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Usability and evaluation of a library mobile web site

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Abstract

Purpose – The purpose of this study is to develop and evaluate the use of a library mobile website at a university library. This paper aims to present the approach adopted to investigate users' reactions to the new mobile platform. A usability test was also conducted to examine its effectiveness.

Design/methodology/approach – Mobile websites for academic libraries were first reviewed prior to identifying the functions and elements to be included. To assess the intended design purpose, the usability of the design was examined through a comparison of the mobile website and the full PC website used by 50 students to accomplish a set of search tasks. A questionnaire survey was used to assess 336 students' responses regarding various criteria including learnability, control, presentation and efficiency.

Findings – The usability test that was conducted before the mobile Web was formally released indicated that the students using it finished more search tasks ($p < 0.001$), and were more efficient in completing search tasks than they were using the PC website ($p < 0.001$). Data from 336 questionnaire responses also indicated the students' positive reactions to the developed mobile system in four defined facets (mean >= 4.0).

Research limitations/implications – The difficulty of recruiting volunteers and the small number of subjects who participated was also a major limitation experienced in this study. Replications or use of different measurements might be needed in future research to confirm the result.

Practical implications – In this study, a library mobile website was developed, tested and evaluated by users. Currently, the library mobile website is being implemented in the university. On-going revisions will continue to improve its effectiveness and efficiency for information retrieval.

Social implications – It is expected that through the library mobile services, a ubiquitous learning environment can be provided to students to fulfil their academic and leisure needs.

Originality/value – Summative evaluation of the mobile system revealed the students' positive reactions to a set of predetermined criteria in various dimensions, including: learnability, control, presentation and efficiency.

Keywords Evaluation, Mobile learning, Interface design, Mobile services

Paper type Research paper

Introduction

Advances in information and internet technologies allow users to more effectively exploit the potential of various learning and communication tools. In recent years, the popularity of mobile devices, such as smartphones and tablets, has changed library services provided through the internet and computers (Liu and Briggs, 2015). Mobile websites have become a gateway to knowledge and a virtual entryway to a variety of resources and services. To cater to users' needs in the ever-expanding mobile technological world, higher education institutions have begun to mobilize their teaching and learning services (Hashim *et al.*, 2015). Many libraries have also been engaged in

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innovating high-tech and user-oriented services in non-traditional ways to provide students with a satisfactory learning environment (Mikkelsen and Davidson, 2011). In this study, development and implementation of a library mobile website in a university library is explored. Student experiences using the system are assessed.

Literature review

According to the *NMC Horizon Report: 2014*, the development of mobile contents and services has become one of the important trends in academic libraries (Johnson *et al.*, 2014). With an increasing number of libraries offering mobile Web access, academic libraries have joined the trend of providing mobile services to fulfil users' mobile needs (ACRL, 2012; Hahn, 2008). The widespread emphasis on mobile services aims to help students, faculty and researchers more conveniently access library content. To implement mobile services, academic libraries are integrating various mobile approaches, such as mobile-friendly versions of websites, apps and catalogues (Johnson *et al.*, 2014). The adoption of mobile technologies in libraries is leading to a whole new model of engagement and participation in the learning community, and it is encouraging conversation, collaboration and creation of knowledge amongst library users (Hopkins *et al.*, 2015).

Library mobile services

The advances in engineering and design of mobile devices have made learning ubiquitous. Mobile applications and services adopted by many academic libraries provide users with convenient and interactive access to diverse learning resources (Kendall and Kendall, 2011; Mahenge and Mwangoka, 2014). A review of several mobile library websites in academic libraries is presented in Table I. These libraries are seeking to add mobile technologies to enhance their traditional services and to make their services more relevant to patterns and behaviours of users. Barnett-Ellis and Vann (2014) stated that instead of expecting people to go and get information, library mobile users want information to come to them. For mobile-savvy users, libraries should be "thinking mobile" about a wide variety of physical collections, digital collections and content managed by and obtained through providers (Thomas, 2012). In successful implementation of mobile technology, a user-friendly learning and knowledge-sharing atmosphere is emphasized in the design of mobile service innovation (Thomas, 2010). To offer users convenient use of materials and space, both physically and virtually, informing the design of new environments and technologies to support transformative learning in virtual communities is needed (Sharples *et al.*, 2005).

