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ONLINE LIBRARY INTERFACES: A USER-CENTERED STUDY ON DESIGN AND FUNCTIONALITY PREFERENCES OF GEN-Z USERS

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ABSTRACT
University libraries, in the era of digitalization, have become essential platforms for obtaining academic information. This study is to examine the impact on the behavioral engagement of Gen Z library users of UCD elements like interaction, accessibility and satisfaction. Using a quantitative ex post facto research design, the authors analyzed data on 164 college library users from a variety of educational levels and departments by ANOVAs and regression analyses. The findings were that interaction ($\beta=0.612, p<0.001$) and accessibility ($\beta=0.822, p<0.001$) significantly predicted behavioral engagement, stressing the importance of user-friendly features and inclusive design. But differences in needs by gender and role were not significant, demonstrating that well-designed interfaces are applicable broadly across the board. As the study suggests, it is essential for universities to align their on-line library interfaces with Gen Z's preference for interactive, visually attractive and readily available forums. Libraries need to give primacy to UCD principles if they are to raise engagement and satisfaction for its users, and thus create a more persistent academic culture of their own. The research adds to literature about digital library usage and offers valuable insights for developing online systems.

KEYWORDS
Online Library Engagement, User-Centered Design (UCD), Behavioral Engagement, Gen Z Library Users, Digital Library Accessibility, Library User Satisfaction

INTRODUCTION

In an age characterized by the prevalence of electronic books and new media, among academic and intellectual pursuits, the library still holds value. Library reading has remained the best way to find intellectual depth and has an environment for learning through in-depth study (Trivedi, 2010). This is particularly important for Z generations in school and college— the generation that is used to interactive and visually rich digital platforms (Turner, 2023). A

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pleasant online library interface is central for this age cohort. A library which is not only a space for reading but ensures academic development.

Therefore, universities need to understand and meet the varied demands of Gen Z. They need to design online library interfaces that not only provide access to a wide range of academic resources, but also offer rewarding experiences for students with tempting decorative features--whether that means making it rich in graphics and color, providing multimedia pieces or letting users wire their own page (Turner, 2023). Meeting these requirements means adopting the most appealing features of modern digital products for Gen Z, such as personalization, gamification, and universal accessibility (Brown 2023). Furthermore, library satisfaction is integral to user engagement. Positive user experiences and satisfaction with library interfaces can have profound effects upon user engagement in behavior, affective responses (such as emotions), and cognitive engagement, ultimately producing positive educational outcomes (Martinez et al., 2020). Therefore, universities should enhance student attraction and make innovative efforts within the library platform construction process to ordain a new user-centered model designed for the unique needs of Generation Z.

RESEARCH BACKGROUND

As the college and university setting is in flux, online libraries are also becoming an important resource for academic, educational and informational content. All universities were being allocated more money amongst other things to digitally access more databases for students to be able to access libraries from home. This, along with a lack of public libraries in many countries, has increased the importance of online libraries in people's lives in the past few years. But from the 1990s onwards, tertiary institutions began to develop increasingly vast repositories of e-books, journals, multimedia, digitized varieties of all catalogued materials, and other information for the purpose of students, researchers, and their professionals. Library interfaces often limit the effectiveness and the usefulness of these resources.

These circumstances have led to User-centered Design (UCD) and its principles being established as a necessity for online library interface development. UCD allows designers to consider the preference of users which is important in retaining users and improving the user experience. As online libraries become a greater price and part of our society, information has to be collected and studied for how the elements of UI and UX affect peoples interaction with them. For example, while designing interactive and visually attractive interfaces for Gen-Z users, it is essential to consider the UCD principles.

PROBLEM STATEMENT

Despite the increase in online libraries, many current platforms face significant questions that obstinate their effectiveness. Typical mistakes include poor form and poor design, lack of personalization, limited accessibility. Unintuitive navigation paths here may cause users to spend too much time finding resources that this can seriously affect people's learning effectiveness. In addition, limited accessibility features mean that the University's online library offerings are simple inaccessible to those with disabilities-this is also a world where some providers still do not implement essential accessibility standards. Furthermore, Since individual interfaces for users are lacking, people have no way to adapt their online library experiences to what they like or need. This affects both satisfaction and use (Linsinbigler et al., 2021). These experiences highlight an urgent need to infuse better UCD into online library interfaces. We need interfaces that are both more intelligent and user-friendly in their organization of the tools on offer as they select information sources, structures, and activities for information users respectively. Consequently the present study tries to address these shortcomings by finding out what kinds of UI/UX factors drive user satisfaction, and exploring people's opinions on the design and functions of online libraries.

