Postprint of Experimental Study on User Emotional Experience in Digital Library Information Interaction Services

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Abstract

[Purpose/Significance] This study selects three types of interactive services—reference consultation services, one-stop retrieval services, and resource recommendation and acquisition services—to investigate the relationship between users' emotional experience and library information service quality, thereby establishing independent and dependent variables for quantifying user emotional experience in digital libraries. [Method/Process] Through experimental research, this study explores differences in emotional experience among digital library users when using different services on different types of websites, and discovers the influence mechanisms of information architecture methods and information quality on user emotional experience. [Results/Conclusions] The research results reveal which types of websites can provide superior experiences for users across various library services; by uncovering the influence mechanisms of user emotional experience, the study provides a referential basis for the development and design of digital libraries and offers effective approaches for improving the interactive functions of digital libraries.

Full Text

Abstract

Purpose/Significance: This study investigates three types of interactive services—reference consultation, one-stop retrieval, and resource recommendation—to establish independent and dependent variables for quantifying user emotional experience in digital libraries, exploring the relationship between users' emotional experiences and library information service quality. **Method/Process**: Through experimental research, we examine differences in emotional experiences among digital library users when interacting with different types of websites across various services, revealing the influence

mechanisms of information architecture approaches and information quality on user emotional experience. **Results/Conclusion**: The findings illuminate which website types can deliver superior experiences across library services, identify the influencing mechanisms of user emotional experience, and provide reference foundations for digital library development and design while offering effective pathways for improving interactive functions.

Keywords: digital library; user emotional experience; quantitative experiment

1. Introduction

In the new network technology environment, heightened user awareness of personalization and participation presents one of the greatest challenges for improving library information service quality: better embedding interactive design into library services to optimize user experience. User experience in library information services manifests not only at functional and informational levels but also in users' emotional responses [1]. Traditional user experience research has focused primarily on external factors such as information interaction and information architecture while neglecting internal emotional reactions—the emotional dimension of user experience. Emotion represents an attitude, a psychological feeling, and a subjective perception of physiological responses, encompassing psychological changes and physiological activities. Researchers have proposed three types of emotional experiences (pleasure, arousal, dominance) and Edell's three major emotion categories (inspiring, negative, warm). Although emotional experience has gained recognition in user experience research, it remains underexplored in the domain of digital library information services.

This study focuses on quantifying user emotional experience in digital library environments. Beginning with the relationship between users' emotional experiences and library information service quality, we establish independent and dependent variables for quantifying user emotional experience in digital libraries. Through experimental research, we explore differences in user experiences across different website types when using various services, uncovering how information architecture approaches and information quality influence user emotional experience. The results reveal which website types provide optimal experiences for different library services and identify influencing mechanisms, offering reference foundations for digital library development and design and effective pathways for enhancing interactive functions.

Current research has produced several relevant findings: (1) studies on constructing emotional scales for user experience quantification; (2) research on factors influencing user emotional experience; and (3) investigations into dimensions and types of user emotional experience quantification. Numerous emotion measurement scales exist, including the PAD Emotion Scale, Differential Emotions Scale (DES), Positive and Negative Affect Schedule (PANAS) and its extended version PANAS-X. Scholars have proposed that library users' emotional reactions can be categorized into direct and indirect influencing factors [2],

while emotional experience quantification dimensions include Holbrook's three-dimensional emotion model. Despite the maturity of research on emotional measurement tools and emotional experience, applying these to experimental studies of library information service interaction offers a new perspective for investigating library user information behavior, enriching theoretical frameworks and providing powerful analytical tools for user experience research.

2. Literature Review

2.1 Emotion Scale Research

International research on emotion measurement has yielded several classic scales. The PAD Emotion Scale measures pleasure, arousal, and dominance [3]. The Discrete Emotions Emotional Labor Scale (DEELS) can be applied to both emotional expression and feeling research [4]. Long-term international research has established that emotions comprise independent positive and negative dimensions, leading Watson et al. (1988) to develop the Positive and Negative Affect Schedule (PANAS) [5], a concise and widely adopted instrument.