It is suggested that prior to the development of mobile services, developers should identify elements that work for that specific library, as well as the necessary budget and support available for development efforts (Wisniewski, 2011; Woodbury, 2010; Yeh and Fontenelle, 2012). Developing library websites optimized for mobile devices should take into consideration the various support and resources available in different library settings (Ryan, 2010). An examination of how the system is used, and whether the intended goal is achieved, is also essential for the mobile library website.

Development and design issues

There are different approaches to mobile-friendly Web design, such as the use of responsive Web design for adapting the layout across a wide range of mobile devices (Marcotte, 2011), or the development of separate sites with a registered mobile domain to

Table I.
Mobile library websites in academic libraries

University library	Library search[a]	Discovery search[b]	Personal circulation	Library information[c]	Collection selected	Recommend a purchase	Contact and feedback	Available seats/spaces	Related links[e]
National Taiwan University Library*		✓		✓			✓	✓	✓
National Taiwan Normal University Library	✓		✓	✓		✓		✓	✓
National Chengchi University Library	✓		✓	✓	✓				✓
National Chung Hsing University Library*		✓		✓	✓		✓		✓
National Tsing Hua University Library	✓		✓	✓			✓		✓
National Sun Yat-sen University Office of Library and Information Services	✓		✓	✓	✓				✓
Yuan Ze University Library	✓		✓	✓	✓		✓		✓
Kaohsiung Medical University Office of Library and Information Science Service	✓		✓	✓	✓		✓		✓
Caltech Library	✓			✓			✓		✓
Harvard University Library	✓	✓		✓			✓		✓
Oxford University Library	✓			✓					✓
UC Berkeley Library	✓			✓			✓		✓
MIT Libraries*	✓	✓	✓	✓	✓		✓	✓	✓
Princeton University Library*	✓	✓	✓	✓		✓	✓		✓
The University of Chicago Library	✓		✓	✓			✓	✓	✓
Fu Jen Catholic University Library	✓		✓	✓	✓	✓	✓	✓	✓

Notes: *Responsive Web Design; [a] library search: search from library catalogue; [b] discovery search: search library catalogue, purchased library database; [c] library information: library news, events, courses, floor layout, introduction, etc; [e]Related links: links to PC version, library Facebook, resources or download of applications; (accessed websites on 23 June 2015)

transcode websites into a mobile display. Several technological limitations and challenges, such as connectivity and the limited processing power of mobile devices, are experienced by users. In addition, one of the major issues to be considered is the small screen size which needs to be manipulated by users for accessing and reading information to meet the specific intended purposes (Wang *et al.*, 2009). Library mobile websites, like other sites, can be formatted specifically for mobile devices, and can offer full or partial library services to users. Libraries seeking to convert their website into a mobile-friendly design must first recognize that the architecture of information displayed on a mobile library website is different from that of general sites (Murray, 2010; Vielmetti, 2008). Several guidelines are also suggested in the design of mobile-friendly operations, including the use of "drill down" hierarchy, iconic links, minimizing navigation pages for assessing information, including links to full websites, the use of easy-reading page content/layout and so on (Murray, 2010).

When evaluating the design of the mobile interface for library users, a systematic study should be carried out to judge its effectiveness and its fitness for the intended purpose (Iqbal and Warraich, 2012; Islam and Tsuji, 2011; Joo *et al.*, 2011). Murray (2010) suggested that librarians should also review their intended goals and the variety of services which need to be highlighted, such as basic information about the library, searching collections, locations of items of interest and status/management of personal information.

The evaluation of system design and development of mobile websites often includes data collection from various aspects, such as ease of use, effectiveness of the approach and usability of the design. Systematic design and development efforts should be user-oriented, focusing on supporting users' intentions to use the technology (Lee *et al.*, 2011). To provide valuable information about the use of systems, indicators of the technology acceptance model for usability examination of the innovative potential are widely used in system evaluation (Persico *et al.*, 2015). Other studies have also examined usability issues (Emanuel, 2013; Nielsen, 2012), as well as the content presentation for mobile applications (Woodbury, 2010). Various aspects were evaluated, such as affect, efficiency, effectiveness, control, learnability and helpfulness (Iqbal and Warraich, 2012; Joo *et al.*, 2011). These indicators may relate to users' performance in the use of applications, the exchange of resources and ideas and the emotional aspects of using the platform for specific purposes. A summary of these evaluation criteria is listed in Table II.

