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Evaluating the Effectiveness of Digital Library Apps in Reducing Information Access Gaps Among University Students in Peru

Javier Quispe Gutiérrez[1]

[1] National University of Trujillo, Trujillo, Peru

Correspondence: Javier Quispe Gutiérrez, National University of Trujillo, Trujillo, Peru.

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Abstract

The increasing reliance on digital library applications in higher education has significantly reshaped how university students in Peru access academic resources. While digital libraries provide on-demand access to scholarly articles, e-books, and research databases, disparities in technological infrastructure, digital literacy, and institutional policies continue to affect their effectiveness in bridging information access gaps. This study evaluates the impact of digital library applications on university students in Peru, examining accessibility, usability, and engagement patterns across urban and rural institutions. Through surveys, usage analytics, and case studies, this research highlights the key advantages of digital libraries, including enhanced search efficiency, remote accessibility, and AI-driven research support, while also identifying persistent challenges such as connectivity limitations, complex user interfaces, and digital literacy gaps.

Findings indicate that urban students benefit more from digital library platforms due to better internet access and institutional support, while students in rural regions continue to rely on traditional libraries due to infrastructural constraints. The study also explores best practices for increasing student engagement, including faculty integration of digital resources, digital literacy training, and mobile-friendly platform enhancements. Finally, recommendations for policy interventions and technological innovations, such as low-bandwidth digital access solutions and AI-powered academic assistants, are proposed to improve digital library utilization. The study concludes that while digital libraries have great potential to enhance information accessibility, their effectiveness remains contingent on infrastructure development, institutional adoption strategies, and student training programs.

Keywords: digital libraries, higher education, Peru, information access gap, digital literacy, university students, academic resources

1. Introduction

The digital transformation of higher education in Peru has significantly altered how students access academic resources, with digital library applications playing a central role in this shift. As universities integrate cloud-based repositories, AI-enhanced search systems, and mobile-friendly academic databases, these digital libraries present a cost-effective and scalable alternative to traditional physical collections. However, their effectiveness depends on internet infrastructure, institutional investment, and digital literacy levels. Universities in major urban centers like Lima have successfully integrated digital platforms into their academic environments, but rural institutions still face significant technological barriers that limit students' access to scholarly materials.

Digital library apps have revolutionized academic research by offering real-time access to peer-reviewed journals, e-books, and institutional archives. Unlike traditional libraries with physical and time constraints, digital platforms allow students to conduct research anytime and from any location. Universities commonly use platforms such as SciELO, Redalyc, and ProQuest, which offer a broad range of academic resources. Additional

features like AI-driven content recommendations, multilingual search capabilities, and cloud storage further enhance the research process, making it more personalized and efficient. Despite these advantages, disparities persist in how students engage with these platforms, largely influenced by university funding, geographic location, and socioeconomic background. The extent to which digital libraries bridge the information gap depends on broadband accessibility, student engagement with the technology, and institutional commitment to integrating these resources into the curriculum.

Significant disparities exist in information access among Peruvian university students, even with the availability of digital library apps. Rural areas face disadvantages due to weak internet infrastructure, low digital literacy, and inadequate institutional support for digital learning tools. While urban students benefit from high-speed broadband and seamless digital access, those in remote regions rely on slow or unstable connections, making it difficult to use digital resources effectively. Socioeconomic factors also contribute, as students from lower-income backgrounds may lack personal laptops or tablets, restricting their ability to engage with digital libraries. Institutional differences further exacerbate the gap, with some universities providing extensive digital platforms and research materials, while others have outdated systems and limited access to online resources.

Table 1. University Internet Infrastructure and Digital Library Access Across Peruvian Regions

Region	Broadband Access (%)	Universities with Digital Library Access (%)	Avg. Internet Speed (Mbps)	Students with Personal Laptops (%)
Lima (Urban)	95%	90%	45 Mbps	85%
Arequipa	78%	70%	30 Mbps	65%
Cusco	60%	55%	20 Mbps	50%
Puno (Rural)	35%	30%	10 Mbps	30%
Amazon Region	20%	15%	5 Mbps	20%

There are clear differences in infrastructure and access across regions. Lima, the country's academic hub, has the highest broadband penetration rate and digital library adoption, ensuring that most students can access resources without major limitations. Secondary urban centers like Arequipa have moderately strong digital library access, but infrastructure constraints still limit widespread adoption. In contrast, rural regions such as Puno and the Amazon struggle with poor broadband connectivity, low digital library integration, and minimal device ownership among students, which significantly hampers access to academic resources.

