medical education is to ensure that students can use PDAs effectively and efficiently during their medical education (SQ18.3). Most respondents agreed (n = 44, 97.8%) (Table 9.7, SQ18.3). The respondents with various professions (e.g. medical faculty, IT specialists, healthcare professionals, etc.) from various countries (e.g. the US, Canada, Europe and other countries) have a similar perception regarding this aspect. This finding also supports the interview finding in this respect.

**Technology comfort**

Technology comfort of both students and medical faculty is important for the adoption of PDAs into medical education. Therefore, it is essential to identify what their perceptions are, regarding the comfort of using such technology. These sections reported and discussed the findings in these aspects. The results of these findings are also compared with the interview findings as to whether they provide positive support on these aspects.

**Table 9.8** Technology comfort of medical faculty and students

<table>
<thead>
<tr>
<th>Technology Comfort</th>
<th>Mean</th>
<th>S.D.</th>
<th>SD (%)</th>
<th>D (%)</th>
<th>N (%)</th>
<th>A (%)</th>
<th>SA (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SQ27</td>
<td>2.87</td>
<td>1.036</td>
<td>8.9</td>
<td>26.7</td>
<td>40.0</td>
<td>17.8</td>
<td>6.7</td>
</tr>
<tr>
<td>SQ28</td>
<td>3.20</td>
<td>1.217</td>
<td>6.7</td>
<td>26.7</td>
<td>24.4</td>
<td>24.4</td>
<td>17.8</td>
</tr>
</tbody>
</table>

*Note. Value labels for 5 Likert scale: SD = Strongly Disagree; D = Disagree; N = Neutral; A = Agree; SA = Strongly Agree. (n= 45)*
Technology comfort of students

There is no significant difference among the respondents, who agreed (n = 11, 24.4%), neutral (n = 11, 24.4%) or disagreed (n = 12, 26.7%) that students will have no problem using PDAs in PBL-medical education (Table 9.8, SQ28). In addition the web-based survey respondents also commented on the technology comfort of students regarding PDA use in medical education.

Web-based survey respondent #11 commented:

"... Also, there is a fairly steep learning curve which is why I disagree students will have 'no problem.' However, once they learn to use them, they love them (according to our students here, 'US and Canada'...)

This finding is significantly different from the interview finding, as the UOW PBL-medical curriculum only accepts students at the graduate entry level. Therefore students are already familiar with the technology since their previous degree. On the other hand, it is possible that students from other medical schools would have various levels of technology comfort. However, this different learning curve can be balanced by providing sufficient education and technology use during their medical study.

Technology comfort of medical faculty

A large number of the respondents neither agreed nor disagreed (n = 18, 40%) that medical faculty members would feel comfortable with IT use in PBL-medical education (Figure 10.2, SQ27). There are 11 respondents who agreed (n = 8, 17.8%) and strongly agreed (n = 3, 6.7%) towards this aspect.

On the other hand, there are a large number of the respondents, who disagreed (n = 12, 26.7%) and strongly disagreed (n = 4, 8.9%), i.e. had a negative perception about the technology comfort of medical faculty. It is possible that are not all medical faculty are competent with technology use in
medical education. Further the respondent from North America also commented on the technology comfort of medical faculty regarding IT use in medical education.

Web-based survey respondent #11 commented:

“Faculty are somewhat behind the curve in learning to use PDA technology.”

Web-based survey respondent #26 commented that:

“Need to train the faculty first. If they do not use the technology, neither will the students.”

This finding provides positive support for the interview finding that the technology comfort level of medical faculty could possibly vary with each person. Comfort level could depend on personal interest, job description and experience of PDA use in daily and professional life.

9.2.2 Electromagnetic interference

The majority of respondents agreed (n = 32, 71.1%) that using PDAs in hospital settings does not affect the operation of medical devices (Table 9.9, SQ17.1).

Table 9.9 EI of PDA use in hospital and clinical placements

<table>
<thead>
<tr>
<th>Electromagnetic Interference</th>
<th>Mean</th>
<th>S.D.</th>
<th>SD (%)</th>
<th>D (%)</th>
<th>N (%)</th>
<th>A (%)</th>
<th>SA (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SQ17.1</td>
<td>3.98</td>
<td>0.812</td>
<td>0</td>
<td>2.2</td>
<td>26.7</td>
<td>42.2</td>
<td>28.9</td>
</tr>
</tbody>
</table>

*Note. Value labels for 5 Likert scale: SD = Strongly Disagree; D = Disagree; N = Neutral; A = Agree; SA = Strongly Agree. (n= 45)*

This particular group of respondents are medical faculty from the US and Canada. On the other hand, the respondents who disagreed (n = 1, 2.22%)
regarding this aspect were medical faculty from others besides Europe, US and Canada. In addition one respondent noted that it depends on which PDA model is being used.

