Application of Cognitive Psychology Theory in University Library Website Layout Design: A Case Study of the Redesign of Peking University Library's English Portal (Postprint)

Authors: Wu Yue, Cui Haiyuan, Zhang Yuanjun, Nie Hua

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Abstract

[目的/意义] The rapid development of Internet technology continuously influences the ways and means through which users access information, requiring library websites to shift from being "content-centered" to "user-centered." Understanding the cognitive mechanisms by which readers acquire and process information during website visits is essential for improving library website usability and ensuring the sustainable development of library websites.

[方法/过程] This study conducted an online survey of 60 top-ranked university library websites both domestically and internationally. Guided by cognitive psychology theory, we analyzed the layout design characteristics of these websites. Additionally, using the redesign of Peking University Library's English portal as a case study, we present the trade-offs and considerations involved in applying cognitive theory to the portal's redesign.

[结果/结论] We ultimately distilled four principles for layout design: design for the first screen, design for scrolling, design for categorization, and design for users, with the aim of providing reference for other libraries undertaking website redesign projects.

Full Text

Preamble

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—A Case Study of the Peking University Library English Portal Redesign

Wu Yue, Cui Haiyuan, Zhang Yuanjun, Nie Hua
Peking University Library, Beijing 100871

Abstract

[**Purpose/Significance**] The rapid development of internet technology continues to transform how users access information, requiring library websites to shift from a "content-centered" approach to a "user-centered" orientation. Understanding the cognitive mechanisms through which readers acquire and process information during website visits is crucial for improving library website usability and ensuring sustainable development.

[**Method/Process**] This study conducted an online survey of 60 top-ranked university library websites both domestically and internationally, analyzing their layout design characteristics under the guidance of cognitive psychology theory. Using the Peking University Library English portal redesign as a case study, the paper discusses the trade-offs and considerations involved in applying cognitive theory to the redesign process.

[**Results/Conclusion**] The study identifies four key principles for layout design: designing for the first screen, designing for scrolling, designing for categorization, and designing for users. These principles can serve as a reference for other libraries undertaking website redesign projects.

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1. Research Significance and Current Status

Library website users are more goal-oriented than typical website visitors, usually accessing library sites with specific tasks in mind (such as searching for resources/books, checking opening hours, or following event information). This makes library website construction fundamentally different from general internet website development, requiring greater focus on user goals and the cognitive psychology underlying task completion. Designing library websites based on user cognition represents a user-centered approach that can effectively improve usability and enhance overall user experience.

In China, cognitive psychology theory has been applied by some researchers to website interface design. Zhao Nan applied cognitive characteristic theories to mobile application design for language education, Guo Yanyan applied cognitive load theory to research-based learning website design, and Zhang Ning applied distributed cognition theory to public information equipment interface

design. However, domestic university library website design remains primarily content-focused and has not yet shifted to a user-centered approach grounded in cognitive psychology theory. Therefore, this study examines library website layout paradigms from the perspective of user cognition.

Cognitive psychology is a psychological science that studies the mental processes underlying cognition and behavior. The information processing model, which views the human brain as a complex computer system, represents the mainstream approach in modern cognitive psychology. This perspective considers cognition as information processing, encompassing the entire process of encoding, storing, and retrieving perceptual input.

2. Cognitive Psychology Theories

2.1 Short-Term Memory

Short-term memory is the core of the brain's information processing system, involving the acceptance of new information from the external environment, its processing and storage in long-term memory, and the retrieval of existing information from long-term memory. G. A. Miller's 1956 research established that regardless of data type, short-term memory can only hold approximately seven units of information. To enable the brain to process large amounts of information within short-term memory constraints, organizing information into chunks is essential. Chunking combines several units into meaningful, larger information units during processing. Peng Quan et al. (2001) demonstrated the significance of short-term memory for human-computer interface design in application systems, while S. Sternberg's 1969 research showed that in short-term memory retrieval, larger memory sets require proportionally longer reaction times for information access.

2.2 F-Shaped Browsing Pattern

The F-shaped browsing pattern was identified by renowned website usability expert J. Nielsen in his 2006 "Eye Tracking Study." Through extensive user testing, Nielsen demonstrated that most users browse webpages in an F-shaped pattern: beginning with a horizontal scan across the top, then moving down slightly for a shorter horizontal scan, and finally conducting a vertical scan along the left side of the page. This pattern underscores the critical importance of the first screen in webpage design.

2.3 Gestalt Theory Design Principles

"Gestalt" is a German term referring to configuration, organization, or layout, and represents a scientific explanation for humans' subconscious grouping behaviors during observation. Gestalt theory posits that eye-brain interaction is a continuous process of organizing, simplifying, and unifying visual elements to create comprehensible, harmonious wholes. This theory yields several princi-

ples applicable to layout and interface design, including similarity, proximity, continuity, closure, and simplicity.