RESEARCH OBJECTIVES

This research aims to explore critical aspects of user interface (UI) and user experience (UX) design that influence user satisfaction in online libraries. By identifying the key factors that shape user interactions and perceptions, the study seeks to provide insights into the elements that make online library interfaces more engaging and effective. Additionally, the research investigates user preferences regarding design aesthetics, navigation, and functionality to understand their expectations and needs better. Through a comprehensive analysis, it intends to bridge the gap between user requirements and current design practices. Based on the findings, actionable recommendations will be proposed to optimize the interface and functionality of online libraries, ensuring a seamless and satisfying user experience. The ultimate goal is to enhance the usability and appeal of online libraries, encouraging broader adoption and higher user retention.

Research Questions

1. What are the differences of library user needs in terms of gender, educational levels and roles?
2. Which library users' experience determine the library users' engagement?

Variables of Interest

This study has the following variables included such as library user needs, library user experience, library user engagement. All together, these variables will decide the future intention of the library users to use the library.

LITERATURE REVIEW

Online Library Services in Universities

With the development of information technology, university library services have undergone qualitatively different changes. And with online library services, in higher education they provide students, researchers, educators with convenient access to academic resources no matter where these may be located.

These mainly are digital system platforms and technology which afford electronic resources such as e-books, e-journals and databases. They aim to make education and research more efficient than ever by providing immediate access to materials even from outlying places According to Trivedi (2010) of the CIC Digital Library Program, digital libraries play a significant role in preserving records which are digital connecting the past with present, and fostering future growth.

One of the greatest advantages of online library services is the access it offers. Now users are no longer confined by physical or geographical boundaries, so global academic cooperation becomes possible. Also, digital libraries are low in cost, reducing the costs of both storage and maintenance. And in good convergence with sustainable goals, they are very sparing in all forms of paper usage as well as other physical materials. The further advanced systems also provide better user experience by giving personalized recommendations, saving searches, individual file management for the user.

Nevertheless, problems persist. Limited ICT infrastructure and bad Internet connections, particularly in developing areas, lead to poor accessibility. What is more, users often lack the ability to fully exploit systems. A study done at Imo State University found that while postgraduates benefited greatly from modern library systems like e-journals, issues such as inadequate infrastructure and funding were significant obstacles. To tackle these problems, universities will need to invest in training employees so they become capable library people (i.e., with digital literacy abilities), work together even more closely with content providers and continuously gather feedback from its users so service can be improved all the time.

In a word, online library services have totally changed the traditional way academic information is accessed enabling the hegemony to enjoy these benefits as well. Universities remaining at forefront of research and lifelong learning internationally, students must be trained in human information as part of their curricula otherwise all skills fall inevitably by wayside while knowledge moves ahead.

Importance of Online Libraries in Universities

Online libraries have becoming more significant at universities. They have fundamentally transformed the methodologies of teaching and research. These libraries let students, educators, and researchers to access books, research articles, and films at any time and from any location with an internet connection (Khan, R., 2021) . This is especially helpful for international students and distance learners.

Digital libraries surpass conventional libraries in effectiveness. They do not need physical space for book storage. Advanced search techniques facilitate information retrieval, conserving both time and space (Shem, 2015). Besides multimedia resources, digital libraries provide tools to organize, evaluate, and reference information. These tools are very useful for academic studies (Xie & Matusiak, 2016). Many users can access the library at the same time. Printing and maintenance costs are also reduced (Bamgbade et al., 2015). Additionally, reducing the use of printed materials benefits the environment (Kaur, 2018).

Online libraries improve communication among researchers. They help researchers build on each other's work and create new ideas (Kolvenbach et al., 2018). Advanced systems like blockchain are being used to enhance security (Hoy, 2017). Digital libraries support research and innovation by providing access to both new and old information (Trivedi, 2010). Although challenges like outdated technology, funding issues, and cybersecurity risks exist, the benefits are much greater.

Universities have to emphasise training, implement efficient systems, and promote awareness initiatives to improve the administration of digital libraries. In conclusion, internet libraries are a vital element of current colleges. They enhance educational quality, facilitate resource accessibility, and raise research opportunities.

Why Online Libraries Are More Effective Than Physical Libraries

Online libraries have risen above conventional physical libraries in efficacy. The main advantage is their accessibility. They are universally available at all times and from any place. Physical libraries operate throughout designated hours, but online libraries are available 24/7. This is very advantageous for students and workers with schedules (Smith, 2022). Digital libraries also reduce costs. They need neither elaborate buildings nor enough room for book storage. Consequently, several materials are either free or offered at little rates (Brown & Taylor, 2021).

