THE USE OF HANDHELD DEVICES TO ENHANCE THE ORIENTATION TOWARDS LIFELONG LEARNING: THE CASE OF MEDICAL STUDENTS FROM TWO UNIVERSITIES IN LEBANON

A Thesis
Submitted in partial fulfillment
of the requirements for the degree of
Master of Arts in Education

By: Hany Nabih Hachem

Department of English, Translation, and Education
Notre Dame University – Louaize
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Mobile Lifelong Learning and Medical Education

Department of English, Translation and Education

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Dedications

I would like to dedicate my thesis in loving memory of my Father, Nabih, and my Grandmother Ramzieh, who have made me the man I am today. May their spirits watch and bless every step I venture in.

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Hany Nabih Hachem

Abstract

Lifelong learning is the process of assessing and recognizing one's educational needs, with an intrinsically-driven purpose of continuously satisfying these needs, using proper tools. The process is deemed as crucial to medical education, by high medical authorities. Mobile learning, in medical education, offers a wide spectrum of benefits to students, educators, and the learning process in general, including the enhancement of lifelong learning and problem-based learning skills. In Lebanon, little research has been done on mobile learning in undergraduate medical education, with no existing empirical evidence connecting both lifelong learning and mobile learning. This study hypothesized an association between the orientation towards lifelong learning and using handheld devices in clinical settings. The Jefferson Scale of Lifelong Learning for Medical Students JeffSPLL-MS measured the orientation towards lifelong learning in a sample of 480 undergraduate medical students. In addition, the study's questionnaire was adapted to investigate the usage patterns of mobile devices in the Lebanese context. From students who received the survey, 156 medical students representing two medical schools in Lebanon, answered it. Results showed a statistical significance ($p=0.011$) between the orientation towards lifelong learning and the use of mobile devices in clinical settings. It was found that the use of handheld devices in clinical settings could support lifelong learning. Cohort studies can be conducted to assess pre- and post- treatment orientation levels towards lifelong learning, in function of a structured training program on efficient use of mobile devices.

Keywords: *Orientation towards lifelong learning, undergraduate medical students, handheld devices, smart phones, mobile learning.*

Chapter 1: Introduction

Medical Education prepares health professionals, who treat illnesses, which are major threats to the life of humans. In addition, the economic importance of medical education lies in producing competent healthcare professionals such as physicians and physician aids personnel. In the United States, medical care consumes approximately $1.2 trillion annually, which constitute 14% of the country's national gross domestic product, and involves 250,000 physicians, almost 1 million nurses, and countless other healthcare providers (Gorman, Meier, Rawn, & Krummel, 2000). Mobile devices improve healthcare delivery and are widely used by clinicians during the delivery of care for accessing up-to-date medical references, especially drug formularies (Garritty & Beng, 2006); a large number of medical professionals own I-phones and other mobile devices. Moreover, an increasing number of medical professionals are bringing their mobile devices with them to the hospital, while medical residents and students are increasingly operating their handheld devices to make use of their educational benefits (Chu, Erlendson, Sun, Alva & Clemenson, 2012).

In Lebanon, seven faculties of medicine currently exist. Each year around 420 medical graduates finish their undergraduate studies; hence, currently the population of Lebanese medical students is 1,680. Medical education starts after acquiring a BS in Sciences or Arts, and after having passed the MKAT standardized examination. Being a physician is one of the most favorite and respected professions, in Lebanon.

Medical education seems not to attract the attention of curriculum designers and educational technologists, who specialized in educational sciences. Rather, it is governed by physicians, who most probably did not acquire backgrounds in the pedagogy of medicine.

Lebanon is considered a medical heaven in the Middle East region, due to the quality of medical education it offers. Yearly, each medical school introduces to the Lebanese labor market around 60 new medical graduates. Annually, 420 graduates face two choices, either stopping after seven years of medical education or venturing further into specialization.

Problem Statement

Facing new medical knowledge. Health professionals are faced with new information, on a daily basis, while knowledge is expanding in an exponential manner. Studies reported a lack of access to information by physicians, who frequently use mobile devices; the main reason for the lack of access remains the illiteracy in using these devices efficiently. Lebanon's brain drain, of Lebanese medical graduates, is partly caused by prevailing teacher-centered approaches to learning and the absence of innovative learning techniques; this jeopardizes Lebanon's chance in competing on the international medical education scene. In Lebanon, research on mobile learning in medicine is shy, while it has been conducted amply worldwide.

The world is witnessing an explosion of information, transforming the 'Space Age' into an 'Information Age'. This made knowledge readily available to everyone. Experts estimated that knowledge doubled every 3 to 10 years, depending on the field of study (Duyff, 1999), however, in the medical field, the number of clinical trials rose from 500 annually in the 1970s to more than 10,000 in the late 1990s (Chassin & Galvin, 1998). Although, these references date back to past decades, they highlight the exponential growth in medical developments and they suggest a continuation of this increase till nowadays. Medical students and staff are required to be equipped with skills allowing them to assimilate considerable new information during their studies, especially with the need for evidence-based practice. To highlight the latter, the General

Medical Council (2009) recommended that medical students must develop skills for lifelong learning to maintain their knowledge updated.

Being up to date in terms of knowledge is challenged by the exponential growth of information, but supported by its availability to everyone, including medical students. According to educators, authorities in medicine and the general public, the most crucial capacity to everyone is lifelong learning. Promoting lifelong learning as, "continuous, collaborative, self-directed, active, broad in domain, everlasting, positive and fulfilling", seems to be problematic and challenging to educators (Collins, 2009, p. 614). Lifelong learning consists of "setting goals, identifying learning resources and reflecting and evaluating the learning process" (Collins, 2009, p. 614). This process "When applied to physicians greater participation in self-assessment, peer assessment, evaluation of performance and documentation of practice-based learning, and mostly learning at the point of care, will certainly be needed" stated Collins (2009) (p. 616). Moreover, Grant (2002) implied that continuous learning, maintaining knowledge and lifelong learning are major responsibilities of physicians. The motivation to assume such responsibilities is executed by identifying learning needs during clinical practice in daily routine encounters with patients and colleagues. Furthermore, Harrison, Reeve, Hanson, and Clarke (2002) indicated that "in contemporary conditions learning becomes not only 'lifelong', suggesting learning as relevant throughout the life course, but also 'life-wide', suggesting learning as an essential aspect of humans' entire life experience, not just that which we think of as 'education'" (p. 1). The life-wide contextual learning invites researchers to speculate on challenges like, how, why, where and with whom learning occurs.

Lack of access to information. Although knowledge is growing rapidly and is readily available to health professionals, there is a lack of access, by health professionals, to medical information and resources, and the lack of access is highly linked to low quality of healthcare (Chang, Ghose, Littman, Anolik & Kovarik, 2012). It is recognized that mobile devices have a potential benefits on patient care and medical education by offering easy and fast access to information (Chu, et al, 2012). The use of handheld devices in medical practice and education is in line with the General Medical Council's requirements (General Medical Council, 2009) and is considered of great benefit to both teachers and students (Ellaway & Masters, 2008). Mobile devices then are the tools, through which better access to information is guaranteed to counter effect the sub-optimal level in delivery of healthcare.

Physicians' lack of handheld devices skills. The use of mobile devices is wide and spread among physicians, students and residents; however, there is evidence that physicians do not have the needed skills to self-assess their own learning (Bandara & Calvert, 2002; Davis, et al, 2006; Eva & Regehr, 2005) facilitated by handheld devices. The necessity of promoting reflective practitioners is suggested a long time ago by Dewey (1993), but methods so far to produce reflective physicians are still elusive.

Limitations of current research. Cheung and Hew (2009) conducted a thorough review of research methodologies used in studies on mobile handheld devices in K-12 and higher education settings. Results concluded four major limitations. Previous research had weak experimental and design structures, and lacked control groups mostly. In addition, research lacked reporting sizes' effects in the results or discussion section, especially when a small sample could not lead to generalizations. Half of descriptive research studies based their findings primarily on self-reported data. Above and beyond, the majority of the studies, 56% were limited in their duration, ranging from as short as a few hours to one semester.

Competition with foreign schools of medicine. A significant number of Lebanese medical graduates are able to join postgraduate training programs in both Europe and the United States. There, the concepts of lifelong learning and self-directed learning are more developed and undergoing extensive research especially with the hypothesized positive impact of mobile technology on medical education. For instance, USA, New Zealand, Sweden, Israel and Peru are examples of countries, where research on handheld devices is established; spending time and resources on research tackling handheld devices in medical education suggest the importance this topic occupies, across the globe. In case Lebanon wishes to compete with occidental countries in the field of medical education, it has to foster more research on this topic.

Teacher centered approaches to medical education. Traditional Lebanese medical curricula cannot make space for concepts like lifelong learning, especially when teacher-centered approaches to education, are still being used. McGaghie (1978) emphasized the importance of medical education being an integrated set of knowledge, skills and attitudes that should be used to treat a patient and not his/her disease. This might not be the case in Lebanon, especially when subject-centered and 'integrated' curricula are still adopted. Pressure is put on clinical educators to meet student-driven approaches to learning and assume positions of role models to their students, who expect a positive impact on their academic and professional career choices (Donner & Bickley, 1993; Grow, 1991; Yazigi, Nasr, Sleilaty and Nemr, 2006). The proposed change in pedagogical approaches needs not only commitment from educators and learners, but requires tools such as handheld devices, representing aspects of newly introduced mobile technology to hospitals and medical schools (Spencer & Jordan, 1999).

Mobile learning absence from Lebanese medical education. One study by Daher and Awada (2007), entitled 'The usefulness of personal digital assistants Palm and Pocket PC in the medical field' was conducted in Lebanon. Since 2007, no other study was published on handheld devices; this suggests a lack of research on this topic. Nevertheless, Daher and Awada (2007) showed that out of 303 medical personnel, who completed the survey, personal digital assistants PDAs possession rate was 30.36%. One third of the sample reported not using PDAs efficiently, based on frequency and types of usages. The study by Daher and Awada (2007) concluded that the use of handheld devices in medicine is not exploited enough. Possession of handheld devices does not mean proper use or even expressing positive attitudes towards the device. Namely, training is lacking when it comes to efficient educational use. The mere use of medical applications when on duty suggests a readiness of health professionals to use their devices for education and problem solving purposes, however, with proper training.

Brain drain of lebanese medical graduates. The lack of research on methods to improve medical education is reflected, as well, by the brain drain among Lebanese medical graduates. Lebanon had the highest physician emigration factor in the Middle East, and the seventh highest in the world (Akl, 2007). Akl (2007) conducted a qualitative study on Lebanese medical students in order to discover underlying reasons behind their emigration to seek foreign education and specialty training programs. The study found many 'push and pull' factors, as Akl (2007) elaborated. Under the category of clinical training, students complained from an insufficient exposure to educational cases, training in procedural skills, autonomy and inability to practice theoretical knowledge, standards of care and continuity of care. On the teaching level, students voiced out concerns about weak institutional and personnel commitment to teaching, in addition to the absence of an explicit curriculum, with a lack of governmental accreditation and supervision. In addition, students complained of unorganized and non-required continuous medical education, a structured form of lifelong learning.

Authorities in medicine recognize the necessity to introduce lifelong learning to medical education. Meanwhile, health professionals around the world, although, they use mobile devices at the hospital, they experience a lack of access to an exponentially increasing medical knowledge, which leads to a demoted healthcare quality. With the lack of skills to self-assess their knowledge, the need for health professionals to be updated is widely recognized. Mobile learning, through mobile devices, enhances lifelong learning, hence, access to information. Nonetheless, empirical research on the subject is still indecisive and incomplete. Lebanese schools of medicine, which thrive to remain leaders in the region, do not lead research on mobile learning in medical education, and still foster curricula, which do not promote it. The main reasons to the brain drain among Lebanese health professionals are the lack of explicit curricula and weak structured lifelong learning programs, when available.

Purpose of the Study

In an attempt to address the different facets of the problem statement, this study aimed at finding an empirical association between lifelong learning and the clinical use of mobile devices in a sample of Lebanese medical students. The study offered recommendations based on results, existing literature and the local context, to pave the way for in-depth research on the benefits of mobile learning in Lebanese medical education.

