Educational Usage of Mobile Devices:

Differences between Postgraduate and Undergraduate Students

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Abstract

The rapid increase of smartphone usage in recent years has provided students the opportunity to participate in mobile learning (m-learning) anywhere, anytime. Academic institutions are also following this trend to launch many m-learning services. This article investigates the differences of the user needs between undergraduate (UG) and postgraduate (PG) students though an online survey with 140 Library Information Systems (LIS) subjects in a Japanese university in order to provide solid foundations for future m-learning studies. We find that UG and PG students do not show significant differences in adopting m-learning by smartphones despite the fact that they have different learning patterns. The m-learning frequencies of smartphones generally range from weekly to monthly, where using search engines is the most frequent, and reading academic resources is the least frequent. They tend to use these services for handling their daily routines (such as search engine, social networks) rather than their academic activities (such as using online databases to search for academic materials). Further, the results also show that content displaying issues (e.g., small display screen, text unable to enlarge) are barriers for most subjects in using these m-learning services.

Keywords: Mobile learning (m-learning); Mixed method; Comparison; Smartphone; Library and information science (LIS); learning patterns

Introduction

In recent years, there has been a rapid increase in the number of smartphone subscribers and mobile data traffic, while the computing power of smartphones are comparable to desktop computers. Nowadays, most university students are millennial learners (aged 18-34) born after the broadband Internet became the essential communication tool in our lives and learning. Prior to the age when the broadband Internet connection was publicly available, teaching paradigms were much different than those of today. According to Crompton's (2013) definition, learning pedagogies gradually progressed from discovery (in the 1970s), constructivist, and constructionist (in the 1980s), to problem-based and socio-constructivists (in the 1990s). These three pedagogical methods are all learner-centered, where the role of instructors is to guide learners through the learning process instead of helping them develop themselves as "knowledge repositories" (Hmelo-Silver, 2004).

Starting from the 21st century, m-learning (2000s) has become the trend due to the availability of mobile Internet connections. According to Traxler (2009), technology plays an important role in the shifting of pedagogical paradigms from the development of printing methods, which contributes to the "effective transmission of the canons of scholarship" (Sharples, Taylor, & Vavoula, 2005, pp. 6), to the current age of technology of implementing components like information processing, modeling, and more importantly, interaction into pedagogies. When broadband Internet became more widespread and with the current paradigm shifts to m-learning, we observe that both learners and instructors almost immediately embraced this new pedagogical approach. Online quizzes and interactive multimedia have become learning tools that can be used in both desktop and mobile devices, and instructors can record their lectures and distribute them to the learners in the most appropriate time. Last but not least, the use of discussion forums in

teaching is becoming a usual way for instructor-learner communication (Ho, 2014).

To investigate the impact of m-learning to university students, we developed the current study, which focuses on uncovering the differences of the usage needs of m-learning of postgraduate (PG) and undergraduate (UG) students. This study is built upon a prior study reported by Ko et al. (2015), which investigated some m-learning behavior of 267 Library and Information Science (LIS) students from Hong Kong, Japan, and Taiwan. We would like to further explore how mobile technology has changed the ways of learning for our current (and future) generations, and, in particular, if there are any differences in the way that UG and PG students utilize mobile technology in their education. There are currently very few such studies and probably pioneer in the Far East. We anticipate that UG and PG students may embrace the m-learning in different ways as most PG students are more engaged with research-oriented curricula and thus, their needs are different from UG students who are usually studying in a structured program with information that are more systematical and readily available. To sum up, we approach the above issues through the following three research questions (RQs):

- **RQ1**: Do PG and UG students have similar habits on participating in m-learning through smartphones?
- **RQ2**: Do PG and UG students have similar barriers to participating in m-learning through smartphones?
- **RQ3**: Do PG and UG students have similar preferences of library services they wish to use through smartphones?

The rest of this paper is developed as follows. First, we review the literature about Net Generations, mobile learning, and related benefits and disadvantages. Next, we describe our research methodology, followed by our data collection and data analysis. Lastly, we discuss the

result of this study and its contribution, and conclude our paper by outlining the limitations of this survey, together with the future study directions.