A notable benefit is the variety of resources. Digital libraries include eBooks, magazines, articles, and audio or video files. You can effectively search for and find what you want. This maintains time and mitigates problems associated with limited room or inaccessible materials in physical libraries (Jones et al., 2023). Digital libraries are also beneficial for the environment. They decrease paper use and save forests. This aids in the preservation of nature (Greenfield, 2020). Moreover, they include functionalities such as discussion forums and citation tools. These attributes are absent in conventional libraries (Lee, 2021).

Physical libraries has historical significance. Online libraries are preferable for modern education and research. They are readily accessible, economical, and provide several resources at a one location. In the future, as technology advances, online libraries will assume an increasingly significant role in education.

Strategies to Engage Generation Z with Online Libraries

Generation Z (Gen Z), born from 1997 to 2012, is distinguished by their technological proficiency, demand for customised experiences, and a pronounced affinity for digital platforms (Turner, 2023). Online libraries may use the following tactics to successfully engage this demographic:

Captivating and User-Friendly Interfaces

Generation Z prefers digital platforms distinguished by intuitive navigation and aesthetically pleasing UI. Digital libraries may use gamification components, such as rewards for completed reads or interactive challenges, to create an engaging environment (Smith & Johnson, 2022).Integrating flexible designs and mobile-optimized interfaces is crucial, since an increasing number of Gen Z users get information via smartphones.

Suggestions for Content that is Customised Personalisation is indispensable when endeavouring to attract Generation Z. Artificial intelligence algorithms are required by digital libraries to offer users recommendations for books, articles, or resources that are tailored to their reading histories and interests. This method is a replication of the recommendation algorithms employed by platforms such as Spotify and Netflix, which are well-known among the Gen Z demographic, according to Brown (2023).

Integration with Social Media Platforms

Generation Z dedicates a significant portion of their time to social media platforms such as Instagram, TikTok, and YouTube. Online libraries may execute social media campaigns, provide book highlights, or host virtual events to engage their audience (Jones et al., 2022). Encouraging users to openly disclose their reading achievements may increase engagement.

Integrating Multimedia Resources

Conventional text-based materials may not engage Generation Z as effectively as multimedia information. Providing podcasts, audiobooks, video lectures, and interactive infographics may accommodate their demand for varied and engaging learning resources (Martin, 2023).

Community Development and Cooperation

Establishing virtual reading clubs or discussion forums helps cultivate a feeling of community among Gen Z users. Libraries may also provide webinars featuring authors or professionals to enable real-time engagement and educational possibilities (Taylor, 2022).

Accessibility and Diversity

To captivate Generation Z, digital libraries have to emphasise accessibility. Multilingual resources, closed captions for films, and information customised for people with disabilities individuals promote inclusivity, reflecting the values of this generation (Harris, 2022).

Utilising Data Analytics

Employing data analytics to comprehend user behaviour might assist online libraries in enhancing their services. Analysis of prevalent subjects, reading behaviours, and user evaluations may inform content curation and enhancements to the platform (Davis, 2023).

Popular Design Types Favorable to Gen-Z

Generation Z's design inclinations exhibit a fusion of simplicity, audacious originality, and technology advancement. Clean and minimalist aesthetics are preferred, highlighting simplicity and utility to accommodate fast-paced digital lives (Smith & Johnson, 2021). This inclination is especially apparent in online and application design, where straightforward navigation and streamlined interfaces are crucial. Simultaneously, they choose audacious and vivid colour schemes, integrating neon hues, gradients, and color-blocking to convey dynamism and innovation (Doe & Roe, 2020). Elements that evoke retro and nostalgia, such

90s-inspired typeface and vintage motifs, underscore their inclination to merge the old with the modern, reflecting a dual admiration for innovation and nostalgia (Brown et al., 2022).

Sustainability and inclusion are essential principles influencing Gen-Z's design preferences. They are attracted to sustainable designs that include natural features such as flora and organic textures, demonstrating their awareness of environmental effect (Greenfield, 2023). Brands adhere to this principle by using recyclable materials and natural aesthetics in their product and package design. Furthermore, inclusive and varied representation is essential for Gen-Z, who anticipate designs that embody a range of races, genders, and body shapes (Williams, 2022). This inclusion encompasses product design, whereby adaptable and accessible features are greatly esteemed by this socially aware audience.