Implementation and assessment

To examine the design of library websites, researchers have used various approaches related to user applications in the implementation of Web services. For example, Battleson *et al.* (2001) used the think-aloud process to study the efficiency and usability of their website design. Hsieh and Liu (2009) triangulated various user data to assess the design of their website's usability, including a usability test, think-aloud, in-depth interviews and questionnaire survey methods. Iqbal and Warraich (2012), Islam and Tsuji (2011) and Joo *et al.* (2011) used questionnaire survey methods to assess user responses to the interface design of library websites. For mobile devices usage, both Pendell and Bowman (2012) and Yeh and Fontenelle (2012) conducted an experimental study to test the website usability via mobile devices. From these assessments, a usability test inviting users to use the website to complete a list of structured tasks was

administered so that the researchers might evaluate the usability of the designed interface. In addition to testing usability, survey questionnaires and interviews also invited users to provide both overall and in-depth reactions to the system. Diverse approaches to evaluating the interface design of mobile devices are needed to obtain guidance for improving the usability and applicability of the design approach.

As in many other fields, advancements in technology influence services provided to users. User behaviours and expectations also impact how technologies should be utilized in the university library. In the development of mobile services, use patterns and reactions of users are of special importance. Usability assessment helps make decisions to advance the quality of the innovative services during periods of change. In line with this purpose, answers to the following research questions are sought:

RQ1. How did students perform tasks (searches) differently with the mobile library website (compared with the full PC website)?

RQ2. How did the students react towards the mobile library website?

Method

Development process

In this study, a library mobile website was developed and evaluated in a university library in northern Taiwan. The development process of the mobile system was based on the ADDIE model (Figure 1), which provided generic processes for building effective

Criteria	Description	References
Learnability	User-oriented; easy to learn and comprehend; intuitive to use; clear organization	Emanuel (2013), Iqbal and Warraich (2012), Joo *et al.* (2011)
Control	Easy to manage search tasks; obtainable information; efficient for manipulation	Iqbal and Warraich (2012), Islam and Tsuji (2011), Nielsen (2012)
Presentation	Processing speed for presentation, screen layout, direction of navigation	Islam and Tsuji (2011), Roward (2001)
Efficiency	Quick updating of information; instant response to information needs	Iqbal and Warraich (2012), Islam and Tsuji (2011), Yeh and Fontenelle (2012)

Table II.
Criteria for evaluation of library websites

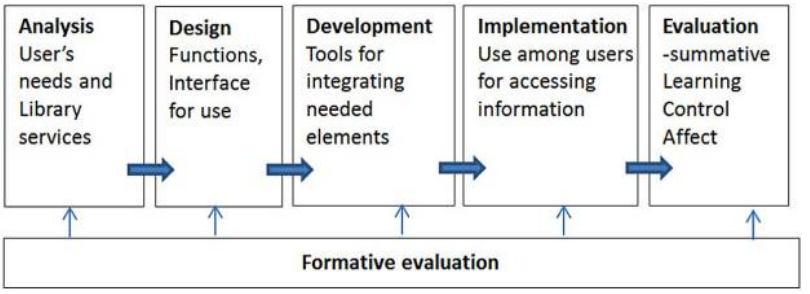

Figure 1.
Use of the ADDIE development model

performance support tools (Morrison, 2010), starting with analysing user needs and the current use of the library automation system for searching collections.

During the stage of analysis and design, implementations from several academic libraries were reviewed (Table I). This review indicated several common functions provided by libraries, including: introduction to the library, news, collection searching, electronic resources, resource use guidance, audio-visual media service, seats/spaces and feedback. Most university libraries have developed mobile services for easy access to needed resources, and recommendation of resources and collections. Some also emphasize the interactive features of their mobile service, such as seeking librarians' help and contact information.

