Research on Mobile Library User Experience Mapping and Service Optimization Postprint

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Date: 2023-04-01T16:03:00+00:00

Abstract

[Purpose/Significance] By constructing a mobile library user experience map, this study effectively reveals the intrinsic relationships among the mobile library service system, service context, and user experience, providing an important basis for user experience-based service optimization. [Method/Process] Based on a detailed elaboration of the user experience map drawing process, and taking the library space reservation service based on WeChat Official Account as an example, the user experience map intuitively demonstrates users' interaction behaviors, real thoughts, and emotional changes throughout the entire service process, accurately measuring user experience from a holistic perspective and revealing its influencing factors. [Results/Conclusion] According to the constructed mobile library user experience map, user pain points and service opportunity points are identified, and specific optimization strategies are proposed from three dimensions: service process, service function, and service environment, providing new ideas and methods for research on mobile library user experience and service optimization.

Full Text

Mobile Library User Experience Map Construction and Service Optimization Research

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Abstract: [Purpose/Significance] By constructing a user experience map for mobile libraries, this study effectively reveals the intrinsic relationships among mobile library service systems, service contexts, and user experience, providing an important basis for service optimization based on user experience. [Method/Process] Based on a detailed elaboration of the user experience map

drawing process, this paper takes the library space reservation service based on WeChat official accounts as an example. Through the user experience map, it visually demonstrates users' interactive behaviors, real thoughts, and emotional changes throughout the service process, accurately measuring user experience from a global perspective and revealing its influencing factors. [Result/Conclusion] According to the drawn mobile library user experience map, user pain points and service opportunity points are identified. Specific optimization strategies are then proposed from three levels: service process, service function, and service environment, providing new ideas and methods for mobile library user experience and service optimization research.

Keywords: user experience map; mobile library; space reservation service; optimization strategy

Mobile libraries provide users with more diverse and convenient access to knowledge resources, enhance information interaction between users and libraries, deepen the user-centered service concept, and highlight the critical role of user experience in mobile library service quality management. User experience refers to the feelings and reactions generated by users during service usage, running through the entire service process as the result of interactions among user behavior, service systems, and service environments. Accurately measuring user experience and proposing corresponding service optimization suggestions have become important bases for improving mobile library service quality and user satisfaction. However, current user experience measurement methods mainly rely on questionnaires and qualitative research, focusing on analyzing users' overall feelings after service usage. These methods struggle to dynamically track user experience changes at different stages of the service process, making it difficult to simultaneously record users' behaviors, thoughts, and emotions in specific service contexts. Consequently, they cannot effectively reveal the intrinsic relationships among mobile library service systems, service contexts, user behaviors, and user experience.

Given this, the authors introduce the user experience map, combining qualitative and quantitative methods to visually present users' interaction touchpoints, behavioral performance, thoughts, feelings, and emotional states throughout the mobile library service process. This approach provides a global perspective for in-depth insight into the user experience change process, enables precise measurement of experience effects, and helps identify user pain points and service opportunity points, thereby providing an important basis for mobile library service optimization.

2 Literature Review

2.1 Mobile Library User Experience Research

The widespread adoption of mobile libraries has gradually transformed users' roles from passive recipients to active participants. How to effectively improve user experience has become a shared focus of both library practitioners and

researchers. Scholars at home and abroad have conducted relevant research on key issues such as mobile library user experience elements, models, measurement methods, and optimization strategies. Qiao Hongli [1] identified eight mobile library user experience elements through questionnaire surveys: sensory cognition, service perception, strategy perception, cognitive perception, emotional perception, user perception, application attitude, and application intention. Wang Canrong et al. [2] constructed a mobile library user experience quality evaluation model (MUQoEE) and established a corresponding evaluation index system. L. J. Chanlin et al. [3] explored usability testing indicators for mobile library service experience, conducting usability assessments from multiple dimensions including learnability, controllability, content presentation, and efficiency. Cui Jingfeng et al. [4] utilized Shapley values to evaluate mobile library user satisfaction and proposed feasible optimization strategies. Wei Qunyi et al. [5] and Meng Meng and Zhu Qinghua [6] systematically reviewed and content-analyzed existing research findings, summarizing and prospecting mobile library user experience evaluation frameworks, methods, and models.