3. Summary and Analysis

This analysis focuses on homepage page elements and layout length in webpage design for digital library websites. The survey, initiated in September 2016, examined 60 university library websites: 30 from top 50 USNEWS-ranked institutions and 30 from top 50 Chinese institutions ranked by the Chinese University Alumni Association Network.

Among the 30 foreign library portals surveyed, 53% featured more than five page elements on their homepage, and 83.3% employed scrolling layouts that extended beyond the first screen. In contrast, among the 30 domestic university library portals, 63.6% featured seven or more page elements, and 86.6% confined their layout to a single screen.

3.1 Designing for the First Screen

The "first screen," or "Above the Fold" in English terminology, refers to website content immediately visible within the browser window upon initial access without scrolling. This concept originates from the newspaper industry, where papers are folded in half, presenting only the content above the fold line to readers first—a critical area for attracting attention and driving sales. In web design, the fold represents the lower edge of the visible area upon initial page load.

Designing for the first screen means optimizing this space to display the most important content, not cramming as much information as possible into it. The survey reveals that domestic university libraries place great emphasis on the first screen, with 86.6% adopting single-screen designs that require no mouse scrolling. However, they overlook the limitation of short-term memory capacity, making it difficult for users to locate target information on overloaded pages. Most domestic library websites place too many page elements on the first screen, exceeding the limit of seven items suggested by short-term memory research. Such designs attempt to provide excessive functionality within limited space, creating visual noise that increases cognitive load. According to short-term memory retrieval theory, more browsing items lead to proportionally longer reaction times, impairing user comprehension, slowing task completion, and ultimately degrading user experience.

3.2 Designing for Scrolling

Domestic university library website design is constrained by first-screen dimensions, often due to concerns that users will not notice content beyond the initial view and that scrolling negatively impacts usability. In Nielsen's early research, he concluded that only 10% of users would scroll, advising against webpages

longer than screen height. However, his 1997 report already corrected this conclusion, acknowledging that scrolling layouts were viable.

With technological development, screen resolutions for mobile devices, laptops, and desktops have increased dramatically, making the first-screen fold increasingly ambiguous. According to the 2015 Mobile Internet White Paper from the China Academy of Telecommunication Research of MIIT, global mobile phone users reached 6.8 billion in 2014, and China's mobile internet users reached 905 million by April 2015, with mobile phones accounting for 31% and tablets 6.6% of global mobile internet traffic origins. The proliferation of smart mobile devices with varied screen sizes has reshaped user browsing habits. The F-shaped browsing pattern itself demonstrates that scrolling has become an essential user behavior. Users increasingly expect to scroll vertically to explore content along the vertical axis of the "F."

Scrolling layouts can accommodate multiple page elements while avoiding the cognitive burden of overcrowding the first screen. University library websites are information-rich service platforms with multiple roles: providing resource retrieval, showcasing various reader services, and serving as important channels for library announcements. This requires rich page elements to meet functional demands. Cornell University's website demonstrates this approach by arranging commonly used items cleanly in the first-screen area, then using scrolling to present richer content. A 2012 survey of 30 foreign university library websites found only 49% used scrolling layouts; four years later, this proportion had increased by 34.3% to 83.3%, indicating that scrolling design is becoming the mainstream trend in foreign library website design.

3.3 Designing for Categorization

Each module on a website homepage requires a focal point—an area of interest or emphasis that attracts visitor attention, conveys the module's central content, and persuades users to explore further visual information. After categorizing information, websites can apply Gestalt principles to create visual focal points for more efficient communication. The three most relevant principles are similarity, proximity, and simplicity, which fundamentally involve targeted visual design for categorized website information. Many foreign university library websites employ these principles.

3.3.1 Similarity Principle The similarity principle emphasizes content grouping. Elements with common characteristics (shape, size, color, etc.) are easily organized together in human cognition. Stanford University Library's website design utilizes this principle by organizing different information types with distinct shapes, borders, and colors, such as displaying exhibition events as gray-bordered calendar items with time, title, and brief descriptions [Figure 2: see original paper].

3.3.2 Proximity Principle The proximity principle emphasizes spatial relationships. Elements with smaller gaps between them are more easily grouped together. Yale University Library's website arranges categorized information with minimal gaps, visually distinguishing three major content blocks: research, services, and opening hours [Figure 3: see original paper].

3.3.3 Simplicity Principle The simplicity principle emphasizes minimalism. Princeton University Library's website highlights the primary function of library websites—searching—by using a large, eye-catching photograph as a background within the first screen and featuring only a "resource search" function [Figure 4: see original paper].