Web-based survey respondent #20 noted:

“Depends on the PDA”

This finding lends positive support to the interview finding regarding this aspect. PDAs could generate the EI depending on various factors, including the distance between the PDA and medical devices, and type of PDA (e.g. PDA, PDA with Wi-Fi or PDA phones). This aspect has already been reported and discussed in the interview findings (Sections 9.1).

In summary, the web-based survey findings regarding practical aspects provide positive support for the interview findings. In addition, the majority of respondents had a positive attitude regarding practical aspects influencing the use of PDAs in PBL-medical curricula. As a result, hypothesis 5 was accepted. This aspect, therefore, should be considered for the incorporation of PDAs into PBL-medical curricula.

9.2.3 Attitudes toward PDA use in PBL medical education

The majority of respondents agreed (n = 32, 71.1%) and strongly agreed (n = 8, 17.8%) that PDA use in PBL medical education should be incorporated into daily medical study and medical practice so their use becomes accepted practice (Table 9.10, SQ20). This finding provides positive support for the adoption of PDAs in the early year of medical study. The early use of PDAs in medical study would enhance students to become familiar with the technology, not only for learning medicine, but also for their medical practice.
Table 9.10 The adoption of PDAs in medical education

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>S.D.</th>
<th>SD (%)</th>
<th>D (%)</th>
<th>N (%)</th>
<th>A (%)</th>
<th>SA (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SQ20</td>
<td>3.78</td>
<td>0.927</td>
<td>4.4</td>
<td>2.2</td>
<td>22.2</td>
<td>53.3</td>
<td>17.8</td>
</tr>
<tr>
<td>SQ21</td>
<td>3.91</td>
<td>0.925</td>
<td>2.2</td>
<td>6.7</td>
<td>13.3</td>
<td>53.3</td>
<td>24.4</td>
</tr>
<tr>
<td>SQ22</td>
<td>3.76</td>
<td>0.933</td>
<td>0</td>
<td>15.6</td>
<td>11.1</td>
<td>55.6</td>
<td>17.8</td>
</tr>
</tbody>
</table>

*Note.* Value labels for 5 Likert scale: SD = Strongly Disagree; D = Disagree; N = Neutral; A = Agree; SA = Strongly Agree. (n = 45)

Further, the majority of respondents also agreed (n = 35, 77.8%) that the incorporation of PDAs into PBL-medical curricula could play a major role in creating and distributing medical and clinical knowledge to assist students when they are providing clinical care (Table 9.10, SQ21). This finding supports the interview finding that having PDAs while offsite could facilitate students in accessing information, in particular while having encounters in the clinical placements. For instance, having used PDAs in the clinical placement could facilitate students in accessing references, clinical procedures, school schedules or relevant information, communicating with peers, and recording or capturing information at the patient bedside.

In addition, the respondents provided positive support, (n = 33, 73.3%, agreed), that it is also feasible to incorporate PDAs into PBL-based medical curricula given the variety of software applications available to support this learning method and clinical practice (Table 9.10, SQ22). This finding confirms the interview finding. It is a fact that there are a number of software applications available for PDAs, for instance, references, clinical decision support, etc. It is possible for medical schools to provide basic or relevant software applications for PBL-medical education. However, it is also essential for students to pick and choose which software applications and other learning tools are suitable for their specific learning needs.
Table 9.11 PDA use in PBL-medical education

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>S.D.</th>
<th>SD (%)</th>
<th>D (%)</th>
<th>N (%)</th>
<th>A (%)</th>
<th>SA (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SQ23</td>
<td>2.89</td>
<td>1.133</td>
<td>13.3</td>
<td>20.0</td>
<td>40.0</td>
<td>17.8</td>
<td>8.9</td>
</tr>
</tbody>
</table>

Note. Value labels for 5 Likert scale: SD = Strongly Disagree; D = Disagree; N = Neutral; A = Agree; SA = Strongly Agree. (n= 45)

The majority of respondents neither agreed nor disagreed (n = 18, 40%) that PDAs are the most important learning tool to assist students in learning medicine in PBL-medical curricula (Table 9.11, SQ23). On the other hand, two groups of respondents provided positive (n = 12, 26.7%) and negative support (n = 15, 33.3%) about this aspect.

Web-based survey respondent #14 noted:

“PDAs are likely to be of some help. ‘most important learning tool’? I don’t think so.”

Web-based survey respondents #26 commented:

“In my opinion, the PDA platform is limited and is a dying technology. Ultra-mobile computers are a better option but the cost is still too high.”

This finding is similar to the interview finding regarding technology options besides PDAs. This is because there are a number of medical students who already own laptops or other mobile devices. Therefore there should be alternative technology to facilitate students in studying medicine besides PDAs. The idea of incorporating PDAs or other gadgets is to facilitate students in learning medicine while offsite for data capture, information access, communication, and organising daily activities.