Study Variables

I chose to study two main variables, in addition to other minor variables. The main variables were the use of mobile devices in clinical settings and the orientation towards lifelong learning. Other variables like academic year, handheld devices possession rate, date and duration of acquisition, type and brand, frequency, expertise, venues and pattern of use, types, purposes and barriers to used applications and availability of wireless connection were investigated as well. The goal behind studying these variables was to investigate the different effects they have on lifelong learning. The variables in question were used to support the study's main hypothesis in addition to five research questions.

The choice of all variables was quantitative and based on an extensive literature review, which was elaborated upon and analyzed in chapter 2.

Chapter 2: Literature Review

In chapter 2, I presented and analyzed existing literature on lifelong learning, mobile learning, handheld devices, in addition to their benefits and limitations. Moreover, I highlighted empirical studies on possession rate, and different educational uses of mobile devices and embedded applications.

Lifelong Learning

The education of healthcare professionals, both present and future, is largely mired in the one hundred-year-old apprenticeship model best qualified by the phase 'see one, do one, teach one' (Gorman, et al, 2000, p 354). Medical education is deemed as the prefecture of medical schools and teaching hospitals. Large and increasing numbers of practitioners provide teaching and promotion of learning outside the traditional environment. This move towards unconventional methods is met by a consensus of most adult educators and educational psychologists, that one of the distinctive characteristics of adulthood is the willingness of individuals to assume responsibility for decisions that affect their lives. In other terms, shedding the ties of dependence and moving to autonomy. To achieve this, a person must learn the skills of independent study and be willing to use them. Brookfield (1980) and Knowles (1971) are two of many education researchers, who defended these two beliefs. The skills of independent studies and their use, as a preliminary component of lifelong learning, are stressed upon by the General Medical Council's education committee. This committee promotes an approach to undergraduate medical education and gives a perspective on its aims, which differ substantially from those of traditional curricula (General Medical Council, 2009).

In a speech given at the Assembly Hall, at the American University of Beirut, 1960's Nobel Prize winner, Sir Peter B. Medawar stated "... now professional education has one important characteristic, which sometimes is overlooked in the course of abstract general discussion. It works. It doesn't work perfectly, but nevertheless it works in the sense that universities of the world do in fact, turn out capable and responsible lawyers, teachers, doctors and engineers" (Sarrouf, 1967, p. 19). Medawar claimed that the "general theme of liberal education is to form ambitious men who are nourished by a wide sensibility and above all, men of judgment" (p. 20). Such individuals are able to cater to their educational needs, on their own, harmoniously with the concept of lifelong learning. To become a full fledged physician an individual has to go through a process called medical education. It is a continuum consisting of pre-medical courses, undergraduate medical education, general clinical training, specialist or vocational training, subspecialty training, and lifelong learning.

Forms of lifelong learning. According to Mocker and Spear (1982) four distinguished forms of lifelong learning exist; they are formal learning, non-formal learning, informal learning and self-directed learning. This study, in particular, dealt with self-directed learning, under which, Tough (1971) and Cross (1981) place approximately 70 percent of all adult learning projects. Therefore, self-directed learning and lifelong learning were used interchangeable in this study.

Definitions of self-directed learning. Broadly, self-directed learning advocated that the learner decides what and how to learn, but other decisions, such as when, where to learn and how much to learn, at any given time, are less tangible. The learner has the choice to reject, add, or change resources at will. S/he can also decide to continue or terminate the learning project, and determines the satisfaction of the outcomes (Mocker & Spear, 1982). I selected many definitions of self-directed learning, as found in the literature, and presented them in a chronological manner.

Tough (1971) and Cross (1981) claimed "Self-directed learning, represents the ultimate state of learner autonomy, whereas, the learner exercises control over and major responsibility for choosing both the goals and the means of the learning". In parallel, Knowles (1972) called lifelong learning "A process by which individuals take the initiative, with or without the assistance of others, in diagnosing their learning needs, formulating learning goals, identifying human and material resources for learning, choosing and implementing appropriate learning strategies, and evaluating learning outcomes" (p. 18). The difference between the first two definitions is the element of evaluation of learning outcomes, based on which the learner will either use same strategies or develop new ones.

Thirteen years later, Brookfield (1985) said that lifelong learning "Has connotations of autonomy, independence, and isolation. The self-directed learner pursues learning with a minimum of assistance from external sources. Individual control over learning is often claimed to be the distinctive characteristic of self-directed learning". Eight years ago, Hojat, Veloskim, Nasca, Erdmann and Gonnella (2005) defined lifelong learning as "A set of self-initiated activities and information seeking skills that are activated in individuals with a sustained motivation to learn and the ability to recognize and address their own learning needs". Based on previous definitions, self-directed learning, was defined consistently with the following components, self initiated activity or behavior; recognition of needs, or needs assessment; addressing needs accordingly, by choosing adequate means. The study's operational definition of self-directed learning was *any intrinsically driven learning activity or behavior, exhibited by students, after assessing and recognizing their educational needs, with the purpose to* *continuously address them, using adequate tools*. Adequate tools could be then mobile handheld devices.

In support of my operational definition, Yuen Pan (1997), proposed a cycle of lifelong learning, called Desire, Ability, Means and Need, DAMN. DAMN illustrates the process of lifelong learning through its three components, the ones mentioned in my operational definition. When the need to learn arises, the question that follows pertains to the desire and willingness to pursue the fulfillment of these needs. The will is conditioned by the ability to learn, and finally the means and methods, which help better address the needs. The three elements are at the core of lifelong learning, a process that students, mainly medical students are subjected to routinely, in clinical settings.

Lifelong learning: a solution to life challenges. In this section, I illustrated the commonality of challenges to humans, and the uniqueness of the significance of lifelong learning as the solution. The universal applications of lifelong learning can address life challenges. Lengrand (1970) wrote "existence has always meant for man, for all men, a succession of challenges" (p. 11). He summarized these challenges, and proposed lifelong learning as a means to overcome them. I chose the most relevant ones, namely acceleration of change, evolution of scientific knowledge, and information. These challenges are better resolved with lifelong learning. Challenges still exist and lifelong learning is still considered as a key solution. On November 15, 2006, the European Union approved decision No 1720/2006/EC, which established an action program in the field of lifelong learning, with the purpose of resisting to daily challenges. The main aims of this program are contributing to the development of quality lifelong learning and to promote high performance, and innovation; helping improve the quality, attractiveness and accessibility of opportunities for lifelong learning; contributing to increased participation in lifelong learning by people of all ages; and supporting the development of information and communication technology (ICT) based resources, since they could enhance lifelong learning. International recognition of the importance of lifelong learning does not only push for better substitutes to current curricula, but it stresses on the importance of lifelong learning as a solution to life's diverse challenges. Lifelong learning is a tool to improve and enhance people's futures which start in the academic setting and extend to professional domains (Europa, 2009).

Mobile Learning

If ICT can enhance lifelong learning on a societal scale as suggested by Europa (2009), mobile learning might be able to fulfill the same purpose in medical education. There is a general excitement with trying new technologies. Studies showed that introducing new forms of technology pushes students to spend more time working on studied subject matters, compared to time spent on other subjects. Moreover, overall students' results become higher, when using new technology; ICT lead students and teachers, alike, to train their creativity (Trifonova, 2003).

Definition of mobile learning. In the previous section, I have pointed at a link between mobile learning and lifelong learning. What follows is a set of definitions which put mobile learning in its context, with relation to distance learning and e-learning. Then mobile learning was defined, and a conclusion was reached on the necessity of considering the human factor as the main driver of mobile learning.

Georgiev, Georgieva and Smrikarov (2004) stated that distance learning enclosed internet learning, which in its turn gave place to mobile learning, considered as well a form of distance learning. Ellaway and Masters (2008) defined e-learning as "the use of internet for education".

However, they elaborated, by not limiting it to a simple broadcast of electronic information to students via the internet. Rather, it is a learning experience that entails flexible, engaging and learner-centered pedagogical approaches that include interaction, collaboration and asynchronous communication, through handheld devices. Murray and Oclese (2011) defined m-learning as "the ability to learn everywhere at any time, without permanent physical connection to cable networks" (p. IV.28-2). Using mobile devices, such as PDAs, cell phones, portable computers and tablet PCs, provide the ability to connect to other computing devices. Moreover, Quinn (2000) and Pinkwart, Hoppe, Milrad and Perez (2003) defined m-learning as "e-learning that uses mobile devices". The majority of educational technology scholars, whether actively or passively, applied a definition that views mobile learning, as learning connected to a mobile device. It could be a regular mobile phone, a smart phone or other handheld devices, enumerated in the following section.

Although, mobile learning is defined as internet learning with a mobile device, it is thought by Dix, Finlay, Abowd & Beale (2004) that the definition of mobile learning should not be 'constrained' to learning through mobiles. It must focus on the human factor, more than the device itself. The success of mobile learning is human dependent (Dix, et al, 2004). It is not enough to use a system; people must want to use it in the first place. The focus on the human factor is the backbone of mobile learning, which allows learners to freely move in physical and virtual environments, to collect information and knowledge according to their needs. Mobile learning offers educational information and makes possible the exchange of such information between students and teachers (Dix, et al, 2004). In order for the latter to happen, pedagogical approaches to learning must be shifted towards student-driven and not teacher-centered, especially when learning is conditioned by an intrinsic independent motivation, with reference to the operational definition of the study. Lifelong learning requires tools to attain desired goals; mobile learning offers tools and devices to serve desired goals.

Handheld devices. The Information Age has changed virtually every facet of our lives, presumably in a positive way; now, people search for information and find answers in a matter of seconds. Answers to questions are readily available at anytime, anywhere, and knowledge is no longer restricted to a physical setting, however, to a handheld tool. Medical education has been hit by the wave of information technology witnessing increasing developments since 2010, despite its unsure effects. Medical students are using CD-ROMs and small drives that could be operated anywhere and at any time, instead of heavy books (Joshi, 2009). Recent news reports show an increasing use of mobile devices and smart phones by young age groups, with facilitated access to the internet and medical applications, such as drug dosage, medical dictionaries, drugs side effects e-manuals, podcasting etc (Ozdalga, Ozdalga and Ahuja, 2012). Ofcom (2011) presented new information on medical topics readily accessible via the internet and handheld computers such as palmtops, PDAs and smart mobile phones (Joshi, 2010). This led to a shift in the choice of technology in the classrooms, from a frequent use of computer labs, to more frequent and essential use of computing technology; this transition was facilitated by handheld devices (Soloway et al., 2001; Tinker & Krajcik, 2001).

Educational functions of handheld devices. Wallace, Clark and White (2012) defined a mobile computing device as "a handheld device, which provides constant connection to the internet via email, text messaging, video conferencing and social networking software, often integrated with additional functions such as a camera" (p. 2). This device could host applications, defined as "programs developed to run on a device for a specific purpose" (Wallace, et al, 2012, p. 2). Moreover, applications of mobile learning target students from K-12 to higher education and from formal and informal, to classroom teaching (Park, 2011). The types of mobile devices were categorized by Murray and Oclese (2011) into notebooks, which simulate the abilities of desktops, yet are still expensive; tablet PCs, which have the full range of abilities of a personal computer, however relatively expensive; cellular phones used only for voice communication and text messaging; and smart phones, hybrid devices, combining abilities of regular cell phones and PDAs. These devices are being used by medical students on a daily basis, for information seeking activities, bedside learning and problem based learning. Sharples (2000) supported the different uses by highlighting important characteristics, giving mobile devices high popularity among medical students. Handheld devices are highly portable, individual, adapting to learner's abilities, needs, knowledge and learning styles, unobtrusive, available anywhere, persistent, useful, and intuitive. These characteristics facilitate social and educational uses of technology. Such uses lead to a positive interaction, between humans and the device itself (Koschman, 1996). Koschman (1996) proposed three different roles computers can assume. The most relevant one is mobile device as a 'tool', with teachers, activities and teams of students being the loci of control; the computer is only a mediating device that is, neither in control nor the controlled object.

