The Role of Mobile Devices in Medical Education
An inquiry to Portuguese Medical Students

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Abstract: Smart Mobile Devices (SMD) usage within the health professional community has been increasing exponentially over the last decade. Such popularization has the potential to change not only how doctors treat patients but how they learn and gain new skills. Since today's students are tomorrow's professionals, it is important to understand how future doctors use SMD in the academic environment by quantifying the number of students using a mobile device; what are the main clinical information sources; and to determine the usage characteristics of these devices, namely in frequency, context, and goal. A survey was distributed amongst the eight Medicine faculties in Portugal, between 2012-12-28 and 2013-01-03, resulting in a sample of 128 filled surveys. Collected data showed that the majority (67.2%) of Portuguese medical students owns an SMD. Of the SMD owners, 34% refer to using their device frequently during academic periods, mostly as a means to consult information and access the Internet. Notwithstanding, paper books are still the main bibliographic source used by Portuguese students, with over 90% referring to using them regularly. The usage of SMD to gather clinical data and anamnesis is residual.

1 INTRODUCTION

1.1 SMD History

Health professionals have been increasingly using Smart Mobile Devices (SMD) – Personal Digital Assistants PDAs, Smartphones, and Tablets – over the last decade. However, the technological era of pocket computers used in HealthCare started long before.

In 1984 the first PDA was launched, the PSION Organizer II. It was a revolutionary device, since at that time it already incorporated, in a single device, a two line screen and a keyboard. In addition, common applications such as the notepad, calculator, clock, calendar, text processor, and spreadsheets were already incorporated. McDonald et al. (1988) described the use of this device in collecting and analyzing dental research data (McDonald and Standring, 1988). In 1989, Tattersall et al. published about the utilization of this same device to collect clinical records in primary health care (Tattersall and Ellis, 1989).

The name PDA (Personal Digital Assistant) was coined for the first time by Apple, in 1993, at the launch of the MessagePad (Newton OS). This was the first PDA with a touch screen and writing recognition, which were very appealing at the time, since it provided a more natural interface than the mouse and keyboard to less experienced users (Le et al., 1995). In 1995 there were already several applications specially developed for healthcare, such as books, medical calculators, and medical file notebooks (Ebell et al., 1995).

The prime breakthrough occurred in 1996, with the launch of two devices that defined the future of mobile technologies: the Nokia 9000 communicator (the first PDA/mobile phone combo), the precursor of the current smartphones, and the PalmPilot. The latter belonged to the first generation of PDAs developed by Palm, which achieved great popularity within health professionals and was the first massively adopted mobile device (OReilly, 2000). This trend was also followed by medicine students, who started substituting pocket books with PDAs (Woznicki, 2001).

In 2004, about 527 of the 1450 applications for PalmOS and 306 of the 900 applications for Windows CE were medical applications (medApps) (Lu et al., 2005).

It's not surprising that, for Payne et al., the most important moment regarding the popularization of SMD was the appearance of the Apple AppStore in July 2008, which enabled users to download and install relevant applications with ease (Payne et al., 2012). Since then, the medApps market never stopped growing, with a staggering estimated value of more than 7000 health related AppStore applications (apps) in the fourth quarter of 2012. The most used apps include therapeutic and drug administration guides and medical calculators (Franko and Tirrell, 2012).

1.2 Adherence to Technology

In 1999, only 15% of USA medical staff had a PDA, with Palm being the most used device brand (*Physicians' Use of Handhelds Increases From 15% in 1999 to 26% in 2001*, 2001). In 2001, these devices were used by 26% of the staff, even though only 18% referred to using them for clinical support (*Physicians' Use of Handhelds Increases From 15% in 1999 to 26% in 2001*, 2001). This market share increased substantially in the first half of the last decade, achieving a share of 45% in 2005 (Garritty and El Emam, 2006). In Portugal, this number appears to be lower. In samples collected from two Portuguese hospitals, only 33% of Portuguese medical staff had a pocket computer (Martins and Jones, 2005). In 2012, 85% of USA medical staff owned a smartphone, 62% have a tablet, and 21% own both devices. Over a half of these health professionals refer to using the tablet regularly for clinical related tasks (Ressi, 2012).

1.3 SMD role in HealthCare and Medical Education

In opposition to desktop computers, SMDs are easily carried, enabling an updated and universal access to information (Fischer et al., 2003a) in otherwise impossible contexts (Franko and Tirrell, 2012); they are usually intuitive, flexible and easy to use(Galt et al., 2005b; McConnell, 2000), with state of the art devices guaranteeing support to rich multimedia applications (Free et al., 2010). SMDs are even proposed as a telemedicine platform in developing countries (Kaplan, 2006).

Thus, it's undeniable the potentially positive impact of SMDs in healthcare (Miller et al., 2004a; Sittig et al., 2000) and medical education (Lindquist et al., 2008), namely in data recollection and analysis for research (Blaya et al., 2010) and education (Mendonça et al., 2001; Torre et al., 2005), in supporting medical practice (Lindquist et al., 2008), in reducing clinical error (Galt et al., 2005a; Nyun et al., 2003; Rosencrance et al., 2004), and in promoting evidence based medicine (EBM) by obtaining credible evidence (Fischer et al., 2003b; Shurtz and von Isenburg, 2011).