In addition, this study has been conducted to gather the experts’ knowledge attitude and experiences within the GSM and internationally. The outcomes of this study were addressed in various angles around the three major aspects.
(functional, technical and practical aspects). In one point, the web-based survey respondent mentioned that “PDA might not be an important learning tool for PBL curriculum”.

PBL actually a self-direct learning is a learning approach that provides flexibility and diversity in learning; it can be implemented in many ways across the subjects in diverse context (Savin-Baden 2007). The focuses of PBL are around four major components, these being (i) scenario setting, (ii) answers to the question of scenario setting, (iii) searching for evidence and (iv) learning outcomes (knowledge creation of students). Therefore the use of PDAs in PBL-medical curriculum can be perceived differently by different people (Savin-Baden 2007), at different moment in different environments depending on medical faculty, IT specialists, educational technology specialists or who involved in the program and use it.

On the one hand, this statement could be true if such perception emphasised on PBL in general (scenario setting, answers to the question of scenario setting, searching for evidence and knowledge creation of students); this will enable students to become the independent learner and also assist them to gain knowledge in the flexible learning process.

On the other hand, such statement may not be true in the sense that PDAs are deployed into PBL-curriculum especially in online context, for instance, providing a context for scenario on PDA-based/ online learning environment to help students understand the problem while students are dispersed into clinical placement elsewhere (e.g. virtual patient for education). In this case, PDAs would be an important learning tool while offsite. The following are other examples of how PDA and its functions can be used in PBL-medical education, these being online story board, case-based management plan related to clinical practice, e-portfolios, wikis, blogs/web-blogs (for
reflection, knowledge and understanding), peer assessment (inter-peer/intra-peer assessment), etc (Savin-Baden 2007).

In PBL, students will perceive the clinical problem as a learning opportunity, which is the heart of PBL. PDA is a tool that will facilitate students in learning medicine in such approach. This would be in terms of accessing information, communicating with medical faculty/peers or recording information especially while offsite. IT helps to speed up the learning process by means of what functionalities being used in this learning context especially while offsite. PDA has its potential to be a part of this learning process in comparison to new launching mobile technology. This is because of its mobility and software availability. PDA device has its roles in such learning process especially when IT is intensively used throughout the learning program.

**Hypothesis 6:** There will be a significant difference of the attitudes towards practical aspects regarding the incorporation of PDAs into PBL-medical curricula, between respondents with different backgrounds regarding country, gender, age and position.

These practical aspects comprised two-major components, namely (i) education and training, and (ii) EI. For the expectation of this hypothesis, the country, age, gender and position of respondents would influence their attitudes toward the use of PDAs in PBL-medical curricula. Before testing this hypothesis, a normality assumption was tested for each group in order to identify an appropriate statistical analysis. This was tested using the Kolmogorov-Smirnov and Shapiro-Wilk tests. The finding revealed that two components of practical aspects were not normally distributed (p > 0.05), with respect to country, age, gender and position (Appendix F). This suggested that the normality assumption was violated. Therefore the Man-Whitney U test - which is a non-parametric equivalent to independent sample
t-test- (Allen and Bennett 2008; Coakes, Steed et al. 2008) was conducted to test this hypothesis. To control type I error, Bonferroni adjustment of 0.025 was used to determine a significant level (Brown 2008).

**Table 9. 12** Mean ranks of demographic group for follow-up scores of technical aspects

<table>
<thead>
<tr>
<th></th>
<th>Mann-Whitney U Test</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>N</td>
<td>Mean Rank</td>
<td>Sum of Rank</td>
<td>U</td>
<td>Z</td>
<td>p</td>
<td></td>
</tr>
<tr>
<td><strong>Demographics</strong></td>
<td><strong>Practical Aspects</strong></td>
<td><strong>Groups</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Country</td>
<td>Education and training</td>
<td>US</td>
<td>31</td>
<td>25.16</td>
<td>780.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Others</td>
<td>14</td>
<td>18.21</td>
<td>255.00</td>
<td>150.000</td>
<td>-1.709</td>
<td>.087</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US</td>
<td>31</td>
<td>25.69</td>
<td>796.50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Others</td>
<td>14</td>
<td>17.04</td>
<td>238.50</td>
<td>133.500</td>
<td>-2.180</td>
<td>.029</td>
</tr>
<tr>
<td>Age</td>
<td>Education and training</td>
<td>45 and under</td>
<td>16</td>
<td>24.34</td>
<td>389.50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Over 45</td>
<td>29</td>
<td>22.26</td>
<td>645.50</td>
<td>210.500</td>
<td>-.530</td>
<td>.596</td>
</tr>
<tr>
<td></td>
<td></td>
<td>45 and under</td>
<td>16</td>
<td>21.78</td>
<td>348.50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Over 45</td>
<td>29</td>
<td>23.67</td>
<td>686.50</td>
<td>212.500</td>
<td>-.492</td>
<td>.623</td>
</tr>
<tr>
<td>Gender</td>
<td>Education and training</td>
<td>M</td>
<td>34</td>
<td>23.78</td>
<td>808.50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>F</td>
<td>11</td>
<td>20.59</td>
<td>226.50</td>
<td>160.500</td>
<td>-.728</td>
<td>.467</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M</td>
<td>34</td>
<td>23.60</td>
<td>802.50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>F</td>
<td>11</td>
<td>21.14</td>
<td>232.50</td>
<td>166.500</td>
<td>-.576</td>
<td>.564</td>
</tr>
<tr>
<td>Position</td>
<td>Education and training</td>
<td>Academics</td>
<td>34</td>
<td>21.84</td>
<td>742.50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Others</td>
<td>11</td>
<td>26.59</td>
<td>292.50</td>
<td>147.500</td>
<td>-1.085</td>
<td>.278</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Academics</td>
<td>34</td>
<td>22.03</td>
<td>749.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Others</td>
<td>11</td>
<td>26.00</td>
<td>286.00</td>
<td>154.000</td>
<td>-.928</td>
<td>.353</td>
</tr>
</tbody>
</table>