Literature review

The millennial generation

One commonly used definition of millennials, i.e., the Net Generation, are those who were born between 1982 and 2002 (Worley, 2011). As of 2017, the majority of university students are considered millennials. They grew up surrounded by technology, though they usually only used limited ranges of technologies in "communication, recreation, information, production, and transaction" (So et al., 2012, p. 1238). In fact, technology molds the ways how the Net Generation act (Wilson & Bolliger, 2013). Worley (2011) summarized the characteristics of the Net Generation: technologically advanced, able to multi-task, impatient, and extremely social.

As reported by Ericsson (2016), the number of smartphone subscriptions worldwide in 2015 was 3.2 billion, with a 23% growth compared with 2014, and the monthly data traffic per smartphone increased from 1GB/month to 1.4GB/month. Poushter (2016) also reported that countries with advanced economies would have an even higher rate of increase and also pointed out that millennials were more likely to own a smartphone for Internet access. They are the group more accustomed to handle their routines using mobile apps because their adoption of smartphones and the Internet is the highest among all age groups. Dahlstrom et al. (2015) reported that there is an increasing trend of UGs owning a laptop or a smartphone to facilitate their learning. Farley et al. (2015) further reported that 86% of the 18 to 24 age group and 91% of the 25 to 29 age group own at least one smartphone. To sum up, millennials in general are tech savvy and are familiar with smartphone usage. They are already using, or at least ready to use, their mobile devices for engaging the learning process.

Mobile learning (m-learning)

To cope with this trend, many academic institutions have developed mobile learning (m-learning) services in the hope of providing a better support to the academic lives of this group of learners who are engaged with mobile technology in their daily lives. M-learning refers to the use of mobile-devices such as smartphones, PDA, SMS, and MMS in learning. This has been transiting from electronic learning (e-learning), which refers to the use of electronic devices such as personal computers and laptops to facilitate learning (Nedungadi & Raman, 2012; Traxler, 2005). Depending on whether "mobile" refers to the mobility of learners or mobile technology, "mobile learning" can have several definitions (Hashemi et al., 2011; El-Hussein & Cronje, 2010). For example, Sharples, Taylor, and Vavoula (2005) provided a broad definition of m-learning as learning outside one's usual learning environment or learning involving the use of mobile devices. Wilson & Bolliger (2013), on the other hand, defined m-learning based on the aspects of mobility of learners and suggested that it is "any sort of learning that occurs with a mobile device, when the learner is not tethered or fixed to a predetermined location" (p. 221). Traxler (2005) has provided a hardware-focused definition of m-learning as "any educational provision where the sole or dominant technologies are handheld or palmtop devices" (p. 262).

There are also some scholars using e-learning as a reference model and use it to define m-learning. When compared to e-learning, m-learning has the distinctive characteristics of being spontaneous, private, portable, and lightweight (Traxler, 2005). Thus, Keegan (2005) suggested that m-learning is "the provision of education and training on PDAs/palmtops/handhelds, smartphones, and mobile phones" (pp. 2). However, Traxler (2007) finds this definition problematic, as he is of the view that using hardware and technologies as the core of defining m-learning is "constraining, techno-centric, and tied to current technological instantiations" (pp.

4).

In the past decade, some research has been conducted to investigate how students use their mobile devices for academic purposes. In general, it is observed that the percentage of mobile usage and willingness of usage are both increasing across the years. For example, Dresselhaus and Shrode (2012) reported that over 54% and 50% of UG and PG students, respectively, participated in m-learning, and 70% of their subjects were likely or very likely to use a smartphone for their academic needs, though the "cost of technology or the current state of mobile readiness in (their) library" (pp. 90) is a concern. More recently, Catharine (2013) noted that even more (76%) UGs were ready to use mobile phone apps to seek academic information. This shows that millennials are ready to engage their learning with the mobile devices.

On the other hand, the EDUCAUSE Center for Analysis and Research (ECAR) studies argued that even though that use of technology in higher education is more widespread, its full potential is not being achieved (Dahlstrom et al., 2015). These technologies include courseware and Web-based training modules (Walter, 2013), as well as other learning platforms, lecture recordings, presentations, and discussion forums (Farley et al., 2015). Yet, as reported by Catharine (2013) and Dahlstrom et al. (2015), search engines (60%) and online encyclopedias (14.4%) are found to be most frequently used app for academic use.