1.4 Information Sources

In the last decades, several researchers have been aware of how practitioners come across multiple clinical questions while having to quickly solve them (DaRosa et al., 1983; Williamson et al., 1989). In fact, the quality of the service provided is influenced by factors such as the way the medical doctor deals with a clinical dilemma, the effort put to find an answer, and the information source.

A 1997 study (Haug, 1997) pointed to scientific papers, colleagues, books, seminars, and conferences as the prime sources of information. Fifteen years later, with the globalization of the Internet and Information Technologies (IT), this pattern has changed substantially, and sites such as Medscape, UpToDate and PubMed (Khalifian et al., 2013; Shariff et al., 2012) are increasingly important as updated information repositories.

1.5 Objectives and motivation

Taking into account the potential benefits from using SMD in healthcare (Miller et al., 2004b; Sittig et al., 2000), and the relative low usage of these devices by the Portuguese doctors (Martins and Jones, 2005), this work aims at understanding the usage of IT as learning tools by medical students. Therefore, the prime objectives of this study are to determine the information sources used by Portuguese medical students for clarification of clinical practice issues; to quantify the number of students using a mobile device for information and communication; and to determine the usage characteristics of these devices, namely in frequency, context, and goal.

2. METHODS

This was a cross sectional study done in a sample of the population of Portuguese medical students. An online survey was distributed via e-mail amongst students from the eight medical

faculties in Portugal. The survey was based on reviewed literature (Payne et al., 2012),(Grasso et al., 2006),(Menzies and Thwaites, 2012), following the guidelines proposed by Sushil and Verma (Sushil and Verma, 2010). A pre-test of the survey was conducted in a small group of medical students and residents. All the medical students were considered eligible for the study, and all the completed surveys were considered valid to enter in the study. Two verification questions were also used: the first (Q1.5) served as exclusion criteria for the whole survey, while the second (Q3) served as exclusion criteria for group Q4.

The survey collected demographic data (Q1), the frequency with which information sources were procured (Q2), the number of students with SMD (Q3), and the SMD usage pattern (Q4). The variables of interest were operationalized in a Likert scale from 1 to 5 (never to always respectively).

Data was collected between 2012-12-28 and 2013-01-03. All the variables were described by the absolute and relative frequency. The chi square test was used to compare proportions and a *p-value < 0.05* was considered significant. SPSS version 21 was used to perform the analysis.

3. RESULTS

A sample of 128 medical students was used with 0 surveys excluded. According to ANEM (*Associação Nacional de Estudantes de Medicina*), it is estimated that there are about 10,000 medical students in Portugal. Thus, the sample represents around 1% of the universe of interest.

The sample is constituted by 60 male individuals (46.9%) and 68 female individuals (53.1%), with ages between 18 and 28 years old with an average age of 22. 54 of the students belong to the *Faculdade de Ciências Médicas da Universidade Nova de Lisboa* (42.2%), 24 to the *Faculdade de Medicina da Universidade de Lisboa* (18.8%), and, with the exception of the *Universidade do Algarve* where no answers to the survey were obtained, all other medical faculties represent at least 11% of the sample. Regarding the course year, 90 (70.3%) students were attending the clinical years (4th, 5th and 6th), while 38 (29.7%) were attending the pre-clinical years (1st, 2nd and 3rd).

Of the 128 inquired students, 86 (67.2%) had a smartphone, PDA, or tablet, whilst 42 (32.8%) had none of these devices (Figure 1). As seen on Table 1, a higher percentage of male students had an SMD (73%). However, there is no apparent association between gender and the possession of SMD ($p > 0.05$).

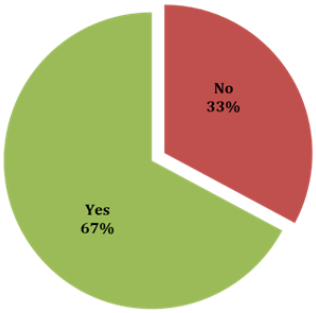

Figure 1 - Percentage of medicine students with SMDs.

Table 1 - Number of students with SMD by gender

Gender	No		Yes		Total	
	N	*%*	*N*	*%*	*N*	*%*
Male	16	27%	44	73%	60	47%
Female	26	38%	42	62%	68	53%
Total	42	33%	86	67%	128	100%

The usage frequency regarding the different types of information sources is present in Table 2. Medicine students seem to be keener on using books as a prime medium for solving questions *($\bar{x}$ = 4.17; SD = 0.056; Var = 0.395)*. This was also the parameter with lowest variance. Internet is also a common information source *($\bar{x}$ = 4.03; SD = 0.068; Var = 0.597)*.

Overall, students do not seem to resort to eBooks and SMD applications as much, although in this case the variance is high *($\bar{x}$ = 2.67; SD = 0.117; Var = 0.395)*. However, there is a strong association between being an owner of an SMD and resorting to eBooks and SMD applications *(Chi sq = 44.703; p < 0.01)*. There also seems to exist an association between using the Internet as an information source and owning an SMD *(Chi sq = 9.753; p < 0.05)*.