There was no significant difference for the follow-up scores on practical aspects, between respondents with different demographics regarding country, age, gender and position. The findings of the Mann-Whitney U test (Table 9.12) indicate that there was no difference at the 0.025 significance level. This suggested that despite a difference in country, age, gender and position, the respondents had similar attitudes towards the practical aspects regarding the incorporation of PDAs into PBL–medical curricula. Therefore, the
hypothesis that there was a significant difference of the attitudes towards the practical aspects for the incorporation of PDAs into PBL-medical curricula was rejected.

9.3 Correlations

**Hypothesis 7:** There will be a significantly positive relationship between PDA functionalities, technical and practical aspects.

The web-based survey respondents had medium and strongly favourable attitudes toward PDA functionalities, IT and practical aspects, respectively. The respondents reported an average mean score on PDA functionalities, IT and practical aspects, respectively. According to Table 9.13, the respondents reported a mean score of 68.18 (SD = 9.11) on overall PDA functionalities attitude scale; meanwhile, there was a mean score of 44.40 (SD = 4.58) on IT aspects, and 48.07 (SD = 7.25) on practical aspects.

**Table 9.13** Pearson correlation coefficient between PDA functionalities, IT and practical aspects

<table>
<thead>
<tr>
<th></th>
<th>PDA functionalities</th>
<th>IT aspects</th>
<th>Practical aspects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean (Standard deviation)</td>
<td>68.18 (9.11)</td>
<td>44.40 (4.58)</td>
<td>48.07 (7.25)</td>
</tr>
<tr>
<td>PDA functionalities</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IT aspects</td>
<td>0.52**</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Practical aspects</td>
<td>0.65**</td>
<td>0.38**</td>
<td>1</td>
</tr>
</tbody>
</table>

** Correlation is significant at the 0.01 level (2-tailed).

According to Table 9.13 Pearson’s correlation coefficient indicated that the attitudes of respondents toward PDA functionalities had a significantly positive relationship to IT aspects ($r = 0.52$) at a 0.01 significance level. This suggests that respondents with high preferable attitudes toward PDA functionalities tend to have high attitudes toward IT aspects (e.g. data
Further, the Pearson’s correlation coefficient findings indicate that the attitudes of respondents toward PDA functionalities had a significantly positive relationship to practical aspects ($r = 0.65$) at a 0.01 significance level. This suggests that respondents with high preferable attitudes toward PDA functionalities tend to have high attitudes toward practical aspects (e.g. education and training and EI).

In addition, the Person’s correlation coefficient findings indicate that the attitudes of respondents toward IT aspects had a significantly positive relationship to practical aspects ($r = 0.38$) at a 0.01 significance level. This suggests that respondents with moderate preferable attitudes toward IT aspects tend to have moderate attitudes toward practical aspect.

**9.4 Chapter summary**

In summary, the findings are similar to the conceptual framework (Chapter IV) regarding education and training, technology comfort, EI, social acceptance and other aspects. However differences were found with other issues, for instance, unsure about the differences between using and not using PDAs in medical education, and equity of learning medicine and accessing information with and without PDA technology. Further, the importance of each aspect has been identified in the findings while each issue in the practical aspects was generally proposed in the conceptual framework.

*Practical aspects* were determined as the factor which may influence the incorporation of PDAs into the PBL-medical curriculum at the UOW. These factors are (i) technology comfort (education and training), (ii) EI, (iii) equity of learning medicine with and without PDAs and equity of accessing
information with and without using PDAs technology, and (iv) social acceptance.

