Medical Students' Attitudes and Perceptions towards the Effectiveness of Mobile Learning: A Comparative Information Need Perspective

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Abstract

The rapid development of information and communication technologies has revolutionized the lifestyles and learning practices of the younger population worldwide. Various new mobile platforms and social media have been so pervasive and influential in the world of higher education that they have contributed much to the training of the next generation of medical professionals. As such, the current study aimed at comparing the adoption of mobile learning amongst three groups of Medical Science students at the University of Hong Kong (HKU), namely students from the following Medical majors: (1) Clinical Science, (2) Chinese Medicine, and (3) Nursing. For this study, we use a questionnaire survey to collect a total number of 150 responses. The data were analyzed using descriptive statistics, Pearson Correlation Test, and multi-regression analysis.

Results from this study revealed that students of the three different medical majors at HKU engaged with their mobile devices at slightly different levels. Although a few significant differences were found, Clinical Science students tended to have more diverse information needs and tended to use their mobile devices for a variety of learning-related activities. In comparison, Chinese Medicine students indicated they were less active users of mobile devices, in terms of both learning and non-learning activities.

Keywords: mobile library; technology acceptance; medical students; information needs; quantitative research; regression analysis

INTRODUCTION

Due to the worldwide proliferation of mobile technologies, current mobile devices such as smartphones and tablets have become almost ubiquitous in people's daily lives (Dukic *et al.*, 2015; Lau et al., 2020). Currently, with computing power comparable to traditional desktop computers, contemporary mobile technology provides additional advantages such as a portable size, a variety of downloadable application options, and many other additional productive features regardless of temporal and geographical limitations, and has enabled them to permeate almost all aspects of our daily lives (Ko *et al.*, 2015; Wai *et al.*, 2018). Along with such new developments of wireless and communication technologies, mobile devices have become essential for learning in both education and workplace. Thus, understanding students' usage patterns of mobile devices for better teaching and learning support has captured the attention of many educational specialists, as well as library and information (LIS) service providers worldwide (Aharony, 2014; Ko *et al.*, 2015; Lau *et al.*, 2020).

Mobile technology possesses the capability to support seamless learning (Wong, 2012) and seamless transition to different modes or styles of learning, such as in-class and out-of-class learning, and as well as between handheld and desktop use. In other words, mobile learning can take place anytime, anywhere, thereby extending the classroom into a variety of virtual and physical environments, while creating an interactive social hub that facilitates collaborative learning and interactions among instructors and students (Lam *et al.*, 2019; Fong *et al.*, 2020).

Indeed, mobile learning has become increasingly popular, not to mention being an essential tool for medical education (Chase *et al.*, 2018; Masters and Al-Rawahi, 2012). As highlighted by Walsh (2015: p.363), "In the past several years, mobile learning made rapid inroads into the provision of medical education. There are significant advantages associated with mobile learning. These include high access, low cost, more situated and contextual learning, convenience for the learner, continuous communication and interaction between learner and tutor and between learner and other learners, and the ability to self-assess while learning." Despite such apparent advantages associated with mobile learning in the clinical setting, there is scant research on the influence mobile devices have in the medical-learning environment, especially in Hong Kong.

To fill this research gap, this study plans to investigate the adoption of mobile learning amongst the following three Medical majors at HKU: (1) Clinical Science, (2) Chinese Medicine, and (3) Nursing. This study is guided by the following research questions:

RQ1. How active are the Medical students at HKU in using mobile devices for their everyday life activities?

RQ2. How active are the Medical students at HKU in using mobile devices for learning-related activities?

RQ3. Are there any distinctive differences between the three groups of Medical students (namely, Clinical Science, Chinese Medicine, and Nursing) in terms of their mobile learning practices?

RQ4. What are their main intentions behind mobile device usage amongst these three groups of Medical students at HKU? What are the factors that shape their mobile learning practices?

LITERATURE REVIEW

Mobile learning and its unique characteristics

In each era, there is a close correlation between contemporary technologies and specified education modes and learning styles. The role that technological advancements play in the learning paradigm shift should not be underestimated. E-learning refers to the delivery of learning materials through electronic media such as videos, computers, televisions, and so forth (Urdan and Weggen, 2000). Quinn (2011) defined mobile learning as e-learning through mobile technologies, which pinpoints the significant change in technological media and implies that mobile learning is an advanced form of e-learning. Early definitions of mobile learning have tended to focus on the importance of technological advancement. However, these tech-centered conceptualizations can be rather constraining since technologies are just vehicles for delivering instruction (Traxler, 2007).

As insights into mobile learning have deepened, definitions have shifted from technology-centered to user experience-centered, mobility-centered, and context-centered (Khaddage *et al.*, 2016). Mobile learning is generally considered as the process of developing knowledge by exploring and communicating across various contexts, using interactive technologies (Sharples *et al.*, 2007). Thus, context is a crucial construct in mobile learning (Kukulska *et al.*, 2007), and needs to be fully understood as context affects not just the users but also the application design (Hong *et al.*, 2007). Context regarding learners' mobility may vary, including spatial, temporal mobility, and mobility in technology (Nelson *et al.*, 2017). Indeed what moves with the human is not just the device but the whole learning environment (Fakomogbon and Bolaji, 2017). All learning experiences occur within contexts, and the mobile context permits contextual learning. Compared with the static context experienced in traditional learning environments (typically a fixed classroom, single teacher, and an agreed curriculum), the mobile context offers dynamism and impromptu tangents. The main characteristic of mobile learning is its capability to support learners in acquiring knowledge and keeping informed across contexts (Kukulska *et al.*, 2007).

Mobile learning distinguishes itself from other methods and platforms by enabling learning irrespective of time and location. Once learners identify their learning needs, they can search for the desired information through powerful mobile devices. Thus, mobile learning can satisfy spontaneous information needs, which is the most important characteristic of mobile learning (Ozdamli and Cavus, 2011). Further to this, mobile devices are portable, easy to carry, and facilitate "everywhere learning." Uzunboylu *et al.* (2009) proposed that mobile technology could be integrated into formal learning. Further, classroom construction and mobile learning are frequently combined to create what is known as blended learning. This can enhance the quality of both top-to-bottom instruction and self-generated mobile learning (Bonk and Graham, 2012). Different from merely uploading passive courses online, mobile learning allows for real-time active, participative learning (Wang *et al.*, 2009). Hence, mobile learning is interactive.