After all, the ideas for shifting the pedagogical paradigm for m-learning is to bring benefits to learners. Prior research suggested that there are several advantages of m-learning. Wilson and Bolliger (2013) pointed out that m-learning can cause students to become "inquiry-driven learners collecting data from multiple resources," and allow dynamic flexibility for students to "recognize and monitor growth with a subject on their own time" (pp. 222). Other benefits of m-learning include the use of mobile devices can facilitate communication and because their

light weight and portability overcomes space and time constraints of using (Hashemi et al., 2011), as well as providing instant access to information (Sung et al., 2016).

Mobile Device Barriers

However, there are still some barriers for using mobile devices in learning. First, mobile devices are usually equipped with small screens (El-Hussein & Cronje, 2010). Hashemi et al. (2011) also stated that mobile devices limit the type and amount of information being displayed, and this triggers the redesign of old text presentation (El-Hussein & Cronje, 2010). Another barrier is cost, which Wilson and Bolliger (2013) pointed out that even though the cost of mobile device has been dropping in recent years, data service plans may still be too costly for some students. There are other limitations of using mobile device in teaching, including the short battery life (Hashemi et al., 2011; Wang et al., 2009; Wilson & Bolliger, 2013), unsuitability for graphics (Hashemi et al., 2011), heavy reliance on bandwidth (Hashemi et al., 2011), the possibility of transaction errors (Wang et al., 2009), limited input capabilities (Wang et al., 2009), etc. Further, Lo et al. (2016) also reported that learners' academic backgrounds would have an impact on the types of applications they needed in using m-learning, and this means that academic institutions may need to conduct more investigations before rolling out their services to meet the needs of students of different academic disciplines. In addition, the users' psychological perspective is also a factor, as some users prefer using mobile devices for leisure activity such as texting friends and accessing social network services than using them for academic work (Park, 2011; Wang et al., 2009).

Methodology and data collection

As such, we noted that m-learning provides an opportunity for both learners and instructors to improve their learning experience and learning outcomes. However, there are also many factors

affecting the success of m-learning due to technological limitations and psychological perspectives. In this research, we focus on the mobile devices and explore how they affect students on their perceptions in using these devices in their m-learning process. Therefore, we hope that we can probe into the issue of the adoption of m-learning by further examining the needs of learners at different stages of their academic journey, i.e., UG vs. PG. This analysis can help academic institutions to design better m-learning platforms to serve their learners based on their level of study.

To probe into the three RQs of this research, we conducted a survey using subjects recruited from a university in Japan. The survey instrument was modified from prior research (Ko et al. 2015) and was translated into Japanese. The focus of our survey questionnaire is to probe into the use of mobile devices in the learning process or m-learning. The survey started with the collection of demographic information of the subjects, followed by asking questions related to their perception on the use of mobile devices in various scenarios, and the problems encountered in using these technology in learning. Most of the survey questions used a Likert scale, which allows us to use the relevant statistical methods to investigate into the research issues. In particular, we use a non-parametric test, i.e., the Mann-Whitney U-Test, to compare the differences between the responses provided by UG and PG subjects (Mann & Whitney, 1947). A total of 139 subjects were recruited from the Library and Information Science (LIS) department. After taking out some incomplete responses, we have 120 usable responses for this study. No incentives were provided for data collection.

Data analysis

Descriptive statistics

The data were analyzed using SPSS Version 23. The demographic information of our subjects are presented at Tables 1 and 2. As shown in Table 1, UG students' responses are three times the rate of PG students. We also noted that, based on Worley's (2011) definition of the Net Generation (i.e., people who were born between 1982 and 2002), more than 98% of our subjects belonged to that age group.

Table 1. Education Background and Gender

	UG			PG		
Age	Male	Female	Total	Male	Female	Total
< 19	4	18	22	0	0	0
20-30	26	42	68	13	15	28
31-40	0	0	0	0	0	0
41-50	0	0	0	0	2	2
Total	30	60	90	13	17	30

Table 2 provides more descriptive statistics related to the mobile phone ownerships of the respondents. 94.2% of our subjects have mobile devices able to access to the Internet. Thus, our subjects are equipped with devices that can help them get access to most of the m-learning activities.

