Challenges and Countermeasures for Remote Services of Electronic Resources During the COVID-19 Pandemic: Postprint

Authors: Xiong Yongjun, Li Zhe, Chen Chunying

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Abstract

[Purpose/Significance] This study addresses the new challenges faced by university libraries in providing remote access to electronic resources during the pandemic prevention and control period, offering actionable methods to effectively enhance remote service capacity and efficiency. [Method/Process] Through investigation of university practices and literature, this paper analyzes the strengths and weaknesses of six remote service methods for electronic resources, examines the challenges confronting electronic resources remote services in the pandemic context from four dimensions—technology, services, resources, and librarians—and proposes corresponding strategies. [Results/Conclusion] Off-campus remote services for electronic resources will feature the coexistence of multiple methods, with federated authentication access showing the greatest potential. In their cooperation and strategic negotiation with database vendors, libraries should prioritize users' rights to access resources off-campus. Following this pandemic, libraries' capabilities in providing remote access to electronic resources will be further enhanced.

Full Text

Preamble

Challenges and Countermeasures for Electronic Resources Remote Services During the COVID-19 Pandemic

Xiong Yongjun, Li Zhe, Chen Chunying Central South University Library, Changsha 410083

Abstract: [Purpose/Significance] In view of the new problems faced by university libraries in providing remote services for electronic resources during the

COVID-19 pandemic, this paper provides reference methods for effectively improving remote service capabilities and efficiency. [Method/Process] Based on investigations of university practices and literature, this paper analyzes the advantages and disadvantages of six remote service methods for electronic resources, explores the challenges faced by electronic resources remote services under the pandemic from four elements—technology, service, resources, and librarians—and proposes corresponding countermeasures. [Result/Conclusion] Multiple remote service methods will coexist for off-campus access to electronic resources, with federated authentication showing the most potential. In cooperation and negotiation with data providers, libraries should attach importance to users' rights to access resources off-campus. This pandemic experience will further improve libraries' remote service capabilities for electronic resources.

Keywords: pandemic prevention and control period; university library; electronic resources; remote service

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In early 2020, a sudden outbreak of COVID-19 swept the globe. To prevent the spread of the epidemic to schools, university winter vacations were extended. On February 7, the Ministry of Education held a national video conference on epidemic prevention and control in the education system, requiring universities to organize and manage online teaching during the pandemic to achieve "suspended classes but continued teaching and learning," and to accelerate scientific research efforts [1].

University libraries provide literature resources to support teaching and research. During the pandemic, although physical libraries were closed, electronic resources services continued. However, the geographical locations of both service providers (librarians) and service recipients (users) changed, shifting from on-campus to off-campus services. Resources were provided primarily through electronic formats, and librarians served users through online platforms. In this new situation, the primary task for libraries was to utilize their human resources, collections, and technology to enable all off-campus users to access literature resources conveniently and efficiently. Consequently, libraries' remote service capabilities and efficiency faced new challenges.

2. Survey of Electronic Resources Remote Services in University Libraries

This study surveyed 18 representative university libraries at home and abroad, focusing primarily on domestic institutions while including foreign ones. The survey covered China's seven major regions (Northeast, North China, Central China, South China, East China, Southwest, and Northwest), with 2 institutions selected from each region, plus 4 foreign institutions. Given that technology and service are the key aspects of electronic resources remote services, the survey

focused on these two dimensions. The investigation was conducted through library portals and WeChat official accounts, with results presented in .

The technical aspect examined the remote access technologies adopted by each university library. The service aspect investigated how libraries organized and delivered information related to electronic resources remote services, such as off-campus access guides, user registration and authentication resources, temporary free resources, and real-time online consultation services. The survey also assessed the concentration and integration of published information, as well as the real-time nature of consultation services. Concentration referred to whether information related to remote services was presented centrally, while integration referred to whether access points and operation methods for various remote services were integrated with library database navigation and other systems.

3. Analysis of Electronic Resources Remote Service Methods

Based on the survey and relevant literature, university library electronic resources remote service methods can be summarized into six categories: traditional network document delivery, VPN virtual private network, software proxy services, user registration and authentication, federated authentication, and temporary open access services. Each method has its own advantages and disadvantages.

3.1 Traditional Network Document Delivery Service

Users submit document requests through online document delivery systems, and librarians obtain and deliver the documents via the system or email. Major systems include globally recognized services such as the British Library Document Supply Centre's (BLDSC) system and the Online Computer Library Center's (OCLC) ILLiad system, as well as domestic services like CALIS, NSTL, and CASHL [2]. Document delivery has been practiced in libraries for many years with mature technology and management. However, this method involves heavy workload, lacks real-time capability, has copyright restrictions, requires inter-library cooperation, and incurs certain costs. Document delivery generally addresses users' urgent needs for difficult-to-obtain literature, particularly resources not purchased by their institutions.