University students' perceptions of mobile learning

Mobile learning behaviors of students are primarily decided by their mobile learning intentions, information needs, attitudes towards mobile learning, and whether they would repeat mobile learning behaviors (Wai *et al.*, 2018; Pinto *et al.*, 2020). Understanding students' learning needs is crucial to enhancing learning efficiency and delivering an effective mobile learning design. Further, Wang *et al.* (2009) noted that the factors that promote mobile learning behaviors include an individual's expectations on their performance and on ease of effort, social impact, facilitating conditions, perceived playfulness, and learning management. Mobile learning distinguishes itself since it aims to address problems that could arise anywhere at any time. In other words, it can be difficult to transfer knowledge acquired through traditional learning to real-life resolutions of problems. Insofar as this is concerned, collaboration and interactions with the authentic context are necessary. Fortunately, mobile learning can help address real-life problems since it is spontaneous, ubiquitous, context-aware, and offers anytime and anywhere learning (Uzunboylu *et al.*, 2009). Thus, the need to address real-life problems constitutes another extrinsic motivation for mobile learning.

Kukulska *et al.* (2007) summarized the implications of mobile learning from the educators' perspective that mobile technology could improve the quality of learners' support and instruction as well as course design and management. From the learners' perspective, mobile learning provides new opportunities to explore and investigate independently and can help them to acquire up-to-date and on-the-spot knowledge (Wai *et al.*, 2018; Pinto *et al.*, 2020). After examining 18 key studies relating to student perceptions of mobile learning, Pollara (2011) concluded that whether by experimental studies or surveys, the overall attitudes of students towards mobile learning are positive and optimistic.

Many other researchers are advocates of this viewpoint (Jonathan, 2012; De Winteret *et al.*, 2010). The study of Kutluk and Gülmez (2014) investigated the attitudes of accounting students towards mobile device integration into learning. The results indicated that a majority of the students hold a positive attitude towards mobile learning and believe they already have the necessary knowledge and skills to exploit the mobile devices' potential to enhance learning. Owing to constant, convenient connectivity to the Internet, teachers can also deliver learning materials by email, replacing the traditional and time-wasting method of handing out documents face-to-face in the classroom. Students have tended to communicate more with their classmates and instructors since constant access to the Internet brought about a change in the communication paradigm (Wai *et al.*, 2018). Communication for short periods, but with high frequency, is considered more effective.

Mobile learning lends itself to short activities instead of intensive reading (Wang *et al.*, 2009; Habitezal, Mark and Prock, 2006). Jonathan (2012) showed the influence of mobile learning on communication by noting that mobile technology help realizes the construction of collaborative learning platforms, where students can work on a single assignment synchronously from anywhere. This method allows ideas, suggestions, and feedback to be transferred instantly. Thus, mobile technology's integration into learning has the potential to transform didactic learning into self-directed and participatory learning. Al-Fahad (2009) investigated the attitudes and perceptions of 186 female undergraduates to the mobile learning techniques used in King Saud University. He found that the students widely accepted mobile learning because it changed them from being passive learners to active and enthusiastic learners who were behaviorally and emotionally engaged in the knowledge transfer and construction that occurred.

Research into mobile learning is blossoming because of the widespread adoption of mobile devices amongst the younger generation, and students generally seem to be willing to embrace mobile learning as a new learning style and are happy to exploit its potential. However, Pikas (2013) and Ko *et al.* (2015) identified some issues that may hinder the adoption of mobile learning, both within the higher education context and in individual lives. Some educators still consider mobile devices to be detrimental to the students' learning process. As mobile devices provide so many functions to satisfy nearly all aspects of an individual's needs, they could cause distractions. In Pikas's study (2013), participants were particularly drawn to social media platforms. Although constant network connectivity is often perceived as one of the advantages of mobile devices' integration into learning, there are instances where this might become a disadvantage. Participants in Jonathan's study (2012) noted that easy social media access, email, apps, and games were the most common distractions in the process of learning.

Challenges posed by the mobile devices themselves were another hindrance. The breaking of iPad screens was identified as a particular issue (Wang, 2014). Likewise, the small screen size affected the reading experience of learners (Ko *et al.*, 2015; Wai *et al.*, 2018; Lau *et al.*, 2020), the small keypads of most mobile devices do not promote fluent and satisfying input, and some students regarded the cost of applications and occasional unsatisfactory Internet connection as impediments to using mobile learning technology (Ko *et al.*, 2015; Wai *et al.*, 2018).

THEORETICAL FRAMEWORK AND HYPOTHESES

As information technology continues to develop at an unprecedented rate and information systems proliferate within fields as diverse as commerce, healthcare, and education, the factors that affect users' actual use of a particular type of technology has piqued the curiosity of experts. To address this problem, experts have developed tools to evaluate the satisfaction level of users. Satisfaction refers to the total of one's perceptions and attitudes towards the factors that influence a particular situation (Legris, Ingham, and Collerette, 2001). Thus, the reasons that lead to user acceptance or rejection of information systems are closely linked with psychological knowledge. For example, the Theory of Reasoned Action (TRA) put forward by Fishbein and Ajzen (1975), from the perspective of social psychology, formed the basis of the Technology Acceptance Model (TAM) proposed by Davis (1989). The TRA model posits that an individual's behaviors are directly influenced by behavioral intentions, rather than attitudes, whereas the influence of the attitudes of the behaviors is mediated through the intentions. Although the TRA has been tested thousands of times in the social science field and has proven a useful model in predicting individual behaviors, it is not without its limitations. It has been determined that it not possible to apply the TRA model to all contexts. Assessing users' acceptance or rejection of certain types of technology, for example, cannot be done using the TRA model as researchers' attempts to create reliable measures to predict user attitudes towards information systems always failed (Marangunic and Granic, 2015). Thus, a reliable model that possesses the capacity to predict the users' acceptance level of information systems is required. To this end, Davis made some changes to the TRA model's predictors and proposed TAM.