Domestic scholars have adapted these scales for Chinese populations. Through translation, back-translation, and empirical validation, research has demonstrated that the Chinese version of PANAS is suitable for Chinese populations, the simplified Chinese PAD Emotion Scale exhibits good structural validity, and the Chinese version of the Emotion Reactivity Scale demonstrates strong reliability and validity. The Chinese version of the DEELS authentic emotion scale is applicable for measuring emotional frequency and intensity in Chinese populations, and the Public Emotion Scale meets psychometric requirements. These scales can serve as tools for quantifying emotional experience in future research, with broad application value—for instance, POMS for competitive contexts and PANAS for product evaluation. Table 1 summarizes these scales.

2.2 Emotional Experience Research in Related Fields

Emotion research spans multiple disciplines including psychology, art design, marketing, and library science, with applications across various domains as shown in Table 2 . Regardless of discipline, emotional experience constitutes a high-level construct based on users' interactions and behaviors, which in turn influences subsequent actions and continuous usage.

2.3 Research on Factors Influencing Emotional Experience

Information architecture emphasizes information expression and presentation to provide users with clear, comprehensible information [18]. Scholars including S. Mahlke [19], M. Hassenzahl [20], and R. Rubinoff [21] identify emotion as a primary factor influencing user experience evaluation. In information services, users prioritize emotional pleasure and satisfaction alongside service content [22], indicating that emotional experience plays a crucial role in information

services. Users may struggle to precisely describe emotional changes, but their affect manifests as preferences or aversions, making emotional scales valuable for quantitative research. B.J. Fogg [23] argues that surface-level elements—color schemes, information layout, and information form—constitute fundamental user experience components. Effective use of three-dimensional elements, color, form, images, lines, and text to convey information creates specific layouts and structures that help users interact with information services and generate pleasant emotions [24]. From a user experience perspective, website information architecture must thoroughly understand users' visual and auditory effects, employing diverse information forms (images, text, audio, video) to create engaging service environments that foster positive emotional experiences and sustained usage. Information color and texture should align with page content and type, maintaining stylistic consistency in color, brightness, and display balance to enhance comfort and experience [25].

3. Experimental Design and Implementation

This study employs an experimental design combined with questionnaires to collect data effectively from multiple angles and quantify user emotional experience. Having users complete questionnaires immediately after tasks captures authentic reactions to the interaction process, enhancing data validity.

3.1 Selection of Experimental Websites

Based on prior research classifying library information service types [26], this experiment targets three interactive services: reference consultation, one-stop retrieval, and resource recommendation. Each service corresponds to two different websites (A/B, C/D, E/F), totaling six websites as shown in Figure 1 [Figure 1: see original paper].

For reference consultation services, we selected: (A) Chinese Academy of Sciences Literature and Information Center (http://www.las.ac.cn/), a self-built platform integrating multiple consultation modes and representing the most comprehensive and typical self-built platform nationwide; and (B) National Library Reference Consultation Alliance (http://www.ucdrs.net/), led by Guangdong Provincial Sun Yat-sen Library with participation from provincial, municipal, and university libraries—currently the largest alliance platform with 50 member libraries.

For one-stop retrieval services, Chongqing University Library (C: http://lib.cqu.edu.cn/) effectively performs data cleaning, while Beijing Normal University Library's "Muduo Search" (D: http://www.lib.bnu.edu.cn/) aggregates books based on call numbers and title-author information [27].

For resource recommendation services, Tsinghua University Library (E: http://lib.tsinghua.edu.cn/dra/) provides feedback within two working days and ranks among six universities nationwide with established recommendation systems, selected for its large purchasing volume and comprehensive nature.

Wuhan University Library (F: http://lib.whu.edu.cn/) independently developed a resource recommendation system with distinctive features [28].

3.2 Independent and Dependent Variables

From subjective and objective perspectives, we quantify user emotional experience through emotional experience influencing factors and library service types.

Independent variables: Based on prior findings [29], user emotional experience in library information services is primarily determined by information architecture quality, information presentation, and information quality. Information architecture quality combined with functional and informational user experiences collectively reflect user emotional experience. Table 3 details these variables.