3.2 VPN Virtual Private Network

VPN technology establishes a private network on a public network, converting users' IP addresses to campus IPs and providing remote users with a low-cost, high-efficiency method to access campus resources. There are two types: traditional VPN and WebVPN. Traditional VPN requires client installation with complicated configuration, high terminal requirements, and poor compatibility. WebVPN requires no client installation and offers better compatibility, but only supports web-based applications, not client/server applications [3]. The survey

shows that VPN is widely used in renowned university libraries at home and abroad, enabling users to securely and conveniently access most library electronic resources off-campus.

3.3 Software Proxy Services

This method uses URL rewriting or redirection technology to redirect off-campus resource requests to proxy servers deployed on campus [4]. The remote access system products based on this approach are mature and widely used in libraries. Universities in Europe and America commonly use HTTP proxy and EZProxy, while Chinese universities primarily use systems such as Yirui, Yangge, and Chuangwen. HTTP proxy requires user configuration and is somewhat complicated. Software proxy limitations include complex and frequently changing URL rewriting rules that require technical expertise to maintain, lack of support for client/server applications, incompatibility with some databases (e.g., SciFinder), and susceptibility to excessive downloading of popular databases (e.g., CNKI, Web of Science) on proxy servers.

3.4 User Registration and Authentication

Commercial databases purchased by university libraries are generally IP-controlled for on-campus use. Some data providers offer remote access through account registration and activation. Personal user accounts typically require an institutional email address, and users must register and activate their accounts on campus before off-campus use. The advantage is that registered users can access databases and their value-added services anytime, anywhere without barriers. The disadvantage is that users must register and activate accounts for each database of interest. Many well-known commercial databases provide this service, such as ScienceDirect, SpringerLink, and CNKI. In the early stages of the pandemic, when remote service capabilities were insufficient, many Chinese university libraries collected and organized registration-authentication resources and published them on their websites for off-campus users.

3.5 Federated Authentication

This authentication technology shares user identity information across heterogeneous systems and identity platforms, enabling users to securely and trustworthily access resources across systems, networks, and domains [5]. Federated authentication features unified user identity information, single sign-on, and access to numerous data provider databases, addressing the limitations of registration-based authentication. Representative solutions in libraries include Athens and Shibboleth.

Athens is a network database login management project initiated by the UK Department for Education in 1996 and has become the de facto standard for resource utilization in UK education and health departments [6]. Early Athens

required user identity information registration, while its second-generation product, OpenAthens, adopts distributed authentication, integrating authentication modules with institutional local systems [7]. Currently, numerous resource providers and institutions worldwide participate in the Athens project [8], primarily covering foreign resources.

Shibboleth is a system for authenticating and authorizing institutional members to access shared resources, an open-source sub-project of the Internet2 initiative [9]. In China, CERNET Authentication and Resource Sharing Infrastructure (CARSI) provides local authentication services based on Shibboleth, supporting integration with institutional unified identity authentication systems and enabling access to numerous connected resources [10]. During the pandemic, as domestic resource providers such as CNKI, Wanfang, and VIP joined CARSI, the number of participating Chinese university libraries increased dramatically.

However, OpenAthens and Shibboleth federated authentication methods have usability issues, requiring users to locate their institution among numerous options and repeat authentication for different resources. To address these poor user experience issues, STM and NISO launched the RA21 experimental project in 2016 to explore best practices for resource access federation, publishing recommendations for improving institutional users' access to information resources in June 2019 [11].

3.6 Temporary Open Access Services

This is a temporary emergency measure adopted by resource providers during specific periods, offering free access to their resources to libraries or the public. Examples include data providers offering temporary institutional public accounts or opening databases to the public free of charge for a limited time.

To address poor user experience in remote access, some universities have developed practical remote service tools, such as browser plugins MyLOFT (provided by iGroup) and Lean Library (provided by SAGE). After installation and registration, users can access library databases and manage their literature anywhere using these tools combined with campus proxies. Shibboleth authentication also employs WAYFless links to help users log in quickly, skipping intermediate steps such as institution selection.

4. Challenges Faced by Electronic Resources Remote Services During the Pandemic

During the pandemic, changes in both internal and external library management and service environments presented new challenges for electronic resources remote services, primarily in technology, service, resources, and librarians.