In the original version of TAM, users' attitudes towards the use of information systems directly influenced behavioral intentions, which in turn directly influenced the system's actual use. Perceived usefulness and ease of use are the two of the most crucial constructs influencing technology use, with perceived ease of use having a direct influence on the degree of perceived usefulness. However, Davis also noted the intrinsic motives and argued that and individual's affections should be equally stressed when evaluating the users' acceptance of technologies. Venkatesh and Davis (2000) emphasized the determinant role that perceived usefulness plays in users' intention and willingness to use information systems. Thus, TAM 2 was proposed. The extended determinants of the constructs of perceived usefulness and usage intention differentiate TAM 2 from the original TAM. Apart from TAM 2, the TAM has been extended numerous times by whether eliminating or adding various variables to adapt it to specific contexts (Wixom and Todd, 2005).

With the help of the TAM instrument, Legris, Ingham and Collerette (2001) reviewed high-quality journals published between 1980 and 2001, which analyzed user attitudes and intentions towards information systems. The results demonstrated that TAM served as a useful prediction model for explaining the users' intentions and behaviors concerning information system utilization since positive relationships between variables were identified generally except a small number of inconsistencies. Both TAM and extended TAM have already been proven trustworthy, powerful, and economical models for assessing users' intentions with technology use. For this reason, they have been widely used across various information technology sectors. Despite this, TAM research in the mobile learning sector is quite sparse. Park (2009) analyzed the behavior intentions of Korean students towards accepting e-learning by building an extended TAM model.

Interestingly, self-efficacy and social norms ranked first and second, respectively, in determining e-learning adoption. Following this, Park (2012) introduced major relevance to the extended TAM model, on the assumption that students who undertake technology-related courses will be more likely to endorse the integration of mobile devices into learning. Major relevance serves as an intrinsic motivational element. The results demonstrated that it has a significant impact on variables, such as students' attitudes towards mobile learning and the perceived usefulness of m-learning.

This study intended to utilize the modified TAM to investigate the learners' attitudes towards the integration of mobile technology into learning, and their intentions to engage in mobile learning. By adopting this analysis and prediction model, it is not only the conceptual value that will be acquired but also the practical value.

Based on the original TAM and its extended versions, we propose a hypothesis model in which three external variables (discipline difference, system accessibility, and social norms) are predicted to relate to the perceived usefulness, ease of use, attitude, and behavioral intention of mobile learning. The hypotheses are as follows:

H1: Perceived ease of use (PEU), system accessibility (SA), discipline difference (DD), and social norms are having positive impacts on perceived usefulness (PU).

H2: SA, DD, and SN are having positive impacts on PEU.

H3a: SA, DD, and SN are having positive impacts on attitudes (AT).

H3b: SA, DD, and SN are having positive impacts on behavioral intentions (BI).

METHOD

This study aimed at examining three different groups of Medical students at HKU on their perceptions and attitudes towards their mobile learning, as well as what roles their academic majors played in shaping their mobile learning practices. A questionnaire survey was used to investigate the attitudes, perceptions, and actual learning practices of medical student groups from three different majors at HKU. All the participants participated in the study voluntarily. The questionnaires (in paper form) were distributed to students to fill out at the HKU Medical Library.

Data collection and analysis

A total number of 165 responses were collected for this questionnaire survey, though 15 of them were identified to be invalid as the responses were not from the targeted participants (as they are non-medical students). Thus, 150 self-completed questionnaires were found to be suitable for subsequent analysis for the study. The collected data were analyzed with the use of IBM SPSS (Statistical Package for Social Science).

Demographics of the survey population

Survey respondents' demographics could strongly influence their information needs, learning practices, and most importantly, their attitude as well as perceptions towards mobile learning. As shown in Table 1, out of all 150 responses, 50 were collected from each medical major. In terms of gender distribution, 69 (46%) were male, while the remaining 81 (44%) were female. Notably, a majority (86 / 57.33%) of the student respondents were pursuing their Medical studies at the undergraduate (Bachelor) level. Meanwhile, Doctoral students made up only 6% of the total survey population (see Table 1).

Table 1. Profile of medical student respondents

		Clinical Science	Chinese Medicine	Nursing	Total
Gender ($p < 0.01$)	Male	26	32	11	69 (46%)
	Female	24	18	39	81 (54%)
Age ($p < 0.01$)	18-22	9	14	31	54 (36%)
	22-25	13	19	14	46 (30.7%)
	25-30	20	16	1	37 (24.7%)
	30-40	8	1	3	12 (8%)
	40-60	0	0	0	0 (0%)
	60 and above	0	0	1	1 (0.7%)
Level of Study ($p < 0.01$)	Doctor	7	0	2	9 (6%)
	Master	27	16	12	55 (36.66%)
	Bachelor	16	34	36	86 (57.33%)
Place of Origin ($p < 0.01$)	Mainland China	36	18	12	66 (44%)
	Hong Kong	14	29	38	81(54%)
	Others	0	3	0	3 (2%)
Total		50 (33.33%)	50 (33.33%)	50 (33.33%)	150 (100%)

Reliability and validity of the survey instrument

We test the convergent validity and internal reliability of the survey instrument using Cronbach's α. As stated in Table 2, all α values > 0.70, except for MD (α = 0.67) and AT (α = 0.62) which are marginally exceeded the threshold of 0.6, which confirmed the internal consistency of the questionnaire. The correlation matrix is reported in Table 3