As users' spiritual and cultural needs continue to grow, the focus of mobile library user experience research is gradually shifting from functional aspects such as service system usability to the emotional dimension. Scholars are paying more attention to whether mobile libraries can bring users more satisfaction and pleasure while meeting their basic knowledge needs, thereby better promoting user-library interaction. Yao Yuan and Xu Tiancai [7] proposed that mobile library user experience is comprehensively influenced by functional experience, emotional experience, interactive experience, and sensory experience, with emotional experience having the most significant impact on users' service usage intention. Shen Junwei and Deng Dejun [8] found through empirical research that the emotional experience formed during user-mobile library interaction affects value identification, which in turn influences user satisfaction and continuous usage behavior.

In summary, user experience has become an important research topic in the mobile library field. Existing achievements provide important theoretical guidance for mobile library service model optimization and service quality improvement. However, universal standards have yet to be formed in constructing user experience evaluation models and index systems. Systematic, dynamic, and visualized methods are lacking in experience effect measurement. More importantly, scalable solutions based on typical cases and empirical research are absent in experience optimization. Furthermore, regarding the focal issue of mobile library user emotional experience, related research is still in its infancy, with no systematic achievements in emotional experience measurement and optimization.

2.2 User Experience Map Research

The user experience map is a user research tool that visually demonstrates users' expectations, behaviors, thoughts, and experiences throughout the entire process of using a product or service from the user perspective, thereby identifying

pain points in user-product (service) interaction and finding optimization directions [Figure 1: see original paper]. Since user experience experts C. Shaw and J. Ivans [10] first studied the basic framework of user experience maps, scholars such as M. Stickdorn and J. Schneider [11], J. Patton [12], and renowned user experience research and consulting institutions including Forrester [13], Adaptive Path [14], and Nielsen Norman Group [15] have continuously supplemented and improved the components of user experience maps, proposing frameworks applicable to different scenarios.

Based on these classic frameworks, currently widely used user experience maps mainly include elements such as usage process, user goals, interaction touchpoints, user behaviors, user thoughts, emotional curves, user pain points, and product opportunity points. When measuring user experience for specific target users and usage scenarios, user portraits and scenario information are often incorporated [15], forming a relatively complete user experience map framework, as shown in Figure 1 [Figure 1: see original paper]. Among them, the user portrait is the target user role established for a specific product (service); the scenario is the environmental state when users use the product (service); the usage process includes specific links in the service process; user goals represent users' specific needs and expectations at each link; interaction touchpoints are the media through which users interact with the service system (such as websites, apps, etc.); user behaviors are users' behavioral performance at each touchpoint; user thoughts reflect various inner feelings generated during user interaction; the emotional curve is the change in users' emotional states corresponding to their thoughts and is also a direct reflection of user experience effects; finally, pain points and opportunity points are the key problems in the product (service) and specific directions for optimization and improvement summarized based on user experience [11, 14-15].

By drawing user experience maps, product (service) designers, developers, and operators can intuitively understand the complex interaction relationships among users, products (services), and environments in specific scenarios, gain insight into user emotional states and experience change processes from a global perspective, and accurately identify key problems in products (services) to propose feasible optimization solutions. Therefore, user experience maps are widely applied in user experience measurement and product (service) optimization design. Li Xiaoying et al. [16] used user experience maps to sort out the food delivery service process, quantified user experience at each service link, and proposed service optimization strategies. N. N. Li et al. [17] explored the digital experience design of cultural and creative products based on user experience maps. Wang Bowen et al. [18] established a mapping relationship between user experience and product design elements by drawing internet product user experience maps, providing effective support for revealing user experience influencing factors and innovating product design concepts. However, in the mobile library field, theoretical research and practical application of user experience maps are almost blank.