These disparities highlight the ongoing challenge of ensuring equal access to digital libraries across Peru. While digital platforms hold the potential to reduce information access gaps, the uneven distribution of infrastructure and technological resources prevents all students from fully benefiting from these tools. The following sections will explore the effectiveness of digital libraries in closing these gaps, analyze student adoption trends, examine technological barriers, and propose strategies for improving digital resource accessibility in higher education.

2. Defining the Core Issues

Despite the increasing availability of digital library applications in Peruvian universities, significant challenges continue to hinder equitable access to academic resources. Traditional libraries, once the primary source of scholarly materials, have long been affected by geographic, financial, and institutional constraints. These barriers have carried over into the digital age, where disparities in infrastructure and technological accessibility further widen the information gap among university students.

Access to traditional libraries remains highly dependent on location and institutional resources. Universities in urban areas often have well-stocked libraries with a variety of academic materials, while rural institutions struggle with outdated collections, limited book availability, and fewer academic journals. Financial constraints also play a crucial role, as many universities lack the funding to maintain physical libraries with up-to-date research materials. Moreover, administrative and institutional barriers, such as limited operational hours and bureaucratic borrowing processes, further restrict students' ability to access scholarly content when needed. These challenges have led many institutions to invest in digital library platforms, yet accessibility and engagement with these digital tools remain inconsistent across regions.

Technological infrastructure and internet accessibility are key determinants of how effectively digital libraries can reduce information access gaps. Broadband coverage in Peru varies significantly, with urban regions

enjoying high-speed internet and stable connectivity, while rural areas experience low penetration rates, frequent service disruptions, and slow download speeds. In remote regions such as Puno and parts of the Amazon, students rely on mobile networks with limited data packages, which are often insufficient for downloading large research articles or streaming academic lectures. Universities with well-developed ICT infrastructure can seamlessly integrate digital libraries into their academic systems, but those with limited funding and technological investment struggle to provide stable digital resources to students.

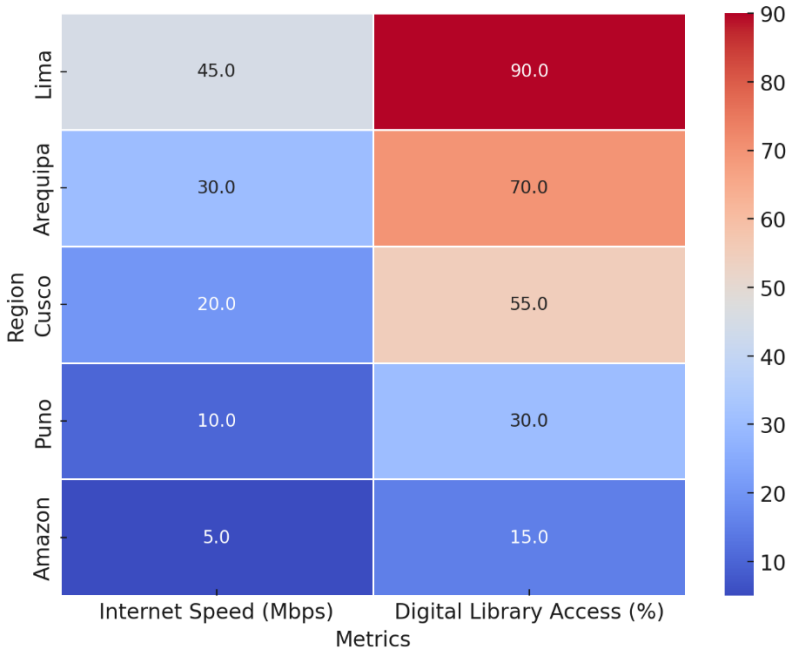

Figure 1. Geospatial Distribution of Internet Speed and Digital Library Availability in Peru

Even when digital libraries are available, student familiarity and engagement with these platforms remain critical concerns. Many students, especially those in low-income and rural areas, lack the necessary digital literacy skills to effectively navigate online databases, perform advanced searches, and differentiate between credible and non-credible sources. Universities that provide digital research training sessions report higher student engagement with digital libraries, whereas institutions that do not prioritize such initiatives see significantly lower adoption rates. Additionally, student engagement is influenced by the usability and interface design of digital library apps. Platforms that offer intuitive search functions, AI-powered recommendations, and mobile-friendly interfaces tend to have higher user retention than those with complex navigation structures or limited search functionalities.

