

# Quantitative Analysis of Themes and Sentiment Characteristics in Online Exhibitions of UK and US University Libraries: Postprint

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## Abstract

[Purpose/Significance] Conducting quantitative research on overseas university library online exhibitions from the dimensions of theme and emotion helps to deeply and objectively understand the current status of such exhibitions, which holds important reference significance for the construction and development of domestic university library online exhibitions. [Method/Process] Utilizing LDA-based topic modeling technology, sentiment analysis technology, and web scraping methods, this study conducts quantitative analysis and visual presentation of 2,278 online exhibition contents from 302 university libraries in the United States and United Kingdom, from perspectives such as semantic association and emotional expression. [Results/Conclusion] Online exhibitions of UK and US university libraries demonstrate obvious differences in cultural heritage at the thematic level while simultaneously showing common concern for university construction and development. The time periods of exhibition works emphasize historical development characteristics, and works involving topics such as war, politics, and race possess strong emotional coloring.

## Full Text

### Preamble

#### Quantitative Analysis of Theme and Emotional Characteristics of Online Exhibitions in British and American University Libraries

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**Abstract:** [Purpose/Significance] A quantitative study of foreign university library online exhibitions from thematic and emotional dimensions helps to objectively understand their current status and provides important reference for the development of domestic university library online exhibitions.

[Method/Process] Using LDA-based topic modeling, sentiment analysis technology, and web crawler methods, this study quantitatively analyzed and visually presented 2,278 online exhibition contents from 302 university libraries in the United States and United Kingdom from perspectives of semantic association and emotional expression. [Result/Conclusion] British and American university library online exhibitions demonstrate obvious cultural heritage differences in themes while showing common concern for university construction and development. Exhibition works emphasize historical development characteristics, and works involving war, politics, race and other topics possess strong emotional coloring.

**Keywords:** university library; online exhibition; topic clustering; sentiment analysis **Classification Number:** G258.6; G252 **DOI:** 10.13266/j.issn.0252-3116.2021.20.015

“Culture and Sustainable Development” represents a key component of the United Nations’ post-2015 sustainable development agenda [1]. As an essential part of cultural systems, libraries play an irreplaceable role in maintaining cultural sustainability, with library exhibitions serving as a crucial means for constructing cultural memory and preserving sustainable cultural development. Library exhibitions employ various forms including paper-based and physical carriers as well as digital and information technologies to conduct in-depth excavation and refinement of collection materials, presenting them visually according to semantic relationships among different resources [2]. Academia widely recognizes that library exhibitions promote public interests and social civilization advancement while strengthening collaboration between libraries and museums, archives, schools, and other institutions, thereby consolidating libraries’ pivotal position in social cultural life and academic research [3-4].

Online exhibitions represent a breakthrough transformation in library exhibition services [2, 5]. Consequently, foreign scholars such as K. Leousis and D. Nicholas argue that libraries should actively utilize new media and interactive technologies to excavate and process collection resources, exhibiting valuable materials to break original communication boundaries and provide multi-dimensional displays of knowledge in specific fields [6-7]. Therefore, in-depth research on the theoretical connotations and practical approaches of library online exhibition services proves extremely necessary for deepening and expanding library functional positioning.

## 2 Research Status

University libraries have long served as traditional cultural communication media and venues for exhibitions. As early as 1654, Oxford University Library hosted an exhibition of “manuscripts, medals, and other curiosities” by diarist M. John Evelyn [8], marking the earliest recorded university library cultural exhibition. China’s university library exhibition services began in 1929 when Central University Library held an exhibition of Xu Beihong’s works [9]. In

recent years, domestic and foreign university libraries have organized physical cultural exhibitions with rich themes and vivid forms based on their collection characteristics and social development needs. For instance, Shanghai Jiao Tong University hosted a historical exhibition titled “Li Zhengdao Science and Art Works Exhibition” [9]; Tsinghua University presented a documentary exhibition “Collection of Rare Republic of China Books” [10]; the University of Chicago Library organized a commemorative exhibition titled “A Bold Experiment: The Origins of the Sciences at the University of Chicago” for its anniversary [11]; and MIT Library held a scientific history exhibition “China Comes to Tech: 1877-1931” [2].