*Technology comfort (education and training):* In terms of practical aspects, the technology comfort of the PDA user plays an important role for the incorporation of PDAs into the PBL-medical curriculum at UOW. Technology comfort is more likely to be an indicator to estimate the readiness of the medical school before incorporating PDA devices and relevant technology into medical education using a PBL-approach. The findings in this study indicated the comfort in using technology of both learners (students) and educators (the medical faculty and honorary clinical academics) are very high and competent in using technology. However, sufficient education and training regarding PDA use is still essential.

This is because medical education is both an art and a science, which has its own culture in learning and doing (Becker, Geer et al. 1977). Therefore before incorporating an additional device, it is essential to ensure that PDAs can really facilitate medical study without posing a technology barrier.

*EI:* The findings indicated that EI is another practical aspect which may influence PDA use in a real clinical practice, especially in hospitals and clinical placements. However, the solution regarding PDA use in hospital and clinical environments rely on the regulations and policies on site. Further, the most important is, firstly, to ensure that the devices are not used in restricted areas, for instance, CCU. Secondly, it is essential to ensure that incorporating and using PDAs would not interfere with professional contact between student-doctors and patients.

*Resource implications:* According to the findings in this study, resource implications is a practical issue which may influence the incorporation of PDAs into the PBL-medical curriculum at the UOW. In terms of resource implications, awareness regarding this aspect not only focuses on providing
PDA devices for students, but also on the financial implications of acquiring software, hardware, peopleware, infrastructure, network facilities, network connectivity, pre- and post-education and training, as well as providing consistent maintenance and support, as reported and discussed in Chapter VIII. However, concerns regarding this aspect would be much less if the incorporation of PDAs can be integrated with other existing resources, for instance web-based technology, which can be used and accessed with other devices besides PDAs.

*Equity of learning with and without PDAs and equity of accessing information with and without PDAs:* These aspects could be a major factor influencing the incorporation of PDAs into the PBL-medical curriculum unless there is no other technology that students can use to facilitate their medical study while offsite.

*Social acceptance:* The incorporation of PDAs into the PBL-medical curriculum cannot be successful if these devices are unacceptable to the community. The use of PDAs has the potential to be used while offsite, especially in hospitals and clinical placements in the community. Therefore it is necessary for the medical school to inform the community regarding the PDA use of medical students while having clinical contacts with patients in hospitals, clinical settings, or clinical placements in the community. However, such usage should not interfere with the professional contact between student-doctor and patients.
Chapter X

Conclusion, implications and recommendations

10.0 Conclusions

The purpose of this study was to identify the feasibility of incorporating PDAs into medical education using a PBL-approach at the University of Wollongong. Therefore, the following two major research questions were constructed to guide this study:

(1) What are the appropriate PDA functionalities for a PBL-approach?

(2) What are the factors or aspects which may influence the incorporation of PDAs into a PBL-approach?

Based on these questions, the study was conducted by using the mixed research method with an emphasis on the qualitative approach (Chapter V).

Data analysis using both qualitative and quantitative methods was reported and discussed respectively in Chapters XII, VIII and IX. The findings were presented in terms of the followings three major themes: (i) PDA functionalities, (ii) IT aspects, and (iii) practical aspects (Figure 10.1).
Incorporation of PDAs into the UOW PBL-medical curriculum

PDA Functionalities
- Clinical-log function*
- Reference function
- Communication function
- PIM function

Technical Aspects
- Education and training*
- Electromagnetic interference

Practical Aspects
- Data security and information privacy*
- Data transmission and network connectivity
- Maintenance and support
- Interoperability

Figure 10.1 Hierarchical categorization of the incorporation of PDAs into the UOW PBL-medical curriculum (Note. * represents most important function/aspect)

A combination of these aspects is the foundation for the guidelines for incorporating PDAs into PBL-based medical education at the UOW. Further, these themes lead to answer to the research questions, respectively (Table 10.1). Theme 1: PDA functionalities (Chapter VII) answers the first research question while Theme-2: IT aspects (Chapter VIII) and Theme-3: Practical aspects (Chapter IX) answer the second research question.

To date the literature regarding PDAs, their functionalities and factors to be considered for the deployment of such devices into PBL-medical curriculum are rarely found. The findings of this study addressed the appropriate/important PDA functionalities and factors/aspects to be considered for the incorporation of PDAs in PBL-medical curriculum. The outcomes are threefold: (i) it could be considered as a key element to support
the medical school stakeholders in decision making regarding the deployment of PDAs into medical education; (ii) it provides the evidence for the future researchers in this area of interest; and (iii) the outcomes of this study could be considered as key success factors for mobile technology adoption in particular PDA devices in medical education.
Table 10.1 Categories of emerged themes, sub-themes and example of codes according to research questions