Table 3 shows the usage pattern of SMDs during the academic year. From the 86 med students owners of SMDs, they seem to use them most frequently as a means to access Internet *($\bar{x}$ = 3.84; s = 1.039; Var = 1.079)* than to collect clinic history *($\bar{x}$ = 1.88; s = 1.111; Var = 1.233)*. Nevertheless, there is a low consensus between students (high data dispersion). We couldn't find any statistically relevant relation between SMD usage pattern and gender or school year.

4. DISCUSSION

Over a half of Portuguese medical students (67.2%) have one or more SMDs, a value only slightly lower than what was found in the literature (Table 4). Alike what was described by other authors, there is no difference in prevalence between genders (Barrett et al., 2004; Martins and Jones, 2005; McLeod et al., 2003). From the students who own an SMD, 34% refer to using it frequently during the academic year. Medical students prefer to use their SMD as a means to access information rather than for collecting data. They use their SMD mostly to access the Internet. Until now, SMD usage for medical history collection is still meager.

These results seem to converge to the empiric observation that, although SMD usage is increasing among students, their full potential is still to be unlocked. This opens exciting opportunities in app development aimed specifically to medical students and young physicians.

Paper books are the main bibliographic source elected by Portuguese students, with over 90% of them referring to using it regularly. However, the Internet shows as the second most frequently used source, particularly amongst students with an SMD. It was also found a strong association between owning an SMD and using eBooks or applications, which confers internal consistency to the survey. The number of surveys collected represents only about 1% of the population of Portuguese medical students. The size and characteristics of this population are not well known, thus not being entirely possible to infer if the sample is representative or not. Since the survey was online, the sample bias cannot be excluded and may favour more technology-friendly subjects.

It was hoped that an association between using SMDs for clinical history collection and the academic year (grouped by clinic cycle and pre-clinic cycle) could be found. Usually, medical students in their pre-clinic years are seldom required to collect clinical data. However, this association could not be statistically proven.

An exact SMD usage pattern is hard to define, for there is great data dispersion. Thus, no relation could be established.

We're planning on conducting a similar study in 2015, using a paper based survey to eliminate the aforementioned bias and to increase the student coverage to values close to 80%.

Table 2 - Frequency with which students use each of the medical information sources when they have doubts (n = 128).

Frequency	**Medical information source**					
	Colleagues	***Professors***	***Books***	***Student Notes***	***eBooks or Apps***	***Internet***
Never	1.6% (2)	6.3% (8)	0.0% (0)	6.3% (8)	28.1% (36)	1.6% (2)
Rarely	4.7% (6)	17.2% (22)	1.6% (2)	9.4% (12)	18.8% (24)	0.0% (0)
A few times	40.6% (52)	53.1% (68)	7.8% (10)	26.6% (34)	17.2% (22)	18.8% (24)
Often	43.8% (56)	20.3% (26)	62.5% (80)	42.2% (54)	29.7% (38)	53.1% (68)
Always	9.4% (12)	3.1% (4)	28.1% (36)	15.6% (20)	6.3% (8)	26.6% (34)
Mean	3.55	2.97	4.17	3.52	2.67	4.03
SD	0.070	0.077	0.056	0.094	0.117	0.068
Var	0.628	0.755	0.395	1.134	1.766	0.597

Table 3 - Frequency with which SMDs are used by function, during the academic year (N = 86).

Frequency	**SMD Function**				
	Collection of		***Consult of***		
	Medical History	***Notes***	***eBooks or Apps***	***Internet***	***Class Notes***
Never	51.2% (44)	32.6% (28)	23.3% (20)	4.7% (4)	20.9% (18)
Rarely	23.3% (20)	27.9% (24)	20.9% (18)	7.0% (6)	20.9% (18)
A few times	14.0% (12)	23.3% (20)	27.9% (24)	14.0% (12)	18.6% (16)
Often	9.3% (8)	9.3% (8)	23.3% (20)	48.8% (42)	20.9% (18)

Always	2.3% (2)	7.0% (6)	4.7% (4)	25.6% (22)	18.6% (16)
Mean	1.88	2.3	2.65	3.84	2.95
SD	1.111	1.218	1.206	1.039	1.422
Var	1.233	1.484	1.453	1.079	2.021

Table 4 Medical doctor/Student owners of SMD prevalence in other studies.

Study	Value	N	Population	Country	Year
(Wallace et al., 2012)	85.0%	213	Students	Canada	2012
(Payne et al., 2012)	79.0%	257	Students	UK	2012
(Payne et al., 2012)	74.8%	131	Residents	UK	2012
(Menzies and Thwaites, 2012)	52.0%	850	Medical Doctors	New Zealand	2012
(Smart, 2012)	83.5%	182	Medical Doctors	UK; Europe	2012
Manhattan Research (Ressi, 2012)	85.0%	NA	Medical Doctors	USA	2012
(Franko and Tirrell, 2012)	85.0%	NA	Medical Doctors	USA	2012

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