4.1 Technical Support Capacity

The technical support capacity for electronic resources remote services became a major challenge when facing large numbers of off-campus users. This capacity is manifested in three aspects: First, whether all library electronic resources technically support remote access. The survey found that in the early stages of the pandemic, most Chinese university libraries used only a single remote service system, primarily VPN or proxy methods. However, no single off-campus access method is suitable for all databases—for example, the SciFinder database supports VPN but not software proxy. Therefore, the singularization of remote service systems resulted in insufficient service guarantee capabilities. Second, systems could not support large-scale concurrent user access, either due to libraries or systems limiting maximum concurrent users, or only allowing faculty access. Third, remote service systems had low service efficiency, with system resource congestion, decreased stability, and slower response times during large-scale off-campus access. For example, Central South University Library's remote service uses the Yirui remote access system, which normally has fewer than 500 concurrent off-campus users. During the early pandemic period, concurrent users quickly exceeded 500, with CPU load, memory usage, and network traffic all running at high levels, making the system's capacity and efficiency insufficient to support off-campus services.

4.2 Service Convenience and Efficiency

During the pandemic, users shifted from on-campus to off-campus resource access. Many users were unfamiliar with methods and procedures for accessing electronic resources off-campus and hoped for timely solutions when encountering difficulties. Meanwhile, librarians also provided services remotely from home. The efficiency and convenience of libraries' information promotion, consultation, and document delivery services faced new challenges.

In terms of information promotion services, including information organization and dissemination, libraries needed to organize and promote information such as off-campus access guides, temporary free resources, and registration-authentication resources. During the pandemic, there was urgent demand for teaching digital resources such as electronic textbooks and reference materials. The survey found that many libraries had issues with incomplete, scattered, and untimely organization and promotion of remote service information, causing inconvenience for users.

In terms of consultation services, during the early pandemic period, most users were accessing library resources off-campus for the first time and were unfamiliar with remote service resources and systems, or the systems themselves had faults. Common issues included remote login account problems, certain special databases not supporting off-campus access, and browser compatibility issues, leading to increased consultation workload and difficulty meeting users' timeliness requirements.

In terms of document delivery services, users' difficulty in obtaining literature off-campus, urgent needs for materials not purchased by the library, or certain databases not supporting off-campus access all increased pressure on document delivery services.

4.3 Resource Availability and Off-Campus Accessibility

During the pandemic, the network location of service recipients (users) changed from the campus IP range to off-campus networks, while library electronic resources were licensed for on-campus IP ranges. Resource availability and off-campus accessibility became another challenge.

Resource availability refers to whether resource providers offer stable and reliable services, whether libraries can monitor resource accessibility in real time, and whether problems can be detected and resolved promptly, which directly affects user evaluation of library services.

Off-campus accessibility refers to whether library resources technically support off-campus access and whether licenses permit users to access resources off-campus. Technically, a single remote service method cannot satisfy off-campus access to all resources. In terms of licensing, based on Li Jia et al.'s [12] investigation of 28 database license agreements in DRAA consortium procurement: (1) Regarding database usage methods, some databases prohibit licensees from using proxy services to access licensed resources; (2) Regarding document delivery, 32.1% of databases allow print document delivery but prohibit electronic document delivery, such as Nature, Emerald, and CNKI, while 25% have no provisions on document delivery, such as LexisNexis, Wanfang, and VIP.

Thus, many library databases provide services without clearly defining users' off-campus access rights. Libraries have not paid sufficient attention to negotiating off-campus access rights and methods during database procurement, leaving users' rights to access resources off-campus inadequately protected.

4.4 Librarians' Online Service and Collaboration Capabilities

In the pandemic context, with both resources and users online, large-scale off-campus use of library electronic resources challenged librarians' online service and collaboration capabilities.

Serving users online requires librarians to provide literature support services from home using networks, computers, and mobile devices, demanding higher professional competence. At least four types of professional capabilities are required: (1) Information consultation librarians familiar with various databases; (2) Technical librarians with high-level skills to maintain system stability and handle failures promptly; (3) Network promotion librarians capable of using new media for resource promotion; (4) Resource guarantee librarians who can communicate and coordinate effectively with data providers to ensure resource availability and off-campus accessibility.

Under normal electronic resources management and service scenarios, librarians work together in the library, facilitating communication and coordination. During the pandemic, librarians worked remotely from home, making communication, collaboration, team division, and efficient operation particularly important for online literature support services for large numbers of off-campus users.