Table 2. Reliability of key variables of the research model			
		Mean (Standard Deviation)	**Cronbach's α**
Exogenous Variables			
System accessibility	SA1: It is easy to access the Internet and search for mobile learning	3.81(0.59)	0.73
	SA2: I have no difficulty accessing and using mobile devices for learning	3.56 (0.79)	
Discipline difference	DD1: Mobile learning is useful for my major study	3.87 (0.58)	0.67
	DD2: Mobile learning is necessary for my major study	3.41 (0.75)	
Social norms	SN1: People who influence my behavior think I should use mobile learning	3.27(0.73)	0.76
	SN2: Teachers are supportive of using mobile technology	3.35 (0.71)	
	SN3: I like mobile learning since my classmates are using mobile devices	3.41 (0.7)	
Endogenous variables			
Perceived usefulness	PU1: Mobile learning would improve my academic study	3.41 (0.7)	0.79
	PU2: Mobile learning would make it easier to study course content	3.47 (0.73)	
Perceived ease of use	PEU1: I find learning through mobile devices easy	3.7 (0.65)	0.74
	PEU2: It is easy to be skillful at using mobile devices to meet personal learning needs	3.61 (0.63)	
	PEU3: Learning to operate mobile learning is easy	3.84 (0.54)	
Attitudes	AT1: I think the teachers should encourage m-learning in class	3.53 (0.71)	0.62
	AT2: Studying with mobile devices is fun	3.87 (0.69)	
	AT3: Compared with computers, I prefer to use mobile devices to learn	3.14 (0.86)	
Behavioral intention	BI1: I will use mobile learning positively	3.69 (0.68)	0.84
	BI2: I will be a power user of mobile learning	3.49 (0.71)	

Table 3. Correlation matrix

	SA	MD	SN	PU	PEU	AT	BI
SA	1						
MD	.433	1					
SN	.357	.442	1				
PU	.297	.508	.659	1			
PEU	.606	.458	.416	.523	1		
AT	.346	.433	.547	.521	.428	1	
BI	.360	.467	.495	.469	.485	.723	1

SURVEY RESULTS AND DISCUSSION

Mobile device ownership and relations to the use of mobile technology

As shown in Table 4, of all 150 student respondents, a majority (111 / 74%) of them subscribed to 4th Generation (4G) wireless data plans, while only a very small number (5 / 3.3%) of them relied on free Wi-Fi service at selected public places. Notably, a majority (90 / 60%) of the student respondents spent an average HK$100 to $300 (US$12.8 to $38.5) on their wireless service plans per month, which usually include xxG to unlimited data service. The majority of students owned more than one mobile device. The most frequently-used mobile devices amongst respondents were smartphones, followed by iPads. Meanwhile, 66 (44%) of them spent an average of 3 to 5 hours per week on their mobile devices to engage in a variety of learning and non-learning-related activities.

Table 4. Mobile device ownership and usage

Wireless Data Plan Subscribed	**Number**	**Percentage**
4G Wireless Service	111	74.0%
3G Wireless Service	32	21.3%
2G Wireless Service	2	1.3%
Only WiFi	5	3.3%
Monthly Expenditures on Wireless Service Plan *(1USD=7.8HKD)*		
HKD $100	50	33.0%
HKD $100 – 300	*90*	60.0%
>HKD $300	10	7.0%
Number of Mobile Devices Owed by Each Student Participant		
One	40	27.0%
Two	79	52.0%
Three	21	14.0%
Above three	10	7.0%
Types of Mobile Devices Most Frequently Used *(including both learning and non-learning-related activities)*		
Smartphone	145	97.0%
iPad	4	2.0%
Other Handheld Mobile Devices	1	1.0%
Average Time Spent on Mobile Devices *(including both learning and non-learning-related activities)*		
Less than 1 hour	2	1.0%
1 – 3 hours	50	34.0%
3 – 5 hours	66	44.0%
Above 5 hours	32	21.0%

Usage of mobile devices in daily life

Table 5 summarizes the patterns of mobile device usage in everyday life amongst the three student respondents. Overall, respondents frequently used mobile devices for conducting daily communications and looking up quick facts such as instant messaging, access to search engines, and emails. On the other hand, relatively low usage was found in the following areas: (1) Engaging in online finance and banking transactions, (2) Reading academic materials, (3) Accessing university library website, and (4) Engaging in lectures. Interestingly, no distinctive differences were found between the three groups of Medical students in terms of their mobile device usage in daily life.

Table 5. Usage of Mobile Devices in Daily Life
(Notes: Numerical value is assigned as: 1=Never, 2=Rarely, 3=Sometimes, 4=Often, 5=Very often)

	Clinical	Chinese Medicine	Nursing	Mean	Standard Deviation
Instant messaging	4.42	4.32	4.46	4.4	0.59
Accessing search engines	4.04	3.9	4.02	3.99	0.71
Check or send e-mails	3.64	3.66	3.76	3.69	0.9
Social networking and sharing	3.48	3.42	3.86	3.59	1.02
Getting directions	3.62	3.38	3.48	3.49	0.91
Watching videos	3.62	3.3	3.4	3.44	0.9
Reading other contents	3.26	3.46	3.38	3.37	0.9
Engaging in casual reading	3.36	3.3	3.14	3.27	1.0
Accessing information about music	3.5	2.96	3.3	3.25	0.95
Accessing information about hobbies and sports	3.38	3.14	3.18	3.23	0.94
Language learning	2.78	3.16	3.38	3.11	0.95
Online shopping	3.44	2.6	3.22	3.09	1.03
Accessing shopping information	3.22	2.5	3.06	2.93	1.06
Playing games and engaging in entertainment activities	2.92	2.98	2.86	2.92	0.98
Accessing university's course management system	2.70	2.86	3.12	2.89	0.99
Accessing information about games and other entertainment activities	2.88	2.84	2.82	2.85	0.95
Text messaging	2.7	2.88	2.68	2.75	0.88
Reading academic materials	3.04	2.52	2.4	2.65	1.05
Engaging in lectures	2.62	2.42	2.58	2.54	0.91
Accessing finance and banking information	2.66	2.5	2.3	2.49	0.94
Engaging in online finance and banking transactions	2.96	2.32	2.2	2.49	0.98
Accessing university library website	2.3	2.34	2.64	2.43	0.92
Overall Average Rating	3.2	3.03	3.15		

As shown in Table 6, respondents often used their mobile devices for the following activities: (1) Searching for unfamiliar medical jargons; (2) Communicating with others; (3) Browsing information about future careers; (4) Taking photos; and (5) Accessing health care information. The researchers initially anticipated that respondents would be actively engaging in the following activities with their mobile devices: (1) Virtual surgical simulation practices; (2) Watching educational videos [related to Medical science]; and (3) Taking part in online discussion forums.