The design and development of the system prototype entailed a great deal of planning of the organization framework of the websites and content to be covered in the mobile services. With budget constraints imposed by the institution, the tools and technology used for the development work were also gauged according to the cost and the intended purposes of the mobile system. A prototype framework was produced based on the analysis of user needs (a user-friendly search interface and quick access to information). Formative evaluation was conducted along with the design, development and implementation processes to obtain relevant information to improve the usability of the library mobile system. For example, based on users' suggestions (from the formative assessment), text layout and the links to previous pages and new arrivals were revised. System stability was improved. The services identified to be included in the mobile website also needed to be considered in light of the budget (Figure 2).

A brief introduction of the development of the service functions is provided in Table III. The development and implementation of the library mobile website was intended to provide its users with a convenient mobile interface to obtain library resources and information. It was structured according to various functions which are often used by local users (Table III). On the main page of the system, icons provide service links to the most frequently used services, including: "online search" (of collections), "news", "personal circulation status", "book recommendations", "seats in the learning commons", "i-reading (college selected)", "feedback", "opening hours" and "contact information".

Figure 2.
Mobile services interface

Service	Development process
Online search	Use of the PHP Simple HTML DOM parser tool to capture the source code from the library OPAC and transfer it to the mobile interface
Library news	Direct access to the database of library news (http://web.lib.fju.edu.tw/chi/news) and rearrangement of the content for mobile devices
Personal circulation status	Use of the PHP Simple HTML DOM parser tool to capture the source code from the circulation status web page and transfer it to the mobile interface
Book recommendations	Direct access to the library book recommendation system through the mobile interface
Seats in the learning commons	Direct access to the seat management system in the learning commons to check for available seats
College selected	Direct access to the database of "college selected" (http://web.lib.fju.edu.tw/chi/100books) and rearrangement of the content for mobile reading
Feedback	Integration with Google Forms to provide the feedback function
Opening hours	HTML file
Contact information	HTML file
Switch to full website	Hyperlink

Table III.
Services for the library mobile website

The most important and core part of the library mobile Web service is the online search function. The integrated library system used by the university library is Sierra by Innovative (www.iii.com/products/sierra). For managing library collections locally, all bibliographical data are only accessible through Sierra's customized management software. To implement the mobile online search function without reaching the database structure of the Sierra system, PHP Simple HTML DOM parser (http://simplehtmldom.sourceforge.net) was used to capture the target Web page and analyze the source code of the Web content (Figures 3 and 4).

Because the full PC version online catalogue provides organized structures of html code to display the bibliographic information (for instance, the title of a book wrapped with a CSS ID or class), the PHP Simple HTML DOM parser was able to exclude irrelevant information, and extract the needed information for presentation on the mobile device. Through filtering and reorganization of the bibliographic information from the Sierra online catalogue, mobile websites provide a simplified interface for the online search service.

Figure 3 illustrates the workflow of the mobile website service. Figure 4 shows how the HTML parser works. The rest of the services in the library mobile Web, such as library news, book recommendations and so forth, are connected to the library Web server to retrieve timely data and synchronize the information on the mobile Web.

Assessment process

To assess the effectiveness of the design of the library mobile website, a usability test was conducted. Fifty students volunteered for the study. They were instructed to use mobile devices to complete the test. A structured task sheet was provided to measure the efficiency of using the library mobile Web. In total, 30 online catalogue search tasks were covered in the task sheet: 15 search tasks (time limit: 10 min, using a mobile device) for the full PC website and 15 search tasks (time limit: 10 min, using a mobile device) for

the mobile Web. The items of the search task for the PC and mobile versions were different, but both followed the same structure, as shown in Table IV. These items were evaluated by two experts for content validity. To avoid the familiarity effect caused by the prior search tasks, the sequences of the different versions (full PC website and mobile website) were swapped during the testing. Half of the participants (randomly selected) used (1) the full PC website and then (2) the mobile website, while the other half used (1) the mobile website and then (2) the full PC website (Figure 5). The number of search tasks completed, total time required for the search tasks and accuracy of the responses were counted for both the PC and mobile websites. Statistical analysis was conducted using paired *t*-tests to determine performance differences among the students using the PC and the mobile websites.