These core issues underscore the ongoing challenges that digital library applications face in achieving their full potential as tools for reducing information access disparities. While technological advancements provide opportunities to enhance accessibility, the digital divide, infrastructure limitations, and disparities in digital literacy remain significant obstacles that must be addressed to ensure that all students, regardless of location or socioeconomic background, can fully benefit from these academic resources. The following section will explore the features and adoption trends of digital library applications, highlighting how different universities integrate these tools into their academic frameworks and the factors influencing student engagement.

3. Digital Library Apps: Features and Adoption Trends

Digital library applications have transformed academic research in Peruvian universities by providing real-time access to scholarly publications, research databases, and institutional archives. These platforms aim to bridge information access gaps, particularly in regions where physical libraries are limited or outdated. Peruvian universities rely on a variety of digital library platforms, ranging from open-access repositories such as SciELO and Redalyc to subscription-based services like ProQuest, JSTOR, and ScienceDirect. Many institutions also maintain their own digital repositories, where students can access theses, faculty research, and locally produced academic work. However, despite the growing presence of these platforms, adoption rates remain inconsistent due to disparities in internet access, technological infrastructure, and digital literacy among students.

The extent to which students utilize digital libraries depends on several factors, including technological accessibility, institutional policies, and individual engagement levels. Universities in Lima and other urban centers benefit from high-speed internet, strong faculty support, and well-integrated digital learning strategies, allowing students to engage more effectively with online academic resources. In contrast, students in rural regions such as Puno and the Amazon face multiple barriers, including unreliable internet connectivity, limited institutional investment in digital resources, and a lack of formal training in digital research methods. These obstacles result in lower adoption rates and reinforce existing inequalities in access to academic materials. While digital libraries hold great potential for closing information gaps, their effectiveness is contingent upon overcoming these structural challenges.

Although digital libraries provide significant advantages in terms of accessibility and search efficiency, traditional libraries still play an essential role in university education. Many students, particularly those in STEM fields, prefer digital platforms for quick access to research papers and scientific journals, while students in the humanities and social sciences often rely on physical libraries for in-depth reading and printed academic texts. A comparative analysis of digital and physical library usage reveals that digital platforms excel in providing real-time search functionalities, AI-powered recommendations, and broad access to international publications, while physical libraries remain valuable for their study spaces, reference collections, and direct academic support. Many students adopt a hybrid approach, using digital libraries for rapid information retrieval and physical libraries for deep research and collaborative study sessions.

The usability and design of digital library platforms also influence adoption rates. Students are more likely to engage with platforms that offer intuitive navigation, AI-driven search recommendations, and mobile-friendly interfaces. Conversely, those who struggle with complex search functionalities or encounter frequent paywalls may become discouraged and revert to traditional library resources. Universities that invest in user training, provide clear search guidelines, and integrate digital libraries into coursework see significantly higher student engagement. Faculty encouragement plays a key role in this process, as professors who incorporate online databases into assignments and class discussions foster a culture of digital research literacy among students. Institutions that offer workshops on advanced search techniques, citation management, and database navigation report greater adoption rates and improved research efficiency.

The success of digital library platforms also depends on institutional strategies that ensure accessibility and engagement. Universities that embed digital library access into their academic programs encourage students to make these resources an integral part of their research workflow. Those that prioritize open-access publishing agreements reduce reliance on paywalled content, making high-quality academic materials available to a broader student population. Mobile compatibility is another critical factor, as a growing number of students access digital libraries through smartphones and tablets. Platforms that support mobile-friendly interfaces, offline access, and personalized research recommendations tend to have higher engagement levels than those designed primarily for desktop use.