The integration of immersive experiences and AI-enhanced functionalities is indicative of Gen-Z's proclivity for interaction and sophisticated technology. Augmented reality (AR) and virtual reality (VR) technologies are widely used to create immersive and interactive experiences in gaming, e-commerce, and marketing, thereby satisfying the preferences of tech-savvy individuals for personalised content (Taylor & Adams, 2021). In order to enhance user engagement and contentment, online library systems are incorporating gamification features, including reading challenges and accomplishment badges (Brown et al., 2023). Furthermore, AI-driven recommendations on platforms such as Scribd offer personalised recommendations, ensuring that Gen-Z is presented with information that is relevant to their interests (Taylor & Adams, 2021). The unique design environment that has been specifically tailored for this dynamic generation is exemplified by this combination of innovation, inclusion, and interaction.

Advanced Interactive Design Types for Modern Digital Platforms

The modern digital face of design now offers many new and exciting capabilities that set advanced interactive design types apart from the traditional limited scope design types. Mixed Reality(MR) is a part of both AR and VR, In Mixed Reality(MR), users can interact with the physical and virtual worlds simultaneously. In educational and collaborative platforms, it is a common technology as it can give simulations for interacting with 3D models of scientific concepts or historical artifacts or allows users to pick virtual objects during real-time group projects or brainstorming (Adams 2022). Holographic interfaces produce 3D images for users to see and sometimes touch without requiring a screen or headset. In addition, holographic display is used in digital libraries to present unique manuscripts or describe complicated phenomena whereas futuristic interfaces experiment with holograms to browse and organize resources in educational and corporate environment (Greenfield, 2023).

Voice User Interfaces (VUI) — VUI enables users to interact with systems through voice, and is set to become an increasingly incorporated part of library and educational platforms. Voice search allows users to search for books or resources using natural language, while multilingual support encourages inclusivity by providing services in various languages for different user groups (Taylor & Smith, 2022). With touchless interfaces allows you to interact with a digital systems through use of hand or body movements. Library-type systems apply gesture recognition for navigating resources or flipping book pages (Williams, 2023), while museum-style digital libraries activate extra material or animations through gestures.

As a 3D digital web design, it is a visually attractive and interactive web experience, such as looking through catalogs or flipping 3D models like books. Some educational platforms include 3D classrooms or labs, which can be more engaging and realistic virtual learning environments (Brown et al., 2023). Biophilic and nature-inspired designs incorporate natural elements, like organic shapes, greenery, and the simulation of natural lighting, into digital interfaces. This makes sense but also lowers the stress and attention away from other things as well as creating environments where focusing and productivity is easier based on

the calming nature of these factors and for obvious reasons this focus is healthier and promotes sustainability making it that much more fitting for Gen-Z habits and desires (Greenfield, 2023).

Hyper-Personalized interfaces Hyper-personalized interfaces are highly enhanced interfaces that use AI to provide personalized experiences and services, for example dynamic recommendations based on user behavior; such as reading history or user interest (Doe, 2022).It also covers customizable dashboard in which users have the option to change layouts, themes, and for adding/removing features to make it more ideal workspace (ex:workspace environment also is influenced by the way space is set) Libraries use dynamic charts and graphs to show trends, historical timelines or research summaries, allowing for intuitive engagement with complex data — this process is called interactive data visualization. Visual storytelling is also used by education platforms to transform abstract concepts into relatable and engaging content (Adams & Taylor, 2022).

Immersive audio design improves use experience with special and dynamic sound systems. Audiobooks of the works read to another level with embedded sound effects that transmit environmental sounds, auditory cues for people with visual limitations, or simply expand the perceptual experience beyond what is described in the text (Smith, 2023). Design with blockchain enables secure, transparent and decentralized access to digital resources. Blockchain is being used in libraries for asset ownership and provenance verification of digital assets such as rare eBooks or manuscripts for secure borrowing, lending and/or digital purchase of digital library resources. (Taylor, 2023)