Advancements in mobile learning. In this section, I highlighted advancements in mobile technology; meanwhile, older technologies like computers are becoming less needed. Keegan (2002) claimed that "mobile learning is a harbinger of the future of learning" (p. 9). The competition, between mobile technology and computers, seem to be more and more uneven. Four billion cell phone users are spread disproportionately around the world; this figure outweighs the market share of traditional computers, facing fierce rivalry from handheld devices (Hendery, 2009). In the year 2014, smart phones are expected to monopolize the cell phone market, exceeding by far computers' market share. This is a glimpse on the future of mobile learning, and how smart phones, could form one important stake to medical mobile education (Hendery, 2009).

Young people are often constantly connected and using their device became an essential part of their life, to the point, where the device is regarded as an extension of the hand (Weilenmann & Larsson, 2001). The following quote elaborated on the evolution in technical aspects of handheld devices, which give mobile learning the required flexibility to enhance lifelong learning.

> In 2006, neither the iPhone nor low cost 3G netbooks existed, wireless connectivity speeds were limited to first generation 3G. The mobile Internet was limited to WAP enabled sites, Google's mobile suite of tools were immature, media-rich smart phone applications required Java implementation across a wide range of different interfaces. In 2009, over five billion songs and 1.5 billion iPhone applications including medical applications have been downloaded from the iTunes store, within a year of the opening of the iTunes App Store, with a catalogue of over 65 thousand applications available. The majority of students owned at least a cameraphone capable of mobile blogging, recording and uploading video to YouTube, email, and browsing the internet. Smart phones have matured into feature-rich miniature multimedia computers, including features such as HSPA connectivity, built-in virtual or physical keyboards for easy text entry, a high resolution digital still and video camera, a GPS, high capacity memory storage, high resolution touchscreen user interfaces, and a wide variety of pre-installed and downloadable applications that integrated with Web 2.0 social software (Cochrane & Bateman, 2010).

Mobile devices are improving daily, enabling physicians and medical trainees to become a predominantly 'mobile' workforce (Chu, et al, 2012). Today's learners have access to a dynamically changing repertoire of devices and services that differ in speed, processing power, monitor and other output characteristics. Keinonen (2003) stated that "new solutions are utilized in ways that never even occurred to their designers" (p. 2), which is in line with the free and individualized aspect of using handheld devices. Low pricing and quality competition allow greater access to mobile learning tools in developed countries, but more importantly in developing countries as well (Keinonen, 2003). Citizens of developing countries owned around one fourth of the world's mobile devices in the year 2000. By 2009, three fourth of the world's mobile devices was owned by citizens of developing countries. Low pricing and better phone quality is guaranteed by growing competition among smart phone producing companies. This allows mobile health to grow as well, an event predicted by Chang, et al, (2012) whereby, 5 hundred million people would have accessed applications of mobile health on smart phones, in the near future. Reduced pricing would allow less privileged social classes to benefit from mobile devices' educational benefits.

Meeting points: mobile learning and lifelong learning. Lifelong learning and mobile technology share more than one characteristic allowing alliance between the two concepts. Common features between both concepts could facilitate efforts to use technology to enhance lifelong learning. Table 1, by Sharples (2000), showed a strong connection between lifelong learning and new mobile technology in terms of functionalities and characteristics.

Table 1

Matching New Communications and Information Technology with Lifelong Learning

Characteristics of lifelong learning	Characteristics of mobile technology
Individualized	Personal
Learner centered	User centered
Situated	Mobile
Collaborative	Networked
Ubiquitous	Ubiquitous
Lifelong	Durable

Benefits and Limitations to Handheld Devices

In this section, I presented literature on the benefits and limitations to mobile learning. Subdivisions included advantages and drawbacks pertaining to the same characteristic. Some controversial subdivisions incorporated contradictory statements by different scholars, who, either, support mobile learning, or underestimate its educational benefits. Kukuslska and Hulme

(2007) grouped drawbacks of mobile learning into two categories, content and software applications limitations and physical environment. However, I found more subdivisions.

Affordability and digital divide. Scholars disagree on issues related to affordability of handheld devices. Particularly, Ellaway and Masters (2008), Dewenter, Haucap, Luther and Rotzel (2007) and Soloway and Norris (2001) thought that handheld devices are currently affordable. Meanwhile, Ellaway and Masters (2008) added that handheld devices seem to be less expensive than desktops, which become outdated on a term of three to four years. Meanwhile, Murray and Oclese (2011) emphasized that mobile devices are currently expensive, and unaffordable. However, above authors agreed that pricing of mobile devices is directly linked to medical students' access to these devices, irrespective of their backgrounds and socio-economical status. Authors suggested that once the problem of access is solved, the digital divide will be reduced.

Mobile applications. Medical students do not have to physically move to the computer lab to gather information on diseases, to make accurate diagnostics and prognostics. Rather, one click on handheld devices generates answers in seconds (Roschelle, 2003). Smart phones can be loaded with medical applications and additional tools to perform concept mapping, running simulations and gathering data. Multimedia have added value to handheld devices, offering features to record lectures, play podcasts and problem based learning videos (Ellaway & Masters, 2008). Multimedia also provides wide connectivity, geolocation and social networks to students and teachers alike (Cochrane & Bateman, 2010; Ellaway & Masters, 2008). Although, these applications entice educational potential, Murray and Oclese (2011) noted that students expressed difficulty when using multimedia applications. The case is aggravated with limited memory size, and the need to recharge batteries with short shelf lives. Another major problem with applications hosted on computers, remains their transferability to handheld devices (Murray & Oclese, 2011).

Social learning. Handheld devices enhance the social constructivist aspect of learning among medical students. Through knowledge sharing, using web 2.0 tools, devices give knowledge the effect of a snow ball, reinforcing conditions for self-directed learning (Rutgers, 2008). Interacting with peers allows medical students to develop collective cognitive responsibility. It offers possibilities for immediate and radical conceptual changes and correction of misconceptions (Laouris & Eteokleous, N/A). The immediacy of conceptual changes gives a dynamic character to mobile learning, which changes and adapts to fit medical students' needs (Hendery, 2009). Social learning can be faced with limitations related to ethics and confidentiality of information, which were discussed in following sections.

Portability and access to information. Medical students access electronic medical resources (Ellaway & Masters, 2008) track patients' files, diagnoses and procedures using their handheld devices, while on the move (Garritty, et al, 2006). Wallace et al. (2012) stated that portability and fast access to information form major contributions by handheld devices to mobile learning. Results of such contributions are enhancement of lifelong learning, and increase in learners' capability to physically move their own learning environment, as they moved (Barbosa & Geyer, 2005). Portability not only allows constructivist approaches to be employed, but also contextual learning; Michie, Glachan and Bray (1998) added, it is now possible to take the learning process out of the classroom into authentic environments, namely in clinical settings. On the move, random places suddenly become educational venues; a patient's room for instance becomes a potential learning space (Cochrane & Bateman, 2010). Medical students and physicians enjoy the privilege of handheld mobility, portability and reduced pocket size, reinforcing their lifelong learning skills (Ellaway & Masters, 2008).

Supporting teaching and learning. New innovative teaching and learning practices are better explored through mobile handheld devices. Student-driven learning becomes possible for medical students, and latest administrative information can be spread through mobile devices, reducing confusion between clinics, floors and classrooms (Ellaway & Masters, 2008). Moreover, smart phones play an essential role in supporting medical education in resource limited settings (Chang, et al, 2012), and improve physicians' clinical skills, learning confidence and attitudes towards patients (Vozenilek, Huff, Reznek & Gordon, 2004). Vozenilek et al. (2004) added that mobile devices increase learning opportunities and time spent on studying outside the hospital setting; inside the hospital, mobile devices increase efficiency. Although, handheld devices offer benefits to learning, according to Wallace (2012), mobile learning is challenged by concerns of superficial learning, trusting information sources and concerns about information privacy and blurring of personal and professional boundaries. "Using mobile devices is in itself a disruption to other activities" said Ellaway and Masters (2008), although this disruption is a natural part of the education process. Educational benefits for just-in-time learning and bed-side learning, enhanced by the use of handheld devices, are found to be unstable and dependent on many factors, as concluded by Vozenilek et al. (2004).

Current research suggests that teachers respond positively to handheld devices. In a study of 100 palm-equipped classrooms, 90% of involved teachers claimed that handheld devices are efficient as instructional tools. They have a positive influence on students' learning and knowledge acquisition, transcending curricula and topics (Crawford & Vahey, 2002; Vahey & Crawford, 2002). Handheld devices as instructional tools, facilitate the shift to a new student-driven approach, this however, adds more pressure on teachers and academic physicians, who were used to teacher-centered approaches to teaching. Mehta, Malligai, Sundarkumar and Kaliyadan (2007) provided a summary of the barriers, which challenge teachers during the implementation of student-driven approaches, when mobile learning is implemented. Teachers reported difficulty in moving traditional content to online platforms. Training and support on the use of handheld devices, which are lacking, are thought to be a preliminary necessity for educators. Providing personalized feedback to learners is time consuming for instructors, since mobile learning should be individualized.

Operating systems. Mobile phones and other handheld devices are operated by four main systems: Palm Operating System, Windows, Symbian OS and Blackberry OS. Application data are not compatible across two different operating systems; this sets a major drawback for medical students who opt to change their device (Ellaway & Masters, 2008). Meaning, a change in the device and its operating system leads to data loss, since it cannot be transferred to a new different device.

Physical attributes. Physical attributes of handheld devices hinder their educational benefits. Corlett, Sharples, Bull and Chan (2005) reported that students express discontent about the size and weight of their PDAs, in addition to inadequate memory and short battery life. Small devices with small screens have a limiting effect with regard to graphical applications, added Ellaway and Masters (2008). Heavy weight, inadequate memory and short battery life are frustrating to medical students (Kukuslska & Hulme, 2007), whereas, small keyboard sizes inhibit the input of information (Murray & Oclese, 2011).

Connectivity. Since the majority of medical applications requires internet connection to be downloaded and used, connectivity is a crucial component, which conditions educational benefits of devices and applications, alike. Technical barriers to mobile learning are connectivity and bad connection (Vozenilek, et al, 2004), in addition to network unavailability, low speed and low reliability (Kukuslska & Hulme, 2007); these barriers subdue the learning experience (JISC, 2005).

Optimal connectivity can be seen as a drawback to mobile learning. High and abundant connectivity is a problem to unprofessional students, when sharing photos of their patients or even their patients' cadavers (Ellaway & Masters, 2008). In addition to privacy issues, academic honesty of online students is jeopardized when excessive use of internet takes place (Mehta, et al, 2007).

Kukuslska and Hulme (2007) stated that evaluation of mobile learning is problematic because of an inescapable interaction between different characteristics like personal, contextual and situated attributes related to the learner itself. This means looking at advantages and barriers outside the context of personal use does not reflect true impacts on mobile learning. Boulos, Maramba and Wheeler (2006) concluded that research on the use and evaluation of web 2.0 tools, in health and medical education is still in the beginning, and evidence in medical education is still deeply lacking. The use of educational technology tools falls below expectations of technology proponents, who make belief that it could transform teaching and learning, when in reality the picture is more prosaic and less transformative (Becker, Ravitz & Wong, 1999). Opponents to mobile technology claim that money spent on educational technology research should be intended to study analog equivalents of today's modern media tools, especially that the current trajectory of research in educational technology did not revolutionize teaching nor learning, yet (Murray & Oclese, 2011).

Traxler (2007) claimed that advances in developing reliable applications and devices make technical limitations of mobile devices a temporary concern.

Empirical Evidence on Handheld Devices Possession Rate and Medical Education

It is not enough to own a system; people must want to use it in the first place (Dix, et al, 2004). Table 2 grouped empirical studies, which aimed at assessing possession rates of handheld devices among health professionals.