Despite the advantages of digital libraries, their effectiveness in closing the information access gap remains uneven across Peruvian universities. While students in well-funded institutions benefit from seamless digital integration, those in underprivileged areas continue to struggle with technological and infrastructural limitations. The next section will evaluate the measurable impact of digital library access on student research performance, academic success, and overall engagement, using data-driven methods to assess whether these platforms effectively reduce disparities in information accessibility.

4. Measuring the Impact on Information Access

Assessing the effectiveness of digital library applications in reducing information access gaps requires a structured evaluation based on key performance indicators. The primary criteria for measurement include accessibility, usability, academic performance support, frequency of use, and search efficiency. Digital libraries are expected to offer advantages in remote accessibility, ease of search, and integration with modern learning methodologies, whereas physical libraries continue to be valued for in-depth study environments and hands-on academic support.

To measure the impact of digital libraries, data collection is conducted through a combination of surveys, usage analytics, and qualitative feedback from students and faculty. Survey data provides insights into student satisfaction, engagement levels, and perceived learning improvements, while usage analytics track login frequency, session durations, and most accessed resources. Additionally, qualitative interviews help understand the challenges faced by students in different regions, particularly regarding digital literacy, search efficiency, and technical constraints.

The effectiveness of digital libraries varies significantly between urban and rural students. Urban students, particularly those in well-funded universities in Lima and Arequipa, benefit from high-speed internet and

institutional support, leading to higher engagement levels with digital resources. In contrast, rural students, especially in Puno and the Amazon region, report frequent connectivity issues, lower digital literacy, and limited availability of subscription-based resources, making them more dependent on physical libraries despite their constraints.

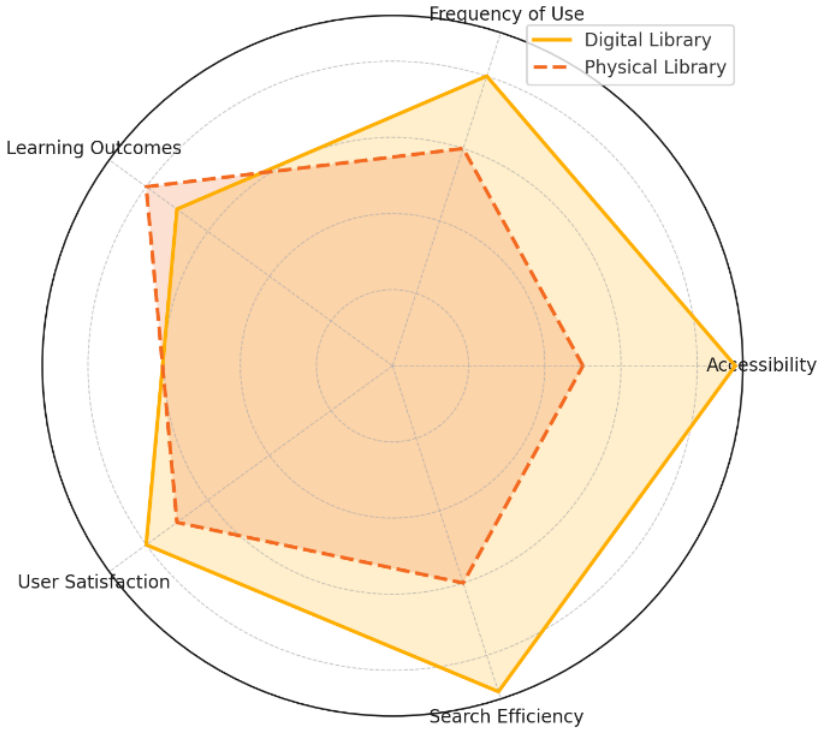

Figure 2. Comparative Effectiveness of Digital vs. Physical Libraries in Academic Performance Support

From the radar chart analysis, digital libraries score significantly higher in accessibility (9/10), frequency of use (8/10), and search efficiency (9/10) due to their ability to provide remote, instant access to vast academic resources. However, physical libraries continue to perform well in learning outcomes (8/10) and user satisfaction (7/10), indicating that many students still benefit from traditional study environments and face-to-face academic support. The gap in accessibility (digital: 9 vs. physical: 5) highlights a key advantage of digital platforms, while the search efficiency discrepancy (digital: 9 vs. physical: 6) suggests that students find it easier to locate resources through AI-driven search functions in digital repositories.

