EXPERIENCING MOBILE LIBRARIES
Comparing flow experience in using digital libraries
Web and mobile context

Xianjin Zha
Center for Studies of Information Resources, Wuhan University, Wuhan, China
Jinchao Zhang
School of Information Management, Wuhan University, Wuhan, China
Yalan Yan
School of Management, Wuhan University of Science and Technology, Wuhan, China, and
Wentao Wang
School of Information Management, Wuhan University, Wuhan, China

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Abstract

Purpose – Flow experience is conceptualized as an optimal experience about an activity, characterized by a match between perceived challenges and perceived skills. The purpose of this paper is to explore mobile libraries by comparing users' perceptions of web digital libraries and mobile libraries in terms of flow experience so as to obtain insights regarding the healthy development of mobile libraries.

Design/methodology/approach – Data collected from university digital library users were used for analysis. One figure was used to present the exact nature of users' perceptions of flow experience in terms of data distribution. The paired samples *t*-test was used to present the exact mean difference between flow experience in using web digital libraries and mobile libraries.

Findings – Fewer users can experience flow and more users cannot experience flow in using mobile libraries than in using web digital libraries. The mean of flow experience in using mobile libraries is significantly smaller than that in using web digital libraries.

Practical implications – Digital libraries have faced severe competition in the modern information society. In China university libraries as a whole are undergoing the transition from web digital libraries to mobile libraries. It is critical to examine user experience in the initial or early stage of mobile library development. The authors believe the findings of this study regarding flow experience provide useful insights for facilitating the healthy development of mobile libraries.

Originality/value – This study explores and compares users' perceptions of web digital libraries and mobile libraries in terms of flow experience, which the authors think provides a new view for university digital library research and practice alike.

Keywords Digital libraries, User studies, Experience

Paper type Research paper

1. Introduction

Digital library research and practice have been the focus with the development of distributed networked systems and the internet. Digital libraries are "an extension and

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enhancement of information storage and retrieval systems that manipulate digital data in any medium (text, sound, static or dynamic image) and exist in distributed networks" (Borgman, 1999, p. 234). Digital libraries enable users to remotely access distributed information resources by breaking down physical barriers between resources (Cherukodan *et al.*, 2013), playing an inescapable role of delivering a collection of information that has associated services to their users by using a variety of technologies (Aghakhani *et al.*, 2013; Heradio *et al.*, 2012). Most of early digital libraries were academic and research libraries which were developed to cater for users' needs related to teaching and research in academic institutions (Kwanya *et al.*, 2011). In China, digital libraries in universities have achieved rapid development since the Ministry of Education (MOE) initiated the China Academic Library and Information System (CALIS) in 1998. It includes four national information centers, namely the Science, Social Science and Humanities Information Center; the Engineering and Technology Information Center; the Medical Information Center; and the Agricultural Information Center.

The mobile internet has achieved substantial progress in recent years, from which users can benefit to access the internet by using mobile devices such as mobile phones and mobile applications. By the end of June 2014, the number of mobile phone internet users in China was about 527 million, accounting for 83.4 percent of the total internet users in China, which exceeds the percentage of users accessing the internet through traditional PC (personal computers) (80.9 percent) for the first time (CNNIC, 2014). Informed by other mobile applications which develop quickly, a growing number of academic libraries in China are creating the mobile version of their digital resources and services for their users to access on the go (Li, 2013). In this study, we use the term web digital libraries to specifically refer to the digital library accessed by users through the use of PC and web broadband and use the term mobile libraries to specifically refer to the digital library accessed by users through the use of mobile phones and wireless networks.

As significant scientific information sources, digital libraries provide abundant electronic collections, information services and powerful searching functions (Lai *et al.*, 2014). However, digital libraries have faced severe competition in the modern information society, being "no longer islands of information, but one among many nodes through which information flows to the users" (Ross and Sennyey, 2008, p. 146). In the new round of competition brought by the mobile internet, we suggest user experience becomes salient and is critical for the success of mobile libraries. Specifically, flow experience which is conceptualized as an optimal experience about an activity, characterized by a match between perceived challenges and perceived skills (Csikszentmihalyi, 1975; Csikszentmihalyi and LeFevre, 1989), can be used to measure the exact nature of users' experience about using mobile libraries so as to obtain insights regarding the healthy development of mobile libraries. On the one hand, mobile libraries are characterized by mobility and accessibility (Anbu and Mavuso, 2012; Wang and Wang, 2010). That is to say, users can create real-time contact with digital libraries systems at any time (accessibility) and anywhere (mobility) through the use of wireless network and mobile phones (Wang and Wang, 2010), which is likely to benefit users' experience. On the other hand, the limitations of mobile libraries such as small screens, inconvenient input and output interface, insufficient contents and limited functionality (Choi, 2009; Zha *et al.*, 2014), are likely to undermine users' experience. This study explores mobile libraries by comparing users' perceptions of web digital libraries and mobile libraries in terms of flow experience, which we think provides a new view for university digital library research and practice alike.