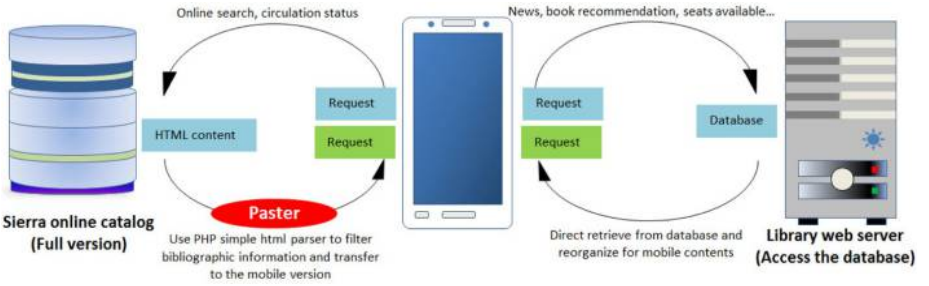

Figure 3.
Workflow of the library mobile website

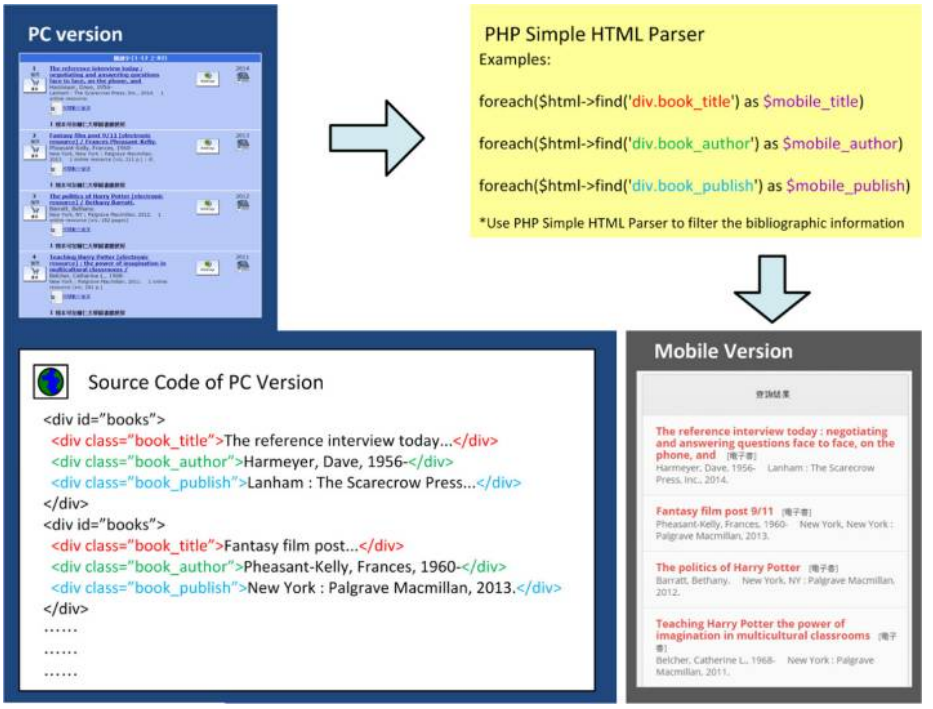

Figure 4.
The use of PHP Simple HTML parser in the mobile website

Type of search tasks	Items	Task No.	Specification A	B	C	D	E	F
Basic								
Collection	4	1		P				
		5			✓			
		9						✓
		13				✓		
Author	2	2					✓	
		6	✓					
Keyword	2	10					✓	
		14					✓	
Advanced								
And	3	3	✓					
		7	✓					
		11						✓
Or	2	8					✓	
		15					✓	
Material type	1	4	✓					
Location	1	12	✓					
Total	15		5	1	1	1	5	2

Table IV.
Design of search tasks

Notes: A= title= B= author= C= call number; D= status; E= number of relevant items; F= bibliographic information