Dependent variables: Library users' emotional reactions constitute subjective emotional experiences with websites, comprising positive and negative emotions. Through focus group interviews, we adapted existing emotional scales [8-10] to develop the "Library Information Service Emotional Experience Scale" [29] as our dependent variable, shown in Table 5 .

3.3 Experimental Design

The experiment comprises six tasks across three service types (two tasks per type). During operation, each service type corresponds to two websites: Tasks 1 and 2 use websites A and B; Tasks 3 and 4 use C and D; Tasks 5 and 6 use E and F. We recorded sessions using written notes and EV screen recording software. To avoid repeated consultations and recommendations, task-specific information varies by participant. The tasks are:

Task 1: Obtain full text of a journal article through real-time consultation, saving it to folders "A Intelligence Center" and "B National Alliance."

Task 2: Request document delivery (pages 1-20) for a specific book via library document delivery service.

Task 3: Conduct one-stop retrieval on the topic "Discipline Services under Double First-Class Background," saving valuable references to folders "C University Library" and "D University Library."

Task 4: As an agriculture graduate student, retrieve full text of "Direct Colorimetric Rapid Detection of Theanine in Green Tea" from both C and D websites.

Task 5: As a physics student, recommend a foreign journal not held in the library collection.

Task 6: As a university teacher conducting deep learning research, urgently recommend a specific book after checking holdings.

3.3.1 Pilot Experiment Implementation To create an authentic search environment and alleviate anxiety, we conducted the experiment in a university computer lab. We installed EV recording and QQ software, created task-specific folders, and prepared paper task sheets. To accommodate A Intelligence Center's limited consultation hours (weekdays 9:00-11:00 and 14:00-16:00), we scheduled all real-time consultation tasks first. To prevent learning effects, remaining tasks were ordered using Latin square design.

3.3.2 Pilot Experiment Issues and Adjustments The pilot involved 20 participants from law, fine arts, and social work programs. Table 6 summarizes identified issues and solutions:

- **Time management**: Participants spent excessive time on certain tasks. Solution: Set total time limits and allow progression to next task if blocked.
- **Task order**: Some skipped task sequence. Solution: Emphasized sequential completion.
- **Page requirements**: Document delivery page limits caused problems. Solution: Reduced required pages and clarified that submission constitutes task completion.
- **Technical issues**: Website access problems and unclear terminology. Solution: Pre-tested equipment, adjusted terminology (e.g., "research direction" to "topic," "real-time consultation" to "ask librarian"), and highlighted key terms.

3.3.3 Participant Selection We recruited 20 participants from diverse disciplines (law, fine arts, social work, business administration, Russian language, world history, English, education, drama, fashion design, software engineering, library science, information management, computer science, education) over three weeks. Participants completed tasks during designated time slots (9:00-11:00 and 14:00-16:00 on weekdays) in the library's electronic reading room. With a 95% confidence interval, even small samples yield meaningful results.

3.3.4 Experimental Implementation To ensure rigor, we prepared software, materials, and contingency plans. Participants were briefed on objectives, procedures, and rules (e.g., using only designated library websites, not search engines like Baidu). Each recorder monitored two participants to document behaviors and issues. Post-experiment, we organized records, collected data, checked for outliers, and calculated confidence intervals.

3.3.5 Questionnaire Design The questionnaire measured variables immediately after each service type to capture authentic experiences. It comprised seven sections: basic demographics and six sections assessing specific website characteristics (font size, color, icon recognizability, layout, information clarity) with 3-7 items each, using a 5-point Likert scale (1=very poor to 5=very good).

4. Analysis and Discussion of User Emotional Experience Results

Analysis focuses on comparative analysis of the six digital library websites, emotional experience influencing factors, and relationships with emotional scale responses.

4.1 Descriptive Analysis of Digital Library Website Information Services

Reference consultation services: For websites A and B, A scored highest on consultation method variety (A12) and staff problem-solving ability (A13) at 4.15, followed by personalized perception (A14). B scored highest on font items (B1, B2, B3) but lowest on staff problem-solving and personalization, with large standard deviations (1.483 and 1.218). A showed higher information quality scores while B showed higher information architecture scores. Table 7 reveals minimal emotional experience differences between A and B.