2. Flow experience

Flow experience originally advanced by Csikszentmihalyi (1975) is conceptualized as the holistic sensation that people feel when they act with total involvement. It describes people's feelings about an activity such as play and study that stem from the perceived balance between the challenges of the activity and people' skills (Csikszentmihalyi, 1975; Csikszentmihalyi and LeFevre, 1989). "If challenges begin to exceed skills, one first becomes vigilant and then anxious; if skills begin to exceed challenges, one first relaxes and then becomes bored" (Nakamura and Csikszentmihalyi, 2002, p. 90). People experience flow as a unified flowing from one moment to the next, in which they feel in control of their action and there is little distinction between self and environment, between stimulus and response, and between past, present and future (Csikszentmihalyi, 1975). Flow experience can be measured as a unidimensional construct or higher-order construct, covering clear goals, immediate feedback, a match between personal skills and challenges, merge of action and awareness, concentration on the task (or telepresence), sense of control, loss of self-consciousness, altered sense of time, autotelic experience, curiosity, intrinsic enjoyment and self-reinforcement (Csikszentmihalyi and LeFevre, 1989; Csikszentmihalyi, 1990; Trevino and Webster, 1992; Hoffman and Novak, 1996; Chen *et al.*, 2000). In extant literature, attention focus, control and enjoyment are the frequently used dimensions of flow experience (Koufaris, 2002; Zhou, 2013a). Following prior studies (Zhou, 2013a, b), we measured flow experience as a unidimensional construct with three basic elements including attention focus, control and enjoyment.

As an optimal and enjoyable experience, flow can occur in numerous activities and is long cherished. The flow theory has been employed as a theoretical foundation in prior research crossing many fields (Yan *et al.*, 2013). For example, prior studies have examined flow experience and its impact on user behavior, taking as their focus online shopping (Guo and Klein, 2009), online learning (Esteban-Millat *et al.*, 2014), virtual communities (Yan *et al.*, 2013), mountaineering (Tsaur *et al.*, 2013), mobile games (Bressler and Bodzin, 2013; Ha *et al.*, 2007), mobile TV (Jung *et al.*, 2009), mobile internet services (Zhou, 2014) and mobile learning (Park *et al.*, 2010). However, the comparison between web digital libraries and mobile libraries in terms of flow experience has been largely overlooked in the literature. In this study, flow experience in using web digital libraries or mobile libraries is defined as the holistic sensation that users feel about using web digital libraries or mobile libraries with total involvement (Csikszentmihalyi, 1975).

3. Method and data collection

We focus on two constructs (latent variables) in this study, namely flow experience in using web digital libraries and flow experience in using mobile libraries. These two constructs and their corresponding measures were adapted from prior literature to fit the context of this study. Specifically, the items measuring flow experience were adapted from the work by Zhou (2013b).

After the instrument had been developed, 20 graduate students were selected for the pilot survey. Based on their feedback and comments, we adjusted the wording of some items to improve readability and clarity. The complete instrument can be found in the Appendix. Each of the items was measured with a seven-point disagree/agree Likert scale (1 represents "strongly disagree" while 7 represents "strongly agree"). Then a large-scale survey was conducted.

The large-scale survey was conducted in a university located in central China, whose library initiated the mobile library in December 2012. In the survey questionnaire, we first described that the university library provides various digital resources and services for its users and listed a range of digital resources including some Chinese databases such as VIP Chinese Science and Technology Periodicals, China National Knowledge Infrastructure (CNKI), CSSCI; some English abstract databases such as SCI (SSCI) and full-text databases such as published by Emerald, Elsevier, IEEE, Wiley, Sage and Springer. Then, we stated that web digital libraries refer to the library's digital resources and services accessed by users through the use of PC while mobile libraries refer to the library's digital resources and services accessed by users through the use of mobile phones.