The findings indicate that digital libraries effectively improve information access and research efficiency, particularly for students with reliable internet access and training in digital research methodologies. However, challenges remain in bridging technological gaps for students in under-resourced areas, where infrastructure constraints and a lack of digital literacy limit the full potential of these platforms. The next section will analyze student experiences and feedback, exploring how digital libraries can be further optimized to enhance their effectiveness in academic environments.

5. Key Insights from Student Experiences

Digital libraries have significantly transformed how university students in Peru access academic materials, offering several advantages over traditional libraries. The ability to search for and retrieve research papers instantly has improved efficiency, particularly for students working on time-sensitive assignments or thesis research. Many students appreciate the convenience of digital platforms, which allow them to access a broad range of resources remotely, often without institutional restrictions. This accessibility is particularly beneficial for those in disciplines requiring frequent journal access, such as STEM fields, medicine, and social sciences. Students also highlight features like AI-driven recommendations, multilingual search capabilities, and integrated citation tools as major benefits that enhance research quality.

Despite these advantages, challenges remain in the widespread adoption of digital library platforms. Technological literacy varies significantly among students, with those in well-funded universities receiving more training on effective search strategies and database navigation, while students in underfunded institutions often struggle with filtering relevant content and using advanced search features. Connectivity issues remain a primary

concern, particularly in rural regions such as Puno and the Amazon, where slow internet speeds and unstable connections make it difficult to access large research files or streaming-based academic content. Additionally, some platforms have complex user interfaces, making it difficult for first-time users to efficiently find and download relevant materials. The lack of consistent digital literacy training programs across universities exacerbates these issues, leaving many students underprepared to take full advantage of digital library resources.

Several universities in Peru have successfully integrated digital libraries into their academic frameworks, ensuring higher engagement levels among students. Institutions such as the Pontifical Catholic University of Peru (PUCP) and Universidad Nacional Mayor de San Marcos (UNMSM) have actively promoted digital literacy programs and provided seamless access to platforms like ProQuest and JSTOR through institutional logins and remote access systems. Some universities have developed customized digital repositories, offering faculty-published research papers, student theses, and open-access journals in Spanish to cater to a broader audience. These initiatives demonstrate how institutional commitment to digital learning can enhance student engagement with academic resources.

Table 2. User Satisfaction Metrics for Major Digital Library Apps Among Peruvian University Students

Digital Library App	Accessibility (1-10)	User-Friendliness (1-10)	Content Diversity (1-10)	Overall Satisfaction (1-10)
SciELO	9	8	7	8
Redalyc	8	7	7	7
ProQuest	6	6	9	8
JSTOR	7	7	9	8
Google Scholar	10	9	6	9

The table presents key user satisfaction metrics for major digital library platforms, evaluating them based on accessibility, user-friendliness, content diversity, and overall satisfaction. Google Scholar received the highest accessibility score, given its open-access nature and ease of use, while ProQuest and JSTOR were ranked highly for content diversity but lower in accessibility due to paywall restrictions. SciELO and Redalyc were well-rated among students who rely on Latin American-focused academic content, highlighting their importance in local research environments.

These insights suggest that while digital libraries have greatly improved research efficiency, the digital divide remains a major barrier to equitable access. Universities that provide training, institutional access to subscription-based platforms, and localized repositories report higher levels of student satisfaction. The next section will explore policy recommendations and technological strategies to further enhance digital library utilization and address existing accessibility gaps in Peruvian higher education.

6. Recommendations for Enhancing Digital Library Utilization

Digital libraries have the potential to bridge the information access gap in Peruvian universities, but their effectiveness depends on infrastructure, institutional policies, and student engagement levels. To maximize the impact of these resources, universities, policymakers, and educators must adopt strategic interventions that improve accessibility, reduce technological disparities, and encourage more students to utilize digital library platforms effectively.

6.1 Strategies for Universities to Improve Digital Resource Accessibility

Universities must take a proactive approach in expanding access to digital libraries by enhancing technological infrastructure, institutional support, and academic integration. One of the most effective ways to improve accessibility is by investing in campus-wide high-speed internet networks and remote-access solutions, ensuring that students can connect to digital libraries from home, dormitories, and university facilities. Universities should also prioritize open-access agreements with international publishers to expand the range of freely available research materials, particularly for students in underfunded institutions.