Table 2

Studies on Possession Rates of Handheld Devices

Author	Results	Location/Venue
Criswell (2000)	67% of family medicine residents use PDAs	Practice/clinical
McCleod (2003)	46% of medical students, specialists, residents and fellows use PDAs	Institutional level, hospitals or university
Vincent (2003)	36% of family medicine residents use their PDAs for log keeping and documentation	Hospital/clinical/administrative
DeGroote (2004)	61% of academic health sciences students, faculty and medical residents use their PDAs	University level/academic
Barrett (2004)	75% of medical residents use PDAs	Practice/clinical
Stromski (2005)	64% of Emergency medicine programs claim their medical residents use their PDAs	Clinical

Possession rates differed from one study to another, but studies it is a common pattern for health professionals, to own and use handheld devices in clinical, academic and administrative venues.

Empirical Evidence on Educational Uses of Mobile Devices

The following studies were conducted in different countries. Studies showed varied educational benefits of mobile learning on medical education of residents and students, as well as, on the professional aspect of medicine.

PDAs were used for lifelong learning in math education of children in a project undertaken at the Tampere University of Technology, Finland. This project concluded an association between communication through PDAs, knowledge sharing and knowledge acquisition, whereby, communication enhances knowledge sharing and acquisition (Trifonova, 2003).

HandLeR project, one of the biggest initiatives in mobile learning, was conducted at University of Birmingham. The project aimed at deeply understanding the process of learning in different contexts and exploring concepts behind lifelong learning. This project stressed on both communication and human-centered systems design, in addition to concept mapping, knowledge sharing, lifelong learning, wearable learning technologies and conversation between mobile learners (Trifonova, 2003).

Another project supporting problem-based learning was *Knowmobile,* Norway. Experiments on medical students were conducted using PDAs and smart phones, at the University of Oslo. Results, suggested that students use their devices to read information rather than retrieving it online, as predicted. Moreover, students are using their devices for communication purposes, solving problems with colleagues and for event management. The main reasons for such results are the lack of training, leading to technical difficulties faced by students.

Sandars and Schroter (2007) conducted a study on British health professionals and their uses of web 2.0 applications. They found that medical students are highly acquainted with web 2.0 applications and this acquaintance is matched with a high use. The main uses were in media sharing and social bookmarking. Health professionals show high interest in web 2.0 technologies but relay their lack of use to the absence of related training.

In a study by Ramos, Linscheid and Schafer (2003) results showed that residents have two sources of information to answer their clinical inquiries, faced during their daily encounters. Asking the attending physician is the number one option, and the second is using a pocket reference. Most searches conducted through pocket reference take less than two minutes, which is less than the time spent to reach and consult the attending physician.

Smart phones were studied as instruments to increase knowledge among African medical residents. A study conducted by Chang et al. (2012) on the uses of smart phones, loaded with point of care tools and applications, found they are effectively used by resident physicians in resource limited settings for both point of care information, at the bedside or for self-directed learning at home. Moreover, this study concluded that resident physicians learn how to effectively operate their devices for learning purposes, in no time. A project conducted in New Zealand by Jayaraman, Kennedy, Dutu and Lawrenson (2008) found that the use of mobile phone cameras significantly increase diagnostics. Mobile phones embedded with cameras are generally acceptable to patients and are of practical use when it comes to clinical practice in rural areas. On cameras as well, Zimic, Coronel, Gilmen, Luna, Curioso and Moore (2009) concluded that the use of cell-phone cameras help in shaping a better and more accurate diagnosis of Tuberculosis testing. Indurations' patterns are easily detected by images sent by remote Peruvian hospitals to central laboratories for quality assurance.

In Sweden, Vishwanath, Brodsky and Shaha (2009) conducted a study on health care personnel and students, who according to findings do not frequently use PDAs. However, evidence was found on the use of handheld devices to improve decision-making, and to enhance the learning process for both students and professionals. This study supports the claimed abilities of handheld devices to improve patient care, through immediate access to medical information.

E-Clinician project was conducted by Adusumilli, Tobin, Young, Kendall and Mahabir (2006) in the USA. This project used PDAs, wirelessly connected to the internet, in rural healthcare practice. The choice of handheld devices was governed by their benefits in enhancing access to information on emergency preparedness, improving patient care outcomes by providing PDA-based clinical decision-support tools, enhancing evidence-based care, encouraging chronic care management and health promotion and finally increasing productivity and efficiency. Wireless connections increase the use of internet-connected handheld devices, which are usually used for information access and gathering, as stated by Fontelo, Ackerman, Kim and Locatis (2003).

As tools for teaching and evaluation of medical education, mobile devices were investigated in a study by Bertling, Simpson, Hayes, Torre, Brown and Schubot (2003). PDAs are used in monitoring clinical experiences of medical students and residents, as well as teaching resources for cardiac auscultation and community health; Kho, Henderson, Dressler and Kripalani (2006) promoted handheld devices for educational purposes and patient care. The satisfaction expressed by medical students after using handheld devices is high, and is correlated to the level of handheld computer experience. Kho et al. (2006) stated that medical textbooks, medication references and medical calculators are the most dominant applications, accessed by students through their handheld devices. Mobile devices are important tools for residency training and medical school rotations, mainly in tracking patient encounters and procedures (Torre & Wright, 2003).

LaGillinghamst, Holt and Gillies (2002) claimed that handheld devices became as important as the stethoscope. PDAs and handheld devices ensure the transition of medical care, from paper-based operations to paperless wireless processes. LaGillinghamst et al. (2002) categorized mobile healthcare applications into five groups, reference/text book, calculator, patient management/logbook, personal clinical/study notebook and utility software.

Although, the use of PDAs is high, among 94% of residents and 79% of faculty, the pattern of use is either stable or increasing. Morris, Church, Vincent and Roa (2007) discussed some of residents' and faculty members' complaints when using their devices. Time and knowledge to operate the device are both lacking.

Israeli residents, when provided with subsidized handheld devices, reported a negative perception of used devices. Meanwhile, residents who had self-paid devices appreciated using their devices for record keeping, medical reference and clinical calculations (Jotkowitz, Oh, Tu, Elkin, Pollak & Kelpen, 2006).

Other researchers conducted studies of experimental design. Davis, Mazmanian, Fordis, Van Harrison, Thorpe and Perrier (2012) grouped 128 healthcare trainees, randomized into control and experimental groups. The treatment consisted of a three-minute movie on chest-tube insertion on I-pods. The assessment evaluated case presentations done by trainees. Results suggested that trainees of the experimental group performed better.

Twenty two, fourth year medical students were randomized into a control and an experimental group, in a study by Tews, Brennan, Begas and Treat (2011). They examined the effects of a treatment, consisting of three preloaded clinical instruction videos, prior to patient encounters. Evaluation was based on case presentations, and results led to concluding that 80% of students prefer a quick review via video rather than text, prior to a patient encounter.

Tanaka, Hawrylyshhin and Maccario (2012) from Stanford University, studied i-pods in teaching anesthesiology in an orthopedic rotation, with nine participating medical residents supplied with course materials such as a syllabus, rotation objectives, reading assignments and journal. I-pods were viewed as helpful educational tools. Rotation goals were more easily understood and recognized at the end of the rotation. Chang et al. (2012) performed a study on seven resident physicians, who were given 3G smart phones preloaded with point-of-care applications, such as *Ucentral, Skyspace, ePocrates*, as well as clinical decision making resources, like *5-Five minutes, Clinical Consult,* and *Dynamed*. The sample was surveyed for comfort level, frequency of use and used applications. Six participants were initially unfamiliar with smart phones, but after eight weeks they were comfortable with using them. In general, smart phones are used for supplementary reading outside of the hospital clinics. Patel, Chapman, Luo, Woodruff and Arora (2012) studied 115 internal medicine residents and generated results showing an increase in objective and subjective efficiency among participating residents. Results were based on treatment consisting of supplying participating residents with i-pads enabling access to medical records, journal articles, and paging systems. Pre-study and post-study surveys depicted an increase in efficiency.

Other health professionals like midwives and nurses were studied as well. Eight midwives enrolled in the new infant physical examination module, were given i-pods preloaded with reusable learning objects, which included educational videos on physical examinations. The majority of the sample claimed devices are easy to use and transport. Clay (2011) concluded that i-pods are conducive to individual learning styles.

PDAs and physical books were distributed to 40 novice nurses practitioners, divided into two groups based on the type of treatment. Clinical scenarios were supposed to be elaborated on, by assessing appropriate laboratory values, diagnosis and medication decisions, using the assigned resources. Participants were evaluated on exhibited accuracy and efficacy, in analyzing the scenarios. Results showed, as per Krauskoph and Farell (2011), the absence of a significant difference between the accuracy of the two groups; however, PDAs assisted group was more efficient on the six efficiency variables measured.

In Table 3, Chu et al. (2012) described a number of applications used by anesthesiology residents during their rotations. The educational usages of these applications could reinforce lifelong learning skills.

Table 3

Anesthesiology Applications and their Educational Uses

Application name	Educational usage
BGA journals	An application to quickly access and read anesthesia journals. With search functions and bookmarking.
Pedi anesthesia	Simplified pediatric anesthesia, by having pre-calculated drug doses for patients from 1 to 40 Kgs.
Crisis code	Taught physicians, the principles of crisis management for advanced cardiac life support and how to provide ACLS in cases of cardiac arrest.
Peds anesthesia	Anesthesia-specific medications dosages were automatically calculated for the given patients' weight.
Anesthesia quick reference	It included lists, charts, checklists, guidelines, for anesthesiology and pre-operative issues.
Handbook of pharmacology	Provided quick access to information about the pharmacology of commonly used anesthetic agents. Provided detailed information on pharmacology, mechanisms of action, physiologic response, indications and contraindications.

Edudemic.com is a website that links education to ICT; it enumerates the top ten most useful applications on i-phone, by medical students. Medscape Mobile is an encyclopedia filled with thousands of medical articles. It is an extensive database of pictures and information about diseases. MedCalc is a medical calculator with embedded pre-existing formulas. Eponyms allows searches for needed eponyms, with relative description. Micromedex is an encyclopedia on pharmaceuticals; it provides a complete database of Canadian and US drugs, with a pill identifier feature. iRadiology contains radiology presentations. Heart Pro has a 3D design to view the human heart in any angle. ACC Pocket Guidelines made by the American College of Cardiology Foundation ACC, is a walking encyclopedia of ACC textbooks; in addition to many other applications providing help and support to medical students, on the move (Edudemic, 2013).

A study by Hojat, Veloski, Nasca, Erdmann and Gonnella (2005) stated that clinical medical students scored better on lifelong learning psychometric test JeffSPLL-MS, then their pre-clinical fellows, with a significance of ($p<0.01$).

Health professionals, including medical students are using handheld devices during their professional, academic and personal aspects of their daily routine. The increasing number of international studies, investigating the educational benefits of such devices, highlights the importance that mobile learning is assuming on the medical education agenda.

Empirical Evidence in Lebanon

Only one study dealt with the use of PDAs in Lebanon; it was conducted by Daher and Awada (2007) in Hotel Dieu de France, a teaching medical center affiliated with Saint Joseph University. This study showed that out of 303 medical personnel, who completed the survey, the PDA possession rate was 30.36%, significantly higher among physicians compared to surgeons. One third of the sample reported not using their PDA efficiently, based on frequency and types of usages. Among none-PDA users, 67% did not know which device to choose, 57% preferred using another device, 55% didn't know the utilities of PDAs in the medical field, 26% did not have the patience for such a technology, 25% thought that the cost/benefits factor was not significant, 14% thought it was a waste of time to own such a device and 22% considered it as a financial burden. Other findings showed that 'Lexi-Drugs' was the most used pharmaceutical guide; 'Sanford Guide' was the most used microbiological guide, while 'iSilo' was the most used medical electronic textbooks reader. More than 85% did not use their PDAs for patient follow-up, nor reading medical journals (Daher & Awada, 2007). One third of the sample, who used PDAs, claimed they reduce medical errors. Sixty to eighty percent of the sample considered the following as great needs: computerization of medical data, installation of wireless network and courses on the use of PDAs in for educational and medical purposes.

On functions of mobile devices, many scholars led different studies to investigate an existing relationship between the use of mobile devices, in specific settings and conditions, and enhancement of self-directed learning, however, without measuring lifelong learning as a psychometric entity, as I did in this study.

Hypothesis and Research Questions

Based on reviewed literature, I investigated five research questions, in addition to a main hypothesis.