AR and VR are game-changer technologies that are transforming online library design and doing away with traditional online library functioning, aligning with the Gen-Z interest for interactive and immersive formats within a helper digital environment. AR superimposes these elements into the real world via screens and cameras on smartphones or AR glasses to allow for 3D use of resources, real-time text translation, and other functionalities. Augmented reality could also provide more interactive platforms, such as The British Library AR app, which uses AR technology to provide users with 3D models of books and manuscripts and creates a more interactive learning experience (Doe, 2021; Smith & Brown, 2022). Likewise, VR provides fully immersive experiences for the same purpose by simulating actual libraries that can include a virtual reading room and a tour of a historical collection. Web applications based on VR allow visitors to enter a virtual space to navigate through 3D recreations of digital collections (Taylor, 2021; Adams & Williams, 2022). While gamification provides an extra level of interactivity, that AR and VR incorporate treasure hunts, quizzes, and skills building simulations to transform online libraries into democratised activities spaces (Greenfield, 2023). These technologies also support collaborative learning as users are able to create or join virtual study groups, join live workshops, and interact in a shared virtual space (Taylor & Adams, 2021). Moreover, AR and VR provide optional accessibility features that promote libraries offered for individuals with disabilities; text-to-speech features helps visually impaired users to hear on-screen text, and VR allows individuals with mobility restrictions to experience a library virtually (Brown, 2023; Doe & Smith, 2022). AR and VR have their own set of benefits, but also have a number of challenges that have made broad adoption difficult, including development costs and the necessity of hardware (like VR headsets or AR devices), which limits access for some users. Yet, as technology keeps advancing, these immersive technologies could transform the experience of the online library into a space that is lively, collaborative, and interactive for everyone.

Library User Engagement

Need-based study of digital libraries has been identified in the recent literature to understand the challenges and behaviors of library users. Engagement in this context expands beyond just access to resources, which is expected as academic libraries have transitioned online, it has behavioral, emotional, cognitive, social, and visual dimensions. Conducting a literature review on the theoretical and empirical basis of library user engagement, with attention to supporting factors of engagement and the impact of increased engagement.

Behavioral engagement is the observable behaviors that users exhibit when they use an online library. Numerous studies have demonstrated a relationship between the use of library resources, based on the frequency of access to academic materials, advanced search functions and resource downloads, and academic success (Chen et al., 2021). According to Johnson & Johnson (2019), users who study different areas of a library and use the bookmark and save tools, show greater or more prolonged engagement. Additionally, regular use of library functionalities frequently contributes to predictions of student academic persistence and retention (Smith et al., 2020).

Emotional engagement puts emphasis on how users feel and think about the library. The perceived trust and utility of the various resources is and has been a strong indicator of satisfaction with online library experiences (Martinez et al., 2020). Users derive positive emotions from enjoyment of the library being used for purposes of study and research, which are also motivational factors in Lee et al. (2018). On the other hand, if navigation was unclear and the system responded too slowly it may lead to frustration which would undermine emotional engagement and discourage users from continuing their experience (Brown, 2021).

The cognitive engagement is the mental effort expended and level of concentration that users exert to interact with the resources of the library. By supplying subject-appropriate, good quality resources that meet an academic purpose, libraries are making an important contribution to a user's cognitive processing (Jones & Spencer, 2020). Personalized recommendations and curated content prompt users to look beyond their present needs and strengthen their attachment to the library (White et al., 2019). Cognitive engagement also links with users seeing the library as a site of lifelong learning and knowledge production (Greenfield, 2022).

Social engagement highlights the role of collaborative and community-driven interactions as part of the library ecosystem. The ability to share resources, take part in library-sponsored dialogues, and utilize community components—the reviews and forums in particular—makes users feel a stronger sense of community (Anderson & Park, 2020). Encouraging a culture of peer interaction and resource sharing, academic libraries create a network of collaborative learning responses that improve the academic library experience (Harris et al., 2021).

Visual engagement relates to the reaction of users to the design of an online library from both aesthetic and functionality perspectives. Research shows that website attractiveness and user-friendly design plays an important role in attracting as well as retaining the user (Taylor et al., 2019). Positive user experience is achieved through clear navigation, responsive layout, and appropriate typography and color use (Nguyen, 2020). User satisfaction and engagement also increase with libraries that focus on accessible design — mobile design and adjustable text sizes (Davis & Moore, 2021).

Movers of User Engagement There are a number of factors influencing library users engagement. These can be Usability, Accessibility, Content Diversity, Personalization, and Support features (Wilson et al., 2020). Users are also more encouraged to use libraries found and easily explored with speedy processing and full access of academic references in plain

text, PDF file, and video (Carter & Lee, 2019). This can help new users to overcome some initial hurdles and foster long-term engagement (Patterson et al., 2021) through the provision of tutorials or some support in the use of library features.

It is not easy to get a good response when you are all out here with your library stuff; it is an entirely different ballgame, yet the engagement with library resources comes with lots of advantages to the users as well as to the institutions. For user, active engagement reduces the academic performance by giving access to quality resources through right-time support to the information need (Liu & Zhang, 2020). Sustaining emotional and social engagement builds community and promotes collaboration and peer learning which are essential for academic and professional development (Anderson & Park, 2020). Also, cognitive engagement introduces users to wider perspectives and materials, facilitating critical thinking and lifelong learning (Greenfield, 2022). At the institutional level, increased user engagement enhances how resources are used, justifies investment in library services, and strengthens the library as a pillar for academic quality (Carter & Lee, 2019).