This study targeted digital library users of this university who are also users of the mobile internet. Drawing on the column of personal profiles on the web site of this university, we randomly selected potential participants and recorded their e-mail addresses. After the questionnaire was published online, potential participants were invited through e-mail to visit the online questionnaire where the purpose of this study was explained and their participation was solicited and appreciated. Meanwhile, we explained the purpose of this study to those who entered the university library and solicited them to participate in the survey in the form of online or printed paper according to their preferences. Data collection was undertaken on a voluntary basis and the average response rate was approximately 50 percent. Finally, 285 valid responses were used for data analysis after dropping those with missing values. Table I documents the demographic information of these 285 respondents.

4. Data analysis

This study investigates the following specific research questions:

RQ1. What is the exact nature of data distribution of web digital libraries and mobile libraries in terms of flow experience?

Category	Item	Frequency	%
Gender	Male	169	59.30
	Female	116	40.70
Age	< 18	1	0.35
	18-25	195	68.42
	26-35	47	16.49
	36-45	24	8.42
	46-55	15	5.26
	> 55	3	1.05
Position	Undergraduate	159	55.79
	Master student	32	11.23
	Doctoral student	33	11.58
	Faculty	61	21.40
Field	Natural Sciences	120	42.11
	Social Sciences	124	43.51
	Arts and Humanities	32	11.23
	Others	9	3.16

Table I. Demographic information of respondents

RQ2. Do users experience higher levels of flow in using web digital libraries or mobile libraries?

RQ3. What is the exact mean difference of flow experience between web digital libraries and mobile libraries?

4.1 Measurement model validation

Prior to data analysis, we first assessed measurement validity in terms of reliability, convergent validity and discriminant validity (Straub *et al.*, 2004). With regard to content validity, since all the constructs and items in the current study are based on the previous literature, we thus believe these constructs and items each have clear and correct meaning.

The left section of Table II shows the results of average variance extracted (AVE), composite reliability (CR) and Cronbach's α. Convergent validity was assessed with Cronbach's α and CR, and can be established with a score exceeding the threshold value of 0.7 (Straub *et al.*, 2004). As shown in Table II, the smaller value of CR is 0.916 and the smaller value of Cronbach's α is 0.863, which suggests higher convergent validity and reliability of these two constructs. Discriminant validity was assessed by comparing the square root of each construct's AVE and the correlation between these two constructs. From the right section of Table II, it can be seen that the square root of each construct's AVE (italics values) is bigger than the correlation between them, suggesting higher discriminant validity (Straub *et al.*, 2004).

Due to the measurement validity, we thus believe it is appropriate to conduct further data analysis. Specifically, the discriminant validity suggests each of these two constructs in this study is a separate variable and it is meaningful to compare flow experience in using web digital libraries and flow experience in using mobile libraries. The reliability and convergent validity of these two constructs make it reasonable to conduct data analysis at the construct level as described below. The score of the two constructs this study examines was each calculated based on their measurement models.

4.2 Comparing flow experience in using web digital libraries and mobile libraries

Flow reflects a kind of internal state with the most enjoyable and optimal experience, which is closely associated with the concept of intrinsic motivation (Csikszentmihalyi and LeFevre, 1989; Koufaris, 2002; Lin and Joe, 2012). Users who experience a higher level of flow state are more likely to engage in using web digital libraries or mobile libraries with total involvement. For the construct flow experience in using web digital libraries in this study, respondents were asked to rate the following statements:

(1) when using my university web digital library, my attention is focused on the activity;

Constructs	Items	AVE	CR	Cronbach's α	FLOWDL	FLOWML
Flow experience in using web digital libraries (FLOWDL)	3	0.785	0.916	0.863	*0.886*	
Flow experience in using mobile libraries (FLOWML)	3	0.867	0.951	0.923	0.581	*0.931*

Notes: AVE, average variance extracted; CR, composite reliability

Table II. Overview of measurement model

(2) when using my university web digital library, I feel in control; and

(3) when using my university web digital library, I find a lot of pleasure.

A seven-point disagree-agree Likert scale was used to measure these three items. First, according to the choice of the 285 respondents, we counted 1, 2, 3, 4, 5, 6 or 7, respectively, for each item. Then due to the adequate reliability and convergent validity of the construct, the corresponding number of 1, 2, 3, 4, 5, 6 or 7 for these three items was summed to, respectively, represent the subtotal for this construct. In this fashion, the total number of this construct amounts to 855 (285×3).

Likewise, with regard to the construct flow experience in using mobile libraries, respondents were asked to rate the similar three items as listed in the Appendix. Due to the adequate reliability and convergent validity of this construct, the calculation of the subtotal of 1, 2, 3, 4, 5, 6 or 7 for this construct is the same as the construct flow experience in using web digital libraries above. Figure 1 presents the comparison between flow experience in using web digital libraries and mobile libraries.