Barrett (2004), Bertling et al. (2003), Chang-et al. (2012), Chu et al. (2012), Clay (2011), Criswell (2000), Daher and Awada, (2007), Davis et al. (2012), DeGroote (2004), Edudemic (2013), Fontelo et al. (2003), Jotkowitz et al. (2006), Kho et al. (2006), McCleod (2003), Stromski (2005), Tanaka et al. (2012), Tews et al. (2011) and Vincent (2003) showed a high prevalence in the possession of handheld devices among health professionals and medical students worldwide. They dealt as well with types and brands of handheld devices, and their relative educational benefits. These studies shaped my first research question, Q1. Q1: What was handheld devices possession rate among Lebanese medical students? What brands and types of mobile devices did medical students use? The importance of this question lies in discovering the number of medical students who owned a handheld device, under which forms and brands. This reflects the prevalent interest of medical students in buying and owning handheld devices and the nature of the devices in relation to mobile learning and lifelong learning.

The following studies Barrett (2004), Bertling et al. (2003), Chang et al. (2012), Chu et al. (2012), Clay (2011), Criswell (2000), Daher and Awada, (2007), Davis et al. (2012), DeGroote (2004), Edudemic (2013), Fontelo et al. (2003), Jotkowitz et al. (2006), Kho et al. (2006), McCleod (2003), Stromski (2005), Tanaka et al. (2012), Tews et al. (2011) and Vincent (2003) studied venues where handheld devices were used, the types and pattern of use of medical applications, in addition to relating mobile learning with medical education, leading to my second research question Q2. Q2: When and where were handheld devices used? What were the most used applications, following which pattern? This question was significant in terms of investigating the contribution of mobile devices and applications to the acquisition of lifelong learning habits and skills; since, applications are supportive of this learning approach.

The following studies Crawford and Vahey (2002), Ellaway and Masters (2008), JISC (2005), Kukuslska and Hulme (2007), Mehta et al. (2007), Morris et al. (2007), Murray and Oclese (2011), Corlett et al. (2005), Traxler (2007), Vahey and Crawford (2002), Vozenilek et al. (2004), and Wallace (2012) discussed the benefits, drawbacks and limitations to using handheld devices in medical education. Such barriers have a limiting effect to enhancing lifelong learning. Therefore my third research question Q3, questioned what were the barriers to using handheld devices by medical students?

Akl (2007) studied the weak institutional and personnel commitment, as one of the main causes to the brain drain in Lebanese health professionals. Medical students look up to their physician educators, who could inspire their students to engage in handheld related activities. The lack of consistent wireless connection might limit the enhancement of lifelong learning through mobile devices, due to the dependency of the latter on the first. This could demote the experience of using mobile devices from being educational and profitable to being a burden. Hence my fourth and fifth research questions, Q4: Were schools of medicine providing free internet connection? This question investigated the effect of connectivity on the use of handheld devices, since these depend chiefly on availability of internet connection. Q5: Were physician educators using handheld devices? Were they encouraging their students to do so as well?

Hojat et al. (2005) established a statistical significance between using handheld devices in clinical settings and the orientation towards lifelong learning of medical students, with ($P<0.01$). The study's hypothesis is H1; medical students who use their handheld devices in clinical settings, have a higher orientation towards lifelong learning.

Chapter 3: Methodology

In this chapter, I explained the study's participants, design, instruments, procedure and ethical considerations.

Participants

The sample of the study amounted to 480 undergraduate medical students, who are the actual population of the two participating universities. The two universities were private and affiliated with a teaching medical center. Both of them were located outside Beirut, and adopted an integrated approach to their medical curriculum. This study intended to include all medical students in Lebanon; however, only two universities answered positively, and were recruited by the study.

The return rate of was 32.5%; thus, the study involved 156 anonymous participants divided between academic years, *M1, M2, M3 and M4,* according to the following percentages; 42 M1 students, 51 M2 students, 21 M3 students and 39 M4 students.

Medical education in Lebanon is divided into 4 academic years, two of which are labeled as basic sciences years, and the last two are called clinical years.

Design

I used a single point survey research study with a cross-sectional design. I chose this design because it is usually selected for health and health services studies, in addition to being rooted in social studies. Usually, data is collected in a standardized form, by the means of a survey. There is no attempt to neither control conditions nor manipulate variables. Such design does not allocate participants into groups, nor vary the treatment they receive. My research, being descriptive in nature, aimed at observing variables, at a single point in time, across the four academic medical education years. The most important advantage of my design is generating empirical data. Meanwhile, one limitation to this design is the inability to go deep into details of the topic being studied (Kelley, Clark, Brown & Sitzia, 2003).

Data Analysis

Data was retrieved on an excel file, from a survey website www.zoho.com, and uploaded on SPSS 20 for analysis. The following tests were used: cross tabulation, chi square and bivariate correlation tests.

Instruments

I used two instruments to achieve the purpose of this study, support the main hypothesis H1 and answer five research questions. The first instrument was a psychometric test known as the Jefferson Scale of Medical Students Lifelong Learning JeffSPLL – MS and the second was an adapted questionnaire, which I designed based on the literature.

JeffSPLL-MS consisted of 14 questions, and had a Cronbach alpha reliability of 0.77 and test retest reliability of 0.65 (Wetzel, Mazmanian, Hojat, Kreutzer & Rafiq, 2010). JeffSPLL – MS assesses attitudes and behaviors related to the orientation towards lifelong learning, exhibited by medical students. The test scoring system consists of 70 points the highest and 14 the lowest, based on a Likert scale of one to five; one being the lowest and five being the highest. Meaning a student scoring 60 on the test has a higher orientation towards lifelong learning than another student with a score of 40 for instance.

The questionnaire includes a mélange of attitudes and action statements covering all aspects of lifelong learning from theory to practice, including digital lifelong learning, represented by three questions. The orientation towards lifelong learning is reflected by the resulting numeric score. Based on a personal judgment, what follows is a repartition of JeffSPLL-MS questions into the three components of lifelong learning, as suggested by the study's operational definition of lifelong learning; *any intrinsically driven learning activity or behavior, exhibited by students, after assessing and recognizing their educational needs, with the purpose to continuously address them, using adequate tools*. The first component 'intrinsic activity or behavior' is covered by questions 1, 2, 3, 8 and 13. The second component 'assessing and recognizing educational needs' is covered by questions 7 and 10. The third component 'continuously addressing needs with proper tools' is covered by questions 4, 5, 6, 9, 11, 12 and 14, (See Appendix 1 for the complete questionnaire).

The second questionnaire was created by me and was inspired from two sources; the first by Chatterley and Chojecki (2010) and the second by Morris et al. (2007). Questions were closed ended, describing usage patterns of smart phones, namely duration, frequency and applications in addition to other key issues (See Appendix 2 for the complete questionnaire). In the two sources, handheld devices' patterns of use were investigated among residents and medical students. Chatterley and Chojecki (2010) studied the applications used by medical students and residents, whereas Morris et al. (2007) investigated the patterns of use of handheld devices in terms of frequency and other utilization variables.

Pilot testing of the survey was conducted on ten medical students, from a third non-participating Medical School. The purpose was to check its validity and to amend questions based on answers and comments from piloted participants.

Procedure

The Deans' offices at the concerned faculties of medicine were contacted to secure permission to conduct the study on medical students from year 1 to year 4. Once the deans' office permissions were granted, the questionnaires were sent to the Institutional Review Board of respective universities, and then they were sent by deans' offices to medical students via email.

Medical students received an email invitation, briefly explaining about lifelong learning, the benefits from finishing the questionnaire, in addition to its purpose and an informed consent. The email included a link to a website called www.zoho.com; students accessed the survey and filled it in. Once done, they received a thank you note, and they were given the option to contact me for more information. Students received a reminder email after one week and then the survey was closed.

Ethical Issues

Ethical considerations were of utmost importance to schools of medicines, students and I. Institutional Review Boards were approached for ethical approval on the survey, which was secured. Informed consents were clear on the first page of the surveys, as well as my contact information. Anonymity and confidentiality for schools of medicine and students alike were promised and guaranteed.

Chapter 4: Results and Discussion

In this chapter I presented and discussed descriptive statistics on collected data from 156 medical students who completed the survey. One hundred and six students belonged to one university, while, the remaining 50 belonged to another. The distribution of medical students per academic year was as follows, 42 M1 students, 51 M2 students, 21 M3 students and 39 M4 students.

I answered each research question separately, presented its relative findings, discussed them by comparison to literature and proposed potential explanations for findings.

H1: Medical Students, Who Use Their Handheld Devices in Clinical Settings, Have a Higher Orientation towards Lifelong Learning.

It was hypothesized that there would be a significant relationship between the orientation towards lifelong learning and the clinical use of handheld devices; findings, which supported my hypothesis, showed that 66.7% (n=156) of participants scored higher than 55/70, while 5.1% scored below 25/70, on JeffSPLL-MS; the mean score was 55.82, and based on it, the 55 cut off score was adopted. Students currently enrolled in the second academic medical year M2, scored higher than those enrolled in the remaining years. Out of 52 M2 students, 42% scored 60 and above on JeffSPLL-MS; M1 and M4 students in respective percentages, 38% and 40%, scored above 60 on JeffSPLL-MS, and M3 students came last, with 36% scoring higher than 60 on orientation towards lifelong learning. Moreover, 42% of students, who used their devices for clinical purposes, scored 60 and above on JeffSPLL-MS. Only 31% of those who used their devices for personal purposes scored 60 and above. Table 4, showed a cross-tabulation of medical students' scores on JeffSPLL-MS with respect to their current academic year.

Table 4

Cross-tabulation: Scores on JeffSPLL-MS and Academic year

Count

		Current academic year				total
		1	2	3	4	
Scores on JeffSPLL-MS	15	0	0	0	2	2
	22	0	0	2	0	2
	24	0	2	0	0	2
	25	0	2	0	0	2
	42	0	4	0	0	4
	44	2	0	0	0	2
	46	0	0	0	2	2
	48	0	0	0	2	2
	49	2	0	2	0	4
	50	2	2	0	2	6
	51	2	0	2	2	6
	52	2	2	0	2	6
	53	4	0	2	0	6
	54	0	4	0	0	4
	55	0	2	0	0	2
	56	4	2	2	2	10
	57	4	2	2	2	10
	58	2	8	2	4	16
	59	2	0	0	4	6
	60	4	6	0	4	14
	61	6	4	0	4	14
	62	0	0	2	0	2
	63	0	2	0	0	2
	64	2	2	4	2	10
	65	2	2	0	0	4
	66	0	6	2	0	8
	67	0	0	0	2	2
	68	0	0	0	2	2
	70	2	0	0	2	4
total		42	52	22	40	156

On the association between academic year and orientation towards lifelong learning, there was a significant relationship (p=0.000) between the two variables; this means that current results were not random, and that these two variables are not independent. Moreover, these two variables showed a moderate positive correlation 0.742.

In addition, the variables clinical use and orientation towards lifelong learning had a significant association (p=0.011), as well. The two variables had a strong positive spearman correlation of 0.901, which meant that students who used their devices for clinical uses, scored higher than their fellows who do not use their devices for clinical ends.

The study's main hypothesis was the existence of a significant relationship between using handheld devices in clinical education and the orientation towards lifelong learning. This hypothesis H1 was supported through (p=0.011) and (p=0.000) in addition to a strong correlation for the first significance. H1 was supported using two variables academic year and clinical use of handheld devices. Lebanese medical students, who were using their devices for clinical purposes, had higher orientation towards lifelong learning, than those who used their devices for personal purposes.

My results, when compared to literature, appear to be in line with previous studies. Hojat et al. (2005) reached a significant relationship between the orientation towards lifelong learning and medical students' clinical use of handheld devices.

Mobile technology supported lifelong learning, problem based learning, bedside learning, authentic learning and point of care learning, as mentioned in the following studies (Barbosa & Geyer, 2005; Laouris & Eteokleous, N/A; Michie, et al., 1998; Rutgers, 2008; Vozenilek, et al, 2004). These types of learning occurred mostly in clinical courses and were enhanced directly or indirectly by the use of handheld devices, as deduced from the statistical significance. My findings, relating clinical uses of handheld devices and the orientation towards lifelong learning are in line with studies proposing that mobile technology enhanced lifelong learning, in medicine.