Table 6. Usage of Mobile Devices for Learning Purposes *(Notes: The results were acquired through comparing means and AVOVA test. Numerical values are assigned as: 1=Never, 2=Rarely, 3=Sometimes, 4=Often, 5=Very often)*					
	Clinical	Chinese Medicine	Nursing	Mean	Standard Deviation
Search for unfamiliar medical jargons ($p > 0.05$)	3.52	3.78	3.8	3.7	0.6
Communicate with others ($p > 0.05$)	3.42	3.46	3.4	3.43	0.87
Browse information about future careers ($p > 0.05$)	3.1	3.22	3.5	3.27	0.85
Download or view professional apps ($p < 0.05$)	3.22	2.78	3.36	3.1	0.92
Search for pictures ($p > 0.05$)	2.9	3.4	2.94	3.07	0.97
Take photos ($p > 0.05$)	3.12	3.1	2.86	3.03	1.05
Access healthcare information ($p > 0.05$)	2.88	2.96	3.22	3.02	0.89
Make study and work plans ($p > 0.05$)	3.18	2.92	2.94	3.01	0.92
Access medical journals and articles ($p > 0.05$)	2.88	2.84	3.14	2.95	0.92
Download/view course-related materials ($p < 0.01$)	3.16	2.5	3.06	2.9	0.99
Consult instructors, colleagues ($p > 0.05$)	2.96	2.84	2.76	2.85	0.87
Download/view PPT ($p < 0.01$)	3.2	2.44	2.84	2.83	1.06
Watch educational videos ($p > 0.05$)	2.72	2.62	3.04	2.79	0.84
Prepare for qualification test ($p > 0.05$)	2.72	2.72	2.82	2.75	0.9
Take notes($p < 0.01$)	2.98	2.34	2.82	2.71	1.02
Share medical records (patients' records) ($p > 0.05$)	2.8	2.54	2.72	2.69	0.95
Record videos ($p > 0.05$)	2.6	2.8	2.64	2.67	0.98
Access medical databases($p > 0.05$)	2.5	2.46	2.9	2.62	0.9
Record internship or working experiences ($p > 0.05$)	2.4	2.8	2.62	2.61	0.97
Participate in online discussion forums ($p > 0.05$)	2.72	2.5	2.56	2.6	0.89
Complete assignment($p > 0.05$)	2.7	2.2	2.54	2.47	1.01
Virtual surgical simulation practices ($p > 0.05$)	2.04	2.46	2.6	2.37	0.97
Overall Average Rating	2.90	2.80	3.00		

Factors that influence students' adoption of mobile technology

Table 7 shows various factors that influenced respondents' level of engagement in mobile learning, while Table 8 illustrates various disadvantages that the student respondents found in mobile learning. The respondents considered the portable size of mobile devices to be a key advantage conducive to learning, as they enable learning to be carried out at any time and location. Being able to "Access information quickly" was also given a high average rating score (4.13) by all three student groups. Meanwhile, "Constant Internet connectivity" (3.81) and "Enable more communication with classmates or colleagues" (3.85) also received relatively high average rating scores (see Table 7). It is also interesting to note that there are significant statistical differences (in terms of rating scores) between the three majors. For example, nursing students gave lower rating scores on the following: "Portal size," "Can carry everywhere," "Enable everywhere study," and "Get feedback quickly when they were asked to give reasons why they adopted mobile learning" (see Table 7).

Table 7. Advantages of Using Mobile Devices for Learning (*Notes: The results were acquired through comparing means and AVOVA test. Numerical values are assigned as: 1=Strongly disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly agree*)					
	Clinical	Chinese medicine	Nursing	Mean	Standard deviation
Can carry everywhere ($p < 0.01$)	4.02	4.14	4.46	4.21	0.63
Portable size ($p < 0.01$)	3.92	4.12	4.50	4.18	0.68
Enable study everywhere ($p < 0.01$)	4.02	4.06	4.46	4.18	0.63
Access information quickly ($p > 0.05$)	4.00	4.18	4.20	4.13	0.64
Memorize professional knowledge efficiently ($p > 0.05$)	3.70	4.00	4.18	3.96	0.77
Provide updated professional information ($p > 0.05$)	3.80	3.86	4.00	3.89	0.71
Enable more communication with classmates or colleagues ($p > 0.05$)	3.64	3.82	4.08	3.85	0.74
Get feedback quickly ($p < 0.01$)	3.56	3.86	4.10	3.84	0.71
Constant Internet connectivity ($p > 0.05$)	3.80	3.80	3.84	3.81	0.62

Table 8. Disadvantages of Using Mobile Devices for Learning (Notes: The results were acquired through comparing means and AVOVA test. Numerical values are assigned as: 1=Strongly disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly agree)					
	Clinical	Chinese Medicine	Nursing	Mean	Standard Deviation
Easily become distracted ($p < 0.01$)	3.78	4.06	4.38	4.07	0.76
Short battery life ($p > 0.05$)	3.74	4.18	4.00	3.97	0.79
Do not support multi-page display ($p < 0.01$)	3.62	3.86	4.16	3.88	0.85
Cannot connect Wi-Fi when needed ($p > 0.05$)	3.70	3.96	3.94	3.87	0.80
Small screen ($p < 0.01$)	3.54	3.78	4.26	3.86	0.81
Difficult input ($p > 0.05$)	3.62	3.68	3.88	3.73	0.80
Lack professional apps ($p > 0.05$)	3.58	3.84	3.72	3.71	0.82
Small keyboard ($p < 0.01$)	3.38	3.70	4.06	3.71	0.79
Inappropriate reading format ($p < 0.01$)	3.38	3.72	3.84	3.65	0.75
Inappropriate web design ($p > 0.05$)	3.58	3.46	3.70	3.58	0.77
Lack face-to-face communication ($p > 0.05$)	3.34	3.50	3.58	3.47	0.78
High cost of mobile learning applications ($p > 0.05$)	3.30	3.44	3.50	3.41	0.89
High cost of mobile network service ($p > 0.05$)	3.36	3.34	3.28	3.33	0.91
Total Average Rating	3.53	3.73	3.87		

Table 8 indicates that students considered "Easily become a distraction" as the highest barrier to mobile learning. With the lowest standard deviation, students' opinions tended to be consistent. Nowadays, a majority of websites have provided various customized user services, such as recommending advertisements to the user based on his search history. If a student lacks self-discipline, using mobile devices to learn may not be advisable.