From Figure 1, it can be seen that 19.42 percent (166/855) of the respondents think that they cannot experience a flow state when using web digital libraries while 54.39 percent (465/855) think that they can experience a flow state when using web digital libraries. Meanwhile, 26.20 percent (224/855) chose four, which reflects the neutral attitude. For flow experience in using mobile libraries, 27.49 percent (235/855) of the respondents think that they cannot experience a flow state while 41.75 percent (357/855) of the respondents think that they can experience a flow state. Meanwhile, 30.76 percent (263/855) chose four, which reflects the neutral attitude.

4.3 Paired samples t-test

Figure 1 presents the comparison of flow experience in using web digital libraries and mobile libraries in terms of data distribution, which answered the first research question. The findings also illustrate there are differences between web digital libraries and mobile libraries. In order to present the exact mean difference between flow experience in using web digital libraries and mobile libraries so as to answer the last research question, we used the statistical method, namely the paired samples *t*-test for dependent samples, to compare means.

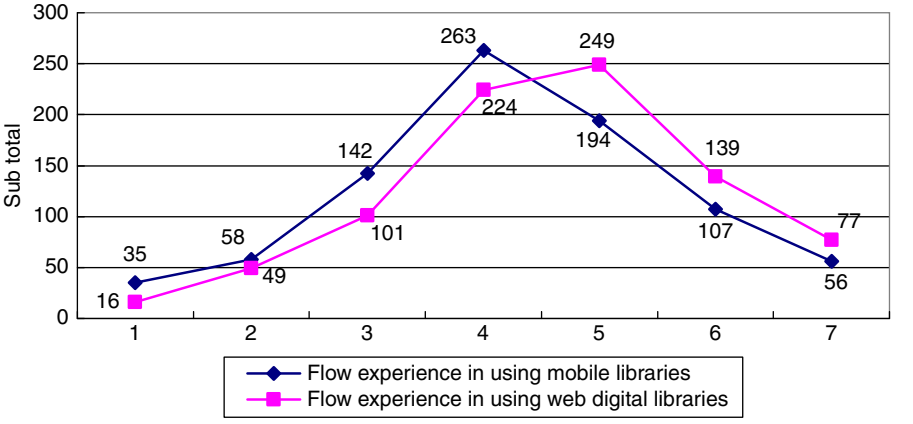

Figure 1.
Comparison between flow experience in using web digital libraries and mobile libraries

Table III shows the result suggesting there is significant mean difference between flow experience in using web digital libraries and mobile libraries. Specifically, the mean of flow experience in using web digital libraries is 4.601 while the mean of flow experience in mobile libraries is 4.249. The mean difference is 0.352, indicating that users' flow experience in using mobile libraries is significantly lower than that in using web digital libraries.

5. Discussion and implications

Digital libraries have gone from a curiosity to mainstream during the last 30 years (Arms, 2012). This study compares users' perceptions of web digital libraries and mobile libraries in terms of flow experience. Specifically, Figure 1 presents the exact nature of users' perceptions of flow experience in terms of data distribution which is supplemented by the paired samples *t*-test in Table III. We believe the findings of this study have important implications.

Digital libraries are viewed as content collected on behalf of user communities and services (Borgman, 1999; Heradio *et al.*, 2012). In China university libraries as a whole are undergoing the transition from web digital libraries to mobile libraries. Mobile libraries are in the initial or early stage of development given only a few of university libraries provide mobile library services (Li, 2013). At this stage, it is critical to examine user experience so as to obtain useful insights for the healthy development of mobile libraries. We suggest flow experience is an important user experience which is characterized by a match between perceived challenges and perceived skills (Csikszentmihalyi, 1975). The lower level of flow experience attributes to the mismatch between perceived challenges and perceived skills (Csikszentmihalyi, 1990).

Digital libraries are conventional and important information sources and the primary cause of using digital libraries is just for the purpose of seeking information. Information seeking which was defined as "the purposive seeking for information as a consequence of a need to satisfy some goal" (Wilson, 2000, p. 49) seems to be difficult given the existence of information overload for users who generally have limited information processing capability (Hemp, 2009). From Figure 1, there are fewer users who can experience flow and more users who cannot experience flow in using mobile libraries than using web digital libraries. From Table III, the mean of flow experience in using mobile libraries is significantly smaller than that in using web digital libraries. It is reasonable to suggest that the lower level of flow experience in using mobile libraries results from the case that perceived challenges exceed perceived skills.