As China's mobile library construction advances, various mobile services continue to emerge, meeting users' diversified needs while also causing numerous service problems. Compared with traditional qualitative research methods (interviews, observations, etc.) and questionnaire survey research based on user experience scales, user experience maps can more completely reflect users' experience changes throughout the entire process of using mobile library services by combining qualitative and quantitative research. This approach effectively reveals the intrinsic relationships among user behaviors, thoughts, and emotions at specific service touchpoints, vividly and intuitively presents user experience measurement results through visualization, accurately identifies user pain points and service opportunity points, and achieves full service process optimization. A comparison between user experience maps and traditional mobile library user experience measurement methods is shown in Table 1 .

Table 1 Comparison Between User Experience Maps and Traditional Mobile Library User Experience Measurement Methods

Dimension	User Experience Map	Traditional Qualitative Research	User Experience Scale
Research Method	Qualitative and quantitative combination	Qualitative research focus	Quantitative research focus
Presentation	Visualization combining colors, text, charts, icons, emoticons, emotional curves, etc.	Framework diagrams, photos, etc.	Data analysis result charts
Measurement Object	User experience changes in full service process	Mainly overall experience effect of a service	Mainly overall experience effect of a service
Content Recorded	User behaviors, thoughts, emotional reactions at different service touchpoints and their relationships	User behaviors, thoughts, user attitudes	User behaviors, thoughts, user attitudes

Dimension	User Experience Map	Traditional Qualitative Research	User Experience Scale
Optimization Strategy	Identify user pain points and service opportunity points based on research findings, propose specific optimization countermeasures for each service link to achieve full service process optimization	Propose service optimization countermeasures based on research findings	Propose service optimization countermeasures based on research findings

3 User Experience Map Drawing Process

According to the user experience map drawing 思路 proposed by K. Kaplan [15], comprehensive and accurate collection of information corresponding to each component of the user experience map is required before completing visual output. In practical applications, scholars and research institutions have proposed diversified collection methods and distinctive visualization design schemes for specific research purposes, objects, and service scenarios [13-15, 19]. Based on relevant research achievements, the authors sorted out and summarized currently widely adopted and verified user experience map drawing methods. Following the user experience map framework shown in Figure 1, the drawing process is divided into five stages: "constructing user portraits," "determining specific scenarios," "collecting user information," "completing map content," and "visualization design," with specific operational steps refined as shown in Figure 2 [Figure 2: see original paper].

Figure 2 [Figure 2: see original paper] User Experience Map Drawing Process

(1) **Construct User Portraits.** Identifying target users is the primary task in drawing user experience maps. Establishing user portraits can precisely locate the target objects of the service. User portraits are abstract user prototypes based on deep understanding of real users and high-precision summarization of multi-source data, typically containing demographic information (name, gender, age, photo, etc.), general characteristic information (occupation, interests, habits, etc.), and service usage information (usage degree, expectations, needs, etc.) [20]. Mobile libraries cover a very broad user group, and providing differentiated services for different

groups is essential to ensure good user experience. Therefore, establishing accurate user portraits is a basic prerequisite to help libraries locate target users, segment user groups, and better understand user experience from an empathy perspective.

(2) **Determine Specific Scenarios.** Scenarios are the environmental states when users use services, generally including time, location, network environment, relevant people and events, and operation tasks being performed by users [21]. The effective implementation of mobile library services cannot be separated from specific scenarios. Therefore, determining scenarios is the cornerstone of drawing user experience maps, helping libraries fully grasp the environmental states in which users generate corresponding experiences and clarifying the complex interaction relationships among users, scenarios, and service systems. Since mobile libraries break through time and space constraints and can provide diversified services anytime and anywhere, service scenarios are very rich. Researchers need to determine representative scenarios through walkthrough interviews, then sort out service processes, identify key links, and fill them into the user experience map.