Short battery life was perceived to be another major disadvantage of mobile devices. Applications and programs that are more dependent on the Internet tend to consume more battery power. To be effective, mobile learning must always be connected to the Internet. So limited battery life become a vital factor in explaining why students reject using mobile devices to learn. What is surprising is that the majority of students did not consider the high cost of mobile technology and applications to be a barrier. Given the proliferation of mobile technology, its price is becoming increasingly affordable (see Table 8).

Our results also showed significant statistical differences between students from different medical majors and the criteria for measuring convenience and ease of use of mobile devices. Nursing students generally agreed that the small screen, small keyboard, lack of multi-page display functions, and ease of use had become the key barriers when it came to mobile learning. Conversely, clinical students generally agreed with these items at the weakest level amongst the three groups of students (see Table 8).

Extended Technology Acceptance Model (ETAM)

Table 9. Interactions between dependent and independent variables

Dependent Variable	Independent Variable	Standardized Coefficients	t-value	Sig.	Adjusted R Square	F	Sig.
		Beta					
Perceived usefulness	Constant	B=0.696	1.166	.245	.483	47.356	.000
	System accessibility	.017	.249	.804			
	Discipline difference	.274	3.947	.000			
	Social norms	.544	8.108	.000			
Perceived ease of use	Constant	B=4.685	6.782	.000	.394	33.272	.000
	System accessibility	.511	7.065	.000			
	Discipline difference	.071	.942	.348			
	Social norms	.179	2.468	.015			
Attitude	Constant	B=3.133	3.535	.001	.341	26.730	.000
	System accessibility	.109	1.451	.149			
	Discipline difference	.201	2.556	.012			
	Social norms	.420	5.543	.000			
Behavioral intention	Constant	B=1.607	2.380	.019	.321	24.438	.000
	System accessibility	.127	1.658	.099			
	Discipline difference	.265	3.324	.001			
	Social norms	.333	4.328	.000			

The Technology Acceptance Model (TAM) has become a trustworthy model for investigating user perceptions and attitudes towards technology and identifying the factors that impact on their attitudes. According to the means and standard deviation statistics, overall, students considered the difficulty level of learning through mobile devices to be relatively low. This is in line with the phenomenon that young people generally find it is easy to operate mobile devices, even without instructions. Although students gave high scores on various disadvantages of using mobile devices as serious learning tools, overall, they deemed mobile learning to be beneficial to their study. Notable advantages included taking full advantage of spare time, accessing more shared valuable learning materials, and sharing of learning information.

Multiple regression analysis was conducted to determine the influence directions and the level of influence between different variables. In Table 9, perceived usefulness was regarded as a dependent variable, whilst system accessibility, discipline difference, and social norms were independent variables. The standardized coefficients of discipline difference and social norms reached a significant level (3.9 and 8.1, respectively), which indicated that they positively influenced perceived usefulness. System accessibility, discipline difference, and social norms were predictors of perceived usefulness, predicting 48.3% variance of perceived usefulness. The regression model was valid since its F value reached a significant level.

Similarly, the standardized coefficients of system accessibility and social norms reached a significant level, and these two variables influence the perceived ease of use positively. Further, discipline difference between the three student groups and various social norms that had positive influences on students' attitudes towards mobile learning, with social norms being the most influential factor. The three independent variables predicted a 34.1% variance in attitudes. Last but not least, discipline differences and social norms had positive influences on students' behavioral intentions towards mobile learning, with social norms being the most influential factor. The two independent variables predicted a 32.1% variance, and thus, the regression model was proven valid.

DISCUSSION

Mobile device penetration into the lives of medical students

Mobile technology involving wireless networks, smartphones, and tablets is inherent in the life of the younger generation nowadays, regardless of academic disciplines. Our findings are consistent with the results of some other studies in that many students indicated a tendency to use their smartphones to engage in various leisure, recreational, and relaxation activities such as watching videos and listening to music (Bomhold, 2013; Ko *et al.*, 2015; Wai *et al.*, 2018; Fan *et al.*, 2020). There is no exception for the medical student respondents from this study, as the majority are digital natives and have been using mobile technology daily for a variety of socialization and entertainment purposes. Given the high penetration rates of mobile devices in their daily life, it is not surprising that over half (79 / 52%) of the total respondents (even as students) owned two or more mobile devices (see Table 4).

Findings from this study extend and reinforce earlier studies (Dukic *et al.*, 2015; Ko *et al.*, 2015; Lau *et al.*, 2020; Fan *et al.*, 2020) in that these medical student respondents commonly used mobile devices for looking up quick facts, as well as for a variety of social networking, and recreational purposes. For example, a majority of the respondents indicated that they used mobile devices for the following purposes: (1) Instant messaging, (2) Accessing search engines, (3) Checking / sending emails, (4) Social networking and sharing, and (5) Getting directions (see Table 5). In other words, students valued quick and easily accessible information. Regardless of their academic disciplines, students tended to use their mobile devices for looking up quick facts, as well as handling their daily routines (such as search engine, social networks) rather than their formal academic activities (such as using online databases to search for academic materials).