One-stop retrieval services: For website C, font items and layout scored highest (4.20, 4.15, 4.00), while personalized perception scored lowest (M=3.30, SD=0.657). For website D, font items and layout rationality scored highest (4.35, 4.30), while retrieval result distribution scored lowest (M=3.30). Information architecture scores were high while information quality scores were low. Table 8 shows C's emotional experience slightly exceeded D's.

Resource recommendation services: For websites E and F, font size items (E1, F1) scored highest (4.15, 4.30), followed by recommendation method and resource type diversity (E12, F11) at 4.20 and 4.10. Layout conformity to user habits and information redundancy (E7, E8) scored lowest (2.95, 3.10). Users were satisfied with font size and diversity but dissatisfied with layout design and information redundancy. Table 9 shows emotional experience scores were relatively high for both sites.

4.2 Comparative Analysis of Digital Library Website Information Services

Wilcoxon signed-rank tests identified significant differences:

Reference consultation: No significant differences in information architecture ($p>0.05$). Significant differences in information quality: A outperformed B in staff affinity ($Z13=0.552$, $p<0.001$), problem-solving ability ($Z14=0.644$, $p<0.001$), and personalization ($p<0.001$). Table 10 details these results.

One-stop retrieval: No significant differences in information architecture ($p>0.05$). Significant difference in information redundancy: C outperformed D ($Z8=-0.262$, $p=0.001$). Table 11 presents the statistics.

Resource recommendation: Significant differences in icon understandability and layout conformity ($Z4=2.368$, $p<0.001$; $Z7=2.014$, $p<0.001$). No significant

differences in information quality. Table 12 shows the results.

Paired t-tests revealed no significant emotional experience differences between A/B (p=0.671) or C/D (p=0.185), but significant differences between E/F (t=-4.570, p<0.001), with F providing superior emotional experience. Tables 13-15 summarize these findings.

4.3 Correlation Analysis of Digital Library Information Service Emotional Experience

Correlation analysis reveals relationships between information architecture, information quality, and emotional experience.

Reference consultation: For website A, emotional experience (A15) correlated with font color (A1, r=0.524), icon understandability (A4, r=0.737), layout rationality (A5, r=0.576), icon recognizability (A11, r=0.753), and personalization (A14, r=0.529). For website B, emotional experience (B15) correlated with font color (B1, r=0.532), information redundancy (B8, r=0.506), icon recognizability (B11, r=0.692), consultation method variety (B12, r=0.707), staff problem-solving (B13, r=0.698), and personalization (B14, r=0.753). Tables 16-17 detail these relationships.

One-stop retrieval: For website C, emotional experience (C18) correlated with information clarity (C9, r=0.830) and navigation ability (C16, r=0.814). For website D, emotional experience (D18) correlated with font color (D1, r=0.620), background contrast (D3, r=0.547), layout conformity (D7, r=0.589), information clarity (D9, r=0.812), and navigation ability (D16, r=0.726). Tables 18-19 present these correlations.

Resource recommendation: For website E, emotional experience (E13) correlated with icon understandability (E4, r=0.721) and layout conformity (E7, r=0.619). For website F, emotional experience (F13) correlated with icon understandability (F4, r=0.620) and layout conformity (F7, r=0.645). Tables 20-21 show these results.

5. Discussion

This study quantifies user emotional experience—the third level of library information service user experience following functional and informational experiences—playing a crucial role throughout the user experience process.

5.1 Independent and Dependent Variables for User Emotional Experience Research

Table 22 summarizes the variables: 22 independent variables covering information architecture (font characteristics, icon clarity, layout, information control) and information quality (consultation/retrieval/recommendation features), with

the dependent variable being emotional responses along ten dimensions (calm-excited, confused-clear, disappointed-hopeful, etc.).