Table 2. Mobile Device Ownership

Mobile Device Ownership	UG	PG	Total
Smartphone with Internet subscription	82	23	105
Smartphone without Internet subscription	3	0	3
Simple mobile phone (cell phone) with Internet functions	4	4	8
Simple mobile phone (cell phone) without Internet functions	0	2	2
None of the above	1	1	2
Total	90	30	120

Daily habit of using smartphones

Table 3. Smartphone Usage Habit

Habit	Total	UG	PG	Z-Score
Communicating with friends and family (e.g., email, SMS, chat)	4.39 (N = 119)	4.49 (N = 89)	4.07 (N = 30)	0.9608
Social activities with social media (e.g. Facebook, Twitter, Goodreads, etc.)	4.26 (N = 119)	4.47 (N = 89)	3.63 (N = 30)	2.528 **
Finance and banking	1.45 (N = 117)	1.33 (N = 87)	1.80 (N = 30)	–1.557
Shopping (e.g. Barcode scanner, Amazon)	2.02 (N = 118)	1.97 (N = 88)	2.17 (N = 30)	–0.6273
Finding locations, like streets, restaurant, etc.	3.22 (N = 117)	3.30 (N = 87)	3.00 (N = 30)	1.024
Games, music, movies, TV series, etc.	3.44 (N = 117)	3.51 (N = 87)	3.23 (N = 30)	1.167
Hobbies, sports, fitness, travel	2.59 (N = 118)	2.52 (N = 88)	2.80 (N = 30)	–0.8251
Tools & productivity software (e.g., calendar, notes, to-do lists)	3.83 (N = 117)	4.02 (N = 87)	3.27 (N = 30)	1.807 *
Casual reading: non-academic books, comics, magazines, newspaper, etc.	2.64 (N = 116)	2.63 (N = 88)	2.64 (N = 28)	–0.0323
Academic reading: articles, e-books, blogs, and websites	2.40 (N = 117)	2.38 (N = 87)	2.47 (N = 30)	–0.2559
Accessing reference materials (e.g., encyclopedia, dictionaries, etc.)	2.86 (N = 117)	2.87 (N = 87)	2.83 (N = 30)	0.1498
Using search engines (e.g., Google, Yahoo, and Baidu)	4.37 (N = 118)	4.47 (N = 88)	4.10 (N = 30)	0.4110
Accessing libraries (e.g., Public and/or academic libraries)	2.42 (N = 117)	2.54 (N = 87)	2.07 (N = 30)	1.770 *

Notes:
(1) Some subjects did not response to some of the items.
(2) Scale: 1: Never used; 2: Using less than once per month; 3 Using it monthly; 4: Using it weekly; 5: Using it daily.
(3) Z-Score is obtained from the Mann-Whitney U-Test; *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

Table 3 summarizes the respondents' daily usage habits of smartphones. Both UG and PG subjects used "communicating with friends and family," "search engines," and "social activities with social media" most frequently. However, they seldom used "finance and banking" or "shopping" applications. We also observed that UG subjects were significantly ($p < 0.05$) engaged with "social activities with social media," and marginally ($p < 0.10$) engaged with "tools

& productivity software," and "accessing libraries" activities, compared to our PG subjects.

M-learning habit by smartphones

Table 4. Use of Smartphone for General M-learning Purpose

M-learning purpose	Total	UG	PG	Z-Score
Browsing through websites, blogs, wikis, micro-blogs, etc.	3.48 (N = 100)	3.43 (N = 72)	3.61 (N = 28)	–0.4875
Browsing or reading posts on social networking sites (e.g., Facebook and Whatsapp)	3.20 (N = 100)	3.25 (N = 72)	3.07 (N = 28)	0.4337
Reading articles from professional journals & magazines	1.48 (N = 100)	1.39 (N = 72)	1.71 (N = 28)	–1.374
Reading e-books	1.68 (N = 100)	1.61 (N = 72)	1.86 (N = 28)	–0.5527
Listening to podcasts	1.33 (N = 100)	1.21 (N = 72)	1.64 (N = 28)	–1.620
Viewing a video clip (e.g., from YouTube, TED talks or similar)	2.40 (N = 99)	2.37 (N = 71)	2.50 (N = 28)	–0.3341
Accessing and browsing learning management platform for information or resources (e.g., Moodle)	1.51 (N = 100)	1.38 (N = 72)	1.86 (N = 28)	–1.436
Accessing other learning stuff (for learning foreign languages, XML, etc.)	1.28 (N = 100)	1.10 (N = 72)	1.75 (N = 28)	–1.919 *