With rapid digital and network technology development, university libraries no longer confine themselves to traditional physical exhibitions but instead employ data mining, data visualization, virtual reality, and machine learning technologies to digitize collection resources and present them diversely online [12]. For example, Cornell University Library hosts dozens of online exhibitions on its homepage covering themes closely related to its collections such as university history, biological illustration, economics, and race; Yale University’s Beinecke Rare Book & Manuscript Library offers ten exhibitions exclusively for online viewing, including themes like “Travelers Who Draw” and “Manuscripts in the Palm” [5]. Compared with physical exhibitions, online exhibitions feature richer content and forms, expanding from passive cultural knowledge display to active interaction between exhibition content and audiences, continuously innovating with technological upgrades. Consequently, through deep integration of cultural exhibition content and information network technology, library online exhibitions transform library functions from knowledge collection and exploration to knowledge display and dissemination [13], significantly improving the effectiveness and efficiency of cultural knowledge transmission while better fulfilling libraries’ educational and cultural inheritance functions.

As exhibition practices increase, corresponding theoretical research continues to deepen. Current theoretical research on library exhibition services focuses on the status quo and development of university library exhibitions, foreign university library exhibition practices and experiences, and existing problems and deficiencies [2, 14-16], with physical exhibitions as the primary research object. For example, Wang Zheng used bibliometric analysis software to analyze hotspot themes in foreign library exhibitions, providing detailed introductions to thematic content and typical cases of physical exhibitions in foreign public and university libraries [2]. By contrast, research on university library online exhibitions remains limited, concentrating mainly on foreign university libraries. For instance, Zhao Xueqin et al. analyzed digital humanities projects in top ten American university libraries, addressing digital exhibition of collection information and services while offering targeted suggestions for domestic university library digital construction and exhibitions [12]; Lei Qiang examined online exhibition contents of twenty renowned American university libraries, analyzing differences between physical and online exhibitions [5].

Moreover, current theoretical research on library exhibition services predominantly employs qualitative analysis of development status, lacking data-driven quantitative research and fine-grained thematic studies. Research content typically focuses on individual cases with small sample sizes and limited regional or national scope, without considering cross-regional or cross-national cultural differences. Methodologically, studies over-rely on literature review and questionnaires with strong subjectivity, particularly in online exhibition research. Case studies include the University of Illinois Library's digitization of special collections and online exhibitions [17], Western Kentucky University Library's use of the institutional repository TopSCHOLAR platform to build permanent online exhibitions of special collections [18], while A. Berenbak et al. employed questionnaire surveys to investigate 79 ARL (Association of Research Libraries) member libraries in the United States [19].

Given these circumstances, this study utilized web crawler tools to extensively obtain content from American and British university library online exhibition websites, employing Latent Dirichlet Allocation (LDA) topic modeling technology [20] and sentiment analysis technology [21-22] to investigate hotspot and frontier themes of online exhibitions in American and British university libraries from multiple dimensions, explaining thematic characteristics and emotional features based on regional cultural differences to provide reference for domestic university library online exhibition service research.

### 3 Research Methods

#### 3.1 Data Collection

The acquisition of textual data from foreign university library online exhibitions proceeded in two steps: Using the Bing search engine for domain retrieval on February 2, 2021, with search syntax “insite:lib&edu&exhibit” (United States) and “insite:lib&ac&uk&exhibit” (United Kingdom), followed by screening and deduplication of results; Using crawler tools to extract website content, removing exhibitions with only simple electronic posters while retaining websites with detailed exhibition content featuring both text and images. Through these steps, this study obtained data from 2,278 online exhibition websites across 302 universities in the United States and United Kingdom, including online exhibitions displayed on university library homepages and some early exhibitions archived in the Wayback Machine. Among these, American university libraries contributed 1,957 websites, while British university libraries contributed 321.