Q1: What was Handheld Devices Possession Rate? What Brands and Types of Mobile Devices were used?

The purpose of research question one was to assess possession rates of handheld devices, in addition to the brands and types of these devices.

It was found that the possession rate of handheld devices, among Lebanese medical students is 98.7% (n=156). In comparison to the literature, the highest possession rate 75% was found by Barrett (2004); locally, Daher and Awada (2007) possession rate was 30.36% (n=303), in Hotel Dieu, Lebanon. My study showed that the possession rate of handheld devices among Lebanese medical students tripled over the period of 6 years, meaning that Lebanese medical students' affinity towards mobile devices increased drastically. The change was not only observed in possession rates, but with types of handheld devices, as well. Medical students reported not owning PDAs, at all. This suggested that either PDAs were considered outdated by current generation of Lebanese medical students, or smart phones were thought to be integrating all needed functions in one device; especially, since PDAs did not have calling functions.

When asked about the types of owned devices, medical students from both universities answered, with the following; I-Phone 4S, I-Pads, Samsung S3, Samsung Galaxy S4, Blackberry, Samsung S2, Samsung Tab, I-Pad mini, Samsung Note, Samsung Galaxy Ace II, HTC Chacha, I-Phone 5, Android Tablet, Sony Smartphone, Samsung S1, Nexus Tablet and HTC HD2. The reported variety in the brands and types of handheld devices could be interpreted in two ways. The first assumption is that there is no single type of handheld devices, which could satisfy different tastes and needs exhibited, by Lebanese medical students. Or the majority of brands and types of handheld devices are being used for educational purposes. The first assumption generates confusion among medical students on what types and brands of handheld devices to own, whereas, the second assumption could mean that access to educational benefits of handheld devices is guaranteed and not restricted to one type of devices. The variety found, in the types of handheld devices used by Lebanese medical students, is in line with the literature. Many studies have used I-pads and smart phones as tools to study mobile learning; for instance, Chang et al. (2012), Jayaraman et al. (2008) and Zimic et al. (2009) studied smart phones, whereas, Patel et al. (2012) studied I-Pads, as part of their research methodologies. The difference in the choice of tools could be due to studied variables, in relation to functions and abilities of mobile devices. However, one of the major limitations caused by the reported variety in used handheld devices is the incompatibility between different types of smart phones (Ellaway & Masters, 2008); this is caused by a difference in operating systems of handheld devices. The latter does not guarantee transferability of information between devices (Ellaway & Masters, 2008), had students wanted to change their device and transfer stored information and applications to a new device.

The choice of handheld devices and their embedded applications affect their abilities to serve as facilitators of learning in medical education. However, the availability of a wide variety of devices offering educational benefits facilitates the process of lifelong learning, but remains challenged with the concern of transferability of information between types and brands of devices. Moreover, the intrinsic aspect of lifelong learning could be encouraged by the lack of restrictions on devices from which educational benefits could be drawn.

Q2: What were the most Used Applications, following what Pattern? When and where were Handheld Devices Used?

The purpose of research question two was to investigate the types and purposes of mobile applications used by Lebanese medical students, in addition to timing and venues of use. Findings showed:

Medical applications. The most used applications, by medical students, were Micromedex Medscape, First Aid, MedCal, USMLE World, Epocrates, Lab Tests, Clinical Medicine, Lex-comp, Ipharmacy, Sanford, Exam Master, Antibiotics and Pubmed. Students used these applications not necessarily equally nor at the same time. Results were consistent among participants, meaning that Lebanese medical students use the same applications across academic years, and types of devices. The Sanford application was the most used microbiological guideline in the study by Daher and Awada (2007), suggesting a permanence in the use of some applications since 2007.

Even in the absence of a structured training on efficient use of mobile tools, students seemed to choose consistently their applications, which were similar to the ones studied in the literature on the most used applications, worldwide. For instance, MedCal, Micromedex, Medscape are the most three commonly used applications by medical students worldwide (Edudemic, 2013). It may be concluded that Lebanese medical students are up to date with using the latest medical applications, on their handheld devices. The variety in used applications was mentioned in LaGillinghamst et al. (2002) who categorized them according to their end uses. Table 5 showed the study's reported applications categorized according to LaGillinghamst et al. (2002) categories of applications' end uses.

Table 5

Most Frequently Used Applications, by Category

Category of use	Reference	Calculator	Personal, Clinical and study notebook
Applications	Micromedex, Medscape, Epocrates, Lex-comp and Pubmed	MedCal and Antibiotics	First Aid, USMLE World, Clinical Medicine, Ipharmacy, Sanford, Exam Master and Lab Tests

Medical students with a percentage of 96.1 browsed the internet using their handheld device, 76.62% used their device as a medical reference, while 64.94% used their device to read medical e-books. Findings showed that mobile devices are being used as medical references for finding resources and reading them online. Lifelong learning is supported by information seeking through mobile devices, which means that students performing the tasks mentioned above are practicing their lifelong learning skills. Table 6 presented the types of applications used by percentages of medical students.

Table 6

Types of Applications Used by Medical Students

Type of applications used	n=154, % of students
Drug reference	61.04
Medical education	74.03
Personal organizer	53.25
Note pad/memo	62.34
Medical reference	76.62
Guidelines	19.48
Medical e-books	64.94
Billing/coding	3.90
Patient tracker	2.60
Internet and web browsing	96.10
Camera/photo shooting	67.53
Email	93.51
Communication and social media	80.52

Furthermore, 83.3% of surveyed students used more than six types of applications, on their handheld devices. On specific tasks they perform using their mobile devices, students' highest percentage was accorded to accessing email, internet, text messaging, then came communication; Sixty four percent of students perform more than nine different tasks on their handheld devices, with the highest ranking task 96.1% being for accessing email, internet and text messages. Table 7 displayed percentages of students performing specific tasks on handheld devices.

Table 7

Tasks Performed on Handheld Devices

Specific Tasks performed on handheld devices	n=154, % of students
Access email, internet and text messages	96.10
Calendar, addresses, task management	66.23
Access rotation/course information (handouts, evaluations and schedules)	61.04
Take notes, do homework, perform other academic tasks	61.04
Access a drug reference	55.84
Perform clinical calculations	40.26
Translate a foreign language (French to English or vice versa)	59.74
Record audio, video, or pictures	67.53
Search for a different diagnosis or treatment plan	41.56
Access patient data (Lab results) or patient orders	5.19
Access a clinical reference or e-textbook	61.04
Access dictionaries	70.13
Access medical literature, abstracts, or guidelines	71.43
Communication, SMS and texting	80.52

Internet access and text messaging are integral features of social media which is seen to reinforce lifelong learning (Ramos, et al, 2003). Using handheld devices, for different tasks as mentioned in table 7, is supposed to enhance lifelong learning and problem-based learning, when students make a habit of consulting their devices every time a question arose.

In addition, 71.8% of medical students used more than six healthcare applications on their mobile devices, for clinical, educational and study purposes. Forty nine percent of medical students reported that communication applications helped them in basic sciences courses and in clinical courses, on the other hand, 51% thought it had no effect. Sandars and Schroter (2007) and Ramos et al. (2003) both elaborated on the benefits of communication and web 2.0 media on lifelong learning, an issue validated partly through my findings, as half of participants did not believe in communication's benefits to learning. The observed lack of interest in web 2.0 and communication applications could be due to the lack of training on efficient use of the devices, as highlighted by the two studies.

The more students use applications, the higher their orientation towards lifelong learning is (p=0.942); a strong positive relationship between lifelong learning and mobile learning, is established. This significance feeds into supporting the study's hypothesis H1, by adding to it that using applications, which could be of clinical nature, is directly related to an increase in the orientation towards lifelong learning, in other terms using medical applications is directly associated with lifelong learning.

Medical students use applications on handheld devices, for communication, internet access and information retrieval, in addition to many more uses, as suggested by Adusumilli et al. (2006), Bertling et al. (2003), Chang et al. (2012), Fontelo et al. (2003), Jayaraman et al. (2008), Kho et al. (2006), LaGillinghamst et al. (2002), Ramos et al. (2003), Sandars and Schroter (2007), Trifonova (2003) and Vishwanath et al. (2009). The reported uses, highly linked to lifelong learning establish that mobile tools, through educational tasks, enhance lifelong learning. Reflecting on the variety in brands and types of handheld devices, in addition to their multiple end uses and tasks through applications and devices themselves, it enables medical students to properly address their learning needs, by using these tools, when engaging in the habit of lifelong learning, as proposed by the operational definition.

Locations for handheld devices use. Forty eight percent of medical students used their devices for clinical and academic purposes, at the university or hospital. When asked on the purposes of mobile applications they used, results were 74.4% claimed using applications for personal, academic and clinical purposes. This limited the percentage of students using applications for personal reasons only to 7.7%. This means that the majority of Lebanese medical students use their devices for professional and educational purposes along with personal uses; such a trend suggests that handheld devices are integrative when combining applications covering personal, academic and clinical purposes, a privilege which PDAs do not have them. Furthermore, 80.8% confirmed using their device for clinical purposes. A high percentage of medical students using their device for clinical purposes supported the study's hypothesis H1, by contributing to higher orientations towards lifelong learning. Findings were in accordance with literature, as the following studies Barrett (2004), Criswell (2000), DeGroote (2004), McCleod (2003), Stromski (2005) and Vincent (2003) confirmed that medical students use mobile devices in clinical, academic and educational settings. This could mean that Lebanese medical students use handheld devices baring the same intentions as their fellow American colleagues.

Lifelong learning is not a structured form of learning, which means it is restricted to neither a physical setting nor a time frame. The capabilities mobile tools can offer to medical students range from personal to clinical uses. This makes it easier for lifelong learning to be supported, being an activity which could be sought for on the move, anywhere at any time.

When did medical students start using handheld devices? Sixteen percent of participants (n=154), started using their handheld device prior to their bachelor degree, meaning in high school. The highest percentage, 42.3% owned a device after they started their bachelor undergraduate education. Those who started using handheld devices in their first medical undergraduate year amounted to 20.5%, while the rest were distributed among Med 2 and Med 3 years. It was observed that medical students tended to pick up the habit of using handheld devices after the first year of undergraduate medical education. However, participants owned a handheld device during their undergraduate education, for more than one potential cause. Most universities in Lebanon provide wireless connection to their students, unlike high schools. Most students would want to stay connected with friends, teacher and administration for both personal and academic reasons. It is then suggested that handheld devices use is not restricted to undergraduate medical education students. University students during their Bachelor degrees are using these devices, as well; medical students are picking up the habit of using their handheld devices, before starting medical education; skills of lifelong learning could have been brought in from undergraduate education. Another observation is that medical students tend to pick up the habit of using their handheld devices since Med I, chances decrease consistently over the remaining years. Meanwhile, no one started using his/her device during the last year of undergraduate medical education. This could be due to students conforming to the trend of owning and using a handheld device as early as undergraduate education or during the first two years of undergraduate medical education. Meanwhile, this could threaten the lifelong and continuous aspects of lifelong learning, thus, inhibiting the acquisition of lifelong learning habits and skills after the first undergraduate medical education year.

When asked to quantify the period of use of handheld devices, results came consistent with the previous question, as 53.9% of students were using their device since at least 3 years. Students who start using their device in undergraduate education, have a higher orientation towards lifelong learning, shown by a significance ($p<0.05$). With a significance of ($p<0.01$), duration of use and orientation towards lifelong are associated. Significance between duration of use and orientation towards lifelong learning suggests a relationship between the two variables, meaning potentially that lifelong learning is enhanced when handheld devices are used for longer periods, since lifelong learning is a set of skills and behaviors which are carried on a continuous basis.