Notes:
(1) Some subjects did not response to some of the items.
(2) Scale: 1: Never used; 2: Using less than once per month; 3 Using it monthly; 4: Using it weekly; 5: Using it daily.
(3) Z-Score is obtained from the Mann-Whitney U-Test; *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

Table 4 shows the smartphone usage for general learning purposes. "Browsing through websites, blogs, wikis, micro-blogs, etc." and "browsing or reading posts on social networking sites" are the most frequently-used applications for both UG and PG subjects. Apparently, browsing or reading posts through Web and SNS are just common activities even for entertainment as well. It is consistent with our results shown in Table 1. For the UG subjects, "accessing other learning stuff" and "listening to podcasts" are the least-used functions. For the PG subjects, "listening to podcasts" and "reading articles from professional journals & magazines" are the least-used. We also observed that our PG subjects are marginally more likely "accessing other learning stuff" (*p*

< 0.10) than our UG subjects." Overall, the usage of smartphones for m-learning is low for both our UG and PG subjects, with the frequency of less than once per month.

In Table 5, we summarized the UG and PG students' habits of accessing information and conducting research. The findings show that there are no significant differences between the usage behavior of our UG and PG subjects in using smartphone for accessing information and conducting research for m-learning purpose. However, it is important to note that our subjects tend to use more reference sources and search engines than the library catalog (i.e., OPAC) and e-databases, despite the fact that the latter are more reliable sources for research.

Table 5. Use of Smartphone for Accessing Information and Conduct Research related to M-learning

M-learning Purpose	Total	UG	PG	Z-score
Library catalog	1.95 (N = 99)	1.93 (N = 71)	2.00 (N = 28)	–0.2214
Library e-database	1.52 (N = 99)	1.46 (N = 71)	1.64 (N = 28)	–0.9712
Accessing reference sources (e.g., Encyclopedia, dictionary)	2.38 (N = 99)	2.35 (N = 71)	2.46 (N = 28)	–0.2797
Searching with search engines (e.g., Google, Yahoo!, etc.)	3.45 (N = 99)	3.49 (N = 71)	3.36 (N = 28)	0.0699

Notes:
(1) Some subjects did not response to some of the items.
(2) Scale: 1: Never used; 2: Using less than once per month; 3 Using it monthly; 4: Using it weekly; 5: Using it daily.
(3) Z-Score is obtained from the Mann-Whitney U-Test; *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

This study also investigated into the usage of productivity and communication tools for m-learning by our subjects, and the results are presented at Tables 6 and 7. The results show that the usage of tools for productivity, and communication and sharing were generally low and were at a monthly-basis level. For productivity tools, "planning or checking personal schedule" is the most commonly used type of tools. We conjecture that our subjects like to use this function because it is unlike the other two (i.e., creating documents and making notes), which require a lot

of typing. Rather, scheduling tools only requires users to input crucial information (such as time and location). Plus, we also observed that the usage pattern of our UG and PG subjects were at a similar usage level.

Table 6. Use of Productivity Tools on Smartphone for M-learning Purpose

Productivity Tools	Total	UG	PG	Z-value
Making notes with note taking tools or memo tools (e.g., Evernote, T memo or similar)	2.27 (N = 99)	2.30 (N = 71)	2.21 (N = 28)	0.2603
Creating documents (text, presentation, spreadsheets, etc.) with Google apps. or similar tools	1.47 (N = 99)	1.41 (N = 71)	1.64 (N = 28)	–1.410
Planning or checking a personal schedule (e.g., Google Calendar and personal organizer)	2.47 (N = 99)	2.49 (N = 71)	2.43 (N = 28)	0.1670

Notes:
(1) Some subjects did not response to some of the items.
(2) Scale: 1: Never used; 2: Using less than once per month; 3 Using it monthly; 4: Using it weekly; 5: Using it daily.
(3) Z-Score is obtained from the Mann-Whitney U-Test; *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

Concerning the use of communication and sharing tools (see Table 7), the results showed that our UG subjects were more engaged with "communicating with classmates to discuss course materials, assignments, etc." compared with our PG subjects, but only marginally ($p < 0.10$). One of the possible reasons that leads to this observation is that our UG subjects have similar course schedules. As a result, they know one another well and thus, and they would like to use these applications to communicate among themselves.