(3) **Collect User Information.** User experience maps are built upon large amounts of real user data. Therefore, comprehensive and accurate collection of user-related data is required, including user behaviors, goals, thoughts, and emotional states. Qualitative and quantitative methods such as questionnaires, interviews, observations, think-aloud protocols, and neuroscience experiments can be comprehensively applied. Since user experience maps reflect target users' behaviors and feelings at different service links, users' behaviors, thoughts, and emotional states have a one-to-one correspondence with service links. During collection, tracking research needs to be conducted on the same (group of) users throughout a complete service process based on the specific scenario determined in step (2).

(4) **Complete Map Content.** After summarizing and deduplicating the collected user data, user goals, behaviors, interaction touchpoints, thoughts, and emotional state information can be sequentially filled into corresponding modules according to the user experience map framework shown in Figure 1, and information visualization can be completed according to relevant requirements [11]. For example, goals, behaviors, touchpoints, and thoughts are generally presented in the form of "text + icons," while emotional curves require quantifying user emotional states and then presenting them through "emoticons + curve connections." On this basis, user pain points and service optimization opportunity points can be further identified according to the high points (positive emotions) and low points (negative emotions) of the emotional curve, and specific optimization solutions can be considered, thus completing all content of the user experience map.

(5) **Visualization Design.** Since one advantage of user experience maps is that they can completely show user experience changes throughout the full service process through visualization, they place great emphasis on intuitiveness, vividness, and diversity in visual performance. Researchers need to select appropriate color schemes, icons, tables, fonts, and other elements for visualization design and output based on the completed map content from step (4), thereby intuitively presenting user experience measurement results.

4 Mobile Library User Experience Map Drawing and Application: A Case Study of Space Reservation Service

Following the user experience map drawing process, this study systematically investigates the practical application of user experience maps in mobile library user experience measurement, taking the typical service of space reservation as an example. In recent years, as library space construction and renovation work continues to advance, numerous libraries have continuously opened and optimized their unique spatial resources, launching specialized services such as research spaces, maker spaces, exhibition spaces, and leisure spaces. These provide excellent cultural venues for readers' learning, discussion, and cooperation, making space reservation services a popular library application. With the increasing popularity of mobile libraries, space reservation services have gradually extended from PC terminals to mobile terminals, providing users with more convenient reservation methods. According to the "Survey and Research on University Library Space Reservation Services" statistics, among "985 universities" that have launched space reservation services, 74.4% have opened mobile reservation services such as WeChat official accounts [22]. In this context, accurately measuring the experience of mobile library space reservation services has become an important foundation for accelerating traditional library space renovation and service transformation. The Ministry of Education's "Regulations on Libraries in Regular Institutions of Higher Education" issued in 2015 clearly stated that "libraries should optimize service space and focus on user experience" [23]. Mobile library space reservation services cover all links of "before reservation," "during reservation," and "after reservation," forming a complete service process from online to offline, making them suitable for service effect evaluation and optimization using user experience maps. According to the main methods of mobile space reservation services, this study takes the space reservation service based on library WeChat official accounts as an example for user experience map drawing and application.

4.1 Space Reservation Service User Portrait Construction

To accurately locate target users of mobile library space reservation services, this study took Wuhan University Library users as empirical objects and used questionnaire surveys. From June 10 to 16, 2021, paper questionnaires were distributed on-site to space users in the self-study area, 3C maker space, and

innovative learning discussion area of Wuhan University Library main building. Questionnaire items included gender, age, education (or occupation), major, interests, learning habits, space service reservation methods, usage frequency, usage duration, usage items, service needs, contact information (optional), etc. A total of 517 questionnaires were distributed. After removing incomplete questionnaires and those that did not select the option "space reservation through WeChat official account," 421 valid questionnaires (81.4%) were recovered. After questionnaire coding, entry, and analysis, the descriptive statistical results of respondents are shown in Table 2 .