5. Countermeasures for Electronic Resources Remote Services During the Pandemic

5.1 Technically Enhancing Remote Service System Capacity and Efficiency

To address insufficient capacity and efficiency of remote access systems for large-scale user demand, technical strategies should focus on expanding remote service methods and improving system performance.

In expanding remote service methods, a single method cannot support remote services for all electronic resources; a multi-method coexistence model is advisable. The surveyed universities adopted at least two or more methods, a common practice among foreign libraries. Domestic libraries such as Tsinghua University, Shanghai Jiao Tong University, and Wuhan University simultaneously provide VPN, software proxy, and federated authentication for remote resource access. Among these methods, federated authentication based on Shibboleth and Athens technology is gradually replacing registration-based authentication. With major domestic resource providers such as CNKI, Wanfang, and VIP joining CARSI, and extensive support from foreign electronic resource databases, CARSI authentication is more effective and convenient than registration-based authentication for universities with unified identity authentication systems, reducing pressure on existing VPN or software proxy services.

Technically enhancing user experience includes adopting browser plugins such as MyLOFT (used by Tsinghua University and Lanzhou University libraries) and Lean Library (used by Harvard University library), which facilitate remote resource access and management after installation and registration. Tsinghua University Library also uses WAYFless links in Shibboleth authentication to help users log in quickly, skipping institution selection steps.

In improving remote service system performance, libraries should negotiate with software providers to temporarily increase maximum concurrent user limits and upgrade server performance. Well-resourced libraries can prepare backup remote service systems. For example, Central South University Library expanded its remote service system from 8 to 32 CPUs and increased JVM virtual memory from 8G to 16G, enabling 1,000 users to access resources simultaneously and efficiently, while preparing an identical backup system for activation when concurrent users exceed 1,000.

5.2 Carefully Organizing Remote Service Information and Conducting Multi-Channel Promotion

The primary goal of information promotion services is to help as many users as possible understand how to access library resources remotely. Therefore, libraries must carefully organize remote service information and conduct multi-channel promotion.

Information organization should include off-campus access guides, temporary free resources, electronic textbooks and references, and registration-access resources. In the early pandemic period, when remote service capacity was insufficient, many Chinese libraries focused on collecting and organizing registration-authentication resources. The survey found that foreign libraries particularly emphasized temporary free resources, collecting numerous such resources and expressing appreciation for data providers' generosity during the public crisis. Foreign libraries also paid special attention to organizing teaching resources.

In information dissemination, pandemic-related information was often scattered, making it difficult for users to discover and access. Therefore, concentration and integration of published information are crucial. For example, Tsinghua University Library centrally published resource service guides through a special webpage including announcements, information services, off-campus access, and electronic references [13], while integrating remote service methods and operation guides into database navigation, enabling users to see at a glance which remote services each database supports. University of Science and Technology of China Library concentrated remote service information on a single page with continuous updates at the top. Foreign libraries considered not only concentration and integration of remote service information but also integration with third-party resource discovery systems (such as Google).

For information promotion, common channels include: (1) establishing special pandemic resource service websites on library homepages; (2) publishing promotion information on school portal announcement sections; (3) releasing promotion information on library or school WeChat official accounts; (4) forwarding resource promotion information through social tools such as WeChat, Weibo, or QQ; and (5) using online live streaming platforms such as WeChat Live, QQ Live, and Douyin to conduct training and resource promotion for remote electronic resource services.

5.3 Actively Cooperating and Negotiating with Resource Providers to Ensure Resource Availability and Off-Campus Access

Ensuring resource availability and users' off-campus access requires proactive cooperation and negotiation with data providers to guarantee stable database operation and secure more off-campus access rights.

Regarding resource availability, libraries should ensure stable system operation for normal searching, browsing, and downloading. Beyond technical guarantees

from data providers, libraries can develop software to automatically monitor database status in terms of access, searching, and downloading, with automatic alerts [14].

Regarding off-campus accessibility, libraries need to: (1) detect which databases support off-campus access and which methods they support, as Tsinghua University Library did by comprehensively reviewing and displaying supported methods in database navigation during the pandemic; (2) negotiate off-campus access rights with data providers. Zhang Lijuan et al. [15] suggested that libraries should explicitly specify document delivery methods, VPN services, and remote service methods in database procurement contract templates to expand usage scope and better align with domestic university library users' habits. In practice, many data providers opened off-campus access permissions during the pandemic, with several types of rights available for negotiation:

(1) Data providers offering user email registration and activation for off-campus access. For example, Elsevier allows "institutional personal email" registration on the ScienceDirect platform for off-campus access to ScienceDirect, Scopus, Reaxys, SciVal, and other platforms; IEEE allows "personal email" pre-registration on campus for off-campus access; SciFinder allows "institutional personal email" pre-registration on campus for off-campus access.