Another critical step is integrating digital library platforms into the university curriculum. Professors should design assignments and research projects that require students to utilize digital libraries, reinforcing the habit of engaging with these platforms for academic purposes. Offering training workshops on advanced search techniques, citation management, and database navigation would further enhance student proficiency in digital research. Universities that have implemented compulsory digital literacy training as part of first-year orientation programs have reported higher long-term engagement with digital libraries.

Additionally, universities can develop mobile-friendly platforms and offline access options to cater to students who may have intermittent internet connectivity, particularly in rural areas. Many students primarily access digital content through smartphones, so ensuring that platforms are optimized for mobile use with downloadable articles, AI-powered search recommendations, and customizable reading interfaces will significantly increase adoption.

6.2 The Role of Policymakers in Bridging Technological Disparities

Government intervention is crucial in ensuring equitable access to digital academic resources, particularly for students in rural and economically disadvantaged regions. Policymakers must prioritize expanding broadband coverage in underserved areas by investing in nationwide fiber-optic infrastructure and public Wi-Fi initiatives. Offering subsidized internet plans for students would further reduce financial barriers to digital learning.

Public funding should also be directed toward university digital resource development, allowing institutions to provide free access to subscription-based journals, e-books, and research databases. A national open-access academic repository could be established to store locally published research, student theses, and faculty articles, reducing reliance on costly international databases. Countries like Brazil and Argentina have successfully implemented open-access education policies, providing a model for Peru to follow.

Additionally, policymakers must implement digital literacy initiatives at the national level. Partnering with universities and technology firms to offer large-scale training programs on digital research methods, cybersecurity, and online academic integrity would empower students to use digital libraries more effectively. These programs could be integrated into public education curricula, ensuring that all students—regardless of location or socioeconomic background—receive adequate digital research training before entering university.

6.3 Best Practices for Increasing Student Engagement with Digital Libraries

Encouraging students to actively use digital libraries requires a combination of awareness campaigns, faculty engagement, and technological enhancements. One of the most effective strategies is leveraging gamification and interactive learning to make digital research more engaging. Some universities have introduced research challenges, digital badge certifications, and leaderboard-based competitions to incentivize students to explore academic databases.

Faculty involvement is another key factor. Professors who actively promote digital library use in their courses create a culture where students see digital libraries as essential tools for learning and research. Encouraging faculty to incorporate digital resources in lecture materials, assignments, and assessments fosters long-term engagement. Universities can further support this by providing faculty development workshops on digital library integration and research-based teaching methods.

Student-led peer mentoring programs have also proven effective. Universities that have established digital research help desks or student ambassador programs—where trained students assist their peers in navigating academic databases—report increased engagement with digital library platforms. Creating online forums, discussion groups, and digital research clubs can also provide students with a collaborative environment for learning how to use digital resources more effectively.

Finally, platform design and usability improvements play a crucial role in engagement. Universities and digital library providers should continuously update search algorithms, AI-powered recommendations, and content categorization features to enhance the user experience. Personalized search suggestions, interactive tutorials, and multilingual support can significantly improve accessibility for students with diverse academic backgrounds.

By implementing these recommendations, universities, policymakers, and educators can bridge the digital divide and ensure that all students—regardless of location or socioeconomic status—can fully benefit from the wealth of knowledge available in digital libraries. The final section will explore future research directions and emerging technologies that could further revolutionize digital academic accessibility in Peru.

7. Future Outlook and Areas for Further Study

As digital education continues to evolve, new technologies and strategic interventions have the potential to further bridge information access gaps in Peruvian universities. While digital libraries have already proven beneficial in expanding academic resources, their full impact remains contingent on technological advancements, equitable accessibility policies, and ongoing research to refine their effectiveness. Future studies should explore emerging trends in AI-driven academic platforms, expanded digital infrastructure in underserved communities, and refinements in digital library engagement models to ensure that these resources reach their full potential.