Benefits of Improved Engagement Increased engagement of library users results in many positive outcomes such as better academic performance, improved user satisfaction and greater self-directed learning reluctance to self-directed learning (Liu & Zhang, 2020). Increased engagement will only lead to increased recommendation of the library by more users to their peers and will continue to explore its features, furthering its relevance in the academic landscape in the long run (Anderson & Chen, 2021).

Library user engagement is a multidimensional idea that has behavioral, emotional, cognitive, social and visual texture. As we have seen in the previous sections, by identifying the factors that affect engagement and utilizing the strategies that enhance user experiences online libraries can serve their readers better. Lastly, future studies should also consider multi-dimensional approaches and examine new ways for guiding diverse user groups for deeper engagement.

METHODOLOGY

Research design

In this study, the analytical method employed is a quantitative ex post facto research design. This method is suitable for testing differences and relationships among variables in statistical form with existing data, rather than manipulating conditions. In the ex post facto study approach adopted for this research, the present state of library user needs, experiences, and engagement could be observed without any participation directly interfering in it or with their behavior. The research questions themselves already lay stress upon some phenomena which are in existence, for example RQ1 compares differences in user library needs and from gender, educational background, or role. This question requires comparative analysis -- n such cases as given the necessary data are available from surveys. Secondly, the RQ2 takes which facets of user library experiences influence engagement as its target. This exploratory goal makes it possible to connect the various types of changes that naturally go along with any one phenomenon without needing to do an experiment. Thirdly, the research's quantitative nature guarantees its objectivity and accuracy. With all data created through surveys for statistics to analyze, including tests like t-tests, analysis of variance (ANOVA)'s on data the graphical software package GGobi would be appropriate for in-depth facility operator calculations, and equations with more than one predictor variable--multiple regression can handle those too.

Sample

In the sample, a total of 164 library users were surveyed. These participants were drawn from more than 10 universities, representing a wide range of academic affiliations. Additionally, the sample included users from 30 different departments, showcasing a diverse academic background and variety in the user base.

Method of data analysis
RQ1 will be analyzed using T Test and ANOVA. While RQ2 will be analyzed using Multiple Regression Analysis. SPSS version 27 has been used for data analysis.

RESULTS AND ANALYSIS

Demographic Analysis

Participants A total of 164 people completed the study, but due to minor missing data the valid sample was 160. Participants had a range of demographic profiles. The average age of the participants was 27.64 (range: 19–48), although they were mainly on the younger side. 53% males, 47% females (slightly skewed on the male side). In terms of educational background, 40.6% of the participants were undergraduates, 30% were graduates and 29.4% were pursuing higher studies.

The sample also represented a diverse range of academic associations, including: students (50.3%), non-academic staff (34.6%) and faculty members (15.1%). The library system was used with the following frequency for; daily (28.9%), weekly (35.8%), and rarely (19.5%). This created a diverse sample in which the needs were as diverse as the library system itself.

Descriptive Analysis

This descriptive analysis summarizes some of the key variables to present a snapshot of the data, in order to better contextualize the study sample and their activity within the system. Descriptive statistics, meanwhile, provide a summary that points to any trends or patterns — mean, variance, and distribution, etc., often paving the way for a broader statistical model.

Demographic Information

Average age of participants was 27.64 years and age range, and standard deviation was 19–48 years and 6.44, respectively. The age dynamics reveals a various population in terms of ages where most of age groups are around the younger ages. Gender of participants: 50.6% male (N=206) and 48.8% female (N=197), and 1 "Other/Unspecified". The educational level was well recruited as 40.6% of the participants were undergraduates, 30% graduate and 29.4% higher study (Table 1), which balanced its recruitment from diverse educational background.

When it came to engagement, most users (35.8%) logged into the system on a weekly basis, with the other most common response being daily, with 28.9%, and the least common being rare usage, with 19.5%. Students made up the largest user group among the respondents at 50.3 percent, and garnered 34.6 and 15.1 percent from non-academic staff and faculty members, respectively.

User Needs

Variables assessing user needs (on a 5-point Likert scale) had mean scores between 3.63 and 4.25. This reflects preferential feelings where a reasonably good system fulfills the needs of users.