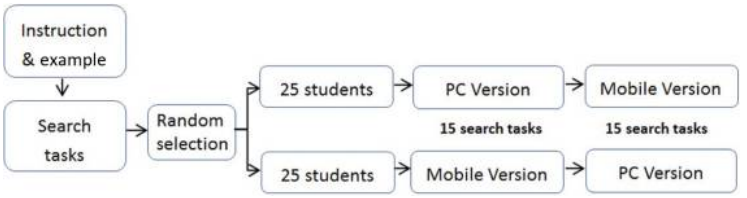

Figure 5.
Procedures for the usability test

At the end of the development stage for system development and implementation, summative evaluation was conducted using the survey method for gathering the overall responses from the users. The survey questionnaire items were organized according to various aspects to assess the users' reactions to the following criteria: system learnability, control, content presentation and efficiency. The questionnaire consisted of 28 items for gathering users' perceptions of and reactions to the mobile system. A five-point Likert scale (with 1 representing agreement from "strongly disagree" to 5 "strongly agree") was used to reflect the users' agreement with each statement. Open-ended responses were also gathered at the end of the questionnaire.

Results

From the assessment of the usability test, data were obtained from 50 volunteer students before the formal implementation of the library mobile services. Of the 50 participants, their majors were distributed among 11 colleges at the university, and there were 14 males (28 per cent) and 36 females (72 per cent). Compared with using the PC Web

version, when the students used the mobile Web, they finished more search tasks ($t = 9.514$, $p < 0.001$) (Table V) in less time ($t = -5.634$, $p < 0.001$) (Table VI). Using the mobile Web is deemed, therefore, more efficient than the PC Web in terms of the time used for completing search tasks ($t = -11.951$, $p < 0.001$) (Table VII). The mean of correct answers obtained from using the mobile Web was also more than that for using the PC Web ($t = 5.933$, $p < 0.001$) (Table VIII). The data reveal that the users completed more search tasks, spent less time to finish tasks and got more correct answers when using the mobile website.

Table IX indicates the evaluation results gathered from 336 respondents. From the results of this study, the majority of users were positive about the use of the library mobile website. They expressed high agreement with the importance of adopting a library mobile website for their use of the library's services, and reacted positively to various criteria for assessing the intended purposes of the system development. The mean rating for each facet is higher than 4.00, especially "perception of use", which was rated the highest (mean = 4.13, SD = 0.588). The results of the students' open-ended reactions also reveal their positive feelings about the system. Their reactions include:

Table V. Numbers of questions finished in 10 min

Finished item no.	M	SD	*t*	*p*
Mobile Web	14.140	1.178	9.514	0.000***
PC Web	12.420	1.773		

Notes: $N = 50$; ***$p < 0.001$

Table VI. Total time required for finishing search tasks

Total search time (second)	M	SD	*t*	*p*
Mobile Web	551.252	41.358	−5.634	0.000***
PC Web	583.407	22.450		

Notes: $N = 50$; ***$p < 0.001$

Table VII. Time for completing a search task

Time/per task (second)	M	SD	*t*	*p*
Mobile Web	39.355	5.247	−11.951	0.000***
PC Web	47.995	7.526		

Notes: $N = 50$; ***$p < 0.001$

Table VIII. Accuracy of responses

No. of correct items	M	SD	*t*	*p*
Mobile Web	13.180	1.674	5.933	0.000***
PC Web	11.700	1.908		

Notes: $N = 50$; ***$p < 0.001$

Category and item	Mean	SD
Perception of use	*4.13*	*0.588*
It is efficient to use the library mobile services	4.09	0.619
It is important to have library mobile services	4.06	0.725
I am willing to use the library resources through a mobile device	4.24	0.732
Learnability	*4.00*	*0.709*
The system is easy to learn	4.02	0.832
It is easy to comprehend the meanings of the menu	4.25	0.743
The vocabulary used in the system is clear to me	4.25	0.726
The system provides organized information	3.96	0.815
Learning to use the system is easy	4.23	0.778
Control	*4.08*	*0.656*
Searching for needed resources is easy for me when I am using the library mobile system	4.19	0.834
I can obtain my search results quickly through the system	4.09	0.829
I am able to obtain needed information through the use of the mobile system	4.02	0.843
I am satisfied with the use of the search service of the mobile system	4.03	0.776
I am able to control the use of various services of the mobile system	4.15	0.780
The interface of the mobile system is easy to control	4.16	0.797
Various application services provided by the system are easy to manipulate	3.95	0.809
Presentation of content	*4.00*	*0.636*
The system reacts quickly	3.87	0.850
The content of the screen is easy to read	4.16	0.809
The content of the screen information is thorough	3.77	0.856
The layout of the screen is pleasing to me	4.06	0.871
I am able to access the information I want from the system	4.02	0.784
The use of the graphic interface is easy to relate to intended functions	4.18	0.758
The location of the menu is easy to identify and access	4.09	0.793
It is easy to go back to the previous screen and follow directions in the system	3.91	0.870
Efficient	*4.00*	*0.709*
I like to use the mobile system to access up-to-date information	3.99	0.818
The mobile system meets my needs for accessing information in a timely manner	3.95	0.852
The mobile system provides sufficient functions for quick access to the updated library collections	3.97	0.851
I feel that the use of the mobile system is efficient	4.09	0.814
I am satisfied with the timing of the services provided by the mobile system	4.01	0.821