On the other hand, students used their smartphones less frequently for formal academic reading. Major factors discouraging respondents from engaging in the formal learning more actively with their mobile devices include: (1) Easily become distracted; (2) Short battery life; (3) Do not support multi-page display; (4) Small screen (see Table 8). This result is also in line with findings from earlier studies (Dukic *et al.*, 2015; Ko *et al*., 2015; Lau *et al.*, 2020). For example, activities associated with formal learning in the medical setting received relatively low scores (average score below 3) by comparison, particularly in the following areas: (1) [Engaging in] virtual surgical simulation practices; (2) Recording internship or working experiences; (2) Sharing medical records; (3) Accessing medical databases; and (4) Participating in online discussion forums (see Table 6). Although mobile devices allow quick access to information facts with geographical independence and academic libraries are offering a variety of services for mobile devices, these services are still not used frequently as the small screen of the devices is a major barrier and not conducive to formal academic learning (Dukic *et al.*, 2015; Ko *et al.*, 2015; Wai *et al.*, 2018).

The benefits of mobile learning in medical education have been highlighted by many researchers (Mickan *et al.*, 2013; Wallace *et al.*, 2012; Walsh, 2015) by enabling educational resources to be available when and where the students need them, even at the bedside. Mackay *et al.* (2017) reported that mobile technology (iPad) could enhance teaching in the medical setting (implementation phase). Clay (2011) also reported that mobile technology has the potential to supplement information communication technology (ICT), online learning, and traditional training methods to educate practitioners in the clinical practice area. Besides, mobile technology allowed medical practitioners to feel empowered by placing the learning process firmly in the hands of the learner, thereby enhancing the acquisition of practical skills.

Factors shaping students' levels of activeness in mobile learning

According to Cao and Brown (2019), "traditional Chinese medicine, includes surgery, moxibustion, hot cupping, acupuncture, massage, herbal medicine, and nutraceutical medicine. [Meanwhile, modern], Western medicine, includes surgery and most commonly single molecular drugs… [As we] moved towards industrialization, modern Western medicine became the dominant medical practice with penicillin as a key discovery in disease treatment and exploration. Since then, herbal medicine gradually lost its dominant position in disease treatment." For a long time, Traditional Chinese medicine was marginalized. In addition to dominating modern medical practices, Western medicine has also dominated the trends in scientific research and publications of Medical Sciences. In our study, the findings show that clinical and nursing respondents belonging to Western medicine had few significant differences in their mobile learning usage and preferences, while the Western medicine group indeed had quite some significant differences with the Chinese medicine group.

Sharples *et al.* (2007: p.4) define mobile learning as "the processes (both personal and public) of coming to know through exploration and conversation across multiple contexts among people and interactive technologies." In other words, in addition to enabling students to learn anywhere and at any time, it is equally important to encourage students to be active through exploration and interaction across multiple contents in an online format for mobile learning to be effective. To that end, whether a student is actively engaged in mobile learning is highly dependent on the amount, variety and relevance of tools, resources and services made available by the university library in the online format. As highlighted by Walsh (2015), despite the convenience brought by such mobile technology, students would be interested in mobile library services only when they could actually see the need, when the benefits are apparent to them, or when the digital contents are relevant to their study and practice. Along the same line of thought, whether the university library is providing access to relevant and adequate content for the learners could be one of the critical factors determining students' level of activeness in mobile learning (Fan *et al.*, 2020). The Appendix shows a comprehensive comparison of tools (online learning apps), e-journals, databases, and other online library workshop materials for Western (clinical and nursing) and Chinese Medical Sciences available at HKU Library. Notably, the digital collection size, scope, and contents on Western Medicine available at HKU Library are overwhelmingly large and wide, in comparison to their Chinese medicine's counterparts. This could be one of the key factors in determining why students of Chinese Medicine tended to be less active in mobile learning.

For such obvious reasons, the researchers initially anticipated that the medical student respondents at HKU would be more actively engaged in mobile learning. Unexpectedly, the results of this study have proven contrary. Whether these Medical students were already aware of the potential positive impacts of mobile learning remains unknown, while some recent studies have shown that HKU students are probably not too much aware of library services, especially mobile ones (Ko *et al.*, 2015; Wai *et al.*, 2018; Lam *et al.*, 2019; Fong *et al.*, 2020). To address this problem, the library should promote more on its mobile services (Chen, 2019), the benefits of mobile learning, and the information literacy required (Allard *et al.*, 2019; Rantala *et al.*, 2019; Aharony *et al.*, 2019), as well as design more innovation information services to attract the patrons (Wójcik, 2019). Educators should also augment the curriculum to maximize exposing students and integrate learning activities to these mobile platforms (Aharony, 2014).

Besides, to what extent these students embrace mobile learning in the clinical setting remains unclear. Given the recent societal changes and the social implications of mobile technology, along with the advances of multimedia technology in the medical publishing industry, it is believed that mobile learning will become a ubiquitous component of medical education, particularly in the medical students' learning practices (Wallace *et al.*, 2012). Hence, further research is needed to determine the impacts of the revolution brought by mobile technology on instructional design and learning effectiveness, as well as 'virtual' interactions between the Medical instructors and students at HKU.

Furthermore, medical schools, libraries, and medical apps developers should make purposeful plans to incorporate mobile learning, while they need to consider how medical students use the mobile devices and their fundamental needs for accessing their desired materials for learning and research. Despite its limitations, this study provides an important reference for the mobile learning practices of medical students from HKU. The characteristics of their mobile learning usages and preferences have also been highlighted. It is expected that the results of this study could serve as a valuable reference for future research in similar fields.

Limitations

Only 150 survey respondents were recruited from the same university (i.e., HKU). Hence, the (small) number of samples may not be large enough to make the results representative of all medical students' mobile learning practices in Hong Kong. Owing to the small sample size for the questionnaire survey, the results from the study make generalizations difficult. Future research may replicate the same research by using a larger sample size, involving medical students of other universities that offer both Western and Chinese Medicine programs in Hong Kong and the Greater China Region, e.g., Mainland China, Taiwan, and Macau.