#### 3.2 LDA Topic Analysis

This study employed the LDA topic model to conduct thematic analysis of library exhibition works. LDA is an unsupervised machine learning topic modeling technique for textual data [20] that calculates the topic distribution of each document in a dataset and the probability of each word appearing in documents. This study utilized LDA for topic modeling analysis of unstructured

text content obtained through web crawling. LDA can be implemented using Python, including the NLTK natural language toolkit, Stop\_{words} package, Gensim topic modeling package, etc.

The data processing procedure consisted of three steps: Using the NLTK toolkit to segment collected textual data into words; Removing stop words using the stop words package and transforming raw, unstructured text into sparse topic vector expressions using the Gensim package; Visualizing analyzed topics as graphical representations. To determine the optimal number of topics in the text collection, this study used perplexity calculation. Perplexity measures language clustering algorithm models and can enumerate topic numbers through Python, selecting the topic number with minimum perplexity as optimal. Through perplexity calculation, this study determined the optimal topic number as 6, thus setting topic\_{number} to 6 in the LDA model. After text vectorization and stop word processing to convert words into term frequency vectors, 80% of data served as training set and 20% as test set for output arrays.

### 3.3 Fine-Grained Sentiment Analysis

Sentiment analysis refers to the process of analyzing, processing, summarizing, and inferring subjective texts with emotional coloring [21]. British scholar M. Thelwall has repeatedly used lexical methods to predict positive and negative emotional intensity in informetric research [22]. The sentiment analysis principle involves constructing a sentiment analysis corpus from core vocabulary and word stems, with each word assigned positive or negative emotional scores. This method matches word stems from the corpus with words in analyzed texts, assigning scores from -5 to +5 to measure emotional intensity, where positive numbers indicate positive emotions and negative numbers indicate negative emotions. For example, in exhibition works about war, economic recession, and political scandal, “War” scores -2, “Depressions” scores -3, and “Scandal” scores -2, thus sentences containing such words may carry moderate negative emotions; whereas in exhibitions about literature, art, and technology, “Love” scores +2, “Humor” scores +2, and “Prize” scores +2, thus sentences containing such words may carry moderate positive emotions. Additionally, sentences containing booster words like “Great” (+2), “Fine” (+2), “Bliss” (+4), or “Horror” (-3) can enhance or reduce overall emotional intensity.

Sentiment analysis can be classified into word-level, phrase-level, document-level, and other categories based on granularity. This study employed word-level fine-grained methods for emotional text information extraction to identify which specific emotional texts play an emotional guiding role in library exhibitions.

## 4 Research Results

Based on the above analytical methods, this study obtained data from 2,278 online exhibition websites across 302 British and American university libraries, including 1,957 online exhibition works from 279 American universities and 321

works from 33 British universities.

#### 4.1 University Distribution

Table 1 lists the top 10 universities by online exhibition frequency in the United States and United Kingdom. The data shows that American university libraries generally host more online exhibitions than their British counterparts, with the former mostly exceeding 40 exhibitions and the latter showing obvious stratification. Cambridge University Library ranks first with 85 online exhibitions, followed by Oxford University and University of Glasgow, each with over 40 exhibitions, while University of Edinburgh and others range between 13-30 exhibitions, showing more significant gaps.