Table 2 Descriptive Statistical Results of Survey Respondents

Variable	Category	Percentage (%)	Variable	Category	Perce
Age	16-20 years	1.2	Usage Frequency	More than 5 times/week	16.9
	21-25 years	87.4		3-5 times/week	57.5
	26-30 years	8.8		1-2 times/week	25.6
	30-45 years	2.6	Usage Duration	Within 2 hours	8.1
Education	Undergraduate	48.9		2-5 hours	62.9
	Master's student	40.4		More than 5 hours	29.0
	PhD student	9.5	Most Used Service	Self-study seat reservation	76.7
				Group study room reservation	16.4
				Multimedia reading	6.9

The results show that the main user group is students aged 21-25, with most using the service 3-5 times per week, each session lasting 2-5 hours, with self-study seat reservation being the most frequently used service item. Usage purposes mainly include academic research, final exam preparation, and graduate school or civil service exam preparation. Based on the descriptive statistical results, the authors identified the undergraduate group with the highest proportion (48.9%) and the graduate student group (including master's and PhD students (49.9%)) as the two main target user groups. The Canopy algorithm and K-means algorithm were then applied to cluster-analyze attribute data and behavioral data of the two user groups, extract typical characteristic labels, and abstract them into two user portraits. The portrait characteristics were described specifically to realistically represent the actual situation of target users, as shown in Figure 3 [Figure 3: see original paper].

Figure 3 [Figure 3: see original paper] Target User Portraits for Mobile Library Space Reservation Service

4.2 Space Reservation Service Typical Scenario Description

After determining target users, following the widely adopted J. Nielsen [24] standard for usability test participant numbers in user experience map information collection [15, 25], this study selected 5 real users who met the characteristics of user portrait "Person 1" (due to space limitations, this study only draws

the user experience map based on Person 1) from respondents who voluntarily provided contact information. First, contextual inquiry was used to understand detailed scenario information (including time period, location, surrounding environment, operation process, etc.) when target users used the library WeChat official account for space reservation, with user consent and privacy protection through actual observation and user interviews. The information was summarized and sorted to extract a universal typical scenario—self-study seat reservation. The scenario content was then refined (see Figure 4 [Figure 4: see original paper]). After consulting librarians, the space reservation service process in the scenario was further divided into seven links: "understanding reservation service," "querying seats," "selecting seats," "reserving seats," "seat check-in," "using seats," and "seat check-out."

Figure 4 [Figure 4: see original paper] Scenario Description of Mobile Library Space Reservation Service

4.3 Target User Information Collection

Against the established service scenario background, target user information was further collected through one-on-one user interviews and satisfaction scales. Interview content mainly included users' specific goals, behaviors, thoughts, and feelings at each link of the mobile library space reservation service. The interview outline is shown in Table 3 .

Table 3 User Interview Outline for Mobile Library Space Reservation Service

Objective: Collect target users' specific goals, behaviors, inner feelings, and thoughts at each link of "mobile library space reservation service" to prepare for drawing the user experience map.

Interview Content: - Basic attributes: gender, age, education, occupation, hobbies, etc. - Service usage environment: learning environment, living environment, work environment - Usage motivation: specific reasons for using this service - User expectations: desired service functions and expected service effects

Link-specific questions (example for "Understanding Space Reservation Service"): - How would you operate on the library WeChat official account to understand reservation services? - What is your goal in understanding the space reservation service link? - How do you learn about space reservation services? - Is the reservation system consistent with your expectations after entering? - What thoughts and feelings did you have during the process of understanding reservation services?