CONCLUSION

The findings of this study reveal the varying attitudes and perceptions towards mobile learning amongst three groups of Medical Science students at HKU. Usage frequencies, patterns, as well as other factors, influenced these medical students' user behaviors, and most importantly, their relations to Technology Acceptance Model (TAM). The study found that a majority of the medical student respondents used mobile devices for various social networking, recreational, and even entertainment purposes. The small screen size, entertainment characteristics, and issues such as privacy prevented them from engaging in other types of formal learning activities with the same frequency as for entertainment purposes. Few significant differences have been found between the three groups of Medical majors, in terms of their specific mobile learning activities. Notably, the Clinical Science and Nursing students had similar perceptions and behavior and tended to have more diverse information needs, in addition to expressing a preference to explore other potential functions of their mobile devices. On the other hand, Chinese Medicine student respondents were not as active as mobile learners in comparison to the other two majors.

The author-tested hypothesis, based on the TAM, and the results were consistent with previous research through the Pearson correlation test and a multi-regression analysis. Thus, system characteristics, social norms, and discipline differences are closely related to perceived usefulness, perceived ease of use, attitudes, and behavioral intentions. System characteristics are the most critical factor in positively influencing the perceived ease of use, while the social norm is the most influential factor that positively correlates to perceived usefulness, attitudes, and behaviors. The majority of the students deemed mobile learning to be beneficial to their professional study and noted that their confidence in using mobile technology skillfully is high. This implies that mobile technology in the context of the medical field is in the prime time of its development and further, that this field is worth further investigating and researching.

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Appendix - List of digital resources on Medical Science available at HKU Library

<table>
<tr><th>Western Medicine</th><th>Chinese Medicine</th></tr>
<tr><td colspan="2">Online E-Journals and Databases</td></tr>
<tr><td>
Alternative Medicine
▪ AMED (Allied and complementary medicine)
Anaesthesiology
▪ AccessAnesthesiology
Anatomy
▪ Anatomy.tv
▪ SMART imagebase
Biochemistry
▪ Biosis previews
▪ ScienceDirect
▪ Scopus
▪ Springer protocols
Diagnostic Radiology
▪ STATdx
Emergency Medicine
▪ AccessEmergency Medicine
Evidence-based medicine
▪ National guideline clearinghouse
▪ Pubmed Clinical Queries
Family Medicine and Primary Care
▪ BMJ learning
▪ JAMAevidence: using evidence to improve care
Microbiology
▪ ASM journals
▪ Biological abstracts
▪ Biological sciences database
▪ BIOSIS previews
Nursing
▪ British Nursing Index
▪ Clinical Skills
▪ Jarvis physical examination and health assessment video series
▪ JBI COnNECT+
▪ JBI EBP Database
▪ Nursing education in video
▪ Nursing reference center plus
Paediatrics
▪ AccessPediatrics
Pathology
▪ ExpertPath
▪ OMMBID
Pharmacy and Pharmacology
▪ AccessPharmacy
▪ Clinical pharmacology powered by Clinicalkey
▪ Drugs@FDA: FDA-approved Drug Products
▪ EMBASE
▪ MedicinesComplete
▪ TOXLINE
Point of care
▪ Cochrane Library
▪ Essential Evidence Plus
▪ STATdx

Physiology
▪ Anatomy.tv
Psychiatry
</td><td>
▪ 中國期刊全文數據庫 (China Journal Net)

▪ 萬方數據. 醫葯衛生學術期刊 (Wanfang Med Online)

▪ 萬方數據. 中國學位論文全文數據庫. 醫葯衛生 (Wanfang Data, China Dissertation Database (CDDB), Wanfang Med Online)

▪ 萬方數據. 中國學術會議文獻數據庫. 醫葯衛生 (Wanfang Data, China Conference Paper Database (CCPD), Wanfang Med Online)

▪ 中醫典海 (Zhong yi dian hai)

▪ 中醫葯知識庫 (TCM Knowledge Base)

▪ 中藥標本資料庫 (Chinese Medicine Specimen Database)

▪ 中藥材圖像數據庫 (Chinese Medicinal Material Images Database)

▪ 藥用植物圖像數據庫 (Medicinal Plant Images Database)

▪ Chinese Medicine
</td></tr>
</table>

<table>
<tr><td>▪ PsycINFO
Public Health
▪ CDC wonder
▪ Gallup analytics
▪ Global health
▪ Health and safety sciences abstracts
▪ TOXLINE
▪ TOXNET
▪ World Health Organization. Global health atlas
Sport sciences
▪ SPORT discus
Surgery
▪ AccessSurgery: a comprehensive resource for surgical education
▪ Transplant library</td><td></td></tr>
<tr><td colspan="2">Other Databases</td></tr>
<tr><td>▪ AACR journals online
▪ AccessCardiolog
▪ AccessMedicine
▪ APS journals
▪ BioMed Central
▪ Books@Ovid
▪ British pharmacopoeia
▪ Current protocols in pharmacology
▪ Faculty of 1000
▪ Journal of medical Internet research
▪ Journal of neurosurgery
▪ Karger
▪ Mary Ann Liebert Inc., publishers
▪ LWW health library.
▪ Oncology nursing forum
▪ Taylor and Francis online</td><td>None</td></tr>
<tr><td colspan="2">Online Mobile Learning Apps</td></tr>
<tr><td>▪ BMJ Best practice
▪ CINAHL Plus
▪ ClinicalKey for nursing
▪ Complete anatomy
▪ DynaMed plus.
▪ IBM micromedex
▪ Lippincott advisor / Lippincott procedures
▪ UpToDate
▪ Visual Body
▪ VisualDx</td><td>None</td></tr>
<tr><td colspan="2">Library provided materials / workshops</td></tr>
<tr><td>Postgraduate
▪ Workbook for postgraduate library workshop
▪ Powerpoint for postgraduate library workshop
Undergraduate
▪ Workbook for Bachelor of Pharmacy library workshop
▪ Workbook for Bachelor of Medicine and Bachelor of Surgery library workshop
▪ Workbook for Bachelor of Biomedical Sciences library workshop
▪ Workbook for Bachelor of Nursing library workshop
▪ Powerpoint for undergraduate library workshop
Library workshops
▪ Browzine
▪ EndNote</td><td>Postgraduate
▪ Workbook for Master of Chinese Medicine library workshop

Undergraduate
▪ Workbook for Bachelor of Chinese Medicine library workshop</td></tr>
</table>

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