We also observed that several mean value scores are less than 1.5, which indicate that our subjects rarely used them. This includes "creating documents," "posting to class forums," and "post on social bookmarking sites." Plus, it is interesting to note that even though our subjects did not like "Posting or commenting study related items to social networking sites" and "Sending photos or videos from your smartphone to social networking sites" (see Table 7), but they like to use the same applications for general purposes (see Table 3).

Fig. 7. Use of Communication and Sharing Tools on Smartphone for M-learning Purpose

Communication and sharing tools	Total	UG	PG	Z-Score
Communicating with classmates to discuss course materials, assignments, etc.	2.71 (N = 99)	2.87 (N = 71)	2.29 (N = 28)	1.915 *
Using email, SMS,MMS or chat apps for study related issues with classmates/teachers	2.91 (N = 99)	2.90 (N = 71)	2.93 (N = 28)	–0.1437
Posting to class forums on the learning management platform (e.g., Moodle)	1.17 (N = 99)	1.13 (N = 71)	1.29 (N = 28)	–1.239
Posting or commenting study related items to social networking sites (e.g., Facebook, Twitter, etc.)	2.01 (N = 99)	2.07 (N = 71)	1.86 (N = 28)	0.3419
Posting study related items on social bookmarking sites (e.g., Delicision and Pinterest)	1.23 (N = 98)	1.23 (N = 70)	1.25 (N = 28)	–0.5348
Sending photos or videos from your smartphone to social networking sites	2.06 (N = 99)	2.11 (N = 71)	1.93 (N = 28)	0.5672
Transport files (e.g., PDF, MS Word, MS PPT, etc.) of retrieved resources	1.98 (N = 99)	1.87 (N = 71)	2.25 (N = 28)	–0.9440
Scan QR codes (e.g., retrieved items from library catalog)	1.66 (N = 98)	1.70 (N = 70)	1.54 (N = 28)	0.4404

Notes:
(1) Some subjects did not response to some of the items.
(2) Scale: 1: Never used; 2: Using less than once per month; 3 Using it monthly; 4: Using it weekly; 5: Using it daily.
(3) Z-Score is obtained from the Mann-Whitney U-Test; *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

Barriers for m-learning by smartphones

Table 8 shows the summary of how UG and PG consider barriers of m-learning using smartphones. Both UG and PG students perceive small screen size as the greatest barrier and difficulty with authentication as the barrier of least concern. Besides the items listed in Table 8, one respondent has mentioned “not able to enlarge font size” as a barrier.

Table 8. Barriers for Engaging M-Learning through Smartphone

Barriers	Total	UG	PG	Z-Score
Screen size is too small	3.19 (N = 97)	3.18 (N = 69)	3.22 (N = 28)	0.05363
Web page is not formatted for smartphone	3.03 (N = 97)	2.99 (N = 69)	3.15 (N = 28)	–0.8199
Text typing is difficult	2.91 (N = 96)	2.87 (N = 68)	3.04 (N = 28)	–0.6936
Difficulty with authentication	2.59 (N = 97)	2.57 (N = 69)	2.64 (N = 28)	–0.3007
No WiFi or wireless where needed	3.00 (N =97)	3.08 (N = 69)	2.81 (N = 28)	0.7321
Difficulty with reading content format (e.g., PDF not sized correctly)	3.08 (N = 96)	3.06 (N = 69)	3.12 (N =27)	–0.2818
Lack of specialized mobile apps.	3.00 (N = 96)	3.04 (N = 68)	2.89 (N = 28)	0.6852
Load time is slow	3.09 (N = 97)	3.13 (N = 69)	3.00 (N = 28)	0.5075

Notes:
(1) Some subjects did not response to some of the items.
(2) Scale: 1: Not a barrier at all; 2: Low barrier; 3: Medium barrier; 4: High barrier.
(3) Z-Score is obtained from the Mann-Whitney U-Test; *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

M-library service used or like to use

Our result showed that our UG subjects were marginally engaged ($p < 0.10$) with "access my library account," "check library hours, library map," and "contacting librarian" more than PG ones. For the result of the m-library services, the preference of our UG and PG subjects were the same. Most items were scored are around 2.0, which indicated that our subjects would at least want to try various kinds of m-library services when they are available. It is also interesting to note that "provide comments & suggestions" and "contact librarian" were the least attractive m-library services for our UG and PG subjects. These services are, in fact, the only items that require interaction of user with other parties (other classmates, professors, or librarians in different situations). It may mean that for m-learning by smartphones, users would rather prefer doing simple tasks or unidirectional information seeking activities.