(Similar questions for other links: querying seats, selecting seats, reserving seats, seat check-in, using seats, seat check-out)

Through integrating, deduplicating, and analyzing user interview information, users' demand goals, behavioral paths, interaction touchpoints, and emotional

feelings at each link of the space reservation service can be clarified. The satisfaction scale was administered during interviews, asking respondents to truthfully reflect their satisfaction degree (measured using a 5-point Likert scale) for specific service links mentioned, thereby characterizing users' emotional experience—higher satisfaction represents more positive emotional states and better experience feelings. Based on statistical analysis of measurement results, target users' emotional experience values at each link of the space reservation service were further calculated using Formula (1) as the reference basis for drawing the emotional curve.

$$S_i = \frac{1}{n}\sum_{j=1}^{n} Q_{i-j} \quad \text{Formula (1)}$$

Where S_i represents the user emotional experience value at the i-th service link, Q_{i-j} represents the average user emotional experience at the j-th interaction touchpoint of the i-th stage, and n represents the number of user usage behaviors at the i-th stage.

The calculation results are shown in Table 4 . It can be found that users have the worst experience in the seat selection link using the library WeChat official account, while the actual seat usage link after arriving at the library provides the best experience.

Table 4 User Experience Measurement Results for Mobile Library Space Reservation Service

Service Link	Interaction Touchpoint	Emotional Experience Value	Service Link	Interaction Touchpoint	Emotional Experience Value
Understand Reservation Service	Follow official account	3.2	Reserve Seat	Select time slot	3.0
	Enter reservation system	3.4		Confirm reservation information	3.2
	View reservation process	3.6	Seat Check-in	Scan QR code	3.8
Query Seat	Browse available seats	2.8		Sign in successfully	4.0
	View seat layout	2.6	Use Seat	Use equipment	4.4

Service Link	Interaction Touchpoint	Emotional Experience Value	Service Link	Interaction Touchpoint	Emotional Experience Value
	View seat type	2.9		Organize learning materials	4.2
Select Seat	Select specific seat	2.4	Seat Check-out	Clean up space	3.6
	View seat details	2.7		Leave library	3.8

4.4 Map Content Completion and Visualization Design

After summarizing and sorting user information obtained from interviews, it was sequentially filled into the goals, behaviors, touchpoints, and thoughts modules of the user experience map framework. The user emotional curve was drawn based on the calculation results in Table 4. Nodes on the curve correspond one-to-one with interaction behaviors, with node heights drawn according to the emotional experience values corresponding to each behavior. On this basis, user pain points and service opportunity points for mobile library space reservation services were extracted according to the "peaks" and "lows" on the emotional curve, combined with user feeling information from interviews. For example, in the seat selection link, users' main pain point is difficulty understanding the library space distribution layout plan, with the corresponding opportunity point being to restore the library's spatial scene as realistically as possible in the mobile terminal seat preview interface, intuitively showing the spatial layout to facilitate users' selection of appropriate self-study seats.

Finally, to more aesthetically and vividly present the user experience map, appropriate color schemes, fonts, icons, and other elements need to be selected for visualization design. According to the empirical object of this study—Wuhan University Library—the authors selected the main color tone of the library's official website as the user experience map color scheme, used vivid icons to represent user service usage behaviors, and used emoji emoticons to vividly present user emotional states, ultimately outputting the complete mobile library space reservation service user experience map, as shown in Figure 5 [Figure 5: see original paper].

Figure 5 [Figure 5: see original paper] User Experience Map of Mobile Library Space Reservation Service

5 Mobile Library Space Reservation Service Optimization Strategies

Based on the drawn mobile library space reservation service user experience map and focusing on user pain points and service opportunity points, this paper proposes specific optimization strategies for space reservation services from three dimensions: service process, service function, and service environment.

5.1 Service Process Optimization

User experience runs through the entire flow of mobile library space reservation services. According to users' real thoughts and emotional feelings generated at each service link, process optimization can be carried out from three stages: before reservation, during reservation, and after reservation, thereby improving the quality and efficiency of space reservation services.