Patterns of use. Patterns of use reflect the level of comfort or discomfort students face when using their devices. Sixty nine percent of students claimed an increasing pattern of use of handheld devices; on the other hand, 3.8% claimed a decreasing one. A fluctuating pattern was observed with 6.4% of students, while 19.2% reported a stable pattern of use. Findings suggest that medical students are increasingly using their handheld devices. Had the use of handheld devices been not favored by medical students, findings could have shown a higher percentage of medical students witnessing a decreasing pattern of use. Furthermore, 59% of surveyed students, claimed to use their devices more than 33 times per day, assuming that uses can be personal, academic and clinical. Such figures, suggest a strong connection between students and their handheld devices, in line with the claim that mobile devices are an extension of the hand (Weilenmann & Larsson, 2001). Finally, students with increasing pattern of use have a higher orientation towards lifelong learning with a significance ($p<0.05$). An increasing pattern of use is linked to using more applications and performing more tasks, which leads to having a higher orientation towards lifelong learning as proven in previous results. Therefore, an increasing pattern of use would lead to increasing levels of orientation towards lifelong learning among medical students.

Q3: What Were The Barriers to Using Handheld Devices by Medical Students?

The purpose of research question three was to study the barriers and limitations to mobile learning, as a result of using handheld devices. It was found, that 83.3% of participants faced only 5 barriers and less. Such a percentage explains the high possession and use rate of mobile devices, in addition to a prevailing increasing pattern of use. One student, who was unhappy with his handheld device said: "NICE guidelines and whatsapp are the only applications that fit on my phone. I am planning on buying a better one soon". This statement is an example of frustration as expressed by one medical student. Table 8, shows the distribution of reported barriers among medical students.

Table 8

Barriers to the use of handheld devices

Barriers to using handheld devices	n=154, % of students
Lack of training, knowledge and guidance	27.27
Installation of applications and needed software	27.27
Cost	57.14
Other devices seem more helpful	1.30
Soft/hardware incompatibility	11.69
Fear of loss of data	40.26
Device malfunction	11.69
Discomfort with technology	19.48
Fear of loss of your device	36.36
Software updates and Maintenance requirements	25.97
Size of the device	22.08
Screen is too small	24.68
Not encouraged by instructors	14.29
Lack of interest	14.29
Other (Please Specify)	14.29

Lebanese medical students face four major limitations; they are the cost of handheld devices, fear of losing data, fear of losing the device itself, lack of training, knowledge and guidance and installation of applications and needed software. These four limitations are similar to those found in Ellaway and Masters (2008), Daher and Awada (2007), Kukuslska (2007) and Murray and Oclese (2011). Lebanese medical students do not only use devices in the same manner of other colleagues from all over the world, but they face the same barriers as well. These barriers not only limit the use of mobile devices, as such, but could inhibit lifelong learning, by reducing the educational benefits of these devices.

Students with increasing patterns of use tend to face a bigger number of barriers than those who have stable to decreasing patterns of handheld devices use, as per the significance of ($p=0.035$) between the number of barriers and the pattern of use; students who use more applications, are faced with much more barriers than those who did not.

When reflected on previous results, barriers do not seem to affect the possession rate nor do they reduce significantly the number of applications and tasks performed on handheld devices. However, due to the intrinsic and continuous nature of lifelong learning, constantly facing the same barriers might discourage students to seek mobile tools to address their learning and educational needs.

Q4: Were Schools of Medicine Providing Free Internet Connection?

The purpose behind research question four was to assess the current situation on institutional support to mobile technology. It was found that, 88.5% of medical students are subscribed to mobile service packed internet, 3G. However, when asked about availability of wireless internet connection at University and/or the hospital, 41% reported having free of charge school-provided wireless internet connection. Thirty seven percent reported paying for such a fee, one student actually wrote: "Btw about the wifi question we have wifi at uni for free but in hospital we should pay 5,000LL/24h like any person in the hospital". Eighteen percent, from both universities, claimed not to have access to a university provided wireless internet connection. Most downloadable medical applications require internet connection, which means a lack in internet connectivity or an expensive one inhibit the use of mobile devices for educational purposes, hindering the acquisition of lifelong learning habits. Moreover, students, who have access to paid or free wireless connection, have a higher orientation towards lifelong learning, than those with no wireless connection, (p=0.000). A reliable internet connection allows better access to medical applications, and therefore increases the use of handheld devices; this leads eventually to a better acquisition of lifelong learning skills. Although, universities were providing to some extent, a free wireless connection, most students seemed to rely on their self-paid 3G connection, supposedly more consistent. Findings showed a lack of serious commitment to providing institutional connectivity to medical students, which threatens the acquisition of lifelong learning skills, through the inhibition of educational uses and benefits which could be drawn from handheld devices, via a suitable and reliable wireless connection.

Q5: Were Physician Educators Using Handheld Devices? Were they Encouraging their Students to do so as well?

The purpose of research question five was to evaluate faculty adoption of mobile learning through their use of handheld devices. It was found that 53.8% of students reported that their mentors frequently used their handheld devices, while 37.2% reported rare use. Nine percent claimed their mentors do not use handheld devices. On the other hand, 52.6% of students reported encouragement by mentors to use handheld devices, and 47.4% reported the absence of any encouragement. Educators' engagement in mobile learning might facilitate mobile education among medical students, who are more likely to pick up handheld devices related habits, when observing educators doing the same. Students, who claimed observing their teachers frequently using their devices, have higher orientation towards lifelong learning, than those, who rarely or never observed their teachers doing so, (p=0.000). On the other hand, students whose teachers encourage the use of handheld devices, have higher orientation towards lifelong learning, as well (p=0.001). The engagement of faculty members and academic physicians in mobile learning would be most probably related to their orientation towards lifelong learning. As mentors, exhibiting favorable attitudes and demonstrating skills of lifelong learning would encourage medical students to acquire lifelong learning skills, equally.

The study's operational definition included three major components to lifelong learning they were intrinsic motivation, continuous need to learn, self-evaluation and proper tools. The first factor, being the intrinsic motivation could be inhibited by the barriers experienced by medical students during their use of mobile devices. In addition, internet access, provided in a non consistent and non reliable manner, could affect the intrinsic drive of medical students to address learning needs through handheld devices, especially since the latter is highly dependent on internet. The involvement level of academic physicians and medical educators in mobile technology might have implications on the intrinsic approach to mobile learning, since teachers are usually viewed as role models by their students (Akl, 2007). The second component which is continuous learning is mostly challenged by barriers to mobile devices, mainly connectivity at the clinical setting. In case connectivity is absent or weak continuity, which is a major component of lifelong learning, will be challenged. On the other hand, handheld devices are easily accessible and can perform operations in a matter of seconds; their portability and accessibility promote lifelong learning by making it possible across time and spaces. Medical applications enhance bedside learning and problem based learning because they address a broad range of educational needs, especially those faced in clinical settings. Having an instantaneous source of information at the tip of the hand allows medical students to keep up the habit of looking for information whenever the need arises, and possibly maintaining this habit all along their medical professional career.

The following chapter summarized findings, limitations, recommendations and future research.

Chapter 5: Conclusion

I studied the orientation towards lifelong learning with medical students, in addition to their acquaintance with mobile learning, through handheld devices. I supported H1, by finding a significant relationship between the orientation towards lifelong learning and using handheld devices in clinical settings. I answered as well, five research questions and reached conclusions on them.

Study Summary and Implications of Lifelong Learning

Lebanese medical students witness a high possession rate of handheld devices. They belonged to a wide variety, from smart phones to digital pads. Medical students tend to pick up the habit of using their handheld devices since Med I, while chances decrease consistently over the remaining years. Students, who start using their device in undergraduate education tend to have higher orientation towards lifelong learning, same trend is observed among students with an increasing pattern of use. Students with increasing patterns of use tend to face more barriers than those who have stable to decreasing patterns of handheld devices use. Barriers as reported by medical students ware the cost of handheld devices, fear of losing data, fear of losing the device itself, lack of training, knowledge and guidance and installation of applications and needed software. Institutional commitment to mobile learning is not significant. Although universities are providing to a limited extent, a free wireless connection, most students seem to rely on their self-paid 3G connection. Connection is mostly used for communication, internet access and information retrieval, with high tendency towards clinical educational purposes. These results provide an idea on the current situation of mobile learning in medical education, using handheld devices.

This study is a first in Lebanon to bring together mobile technology and lifelong learning in medical education. Findings suggest that Lebanese medical students are acquainted with handheld devices, and do in fact use them for personal, academic and clinical purposes. Lebanese medical students have high orientation towards lifelong learning, despite the barriers and limitations they face when operating their devices. Lifelong learning is then dependent on more than one variable, based on the study's results. As a non-ending process, lifelong learning is enhanced by students' readiness to acquire lifelong learning skills, students' use of handheld devices, handheld devices themselves, mobile applications, barriers faced during use and availability of consistent connectivity.

As per the study's operational definition, lifelong learning's three components, intrinsic motivation, continuous need to learn, learning evaluation and proper tools were touched upon by the findings of this study. Many empirical conclusions were drawn from this study; although, lifelong learning is not a mandatory part of medical curricula, it implies that health professionals take on full responsibility of their own learning, and assess proper tools to address their learning needs. Handheld devices through their clinical uses are associated with higher orientation towards lifelong learning. Despite the fact that tools are only one component by which lifelong learning is defined, it contributes to the two other components. Handheld devices could help medical students remain intrinsically motivated, since the tool is already in their hands, and being used for other ends. Devices help as well in the identification of learning needs and evaluation of proper resources, especially with a wide access to information provided by mobile devices to medical students. Limitations to mobile learning not only affect the efficiency of handheld devices, but may negatively touch upon the acquisition of lifelong learning skills, since lifelong learning is mostly dependent on mobile tools.

Limitations

There were many limitations to my study. Regarding my methodology, online surveys have a conventional return rate of 26% (Hamilton, 2009), below which sampling could be weak. My response rate was 32.5%, which is moderate. Concerns with online surveys are usually freezes, crashes, error messages, and double entry. The choice of a paid service was to try to make sure such technological limitations are avoided. As for the double entry, the hosting website provided an option of limiting each IP address to only one answer. However, this was not a definite solution, since a student could have filled in the application using a different computer, i.e. a different IP address.

A bigger number of participants could have allowed me to study the orientation towards lifelong learning of those, who do not own a handheld device, in comparison to those who do. Another limitation to the sample was non participation of schools of medicine, which follow the French language system of instruction. Moreover, my original intention was to study the entire medical students' population; however, only two schools cooperated with me. These two limitations posed a major negative effect on generalization to the Lebanese population of medical students. Answers were self-reported; bias towards socially accepted answers could have taken place.

Recommendations

Based on my literature review and my findings, I recommend the following. Future efforts should be directed to: Study the existing medical curricula, and allow space for officially introducing mobile learning into medical education. Invite educational technology scholars to decrypt the learning values of new technology innovations in the world of medical education, while paying attention to control and representation. Provide training sessions for both teachers and students on the uses and benefits of mobile learning and teaching, as a way to enhance lifelong learning. Provide technical support to students and teachers, in addition to training. Provide wireless connection available all the time, at the schools of medicine and at medical centers as well, to guarantee continuity and consistence, to facilitate mobile learning. Train physician educators on principles of curricula development, evaluation and assessment. Invite teachers stress on enhancing learners' techniques, helping learners make learning more permanent, and more readily available for future use, and urging learners to the importance of continuing in meaningful purposeful learning even after the assignment or task is over.

Future Research

Since results of this study established an association between mobile learning in clinical settings and lifelong learning, it is recommended to investigate the nature of this relationship with respect to causality, by conducting experimental cohort studies with specific treatments. Moreover, special attention should be given to the difference in the language system of instruction, and the implication it could have on lifelong learning and mobile learning, indirectly through adopted curricula.