Table 9. M-library Service Used or Like to Use with Smartphone

M-library service	Total	UG	PG	Z-Score
Search library catalog — OPAC	2.19 (N = 98)	2.22 (N = 70)	2.11 (N = 28)	0.6225
Search & access electronic resources	1.87 (N =97)	1.84 (N = 69)	1.93 (N = 28)	–0.5256
Access my library account	2.18 (N = 96)	2.28 (N = 68)	1.96 (N = 28)	1.910 *
Book a seat, a computer or a study room	1.95 (N = 97)	2.01 (N = 69)	1.81 (N = 28)	1.238
Check library hours, library map	2.34 (N = 97)	2.45 (N = 69)	2.11 (N = 28)	1.871 *
Provide comments & suggestions	1.43 (N = 97)	1.45 (N = 69)	1.38 (N = 28)	0.3430
Contact librarian	1.60 (N = 95)	1.67 (N = 68)	1.42 (N = 27)	1.790 *

Notes:
(1) Some subjects did not response to some of the items.
(2) Scale: 1: Not interested; 2: Maybe interested if available; 3: Interested/Already using.
(3) Z-Score is obtained from the Mann-Whitney U-Test; *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

Discussion

In this study, we would like to investigate the three RQs related to the use of m-learning through smartphones by UG and PG students. The discussion of our results are as follows.

RQ1. Do PG and UG have similar habits on participating in m-learning through smartphones?

First, we observed that nearly all our subjects had a mobile phone with Internet access, which is the basic equipment for them to participate in m-learning if they wish to, which follows the millennial mobile behavior (So et al., 2012) . However, we observed that (as presented at Tables 4 to 7) the adoption of m-learning rates through smartphones is not that high. Most of m-learning activities studied are performed by our subjects in a weekly to monthly-basis. While this result may not be contradicted to prior study results (such as Dresselhaus & Shrode (2012) and

Catharine (2013)) as those prior study are focused on the adoption of the m-learning, we are studying the frequency of use. However, our result of low usage frequency reflects that there is a need to understand why millennial mobile device users like to use them and have a high adoption rate of m-learning, but low frequency of use. It is possible that because of the various barriers of m-learning, our subjects were not so enthusiastic in using them to get access to its functions. Second, unexpectedly, we observed that the m-learning habits of our UG and PG subjects do not show dramatic differences at all. This suggests that m-learning operators may be able to use the same set of criteria for developing m-learning applications for both UG and PG students.

As shown in Tables 4 to 7, Facebook, searching through Web / blogs, and using search engines are the most frequently performed activities for learning. On the other hand, academically-specific activities, such as reading e-journals and accessing e-databases, are less frequent through smartphones despite the fact that they are a more reliable content for research. This may be, once again, due to the limitation of general smartphone design. It is also possible that our subjects only want to use smartphones to perform general information-seeking activities in their m-learning activities, for which the search engines and encyclopedia are already good enough. Another observation of m-learning habits is that the use of productivity tools is generally low, with the exception of schedulers. This may be caused by the fact that the use of scheduler/calendar is common in students' daily lives as millennial mobile users (So et al., 2012), and thus, our subjects are more readily to adopt it for learning purpose. Overall, our results are coherent to psychological barriers that university students prefer leisure activities mentioned in the literature review part.

RQ2 Do PG and UG have similar barriers to participating in m-learning through smartphones?