**Table 1 Top 10 British and American University Libraries by Online Exhibition Frequency**

American Universities	Exhibitions	British Universities	Exhibitions
Cornell University	69	University of Cambridge	85
Yale University	60	University of Oxford	57
Brown University	57	University of Glasgow	51
University of California	51	University of Nottingham	46
University of Chicago	46	University of Wales	45
University of Delaware	45	University of London	42
Duke University	42	Edinburgh University	41
University of Pennsylvania	41	Queen's University	39
University of Virginia	39	Reading University	38
Harvard University	38	Royal College of PE	-

#### 4.2 Thematic Characteristics

To analyze thematic characteristics of each university library's online exhibitions, this study conducted cluster visualization analysis of themes from American and British university libraries, as shown in Figure 1 [Figure 1: see original paper] and Figure 2 [Figure 2: see original paper]. Bubble size indicates word frequency, with TOPIC1-6 sorted in descending order by total word frequency (TOPIC1 largest, TOPIC6 smallest). The figures reveal that American university library online exhibitions concentrate on science and technology, space exploration, history, military and politics, and minority ethnic cultures, with relatively fewer exhibitions on university life and literature. In contrast, British university library online exhibitions focus on urban life, social movements, human rights, history, religion, and military affairs, with less attention to natural sciences, technological inventions, and university life.

Thus, American and British university library online exhibitions show both significant differences and common topics of interest. American university libraries feature very high frequencies of science and technology-related exhibitions, while

British university libraries host more history and religion-themed exhibitions, closely related to each country's historical depth and developmental characteristics. Both countries' university libraries commonly address themes like university life and campus architecture, demonstrating that these topics reflect unique cultural characteristics and historical heritage while evoking audience pride and identification.

### 4.3 Emotional Characteristics

Figure 3 [Figure 3: see original paper] presents sentiment analysis results for British and American university online exhibition content, with gray indicating neutral words, dot patterns indicating positive words, and stripe patterns indicating negative words. The results show that emotional characteristics in both British and American university library online exhibitions are primarily neutral, though American libraries show a higher proportion of neutral words at 73% compared to Britain's 58%. Conversely, British university exhibitions contain a larger proportion of positive words (approximately 25%), while American exhibitions contain more negative words (approximately 20%).

Overall, American university library online exhibitions feature primarily neutral expressions but with stronger negative emotional tendencies; British exhibitions show balanced proportions of positive and negative emotions, with neutral expressions as the main component. Further mining of emotionally colored text and quantitative analysis of each emotional word yielded results shown in Table 2 and Table 3 .

American university library exhibitions concentrate negative emotional words such as "War," "Battle," "Protest," "Crime," "Racism," "Disaster," "Revolution," "Propaganda," and "Disease," consistent with TOPIC3 (American law, history, propaganda, human rights, military, war history) and TOPIC4 (Black, Indian, Latino, minority cultures) in the thematic cluster diagram. Other topics like TOPIC1, 2, 4, and 6 show neutral and positive emotions, with strongly positive words including "Treasure," "Great," "Fine," "Humor," "Celebration," "Romanticism," and "Prize."

In contrast, British university library exhibitions concentrate negative emotional words in "War," "Death," "Battle," "Propaganda," "Controversial," "Protests," and "Crime," reflected in TOPIC1 (urban life, government records, social movements, human rights) and TOPIC3 (military history, war, royal army, World War II) of Figure 2. Other topics (TOPIC2, 4, 5, 6) use more positive words like "Great," "Treasure," "Friend," "Love," "Heroism."

## 5 Discussion

### 5.1 National Cultural Heritage and Historical Development Influence University Library Online Exhibition Themes

This study's quantitative analysis based on topic modeling reveals the significant impact of national cultural heritage and historical development on university library online exhibition themes. With only 245 years of history, the United States became the world's most powerful nation after World War II, with breakthroughs in natural sciences and engineering inventions playing decisive roles. The protagonists of technological innovation are the numerous renowned universities across the country. For example, Harvard University's medical research is world-famous, producing 19 Nobel Prize winners in medicine; the University of Chicago played a major role in the Manhattan Project, producing outstanding physics research talent; and the University of California system is highly influential in life sciences, neuroscience, and mechanical engineering. These universities' profound foundations and strong capabilities in science and technology provide rich source materials for hosting related online exhibitions, making science and technology themes most frequent.