(1) **Strengthen pre-reservation service promotion to reduce user cognitive pressure.** Currently, although many libraries have launched mobile space (seat) reservation systems, the lack of extensive publicity and detailed introduction has resulted in most users being unfamiliar with the mobile reservation process, operation methods, and precautions, frequently leading to operation errors and reservation failures that seriously affect user experience and the popularization of mobile reservation services. To address this, libraries should strengthen the publicity and introduction of mobile reservation services, fully utilizing the timeliness, flexibility, and diversity of mobile terminal information release and presentation methods to push the latest service information to users with high space reservation service usage frequency in a timely manner. Libraries should actively introduce mobile terminal common methods such as H5, short videos, and mobile games to introduce space reservation service operation processes, facilitating users' intuitive understanding and improving service usage willingness. For example, Nanjing University of Science and Technology uses H5 animation to introduce the main functions of mobile library services [26]; Grand Valley State University in the United States helps users familiarize themselves with mobile library space services through the mobile game "Library Quest" [27].

(2) **Improve reservation process intelligence to simplify system operation procedures.** The mobile library space reservation service user experience map shows that the cumbersome reservation process leads to poor user experience. Especially for frequent users, performing large amounts of repetitive operations often generates 厌烦情绪. In response, mobile libraries should establish user preference models using data mining, machine learning, and context-aware technologies based on user registration information and behavioral data, analyze user reservation habits and service usage behaviors, accurately push vacant seat information or other space services to users, and modularize design users' common operation steps to auto-

matically complete system reservations, simplifying service processes and improving mobile library service intelligence.

(3) **Optimize post-reservation user peak-end experience to form a complete experience 闭环.** At the endpoint of the space reservation service user experience map, the emotional curve shows many "low points," indicating poor user experience. According to psychologist D. Kahneman's [28] peak-end law, users' experience feelings are mainly determined by peak period and end period experiences, with users' emotions at the endpoint directly affecting their overall feelings about the product or service. Therefore, a "perfect" ending link needs to be carefully designed to give users the best "end value" experience. In mobile library space services, after users finish using self-study seats, libraries can send users' learning duration, public learning equipment usage, and literature borrowing information for the session via text message or WeChat official account in a timely manner, and welcome them to make future reservations. Simultaneously, users' reservation priority can be appropriately increased based on their usage frequency and duration, thereby generating pleasant feelings and forming a good experience 闭环. Additionally, libraries can regularly summarize users' weekly and monthly learning situations at the library, automatically generate space usage reports and push them to users, enhancing users' sense of achievement and learning interest, thereby motivating them to continue using space services and forming positive feedback.

5.2 Service Function Optimization

Based on service process optimization for mobile library space reservation, service function optimization can be further carried out according to user pain points in interaction behaviors at each service link.

(1) **Innovate interaction methods to achieve seamless online-offline integration.** The complete library space service process covers online reservation and offline space usage, involving multiple virtual and physical service touchpoints that require seamless integration between online and offline services. Addressing pain points such as poor space preview experience when selecting self-study seats online and excessive time spent finding reserved seats offline, libraries should better leverage mobile internet advantages to improve interaction experience. For example, add a 3D panoramic view mode in the mobile reservation system to transform abstract space seat distribution layout plans into three-dimensional, intuitive real-scene images, facilitating user preview and selection. After users arrive at the library, augmented reality (AR) functions can guide users to quickly find reserved seats and display current space usage with digital tags. Additionally, interactive activities such as online and offline check-ins and social network sharing can increase user activity and pleasure in using space reservation services.

(2) **Enrich service content and provide diversified value-added services.** High-quality user experience comes not only from satisfaction of needs obtained from services but also from surprises beyond needs. As mobile library basic services become increasingly mature, how to provide diversified value-added services for users is becoming an important direction for libraries to improve user experience. While continuously improving mobile space reservation services, libraries can simultaneously open reservation services for handheld reading devices, interactive electronic whiteboards, literature printing services, online collaboration systems, video conference management systems, and other supporting software and hardware for space usage. Libraries can also provide one-stop services for space reservation, reference consultation, and literature borrowing based on users' actual usage needs and habits, helping users timely obtain needed knowledge resources during learning and discussion to improve learning efficiency.