(2) Data providers offering institutional unified accounts or personal temporary accounts for off-campus access. For example, CNKI, SIMO, Choice (Eastmoney), Wisers, and Yuedan Knowledge Base provided temporary or roaming accounts for individuals during holidays; HKMO Academic Full Text, EBSCO foreign language electronic resources, Frontiers Journals, SAGE Research Methods, and other databases provided institutional public temporary accounts during the pandemic.

(3) Data providers opening databases to the public free of charge. For example, Wanfang, VIP, Chaoxing Journals, Tsinghua University Press e-books, SinoMed, National Index to Chinese Newspapers and Periodicals, New Oriental Multimedia Learning Platform, and EPS Data Platform provided free access to society during the pandemic.

(4) Requiring data providers to join CARSI for unified authentication and off-campus access. As of May 19, 2020, 562 Chinese universities had joined or were joining CARSI, with 58 databases connected and launched, including commonly used Chinese databases such as CNKI, Wanfang, and VIP, and commonly used foreign databases such as Web of Science, EBSCO, Elsevier, Springer, Emerald, IEEE, and ProQuest series resources [10].

5.4 Establishing Efficient and Collaborative Online Resource Service Teams

During the pandemic, libraries should demonstrate responsibility and dedication by organizing efficient and collaborative online resource service teams that leverage librarians' professional expertise in information services to provide orderly, professional, efficient, and collaborative literature support for teaching, learning, and research.

In team building, libraries can organize specialized online service teams by service type to enhance capabilities. For example, Tsinghua University Library organized network resource guarantee teams, electronic reference guarantee teams, information technology guarantee teams, information service teams, and promotion teams, with division of labor and collaboration ensuring smooth delivery of services including electronic resources for teaching and research, off-campus access control systems, online consultation, and network services [13]. Tongji University Library similarly organized online service teams by service type for resource access, reference consultation, subject services, and resource acquisition.

Regarding service collaboration and real-time response, during the pandemic, increased workload in user consultation and document delivery services demanded greater timeliness. These resource remote service issues often required librarian collaboration. Traditional consultation methods such as telephone, email, and online messages were insufficient for real-time and collaborative needs during emergency services. Using social tools such as WeChat or QQ proved effective, offering real-time and collaborative capabilities without additional costs. Libraries established "WeChat resource service groups" for teachers and students, while creating "back-office business groups" where dedicated staff collected user inquiries, distributed them to relevant departmental groups for collaborative processing, and provided real-time responses. Many libraries, including Tsinghua University, Xi'an Jiaotong University, and Central South University, implemented WeChat group consultation services during the pandemic.

Electronic resources remote service is a crucial daily library service that became the primary service during the pandemic. Although facing challenges, this experience offers several insights: (1) Electronic resources remote services are diversifying. Each method has advantages and disadvantages, and multiple methods will coexist. Federated authentication will become the most important method for off-campus database access, with good prospects for resource usage analysis, user behavior analysis, and personalized services through its ability to record user access data. (2) In cooperation and negotiation with data providers, libraries should emphasize securing users' off-campus access rights, explicitly specifying off-campus access rights and methods in license agreements. (3) Online social tools and live streaming platforms play increasingly important roles in information consultation and resource promotion, demonstrating back-office collaboration, front-office real-time response, and service embedment in

user WeChat or QQ groups. (4) This pandemic experience will significantly improve libraries' off-campus remote service capabilities and efficiency, and promote standardized management of electronic resources remote services in the library profession.

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Abstract: [Purpose/significance] In view of the new problems faced by the remote service of electronic resources in university library during the epidemic prevention and control period, this paper provides reference methods for effectively improving remote service ability and service efficiency. [Method/process] Based on the investigation of university practice and literature, this paper analyzes the advantages and disadvantages of six remote service modes of electronic resources, explores the challenges of electronic resources remote service under the background of epidemic situation from the four elements of library technology, service, resources and librarians, and puts forward countermeasures. [Result/conclusion] There will be many kinds of remote services out of school for electronic resources, and united authentication will have the most potential. In the cooperation and game between the library and the data provider, we should attach importance to the rights of readers to obtain resources outside the school. Through this epidemic situation, the remote service ability of library electronic resources outside school will be further improved.

Keywords: epidemic prevention and control period; university library; electronic resources; remote service

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