By contrast, Britain is a historically established capitalist power with origins traceable to ancient Roman rule. British universities similarly inherit these ancient historical characteristics, with Oxford, Cambridge, Glasgow, and Edinburgh ranking first, second, fourth, and sixth respectively among the oldest universities in the English-speaking world. Deep cultural heritage and historical accumulation provide British university libraries with numerous ancient and diverse precious historical materials. For example, "Hebrew Manuscripts" covers all aspects of Jewish life from the 13th to 15th centuries; "William Hacke Manuscripts" displays 17th-century pirate William Hacke's manuscript maps. Consequently, British university library online exhibitions most frequently feature themes of culture, religion, and politics. Additionally, the Middle Ages and Renaissance constitute another high-frequency theme, related to European culture's prosperity in Greco-Roman times, decline in the Dark Ages, and regeneration after the 14th century, during which literature, drama, painting, sculpture, and other artistic treasures emerged continuously, providing excellent thematic material for cultural exhibitions.

### 5.2 Campus Culture Construction Display Represents an Important Aspect of University Library Online Exhibitions

Both British and American university library online exhibitions show common interest in university life and campus architecture themes, indicating that beyond displaying cultural and technological information through collection materials, introducing and promoting universities' own construction and development constitutes an important component. As K. Miller eloquently stated, "Visitors enter the future university through the library's front door" [23], illustrating the significance of university library exhibitions in cultural construction. Library

exhibitions greatly help audiences understand university development status, architectural characteristics, and historical heritage, with online exhibitions offering greater selectivity, flexibility, and interactivity than printed materials or campus tours, thus playing an important role in attracting outstanding students and scholars and enhancing universities' social influence and public reputation.

### **5.3 Online Exhibition Theme Emotional Expression Closely Relates to National Cultural and Historical Development**

Emotion represents the most resonant element in exhibition design, with themes responding to social hotspots particularly emphasizing multi-dimensional displays through text, images, and video to evoke emotional engagement and resonance. Interestingly, positive words account for only 8% of emotional features in American online exhibition themes, far lower than the 25% in British exhibitions. This likely relates to painful experiences and cultural reflection from America's long history of warfare and racial conflicts. As a multi-ethnic immigrant nation, racial contradictions have always constituted a core social conflict, making cultural identity conflict an inherent American issue fully reflected in university library online exhibitions. For example, the University of California's exhibition "California Minorities: Parallel Histories and Alternative Voices" uses collection images and historical materials to reveal painful experiences of California minorities during the Gold Rush, World War II, and Vietnam War, employing strongly negative words like "Painful," "War," "Protest," "Anarchy," "Revolt," and "Conflict" to evoke resonance. Duke University's "Representation of African Americans in Film" cleverly uses film resources as an entry point to trace the complex and controversial history of African Americans. These examples demonstrate that thematic and emotional characteristic quantitative analyses complement each other, comprehensively revealing characteristics and connotations of university library online exhibitions across different countries and regions.

### **5.4 Quantitative Analysis Serves as an Important Means for Studying Library Online Exhibition Theory and Practice**

This study's quantitative analysis of 2,278 online exhibition data from 302 British and American university libraries demonstrates that online exhibitions have become a new trend in foreign university libraries' development of collection resources, consistent with theoretical and empirical qualitative research by Lei Qiang, Wang Zheng, Zhao Xueqin, and others. Wang Zheng noted that offline exhibition themes in ten British, American, and Canadian public and university libraries primarily focused on history, art, commemorative activities, science and technology, politics, summaries, and regional culture [2], showing good overlap with this study's results. Lei Qiang analyzed online exhibition services in 20 American university libraries [5], largely matching the top 10 high-frequency exhibition universities identified in this study. Zhao Xueqin et al. found widespread application of data mining, data visualization, virtual re-

ality, and machine learning technologies in digital humanities projects among top 10 American university libraries [12], similar to methods used in this study. Thus, this study's quantitative analysis results show good consistency with previous qualitative analyses but with larger sample sizes, more precise thematic positioning, and more intuitive quantitative analysis. Therefore, applying digital information technologies such as web crawling, LDA, and sentiment analysis to university library online exhibition research demonstrates good feasibility and reliable results, warranting promotion in related research.