5.2 Differences in User Emotional Experience Across Digital Library Types

The study systematically examines relationships among service quality, information architecture, and emotional responses within a unified framework. Key findings:

Reference consultation: Self-built platforms excel in information quality due to better understanding of user needs and personalization. Alliance platforms show advantages in web design (fonts, layout) but provide less accurate content and slower feedback. No significant emotional experience differences exist between types, supporting Fogg's view that surface elements are fundamental. **Recommendation**: Prioritize self-built platforms with alliance services as supplementary.

One-stop retrieval: Most libraries purchase database provider systems. While both systems have strengths, Chongqing University Library's secondary data cleaning improved retrieval precision and user emotional experience. **Recommendation**: Service quality gaps depend on libraries' commitment to data cleaning rather than provider differences.

Resource recommendation: Both website types scored relatively high. Self-developed recommendation systems showed clear advantages in information architecture and emotional experience. **Recommendation**: Libraries should establish recommendation policies and develop customized systems based on user needs and resource characteristics.

5.3 Emotional Experience Influence Mechanisms

Emotional reactions depend primarily on information architecture—including layout rationality, user habits, and font/icon usability. Service-specific factors also matter: consultation services are influenced by communication methods and staff problem-solving ability; retrieval services by navigation capacity; recommendation services by icon clarity and layout conformity. Libraries should prioritize website and interface design improvements, potentially adopting high-saturation colors and flexible layouts to evoke positive emotions.

The six tasks represent a crucial experimental component. Using written records and EV screen recording minimized interference; Latin square ordering reduced sequence effects; repeated tasks under identical conditions enhanced reliability. This design meets professional and statistical requirements, providing a reference for user experience quantification studies.

This research overcomes limitations of segmented, cross-sectional studies, offering tools for comprehensively measuring and evaluating user emotions. Results

can guide improvements to interactive environments, processes, and service levels, optimizing emotional experience and satisfaction. Limitations include sample size and reliability issues; future research should expand library and user type diversity for broader validation.

References

[1] QIAN W W, JIA C. Quantization model of user experience for electronic information services[C]//2015 IEEE international conference on logistics, informatics services science. Beijing: LISS, 2015.

[2] Zhang Ru, Wang Fengxuan. Review of emotional issues in library and information science[J]. Library and Information Service, 2014, 58(9): 114-120, 135.

[3] MEHRABIAN A. Framework for a comprehensive description and measurement of emotional states[J]. Genet Soc Gen psychol monogr, 1995, 121(3): 339-361.

[4] THE GLOMB T M, TEWS M J. Emotional labor: a conceptualization and scale development[J]. Journal of vocational behavior, 2004, 64: 1-23.

[5] WATSON D, CLARK L A, TELLEGEN A. Development and validation of brief measures of positive and negative affect: the PANAS scales[J]. Journal of personality and social psychology, 1988, 54(6): 1063-1070.

[6] Wu Yuju, Ling Wenquan, Lu Hong, et al. Revision of the DEELS authentic emotion scale[J]. Journal of Guangzhou University (Social Science Edition), 2012, 11(5): 52-56.

[7] Yang Li. Study on mental health and psychological intervention effects among college students[D]. Shenyang: China Medical University, 2003.

[8] Huang Li, Yang Tingzhong, Ji Zhongmin. Applicability study of the Positive and Negative Affect Schedule in Chinese population[J]. Chinese Mental Health Journal, 2003(1): 54-56.

[9] Guo Mingzhu, Gan Yiqun. Reliability and validity test of the Chinese version of PANAS-X in 660 college students[J]. Chinese Mental Health Journal, 2010, 24(7): 524-528.

[10] Li Xiaoming, Fu Xiaolan, Deng Guofeng. Preliminary trial of the Chinese simplified PAD emotion scale among Beijing college students[J]. Chinese Mental Health Journal, 2008(5): 327-329.

[11] Zhang Guannan. Reliability and validity test of the Public Emotion Scale in Chinese college students[A]. Chinese Psychological Society. Psychology and Innovation Capacity Enhancement - Proceedings of the 16th National Psychology Academic Conference[C]. Nanjing: Chinese Psychological Society, 2013: 1.

[12] Wang Liya. Research on interactive interface design of urban life mobile platforms based on user cognitive psychology[D]. Xi'an: Xi'an Polytechnic University, 2018.