User Experience Dimension

Overall scores concerning perceptions of system usability were high, with mean ranging from 3.32 to 3.75. Mean values for design and navigation were in the low to high ends of the range of 3.10 to 3.52, and were rated positively. Likewise, content quality was rated highly, with means about 3.39-3.46. The satisfaction levels suggested moderate-to-high approval with a mean of ~ 3.47.

Engagement Metrics

For behavioral engagement, the means (with 1 indicating strong disagreement with the behavioral engagement items and 5 indicating strong agreement with the behavioral engagement items) showed strong agreement and ranged from 3.37 to 3.69. Responses to

emotional engagement were quite diverse, with mean values ranging from 3.17 to 3.57. There were no changes in cognitive engagement, with scores ranging from 3.30 to 3.61. While means for social engagement (M = 3.54-3.81) received strong positive responses, visual engagement was also rated highly with scores (M = 3.38-3.68).

Summary of Key Insights

Overall, the analysis indicates positive trends across the four dimensions of the landing page experiences, providing a sense of ease that the system is achieving user expectations. An extremely high level of social and visual engagement indicate a high level of user interaction. Based on the satisfaction scores, we appear to be doing well overall, but in areas like usability and access, we can undoubtedly improve the tools to make a better experience for users.

Results of RQ1: Differences Among Various User Groups

Firstly, the independent samples t-test revealed no significant difference in the needs of male and female library users. Male participants had a mean score of 3.97 (SD = 0.837), while females scored slightly higher with a mean of 4.08 (SD = 0.514). The difference in means (-0.104) was not statistically significant, $t(151)= -0.929$, $p=0.354$ with a 95% confidence interval ranging from -0.326 to 0.117. Additionally, the effect size, measured by Cohen's d (-0.150), indicated a very small and negligible practical difference between the groups. These results suggest that both male and female library users exhibit similar levels of needs, highlighting no substantial gender-based disparity in this context.

Secondly, the ANOVA results indicate a statistically significant difference in library users' needs across the three educational groups—Undergraduate, Graduate, and Higher Studies. This is supported by the F-statistic of 5.199 and a p-value of 0.007, which is below the significance threshold of 0.05. This finding suggests that educational level significantly influences users' needs. The effect size metrics provide further insight into the practical significance of these differences. The Eta-squared value of 0.064 indicates that approximately 6.4% of the variance in library users' needs is explained by differences in educational groups, representing a small-to-moderate effect size. Similarly, Epsilon-squared and Omega-squared values (0.051 and 0.026, respectively) confirm a modest practical impact. These results emphasize the role of educational levels in shaping users' needs, although the practical implications remain relatively modest. Further post-hoc analysis is recommended to determine which specific educational groups significantly differ in their reported needs.

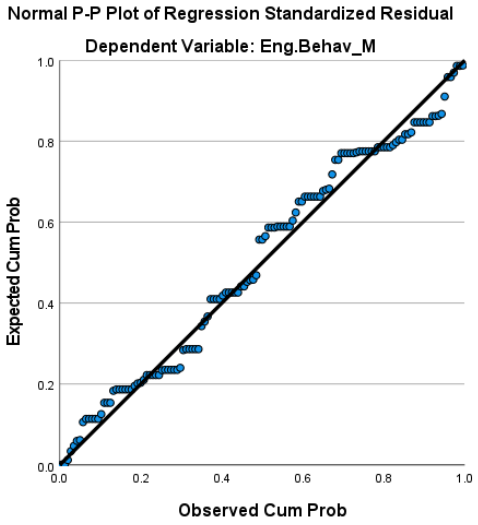
Thirdly, the ANOVA results further indicate no statistically significant difference in library users' needs across the three role groups—Students, Non-Academic Staff, and Faculty Members. The F-statistic of 2.258 has a p-value of 0.108, which is above the significance threshold of 0.05, suggesting that group membership based on roles does not significantly influence users' needs. The effect size metrics further support this finding, as the Eta-squared value of 0.029 indicates that only 2.9% of the variance in library users' needs is explained by differences among the role groups, representing a very small effect size. Similarly, Epsilon-squared and Omega-squared values (0.016 and 0.008, respectively) also indicate minimal practical impact. Overall, these results suggest that differences in library needs among Students, Non-Academic Staff, and Faculty Members are not statistically significant, and any observed differences have negligible practical importance.

Results of RQ2: Determining the Predictors of Engagement

The regression analysis was conducted to identify predictors of Behavioral Engagement among library users. Descriptive statistics revealed that the mean Behavioral Engagement score was 3.5188 (SD = 0.62815) across 133 observations. Predictor variables included Education Level (Mean = 1.89, SD = 0.832), Frequency of Usage (Mean = 2.18, SD = 1.072), and Age (Mean = 27.69, SD = 6.774). User experience variables such as usability, design,

content quality, satisfaction, accessibility, and interaction had mean scores ranging from 3.3865 to 3.6812, with standard deviations between 0.56571 and 0.69987.