<table>
<thead>
<tr>
<th>Categories of themes</th>
<th>Sub-themes</th>
<th>Response from participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research question 1: What are the appropriate PDA functionalities for medical education in PBL-approach?</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>A. PDA Functionalities</strong></td>
<td>1. Clinical-log function</td>
<td>“The log is more the skeleton of how the patient presented...just the basic information, how your confidence has grown using and dealing with situation, and what the key feature that helps you reach an hypothesis about what was going on...that will help me grow confidence.” “...to make sure...student tracking patients...demonstrating themselves, their range of experiences and identify the gaps in their experiences.”</td>
</tr>
<tr>
<td></td>
<td>2. Reference function</td>
<td>“...a lot of resources...pharmacopoeia...look up drugs, drug dosages...use them for information...they can immediately look up information on PDA...” “...having access to evidence-based materials when with patients or on the ward...that would be useful...”</td>
</tr>
<tr>
<td></td>
<td>3. Communication function</td>
<td>“...sharing information and allocating tasks to different members and share things together...it can allow that interaction to happen across distance. ...PDAs would help keep the interaction that coordinate the PBL process, in tagging people (peers, clinicians and the GSM faculty).”</td>
</tr>
<tr>
<td></td>
<td>4. PIM function</td>
<td>“...have them be able to use...the address books, calendars, organizers, reminders, all sort of things...”</td>
</tr>
<tr>
<td></td>
<td>5. Data security and information privacy</td>
<td>“...there is data security...data so it is not identified by the students’ name...a growth confidence in students over time for research purposes...a few people have access to it...by username and password...then managed by an educational technology team to ensure...not allow any security break...”</td>
</tr>
<tr>
<td></td>
<td>6. Data transmission and network connectivity</td>
<td>“...Bluetooth and Infrared might be problematic. ...Bluetooth might be an option within the room...either at the lecture theatre or tutorial room. ...Wi-Fi would probably be the easiest...because we just provide everything through the web whether the students can look at stuff from the desktop, laptop or PDA.” “...we need to give them access to the server and the Internet. ...if the PDA just plugs into a computer, if that is already a network then they will be automatically networking. ...if not going wireless, we need to make sure that they have access to a network computer and then simply put the PDA into that. That will give them the most mobile thing with the wireless-network...”</td>
</tr>
<tr>
<td></td>
<td>7. Maintenance and support</td>
<td>“...provide adequate support as well as the facility. ...we will have people who can determine whether that difficulty is a software or user interface problem ...if it is a problem with the device, it is somebody else.”</td>
</tr>
<tr>
<td></td>
<td>8. Interoperability</td>
<td>“...it is cross-platform because some students already have Palms ...the priority would be Windows-based, Pocket-PC. We have to look at Palm as well. ...if it is web-based, that would be an issue because it would be just on the PDA browser.” “...I much prefer to use open-standard like “html” and “web-pages” and be agnostic about the actual platform. ...the idea is to let students access through web-based, through their handheld device.”</td>
</tr>
<tr>
<td><strong>B. Technical Aspects</strong></td>
<td>9. Education and training</td>
<td>“...have some base level training...for everybody...specifically on knowing how to turn it on and manipulate it, how it should be used and how it benefits medical education, how the faculty or school expect it to be used. ...you need drop-in sessions, extra assistance or individual assistance for people struggling with the technology...” “Just giving them training session...we have already put FAQ and information sheets upon Vista for any value material...we do some distance learning modules.” “...we need to educate the community where they are to what the students are doing”</td>
</tr>
<tr>
<td></td>
<td>10. Electromagnetic interference</td>
<td>“...it is up to each hospital to set up the policies. ...hope that students are allowed to use them because we have been discussing that it would be a very helpful thing for the students. ...the hospital might set policies that they cannot use them. if that is the case.”</td>
</tr>
<tr>
<td></td>
<td>11. Financial and resource implications</td>
<td>“...the main problem would be the expense and actually getting it to work, getting the technology to work. If it could be done, it wouldn’t be the problem. But what I have mentioned (financial implications) is problem...it might turn up to be very difficult.”</td>
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</table>
**What are the appropriate PDA functionalities for a PBL-approach?**

The findings in this study indicated that clinical-log, reference, communication and general functions are the appropriate PDA functionalities for a PBL-medical curriculum. Even though these PDA functionalities are similar to medical schools elsewhere, the importance of each function is prioritised differently into a PBL-medical curriculum, as reported and discussed in Chapter VII and section 7.3.

**What are the factors which may influence the incorporation of PDAs into a PBL-approach?**

The principal findings to this research question are categorised into two aspects, namely IT aspects (Chapter VIII) and practical aspects (Chapter IX).

**IT Aspects**

On the one hand, the findings in this study indicated that four factors may have the potential to influence the incorporation of PDAs into the PBL-medical curriculum at UOW. These factors are (i) data security and information privacy, (ii) data transmission and network connectivity, (iii) maintenance and support, and (iv) interoperability, as reported and discussed in Chapter VIII.