4. Trade-offs and Practice in Peking University Library's English Portal Redesign

University library websites serve not only as image windows for library promotion but also as highly usable information retrieval tools assisting readers in resource discovery. Peking University Library's old English portal, released in 2009, featured a crowded single-screen layout that could not adequately meet English users' usability requirements in the new information environment. To better align with evolving user behavior patterns and improve website usability, the library undertook a comprehensive redesign in 2016.

While website redesign poses minimal challenges for younger readers who quickly adapt to new interfaces, it can inconvenience many senior faculty or humanities scholars with limited internet experience. The new design had to maximize usability while keeping pace with design trends and accommodating established user habits to guide adaptation to the new layout. One of the most difficult decisions in the phased redesign process was layout selection—carefully weighing whether to maintain the original single-screen design or break through first-screen limitations. After thorough research into relevant cognitive theories, Peking University Library ultimately selected a scrolling layout [Figure 6: see original paper].

4.1 Designing for the First Screen: Highlighting Key Functions and Services

The new English portal places the most important page elements within the first screen: navigation, tabbed search bars, latest news/resources, recent events, and consultation desks. The design essentially displays all content from the old portal's first screen within the new first-screen area, allowing established users to browse most content without scrolling.

Regarding navigation, the old portal did not display all library resources and services completely but instead made reductions that prevented English users from locating specific information. The new design adopts navigation unified with the Chinese version. However, because English translations require more

width, affecting user experience and aesthetic appeal, the new design separates the navigation into its own space rather than displaying it to the right of the logo. This approach allows navigation to be updated now and in the future without space constraints.

4.2 Designing for Scrolling: Reducing Cognitive Load Through Vertical Expansion

A library website's homepage is as important as a newspaper's front page, but listing all library services and information within the first screen creates overwhelming textual lists that interfere with users' ability to find needed content. Scrolling design extends webpage length, enabling rich content presentation through reasonable layout. In both the first screen and subsequent screens, the new design chunks content to reduce memory units, keeping page elements under seven items per screen. Within the first screen, the design applies Gestalt's simplicity principle and follows responsive web design trends by using a wide, adaptive large image that prominently features the search bar.

4.3 Designing for Categorization

The new design divides the page into three major sections from top to bottom. In the second and third sections, the design fully integrates Gestalt's similarity and proximity principles to organize information visually, leaving substantial white space as gaps to create five distinct blocks: news, image news, popular services/links, and services/resources. This approach provides visual order and reasonable resting points while enabling readers scrolling to the second screen to quickly group closely spaced content for efficient browsing.

4.4 Designing for Users: Guiding Established Users to Scroll

Both Gestalt's continuity and closure principles suggest that viewers mentally complete discontinuous or gapped graphics, visually closing open or incomplete contours. The new design vertically divides the portal into two approximate parts: a search bar area and a text content area below. By displaying only the first part and half of the second part within the first screen, the design leverages viewers' psychological tendency toward continuity and closure. Based on the brain's bottom-up information-driven processing theory and Gestalt's closure principle, users naturally infer that additional content exists below and scroll to explore it.

Conclusion

Through analysis and synthesis of university library website layout design research, application of cognitive psychology theory to examine domestic and international university library website layouts, and integration of Peking University Library's practical experience, this paper summarizes four layout design principles for reference by other libraries undertaking website redesign: design

for the first screen by emphasizing content arrangement and layout without being limited by first-screen constraints; design for scrolling by vertically extending webpage length to enrich portal content; design for categorization by organizing, merging, and grouping website content and applying Gestalt design principles to visually arrange grouped content, thereby reducing cognitive load; and design for users by considering both new and established users' experiences with website redesign and guiding established users to adapt to new interfaces.

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Author Contributions

Wu Yue: Overall writing of the paper, overall design of the English version redesign;

Cui Haiyuan: Revision of the abstract, design consultation and guidance for the English version redesign;
Zhang Yuanjun: Revision of Section 4, front-end implementation of the English version redesign;
Nie Hua: Revision of the full paper, design consultation for the English version redesign.

Library Website Layout Design Study Based on Cognitive Psychology Theory
—A Case Study of Peking University Library English Website

Wu Yue, Cui Haiyuan, Zhang Yuanjun, Nie Hua
Peking University Library, Beijing 100871

Abstract: [Purpose/significance] User-friendly interface has a direct impact on website usability. It's important to study how users think when interacting with a website page. [Method/process] This paper conducted a peer study in 2016 about university library website layout design both at home and abroad, implementing cognitive psychology theories. The paper takes Peking University Library English Website as an example to introduce how to implement related cognitive psychology theories in actual situations. [Result/conclusion] To sum up, the paper gives three suggestions in layout design: design for the fold; design for scrolling; design for grouping; design for users.

Keywords: cognitive psychology, human computer interaction, gestalt, website design, layout design

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