In terms of barriers, UG and PG students did not really note any major limitations to m-learning, although they felt that screen size and loading times could be factors. However, smartphones' screen sizes are hardware limitations that academic institutions cannot control, while loading times can be improved by providing a broader bandwidth for Internet connection. For other barriers that have some impact on the users, there are possible workarounds, including customization of mobile Website or even build mobile apps. Although Portable Document Format (PDF) is a third party software, some parts of articles (e.g., abstract) can be extracted and converted to HTML formats for a more convenient display. In fact, more e-databases and e-journal services are now providing HTML versions of their full-text. More effort could be put in system design, such as the ways to organize, search, and display the contents. Judicious choices of functions to be put in mobile Web and apps is another direction. With the unavoidable limitation of screen size and the different operating environment of PCs / laptops from smartphones, not all functions available in desktop versions can fit well into mobile versions. Qualitative studies such as interviews can be done to know when, how, and why students use smartphones for m-learning, and this will be one of the areas that we will continuously to probe into as a future research direction. This information can help determine the priority of functions to be made accessible from mobile devices.

RQ3. Do PG and UG have similar preferences of library services they wish to use through smartphones?

We observed that both UG and PG subjects have similar preferences for m-library services. Services such as "search library catalog," or "access my account" are indeed already provided by

the library in the university concerned, but some subjects still consider them something that they might be interested if available. This reflects that these subjects are not aware of the existence of these services. Therefore, academic institutions would need to do more promotion to students, so that they would know these services are available and make good use of them (Olu Adeyoyin, 2005).

Limitations

Similar to other studies, this has a few limitations. First, as we are using samples from a single university, and we have limited control of the composition of our subjects. Eventually, due to the enrollment of the university concerned and the class size, we have an unevenly distributed response (total number of UG students was 466 of which we collected 90 useable responses, 19.3%; and PG students was 185 of which we collected 30 useable responses, or 16.2%). Our UG subjects number is almost three times that of our PG subjects and the university setup would have create some bias on the response. Plus, as all subjects were recruited from the same college, i.e., the LIS majors, it will create another level of bias. However, we are of the view as we have recruited sufficient subjects for performing our statistical test (i.e., Mann-Whitney U-Test), our results would be representative.

Future study direction

This study provides a solid foundations for future m-learning studies. Based on our finding, we would suggest that there is a need for qualitative studies to further probe into the issues that we observed here. Quantitatively, we have a representative result showing that millennial UG and PG students are both actively engaged in m-learning, and they react differently to different types of m-learning activities and applications. To gain a better understanding of the reasons behind such polarized results on the usage of m-learning activities and applications, we need a more

detailed qualitative study to complement this. Thus, the qualitative study for the next phase can be a study focusing on probing into the low adoption rate of m-learning activities such as the low usage of productivity apps.

Apart from conducting qualitative study, we also see an opportunity to probe into this research area further by conducting more advanced quantitative study. A possible method that we can apply in this area of research is using the conjoint analysis (Green & Srinivasan, 1990). Prior research has shown that the conjoint analysis allows researchers to probe into the design issue of an electronic service, such as electronic payment service (See-To & Ho, 2016). Thus, we can use this method to study the design issue of the m-learning, and, as a result, it is possible for us to find the optimal design for m-learning service design. Finally, we also plan to address the issue on the sample collection issue, i.e., our samples are coming from a specific major, i.e., LIS. Therefore, we are planning to conduct a similar study for different academic areas to generalize the findings of this area of research (Wai et al., 2016), along with studies of universities in other East Asian countries. Furthermore, we would also like to probe further into the mobile usage of e-journals and e-magazines (Wang et al., 2016, Zhou et al., 2017) as well as m-library usability issues (Fung et al., 2016).

Conclusion

This study is an investigation into the needs of both UG and PG students with regards to m-learning services provided by academic libraries. In spite of limitations, this study provides a glimpse into the m-learning behavior of college students. Although an overwhelming majority of the respondents in this study used a mobile device in some way, the adoption rate for m-learning was low. Respondents tended to use smartphones more for social and daily life purposes than for academic activities. More qualitative studies will be needed for uncovering why this rate is so

low. Further, students at both UG and PG levels found that there were some inconveniences found in m-learning such as small screen sizes and web compatibility with mobile devices. Fortunately, they did not find any major barriers. This study also notes a relative lack of awareness of m-learning services that the library provides. More promotion, then, would be needed to raise awareness for these programs. As these students would be the likely patrons of these services, it is important to understand their user needs and the barriers they face through m-learning.

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