Conclusion

The General Medical Council recommended, since the nineties that medical curricula should be informed by modern educational theory to promote curiosity-driven self-directed learning, in addition to critical appraisal of evidence (General Medical Council, 1993). Contemporary educational theory should be linked to undergraduate medical education requirements, in order to facilitate experiential learning, which gives space to professional knowledge acquisition, critical thinking, problem solving, clinical problem solving and lifelong professional learning (Maudsley

& Strivens, 2000). My study, among others, have contributed to the link between lifelong learning and mobile learning, however, in order to make use of mobile devices in the learning process, it is crucial to study the type of knowledge which medical students attend to. Maudsley and Strivens (2000) stated that application and advancement of the knowledge base reflects good professional practice, which links both professional knowledge and professional practice. Eraut (1995) and (1992) proposed four different characteristics that professional knowledge should maintain, they are know-what, know-how, personal knowledge and moral principles. Handheld devices could contribute to each characteristic of professional knowledge, hence enhancing lifelong learning and experiential learning. Handheld devices through their portability and connectivity can enhance Kolb's (1984) experiential learning cycle. Abstract conceptualization is fortified by accessing resources on mobile devices; the active experimentation could be facilitated by the use of action applications, concrete experiences are then enhanced through the social media component of handheld devices, generating reflective observations that improve problem-based learning.

The use of mobile technology in medicine and medical education is only one dimension contributing to the overall medical professional competence; as stakeholders call for a major shift towards e-health, which is blooming worldwide. Nations are moving towards implementing e-health systems to reduce bureaucracy, increase efficiency and improve healthcare. E-health professionals would have to meet new requirements of professional competence, which has mobile lifelong learning as one of its major components. On the other hand, knowing-in-action is an established concept, which is promoted to improve professional competence and practice especially in clinical skills. To meet emerging e-healthcare, and eventually new requirements of medical professional competence, medical students have to be mobile lifelong learners, at the core, able to master their knowing-in-action armed with handheld devices.

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Appendix 1

Jefferson Scale of Medical Students Lifelong learning JeffSPLL-MS

The JeffSPLL-MS (Hojat, et al, 2005) questionnaire is a psychometric questionnaire measuring the orientation of medical students towards lifelong learning. It is formed of 14 Likert scale questions, answered based on a scale of 1 to 5, with 1 being Strongly Disagree, 2 Disagree, 3 neutral, 4 Agree, and 5 Strongly Agree. The total score should be 70.

1 Searching for the answer to a question is, in and by itself rewarding

2 Life-long learning is a professional responsibility of all physicians

3 I enjoy reading articles in which issues of medicine are discussed

4 I routinely attend meetings of student study groups

5 I read medical literature in journals, websites or textbooks at least once every week

6 I routinely search computer databases to find out about new developments in my specialty

7 I believe I would fall behind if I stopped learning about new developments in medicine

8 One of the important goals of medical school is to develop students' life-long learning skills

9 Rapid changes in medical science require constant updating of knowledge and development of new professionals skills

10 I always make time for learning on my own, even when I have a busy class schedule and other obligations

11 I recognize my need to constantly acquire new professional knowledge

12 I routinely attend optional sessions, such as grand rounds, guest lectures, or clinics where I can volunteer to improve my knowledge and clinical skills

13 I take every opportunity to gain new knowledge/skills that are important to medicine

14 My preferred approach in finding an answer to a question is to search the appropriate computer databases

Appendix 2

Adapted questionnaire

The below questionnaire has 24 questions, which cover in details all the aspects of usage of handheld devices. Variables are: academic year, frequency and duration of use, used applications and their relevance and number, availability of wireless connection of network connection etc … I used questions from surveys by Chatterley and Chojecki (2010) and Morris et al. (2007) in addition to adapting questions to the Lebanese context.

Which University do you go to?

Select your current academic year

Med I
Med II
Med III
Med IV

Define lifelong learning in your own words (try to even if you don't know)

Do you own a handheld device (Smart phone, Tablet etc ...)?

Yes
No (Skip to 22)

When did you start using your handheld device?

Prior to your BS/BA years
BA/BS years
Med I
Med II
Med III
Med IV

For how long have you been using your device?

Less than one year
One to two years
Three to four years
More than four years

What type of a handheld device/smart phone you own, and which brand is it?

On an estimate figure, how many times do you use your device daily?

Describe the pattern of use of your device since you first owned it

Stable
Decreasing
Increasing
Fluctuating

Each time you use your device, how much time you spend using it, expressed in minutes?

Do you use your device inside the hospital as part of your clinical education?

Yes
No

The applications you use are mostly described as

Personal
Professional/medical/academic
Personal and
Professional/medical/academic

In which setting do you use your device the most?

Clinical/academic (Faculty/Hospital)
Personal (Anywhere else)

How do you evaluate your skills while using your handheld device?

Expert
Average user
Beginner

Indicate which types of applications do you access while using your handheld device

Drug reference
Medical education
Personal organizer
Note pad/memo
Medical reference
Guidelines
Medical e-books
Billing/coding
Patient tracker
Internet and web browsing
Camera/photo shooting
Email
Communication and social media

Do you have access to wireless internet connection at your college/clinical premises, supplier being the educational institution or medical center?

Yes, free of charge
Yes, paid service (part of medical education tuition)
No
Not sure

Are you subscribed to mobile service packed internet, 3G?

Yes
No

Please indicate the ways in which you use your device, check all that apply

Access email, internet and text messages
Calendar, addresses, task management
Access rotation/course information
(handouts, evaluations and schedules)
Take notes, do homework, perform other
academic tasks
Access a drug reference
Perform clinical calculations
Translate a foreign language (French to
English or vice versa)
Record audio, video, or pictures
Search for a different diagnosis or
treatment plan
Access patient data (Lab results) or
patient orders
Access a clinical reference or e-textbook
Access dictionaries
Access medical literature, abstracts, or
guidelines
Communication, SMS and texting

Do you believe the use of Whatsapp, Tango, Viber, BB messenger etc… helps you

In basic sciences
In the clinical setting
a and b
Does not help

What medical applications have you downloaded to your device? Check all that apply

Lex-comp
Clinical diagnosis
Exam master
Lab tests
Differentials
Clinical medicine
Antibiotics
MedCal
Lab Values
Kaplan USMLE
Emergency

Sanford
Other (Please Specify)

Have you seen your mentors/attendings using a smart handheld device?

Yes, frequently
Yes, rarely
No

Have any of your instructors encouraged you to purchase/use a smart handheld device?

Yes
No

Select the cause or causes which form barriers to the use of smart phones or tablets in general

Lack of training, knowledge and guidance
Installation of applications and needed software

Cost

Other devices seem more helpful
Soft/hardware incompatibility
Fear of loss of data
Device malfunction
Discomfort with technology
Fear of loss of your device
Software updates and Maintenance requirements

Size of the device

Screen is too small
Not encouraged by instructors
Lack of interest
Other (Please Specify)

Tables and Figures

This section of the thesis presented tables and figures used with an introductory paragraph highlighting their significance.

Table 1: Highlighted similar characteristics between lifelong learning as a learning approach, and mobile technology as a tool to reach and implement lifelong learning.

Matching New Communications and Information Technology to Lifelong Learning

Characteristics of lifelong learning	Characteristics of mobile technology
Individualized	Personal
Learner centered	User centered
Situated	Mobile
Collaborative	Networked
Ubiquitous	Ubiquitous
Lifelong	Durable

Table 2: Showed studies conducted with the purpose to assess possession rates and venues of use of handheld devices among health professionals.

Studies on Possession Rates of Handheld Devices

Author	Results	Location/Venue
Criswell (2000)	67% of family medicine residents use PDAs	Practice/clinical
McCleod (2003)	46% of medical students, specialists, residents and fellows use PDAs	Institutional level, hospitals or university
Vincent (2003)	36% of family medicine residents use their PDAs for log keeping and documentation	Hospital/clinical/administrative
DeGroote (2004)	61% of academic health sciences students, faculty and medical residents use their PDAs	University level/academic
Barrett (2004)	75% of medical residents use PDAs	Practice/clinical
Stromski (2005)	64% of Emergency medicine programs claim their medical residents use their PDAs	Clinical

Table 3: Grouped Anesthesiology applications and defined their educational usage.

Anesthesiology Applications and their Educational Uses

Application name	Educational usage
BGA journals	An application to quickly access and read anesthesia journals. With search functions and bookmarking.
Pedi anesthesia	Simplified pediatric anesthesia, by having pre-calculated drug doses for patients from 1 to 40 Kgs.
Crisis code	Taught physicians, the principles of crisis management for advanced cardiac life support and how to provide ACLS in cases of cardiac arrest.
Peds anesthesia	Anesthesia-specific medications dosages were automatically calculated for the given patients' weight.
Anesthesia quick reference	It included lists, charts, checklists, guidelines, for anesthesiology and pre-operative issues.
Handbook of pharmacology	Provided quick access to information about the pharmacology of commonly used anesthetic agents. Provided detailed information on pharmacology, mechanisms of action, physiologic response, indications and contraindications.

Table 4: Cross-tabulation of orientation towards lifelong learning with current academic medical year for undergraduate medical students.

Cross-tabulation: Scores on JeffSPLL-MS and Academic year

Count

		Current academic year				total
		1	2	3	4	
Scores on JeffSPLL-MS	15	0	0	0	2	2
	22	0	0	2	0	2
	24	0	2	0	0	2
	25	0	2	0	0	2
	42	0	4	0	0	4
	44	2	0	0	0	2
	46	0	0	0	2	2
	48	0	0	0	2	2
	49	2	0	2	0	4
	50	2	2	0	2	6
	51	2	0	2	2	6
	52	2	2	0	2	6
	53	4	0	2	0	6
	54	0	4	0	0	4
	55	0	2	0	0	2
	56	4	2	2	2	10
	57	4	2	2	2	10
	58	2	8	2	4	16
	59	2	0	0	4	6
	60	4	6	0	4	14
	61	6	4	0	4	14
	62	0	0	2	0	2
	63	0	2	0	0	2
	64	2	2	4	2	10
	65	2	2	0	0	4
	66	0	6	2	0	8
	67	0	0	0	2	2
	68	0	0	0	2	2
	70	2	0	0	2	4
total		42	52	22	40	156

Table 5: Categorized most frequently used applications, as reported in the findings.

Most Frequently Used Applications, by Category

Category of use	Reference	Calculator	Personal, Clinical and study notebook
Applications	Micromedex, Medscape, Epocrates, Lex-comp and Pubmed	MedCal and Antibiotics	First Aid, USMLE World, Clinical Medicine, Ipharmacy, Sanford, Exam Master and Lab Tests

Table 6: Grouped the types of applications used by medical students in respective percentages, based on the findings.

Types of Applications Used by Medical Students

Type of applications used	n=154, % of students
Drug reference	61.04
Medical education	74.03
Personal organizer	53.25
Note pad/memo	62.34
Medical reference	76.62
Guidelines	19.48
Medical e-books	64.94
Billing/coding	3.90
Patient tracker	2.60
Internet and web browsing	96.10
Camera/photo shooting	67.53
Email	93.51
Communication and social media	80.52

Table 7: Presented percentages of medical students based on the tasks they performed on their handheld devices.

Tasks Performed on Handheld Devices

Specific Tasks performed on handheld devices	n=154, % of students
Access email, internet and text messages	96.10
Calendar, addresses, task management	66.23
Access rotation/course information (handouts, evaluations and schedules)	61.04
Take notes, do homework, perform other academic tasks	61.04
Access a drug reference	55.84
Perform clinical calculations	40.26
Translate a foreign language (French to English or vice versa)	59.74
Record audio, video, or pictures	67.53
Search for a different diagnosis or treatment plan	41.56
Access patient data (Lab results) or patient orders	5.19
Access a clinical reference or e-textbook	61.04
Access dictionaries	70.13
Access medical literature, abstracts, or guidelines	71.43
Communication, SMS and texting	80.52

Table 8: Displayed percentages of medical students based on their reported barriers when using their handheld devices.

Barriers to the use of handheld devices

Barriers to using handheld devices	n=154, % of students
Lack of training, knowledge and guidance	27.27
Installation of applications and needed software	27.27
Cost	57.14
Other devices seem more helpful	1.30
Soft/hardware incompatibility	11.69
Fear of loss of data	40.26
Device malfunction	11.69
Discomfort with technology	19.48
Fear of loss of your device	36.36
Software updates and Maintenance requirements	25.97
Size of the device	22.08
Screen is too small	24.68
Not encouraged by instructors	14.29
Lack of interest	14.29
Other (Please Specify)	14.29