Table IX.
Evaluation of library mobile website

Note: $N = 336$

"nice interface", "easy to read", "organized layout", "easy to operate", "very convenient" and "easy to access needed information". They also provided some suggestions including: "simplified structure", "larger text" and "change of colour and theme for different holidays and seasons".

Discussion

In this study, the development of mobile technologies and their applications in the academic library was the aim to prompt library users to access information efficiently. Konnur *et al.* (2010) emphasized the importance of assessment for determining the value of the library website design. It also helps identify design flaws and improve the functions used for browsing, navigation, searching and locating desired information. In the present study, a mobile library website was developed and tested. Similar to Iqbal and Warraich's (2012) and Joo *et al.*'s (2011) approaches, the study explored the effectiveness of a newly designed mobile website through a usability test. The test results indicated that users accessing the mobile website completed more search tasks, spent less time finishing tasks and obtained more correct answers ($p < 0.001$). It is expected that more opportunities brought about by mobile technologies might improve the accessibility of resources for users, and facilitate a participatory culture in the library (Barnett-Ellis and Vann, 2014; Hopkins *et al.*, 2015; Mahenge and Mwangoka, 2014).

Although some merits of using the mobile website were identified in the usability test, some limitations were also found when conducting the test. As addressed by Emanuel (2013), lack of time, human power and financial support is a problem in usability research. The difficulty of recruiting volunteers and the small number of subjects who participated were also major limitations experienced in the present study. Replications or use of different measurements might be needed in future research to confirm the results.

To triangulate data for interpretation, this study also used a questionnaire survey to obtain responses from a larger population of users. From the overall survey results, the students' perceptions of and reflections on various criteria were assessed. Most students perceived the library mobile services as being important and efficient, and were willing to use the services. Similar to other user studies by Dresselhaus and Shrode (2012) and Iwhiwhu *et al.* (2010), the participants perceived the use of mobile services as being beneficial to them. To respond to the changes in our information society and user behaviour, libraries should redefine their future functions and services to attract use of various physical and virtual resources (Nazi *et al.*, 2014).

Summative evaluation of the mobile system revealed positive reactions to a set of predetermined criteria in various dimensions, including learnability, control, presentation and efficiency. Prior to the development process, a preliminary analysis of user needs and experiences and approaches from other libraries was helpful for establishing the criteria and intended purposes of the system. Along with the development, formative information was obtained. The system was revised accordingly to improve its design and usability. The study reflects users' satisfaction with the developed system. However, the open-ended responses gathered from the students also contribute information on user expectations and the need for a future tune-up.

Conclusion

The use of a library mobile system was considered by most users as a more accessible tool for locating and obtaining library resources as shown in the literature review. In this study, a library mobile website was developed, tested and evaluated by users. Currently, the library mobile website is being implemented in the university. On-going revisions will continue to improve its effectiveness and efficiency for information retrieval. It is expected that through the library mobile services, a ubiquitous learning environment can be provided to students to fulfil their academic and leisure needs. With convenient access to the mobile service, users can benefit from the abundant library resources. Because the implementation of mobile technology has created a new approach to promoting library use and value, it is also expected that this will impact how libraries deliver services to their users in the future. Further exploration of related issues of various mobile services provided by libraries is also needed in the future.

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