[13] Gao Yun, Qian Weiwei. Construction of a public experience quantification model for government electronic information services[J]. Information and Documentation Services, 2015(6): 22-27.

[14] Li Xiaoqing. Design of a Web user experience model based on general psychological hierarchy theory[J]. Information and Documentation Services, 2010(1): 62-65, 81.

[15] Chen Na, Hou Guanghui. User perceived value and participation intention in library subject service context: The moderating effect of service communication[J]. Science and Technology Management Research, 2013, 33(20): 230-235.

[16] Zheng Dejun, Xuan Shuangxia, Shen Junwei. Construction of a user-perceived mobile library service quality evaluation model[J]. Journal of Academic Libraries, 2015, 33(5): 83-92.

[17] Chen Yang. Research on the relationship between social cues in shopping websites and customer behavioral intention[D]. Shenyang: Northeastern University, 2011.

[18] Hu Changping, Li Yanghui. Analysis of user-oriented interactive information service organization[J]. Library Tribune, 2006(6): 188-193.

[19] MAHLKE S. Factors influencing the experience of website usage[C]//CHI extended abstracts. New York: ACM Press, 2002: 846-847.

[20] HASSENZAHL M, TRACTINSKY N. User experience-a research agenda[J]. Behaviour & Information Technology, 2006, 25(2): 91.

[21] RUBINOFF R. How to quantify the user experience[EB/OL]. [2021-04-09]. https://www.sitepoint.com/quantify-user-experience/

[22] Zeng Ying. Exploration of constructing a digital library information service model based on user experience[J]. Library Science Research, 2011(9): 81-83, 24.

[23] FOGG B J, SOOHOO C, DANIELSON D R, et al. How do users evaluate the credibility of websites?[P]. Designing for user experiences, 2003: 1-15.

[24] Hu Zhanmei. Research on the application of interactive emotion and cognitive experience in user interface design[D]. Xi'an: Shaanxi University of Science and Technology, 2014.

[25] Jiang Yani. Research on visual design of mobile application interfaces based on user experience[D]. Shanghai: Donghua University, 2016.

[26] Qian Weiwei, Feng Zhiying. Experimental study on quantifying functional user experience of library information services[J]. Library and Information Service, 2019, 63(11): 52-65.

[27] Wang Xiao. The impact of WeChat use on college students' self-identity development[D]. Nanjing: Nanjing University, 2018.

[28] Huang Xiaochun. Discussion on digital library experience services based on online-offline mode[J]. Information Exploration, 2016(3): 89-92, 111.

[29] Wang Tianhui. Research on library information service quality control based on user experience in network environment[D]. Tianjin: Tianjin Normal University, 2019.

[30] Lan Qing. Research on innovation and practice of the National Library Reference Consultation Alliance[J]. Library Science Research, 2012(14): 85-88.

[31] Qian Li, Zhang Zhixiong, Li Ling, et al. Construction of an integrated digital reference consultation service platform[J]. Library and Information Service, 2015, 59(6): 28-34.

[32] Wu Defei, Pang Zhenlu. Research on the application of one-stop retrieval in the construction of university library subject service platforms[J]. Modern Economic Information, 2015(19): 378-379.

[33] Zhang Guofang, Li Xiaohong. Research on the construction of one-stop retrieval services for university library information resources[J]. Lantai World, 2014(32): 131-132.

[34] Xie Jinlan, Wang Yajuan. Research on one-stop retrieval services for information resources based on new portal construction: Taking key university libraries in China as examples[J]. Information Theory and Practice, 2013, 36(8): 62-65.

[35] Fang Xiangming, Shen Ling. Review of library reader recommendation research[J]. Library and Information Service, 2018, 62(9): 143-150.

[36] Chen Xinhong, Guo Dongmei. Construction of literature resources in university libraries based on reader recommendations[J]. Chinese Journal of Medical Library and Information Science, 2011, 20(9): 36-37, 80.

[37] Fan Chunmei. Discussion on resource recommendation services in university libraries[J]. Library Development, 2010(5): 11-13, 17.

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Note: Figure translations are in progress. See original paper for figures.