(3) **Optimize operation interface and improve service usability.** The mobile library service system interface is an important guarantee for guiding users to successfully complete space reservation and requires reasonable design. According to human-computer interaction expert J. Nielsen's [29] environmental concordance principle, interface element symbols should be as close to the real world as possible to facilitate user interaction. Therefore, the interface design of mobile space reservation service systems should follow users' shared cognition, adopt widely accepted visualization elements, improve the similarity between graphic symbols for space location and seat types in system preview pages and physical entities, and optimize the layout of function buttons, icons, and text from the perspective of users' visual habits and mobile terminal operation habits to reduce user operation error rates and improve space reservation service usability.

5.3 Service Environment Optimization

While optimizing online reservation services for mobile library space reservation, establishing a good offline service environment for users is also necessary to ensure good experience throughout the entire service process.

(1) **Create a harmonious cultural space atmosphere.** Libraries provide different types of space services such as self-study spaces, discussion spaces, and maker spaces. To fully leverage the service functions of various spaces and meet different users' diversified needs, libraries should conduct reasonable planning in the physical environment to achieve dynamic and static space zoning and spatial function complementarity. This provides communication venues for people needing brainstorming while avoiding interference with those needing immersive learning, thereby creating a harmonious spatial atmosphere and truly fulfilling libraries' role as important knowledge and cultural centers.

(2) **Create personalized space service environments.** Space environments that meet users' personalized needs can make users fully feel service warmth and improve emotional experience. For example, for users who use self-study seats for long periods, libraries can send warm reminders via text message or WeChat official account to stand up and move appropriately. For special learning groups such as people with disabilities, specialized spaces and seats can be established for their convenience. Additionally, libraries can integrate environmental aesthetics in space design, using different theme styles for scene layout to present different cultural characteristics in each space, providing users with more choices. On the basis of meeting rigid space needs, aesthetic colors and cultural heritage can be added through cultural relic displays and calligraphy decorations.

(3) **Establish work-rest combined space service scenarios.** Since target users of library space reservation services are mainly research and exam preparation groups, libraries can establish WeChat learning groups for different target groups through WeChat official account service platforms, extending from online discussion and knowledge sharing to offline face-to-face communication. Specialized learning spaces can be set up according to different group needs to create a collaborative learning atmosphere. Meanwhile, libraries can appropriately build leisure and entertainment spaces, allowing users to relax, inspire, and cultivate their temperament through leisure and entertainment activities such as famous music appreciation, classic film and television appreciation, and cultural and creative works exhibitions, establishing work-rest combined space service scenarios that bring users pleasant and comfortable service experiences.

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Author Contributions: Zhao Yang: Proposed the research topic and ideas, designed and improved the research plan, wrote and revised the paper. Ban Jiaojiao: Participated in research plan design, collected and analyzed data, wrote the paper.

Abstract: [Purpose/significance] By drawing the user experience map of mobile libraries, the internal relationship among mobile library service system, service situation, and user experience is effectively revealed, which provides an important basis for service optimization based on user experience. [Method/process] Based on the detailed description of the user experience map drawing process, this paper takes the library space reservation service based on WeChat official account as an example. Through the user experience map, the user's interactive behavior, real thoughts, and emotional changes in the whole service process are visually displayed, and the user experience is accurately measured and its influencing factors are revealed from a global perspective. [Result/conclusion] According to the drawing of the mobile library user experience map, user pain points and service opportunity points are found, and specific optimization strategies are proposed from three aspects: service process, service function, and service environment, which can provide new ideas and methods for the research of mobile library user experience and service optimization.

Keywords: user experience map; mobile libraries; space reservation service; optimization strategy

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