The final aim of digital libraries is to facilitate human knowledge to be fully accessed by people anytime anywhere through various information and communication technologies in a friendly way without any barriers (Heradio *et al.*, 2012). Mobile libraries which permit users to create real-time contact with digital libraries anytime (accessibility) and anywhere (mobility) (Wang and Wang, 2010), essentially reflect a further step taken by digital libraries toward this final aim.

	Mean	*n*	SD	Paired mean difference	*t*	Sig. (two-tailed)
FLOWDL	4.601	285	1.224	0.352	5.044	*0.000****
FLOWML	4.249	285	1.338			

Note: ***$p < 0.001$

Table III.
Paired samples *t*-test

However, mobile libraries also bring more challenges to users in the initial or early stage of development. For example, small screens of mobile phones and inconvenient input and output interface are just the disadvantages that accompany the advantages of accessibility and mobility. Compared with web digital libraries, the contents of mobile libraries are obviously insufficient and the functionality is limited (Choi, 2009; Zha *et al.*, 2014). Students express more interest in using their mobile web devices to interact with library resources and services than anticipated (Seeholzer and Salem, 2011), and many undergraduate students use smart phone applications to find academic information (Bomhold, 2013). However, there are more users who think mobile libraries are neither easy to use nor useful, compared with web digital libraries (Zha *et al.*, 2014). Prior research indicated that well designed web sites, such as clear navigation, good screen design, sufficient contents, relevance of digital libraries to users' information needs, would help users to interact with digital libraries more easily and would also be important to induce flow experience (Hsu *et al.*, 2014; Hong *et al.*, 2001). Ease of use (effort expectancy) and usefulness (performance expectancy) are suggested to be able to determine users' intention to use library mobile applications (Chang, 2013). We thus recommend that Chinese university libraries should give top priority to the mobile library initiative so as to overcome the challenges above. Specifically, voice inputs can be applied to improve the inconvenient input and search function. More mobile contents which can adapt to small screens of mobile phones should be designed and delivered to users as quickly as possible given adequate mobile contents can usefully highlight the important status of mobile libraries as conventional information providers.

Digital libraries are managing the migration to digital information services (Attis and Koproske, 2013). Chinese university mobile library service modes basically include short message service and wireless application protocol service (Li, 2013). Other mobile library services include collection inquiry, reservation and renewal, due-day reminder, document retrieval and download, e-book reading, etc. We suggest mobile libraries provide an opportunity for university libraries to provide various mobile value-added services to users given the extensive penetration of mobile internet applications and service innovations to every corner of life. We recommend that university libraries should actively interact with current and potential users to capture their exact needs regarding mobile services, trying to involve them in the process of service development in the hopes that mobile libraries can develop much needed service contents. Mobile services would usefully help users to overcome the challenges in using mobile libraries with the result that more and more users can totally involve themselves in mobile library usage activities and achieve an optimal experience.

When perceived challenges exceed perceived skills, one would first become alert and then anxious (Nakamura and Csikszentmihalyi, 2002). We suggest respondents' perceptions of lower levels of flow experience in using mobile libraries could be related to library anxiety to some extent. Library anxiety has been theorized to result from one or more of the following dimensions: barriers with staff (users' perceptions that the library staff are intimidating and unapproachable), affective barriers (users' perceptions that their library skills are inadequate), uncomfortable with the library (users' perceptions that the library is not safe, welcoming or non-threatening), lack of knowledge of the library (users' unfamiliarity with the library) and mechanical barriers (users' perceptions that they cannot use library equipments) (Jiao and Onwuegbuzie, 1997; Booker *et al.*, 2012). In the mobile context, library anxiety seems to become stronger. We thus recommend that university libraries should never stop user

training since this is always an efficient way to overcome the barriers above and improve users' potential skills, thus tending to provide users with positive library experiences.

Digital libraries function differently from business entities (Kiran and Diljit, 2012). For web digital libraries and mobile libraries, they share the same final aim of facilitating human knowledge to be fully accessed by people. This study compares users' perceptions of web digital libraries and mobile libraries in terms of flow experience so as to highlight the importance of the quality of user experience. The challenge university libraries are now facing is to create compelling information services containing digital content available in a way that users will find not only acceptable but also tailored to their needs (Paterson and Low, 2011; Wang, 2013). We believe web digital libraries and mobile libraries can potentially inform each other in overcoming the challenge. When more and more users can experience enjoyable and optimal flow in using both web digital libraries and mobile libraries, the final aim of digital libraries would not be far away.