*Data security and information privacy:* This is the most important factor (IT aspects), which may influence the incorporation of PDA use into the PBL-medical curriculum at UOW. This is because, firstly, there is an association between this factor and other PDA functionalities, for instance clinical-log, communication function, PIM, etc. Secondly, it is because the clinical-log function is planned to be used and accessed using a web-based interface. Therefore the emphasis on data security and information privacy has been put
forward on how to safeguard the data, data access plan, privacy of information, data disclosure and data disposition, even though all data (in particular patient information) remain anonymous, as reported and discussed in sections 8.1.1 and 8.2.1 (Chapter VIII).

Finally, another reason why this factor is so important is that the information needs to be secured and well kept for educational use, future research, curriculum evaluation and development, or students’ future employment. Beyond the technical aspects (in terms of data security and information privacy), there are also issues of ethics and professional conduct to consider in practicing medicine before entering into a real medical practice.

*Data transmission and network connectivity:* The findings in this study indicated that data transmission and network connectivity is the second factor which may influence the incorporation of PDAs into the PBL-medical curriculum at the UOW. This is because potential for using PDAs is more likely at clinical placements, clinical settings and hospitals while students are offsite. Therefore using PDAs with the ability to transfer data onsite via the available communication channel is the most preferable. This factor may influence students in using PDAs while there are offsite, recording their clinical encounters, accessing online references, communicating with the medical faculty, clinical preceptors and peers, and managing their daily activities with school timetables. At the same time, this factor also facilitates students to gain optimum use of their PDA, not only while offsite but also using the device as a learning tool anywhere and anytime. However, there are other factors that need to be considered along with data transmission and network connectivity, for instance financial implications, community acceptance, and network coverage, as reported and discussed in Chapter VIII.
Practical Aspects

On the other hand, the findings in this study indicated that practical aspects are additional factors which may influence the incorporation of PDAs into a PBL-medical curriculum. These factors are (i) technology comfort (education and training), (ii) EI, (iii) financial and resource implications, (iv) equity of learning medicine with and without PDAs and equity of accessing information with and without using PDA technology, and (v) social acceptance. The findings on each factor were reported and discussed in Chapter X.

The guidelines for the incorporation of PDAs into the PBL-medical curriculum are fourfold.

Firstly, it is essential for the medical school and university to determine firstly how PDAs, their functionalities and benefits can assist medical education in a PBL-approach, and to identify the constraints or barriers of these devices which may influence medical study in a PBL-approach, as reported and discussed in Chapter VII. Secondly, it is significant to determine the consider aspects which may affect the incorporation of PDAs into the PBL-medical curriculum, as reported and discussed in Chapter VIII. Thirdly, identifying the important element in each aspect (PDA functionalities, IT aspects and practical aspects) is important for the incorporation of PDAs into the PBL-medical curriculum. The researcher, therefore, prioritised the significant elements in each aspect based on coding references from Nvivo in Table 7.1, 8.1 and 9.2, respectively. Finally, the incorporation of PDAs into the PBL-medical curriculum cannot be successful without collaboration from both educators and learners and importantly among the university, medical school, IT units, hospital, clinical placements and the community.

In conclusion, the clinical-log and reference functions are the critical PDA functionalities for the PBL-medical curriculum. Further, data security,
information privacy and network connectivity are the critical IT aspects for the incorporation of PDAs into the PBL-medical curriculum, as reported and discussed in Chapter VIII. Moreover, considerations on providing proper education and training of PDA use in the community, maintaining professional conduct while using PDAs in the community and clinical placements and providing a backup plan for financial considerations are important issues in practical aspects for the incorporation of PDAs into the PBL-medical curriculum. In addition, the feasibility and future plan for the incorporation of PDA devices into the UOW PBL-medical curriculum was reported and discussed in Chapter IX.

The principal findings to this research question are also identified in practical aspects regarding the strategies for adopting PDA technology into the UOW PBL-medical curriculum (Chapter IX).

10.1 Implications

In terms of strategy, approach, policy and procedures regarding the incorporation of PDAs into the PBL-medical curriculum, it is essential that the university, medical schools and community should collaborate for the deployment of PDA devices among each other. This would assist the medical school in facilitating optimum use of PDA devices in a PBL-approach. In conclusion, the findings in this study could be used as a guideline for the future deployment of PDA devices at other medical schools.

Strengths

The strengths of this study are fivefold. Firstly, the study provided the appropriate PDA functionalities and influence factors for incorporating PDAs into PBL-medical curriculum which were evaluated and determined by the GSM and international experts using triangulation method (data and method
triangulations). The research outcomes are beneficial for future deployment of PDAs into PBL-curriculum.