7.1 Emerging Trends in Digital Education and AI-Driven Library Resources

Artificial Intelligence (AI) is increasingly playing a central role in digital education, and AI-powered library resources have the potential to revolutionize academic research. Many digital library platforms are beginning to

incorporate machine learning algorithms that personalize recommendations based on student reading habits, research topics, and past searches. AI-driven smart search engines can filter the most relevant academic papers, saving students time and improving research efficiency. Additionally, automated citation tools are becoming more advanced, reducing errors and enhancing academic integrity in student research.

Another major development in digital education is the integration of Natural Language Processing (NLP) tools in digital libraries. These tools allow multilingual searches, real-time text summarization, and AI-generated research assistance, helping students overcome language barriers in accessing international academic literature. Some platforms are also exploring voice search functionalities and conversational AI chatbots, which can guide students through complex research queries and provide instant academic support.

The growing use of blockchain technology in academic publishing could also transform digital libraries by ensuring the authenticity, security, and traceability of research papers. Blockchain-based repositories can prevent plagiarism, unauthorized alterations, and fake publications, creating a more reliable academic environment. Future studies should assess the feasibility of blockchain-secured open-access repositories for universities in developing regions like Peru.

7.2 Potential for Expanding Digital Access in Underserved Communities

Despite technological advancements, digital disparities persist, particularly in rural areas where students continue to face limited internet access, outdated university infrastructure, and low digital literacy rates. To address this, innovative community-based digital access initiatives must be explored. One promising solution is the deployment of offline digital library hubs in underserved communities. These hubs function as local server networks that store large academic databases and can be accessed without requiring an active internet connection. Some universities in Africa and Southeast Asia have successfully implemented offline library kiosks, allowing students to download materials using mobile devices and access educational content without connectivity constraints.

Another emerging model is the use of low-bandwidth digital library applications, which optimize search functionalities and download speeds for students with limited internet data plans. Some universities are experimenting with text-based digital library interfaces, allowing students to access essential research articles using SMS-based search requests or lightweight mobile apps that function with minimal data usage. Expanding these models in Peru’s remote regions could significantly improve access to academic materials.

Public-private partnerships could also play a key role in expanding digital library access. Collaborations between government agencies, telecommunication companies, and academic institutions could lead to subsidized internet packages for students, free public Wi-Fi zones near universities, and cloud-based open-access repositories that ensure uninterrupted access to essential research materials. Studies examining the long-term impact of public-private digital education initiatives would provide valuable insights into sustainable strategies for expanding digital library access.

7.3 Limitations of the Study and Proposed Refinements for Further Research

While this study provides valuable insights into the effectiveness of digital libraries in bridging information access gaps among Peruvian university students, certain limitations must be acknowledged. One primary limitation is the reliance on self-reported survey data, which may be subject to response biases and over- or underestimation of digital library engagement levels. Future studies should incorporate direct usage analytics from digital library platforms, tracking actual search behavior, download frequencies, and interaction patterns to obtain a more objective assessment of student engagement.

Another limitation is the regional scope of data collection. While this study includes perspectives from urban and rural universities, a more comprehensive national survey incorporating a broader range of institutions, including technical schools and private universities, would provide a more holistic understanding of digital library utilization trends in Peru. Expanding research to include qualitative ethnographic studies could also reveal deeper insights into the cultural and social factors influencing digital library adoption.

Lastly, this study focuses primarily on existing digital library platforms but does not extensively explore emerging digital research models such as AI-driven learning assistants, collaborative online research communities, and interactive research annotation tools. Future studies should examine how next-generation academic technologies could complement traditional digital libraries, creating a hybrid research ecosystem that is more adaptable, interactive, and inclusive.

The future of digital library access in Peruvian universities hinges on technological innovation, equitable expansion strategies, and continuous refinement of engagement models. As AI-powered research tools, low-bandwidth digital access initiatives, and blockchain-secured repositories gain traction, their integration into university systems will define how effectively students can leverage digital resources for academic success.

While infrastructural and policy-related challenges remain, coordinated efforts from universities, policymakers, and the private sector can ensure that digital libraries evolve into truly inclusive academic platforms, enabling all students—regardless of their socioeconomic background—to benefit from the wealth of knowledge available in the digital age. Future research should focus on longitudinal studies tracking the impact of digital libraries over time, further refining policies and technological solutions to create a more accessible, efficient, and student-centered digital academic environment.

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