6. Conclusion

University libraries incessantly endeavor to offer better and more useful services to meet users' dynamic needs using the modern technologies (Kwanya *et al.*, 2011; Kaur and Verma, 2009). This study explores and compares users' perceptions of web digital libraries and mobile libraries in terms of flow experience so as to understand the exact nature of users' experience in using web digital libraries and mobile libraries. We find that there are fewer users who can experience flow and more users who cannot experience flow in using mobile libraries than using web digital libraries. In general, users perceive lower levels of flow experience in using mobile libraries than in using web digital libraries. Given mobile libraries offer an opportunity for libraries to develop new and exciting services and outreach to more and more users who heavily use their mobile devices (Becker *et al.*, 2013), we suggest the current study provides timely and useful insights for facilitating the healthy development of mobile libraries in China.

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Appendix. The questionnaire

This survey will be only used for research. University libraries provide various digital resources and services for users. For example, Chinese-language digital resources include China National Knowledge Infrastructure (CNKI), VIP Chinese Science and Technology Periodicals, CSSCI, etc. English-language digital resources include SCI, SSCI, as well as some full-text databases published by Emerald, Elsevier, IEEE, Wiley, Sage, Springer, etc. With the development of the mobile internet, mobile libraries have emerged in university libraries. Users can access the digital resources and services of their university libraries at anytime from anywhere through their mobile phones. Specifically, mobile libraries refer to the library's digital resources and services accessed through the use of mobile phones while web digital libraries refer to the library's digital resources and services accessed through the use of PC. Many thanks for your support!

Basic information

(1) Gender

□ Male □ Female

(2) Your age

□ < 18 □ 18-25 □ 26-35 □ 36-45 □ 46-55 □ > 55

(3) Your current position

□ Undergraduate □ Master student □ Doctoral student □ Faculty

(4) Your field

□ Natural sciences □ Social sciences □ Arts and humanities □ Others

For each of the following statements, please answer according to your own beliefs and knowledge. Please note that there are no right or wrong answers to any of the questions. Please answer all questions if possible. If you are not sure exactly how to answer, please provide your best and most accurate judgment. You can respond by selecting one of the numbers 1, 2, 3, 4, 5, 6, or 7 according to your judgment.

Flow experience in using web digital libraries (strongly disagree (1) – strongly agree (7))

1. When using my university web digital library, my attention is focused on the activity.
   1 2 3 4 5 6 7
2. When using my university web digital library, I feel in control.
   1 2 3 4 5 6 7
3. When using my university web digital library, I find a lot of pleasure.
   1 2 3 4 5 6 7

Flow experience in using mobile libraries (strongly disagree (1) – strongly agree (7))

1. When using my university mobile library, my attention is focused on the activity.
   1 2 3 4 5 6 7
2. When using my university mobile library, I feel in control.
   1 2 3 4 5 6 7
3. When using my university mobile library, I find a lot of pleasure.
   1 2 3 4 5 6 7

About the authors

Xianjin Zha is a Professor at the School of Information Management, the Center for Studies of Information Resources, Wuhan University. His research interests focus on information resources management, adoption and use of information systems in the Chinese context, competitive intelligence and information analysis. His publications have appeared in such journals as *Library & Information Science Research*, *Online Information Review*, *Computers in Human Behavior*, *Library Hi Tech*, and *Serials Review*, among others. Professor Xianjin Zha is the corresponding author and can be contacted at: xianjinzha@163.com

Jinchao Zhang is a PhD Candidate at the School of Information Management, Wuhan University, majoring in information science. His research interests focus on information resources management, and the adoption and use of information systems in the Chinese context. His publications have appeared in such journals as *Computers in Human Behavior*, *Library Hi Tech*, *Serials Review* and *Library & Information Science Research*, among others.

Yalan Yan is an Associate Professor at the School of Management, Wuhan University of Science and Technology. Her research interests focus on knowledge sharing and management, information resources management, adoption and use of information systems in the Chinese context. Her publications have appeared in such journals as *Journal of the American Society for Information Science and Technology*, *Computers in Human Behavior*, *Library Hi Tech*, *Serials Review* and *Online Information Review*, among others.

Wentao Wang is a PhD Candidate at the School of Information Management, Wuhan University, majoring in information science. His research interests focus on information resources management, and the adoption and use of information systems in the Chinese context.