### **5.5 Development and Recommendations for Domestic Library Online Exhibitions**

Compared with the thriving development of foreign university library online exhibitions, currently only Tsinghua University Library in China has launched large-scale online exhibition services, showing obvious gaps in both theoretical research and practical application. Nevertheless, domestic museums have accumulated considerable experience in online exhibitions worth emulating. For example, the Palace Museum utilizes Virtual Reality (VR) technology for online exhibitions like "VR Palace Museum" and "Panoramic Palace Museum," constructing a virtual panorama of the resplendent Forbidden City through 3D data collection. The National Museum of China has launched diverse 3D online exhibitions covering both Chinese cultural characteristics and historical development like "The Road to Revival," "Mirrors Through the Ages," and "Tang Dynasty Elegance," as well as Western cultural and artistic features like "Rembrandt and His Era," "The Origin of the Louvre," and "The Arab Road." These successful practices demonstrate that domestic university libraries should fully seize opportunities presented by the data technology wave to digitize, informatize, and network collection resources, designing diverse, characteristic, and diversified exhibition themes tailored to local conditions with positive emotional features aligned with core socialist values, presenting comprehensive displays to the public through entirely new and varied online forms from multiple perspectives. This can not only narrow gaps between domestic and foreign university library online exhibition research and practice but also play an important role in the great historical task of rebuilding national cultural confidence and inheriting national culture. However, achieving these goals requires solving multiple challenges, including digital organization of collection resources, inter-library resource sharing, effective integration of information and network technologies, and introduction and updating of artificial intelligence technologies, necessitating continuous deepening of research and application in theoretical analysis and practical work by domestic university libraries.

## **6 Summary and Outlook**

This study employed topic modeling and sentiment analysis technologies to conduct quantitative analysis of content and emotional characteristics from 2,278 online exhibitions across 302 British and American university libraries from per-

spectives of semantic association and fine-grained sentiment analysis. Results demonstrate that British and American university library online exhibitions exhibit both distinctive cultural heritage and historical development characteristics with emotional color differences, while showing common concern for university construction and development. This represents the first large-scale quantitative analysis study of library online exhibition themes utilizing multiple technologies including web crawling, topic modeling, and sentiment analysis. Its findings help objectively understand the development status of foreign university library online exhibitions and provide reference for constructing and developing domestic university library online exhibitions.

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## **Quantitative Analysis of Theme and Emotional Characteristics of Online Exhibitions in British and American University Libraries**

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**Abstract:** [Purpose/Significance] This paper makes a quantitative study of the online exhibitions of foreign university libraries from the theme and emotion dimensions, which not only helps to understand the current situation and development trend of the online exhibitions of foreign university libraries, but

also has important reference for the construction and development of the on-line exhibitions of domestic university libraries. [Method/Process] Using LDA, sentiment analysis technology and Web crawler method, the present study quantitatively analyzed and visually displayed the semantic association, emotional expression of 2,278 webpages regarding online exhibitions of 302 British and American university libraries. [Result/Conclusion] The results show that the online exhibitions of British and American university libraries not only have obvious cultural heritage in the theme, but also show common concern for the construction and development of universities. They pay attention to the historical development characteristics in the age of the exhibition works, and have strong emotional characteristics of the works involving war, politics, race and other topics.

**Keywords:** university library; online exhibition; topic clustering; sentiment analysis

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

*Source: ChinaXiv — Machine translation. Verify with original.*