Secondly, the study provided the research evidence that was being proven that it is feasible to incorporate PDAs in PBL context. Moreover the context of this study provided an overview of PDA use in various areas in particular medical professions. Thirdly, it assisted the researcher to understand the use of PDAs not only medical professions but also medical education. Further, the study allowed the researchers to seek the insights of the experts’ attitudes, knowledge and experiences of learning medicine in PBL-approach in the 21st century. This also realised the answers of research questions. Finally, the outcomes of this study can be generalised for future mobile technology adoption in medical education elsewhere given this research outcomes as the jump start.

In summary, it is feasible to incorporate PDAs into a PBL-approach to medical education by starting with four basic functions and taking two important aspects (technical and practical aspects) under consideration.

**Limitations**

On the other hand, there were several *limitations* of this study. Firstly, there were *limitations* on data collection in both the interview and the web-based survey. This study was conducted at the very beginning of the GSM therefore medical students were excluded from the participant sampling. The interview participants are highly competent with technology use. However, they have yet to become experienced PDA users in a PBL-medical curriculum context. This is because the GSM is newly established (it just started its medical program in 2007).

On the other hand, the web-based survey was *self-reported information* (*Kelly and Gennard 2001*). The respondents were a typical group of experts
in both the medical profession and in medical education, who already have experience of PDA use. The respondents rated each item according to their feeling, opinions and experience. In addition, these groups of respondents were already keen on technology and PDA use.

Further, the number of the web-based survey respondents was too small to perform additional statistical analysis, for instance factor analysis, to identify the impact of each factor which might influence the incorporation of PDAs into a PBL-medical education.

Finally, this study was focused around PDA device while other mobile devices in particular iPhone, iPad etc. were not launched at the time of conducting this study.

10.2 Recommendations to consider for future research

The followings are recommendations for future research regarding (i) information privacy of health information stored on PDA devices and (ii) evaluation of students’ outcomes in learning medicine by using PDAs.

1. Ensuring privacy and confidentiality of health information stored on PDA devices

There are policies to ensure information privacy of health information such as Privacy guidelines and Health Record Information Privacy Acts that is to be applied. However, mobility and connectivity of devices through Bluetooth and wireless applications will increase the risk of information security. Therefore studying how to maximise privacy and confidentiality of health information stored on PDAs would be an added value.
2. Evaluation of PDA use in medical education based on learners’ perspective

The longitudinal study can be conducted to understand the students’ learning outcomes of PDA use and its functionalities (e.g. clinical-log, reference, communication and PIM functions) during their medical study. This study could enhance the understanding of the incorporation of PDAs in medical education, benefits and constraints based on students’ perceptions.

3. Students culture in learning medicine in the 21st century

Medical culture is the shared understanding and perceptions among the medical professions as well as using the technology in diagnosing and treating patients (Becker, Geer et al. 1977). Students then later encounter and experience in such culture in various ways, especially when the technology can accommodate them in learning and also facilitate doctors in practicing medicine. Students’ culture in learning medicine can be absorbed by a number of ways, for instance, medical faculty, physicians, healthcare staff in the affiliated hospital with the medical school, etc.

Technology plays a major role in daily life as well as in medical education. These days, number of new technology have been applied and used in practicing and learning medicine. Such technology may affect the students in learning medicine somehow. For instance, teaching methods may be changed according to the available technology which could affect to the students’ learning style. The observational filed-work method would enhance the greatest opportunity to discuss what the important elements are for students in learning medicine in the 21st century.
Reference


Dyck, T. (2002). Adaptivity Takes New Path to PDA App Development; Mobile application developers face tough choices deciding which mobile hardware is the best strategic platform and how to deal with the network connectivity problems that plague mobile workers. eWeek. New York. 19: p.46.


Martins, H. M. G. and M. R. Jones (2005). "What's so different about mobile information communication technologies (MICTs) for clinical work


Appendix A
### Appendix A: PDA software applications for PalmOS and PocketPC

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Appendix D
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Appendix E
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Appendix F
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Appendix G

Excerpt from Coding, Nvivo Node Listing
Appendix G: Excerpt from coding, Nvivo node listing

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Considerable factors about PDA-based real-time data collection:

- Cost
- Technical aspect
- Data synchronisation
- Data updating methods

Network coverage

Other concerns

Time

Frequency of data synchronisation

Possible and appropriate data synchronisation

Off-campus network connectivity:
- Network computer via docking station
- Telephone network
- Wi-Fi

On-campus network connectivity:
- Bluetooth
- Wi-Fi

Uncovered network areas

Network connectivity strategy

PDA platform and interoperability

System maintenance and support:
- Backup plan
- Maintenance and problem-solving
- Maintenance and support plan for PDA

Hardware support

Software support

PDA and DB server

PDA application and troubleshooting

Concerns:
- Technology comfort
- Medical faculty degree of
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