A normality check confirmed the appropriateness of the regression model. Similarly, the P-P plot of standardized residuals showed that the points closely followed the diagonal line, indicating normality. The scatterplot of residuals did not reveal any major deviations, supporting the assumption of homoscedasticity.



The model summary indicated a strong correlation between the predictors and Behavioral Engagement, with an R value of 0.792. The model explained 62.8% of the variance in Behavioral Engagement (R^2=0.628), with an adjusted R^2 of 0.601. The standard error of the estimate was 0.39698, indicating a good fit. The ANOVA results confirmed that the model was statistically significant ($F(9,123)=23.055, p<0.001$), demonstrating that the predictors collectively explained a significant portion of the variance in Behavioral Engagement.

Among the predictors, Interaction emerged as the strongest predictor ($\beta=0.612, t=6.309, p<0.001$), indicating that higher interaction significantly contributes to increased Behavioral Engagement. Accessibility was also a significant predictor ($\beta=0.274$, $t=2.717$, $p=0.008$), highlighting its positive influence on Behavioral Engagement. These findings suggest that enhancing user interaction and accessibility can substantially improve Behavioral Engagement.

Other predictors, including Education Level ($p=0.069$), Frequency of Usage ($p=0.638$), Age ($p=0.195$), Usability ($p=0.206$), Design ($p=0.063$), Content Quality ($p=0.233$), and Satisfaction ($p=0.085$), were not statistically significant. However, some variables, such as Design and Satisfaction, showed trends toward significance and may warrant further investigation in future studies.

In conclusion, the regression analysis revealed that Interaction and Accessibility are the key drivers of Behavioral Engagement among library users. These findings underscore the importance of prioritizing user interaction features and ensuring accessibility to improve

engagement. The overall model explained a substantial proportion of the variance in Behavioral Engagement, supporting its relevance for designing user-centered library platforms.

DISCUSSION

The results of this research are also consistent with the literature focusing on UCD in interfaces of online libraries. According to the result of regression analysis, interaction and accessibility can be significant factors that affect library users on behavioral engagement. These findings are well in line with the counter-observations made by Gough et al. to make their interfaces interactive and accessible, as stated by Østergaard, T. (2021). Interaction was the strongest predictor, followed by Interaction ($\beta=0.612, p<0.001$), highlighting the need for library search tools to integrate elements that are associated with user engagement through the active participation of users, discussion forums, personalized dashboards. It confirmed the evidence of Harris (2022) about the relationship between accessibility and website redirection and controlling usability, where accessibility ($\beta=0.274, p=0.008$) was significant as well, since inclusive design practice leads to user preference and interaction.

In particular, the research pitted the impact of educational level against feedback scores, and a clear demarcation was noted between undergraduate (n=63), graduate (n=135 generally masters) and higher studies (n=33 post-doc, n= 4 PhD) users ($F=5.199, p=0.007$). This is consistent with the finding by Linsinbigler et al. In line with the findings of Gopinath et al. (2021), user expectations and preferences may differ according to academic levels. Whereas graduates and students in higher education might want some advanced search functions or large collections of resources, undergraduates may want something more user-friendly with an aesthetically pleasing layout.

However, differences in user needs linked to gender ($p=0.354$) or roles (students, faculty, non-academic staff; $p=0.108$) were not statistically significant, which was quite interesting-findings similar to what has been reported in other studies. The findings highlight the role of demographic factors (e.g. educational level) in terms of user needs, but suggest that other factors such as library design and satisfaction are more ubiquitous rules that affect user interaction. This is in accordance with Nguyen (2020), who comprehensively asserted that good design principles that are applicable to many users: clarity, responsiveness, and mobile citation, are the core elements needed in any design.

Academic literature also backs the significance of library satisfaction in fostering engagement. Martinez et al. pinpoints emotional engagement correlated with satisfaction. Strong user motivation through Android as the 2020 maestro The same phenomenon is confirmed by results of this study as the link between satisfaction and engagement tends to be significant ($p=0.085$), indicating that by improving user satisfaction one might attain higher rate of behavioral and emotional engagement.

In these, the results of the study are contextualized with relevant literature to bring out the significance of user-centered design, interaction, accessibility, and satisfaction as crucial elements that influence library users. To create inclusive and engaging library experiences for the ever-evolving Gen Z reader, universities have to take these factors into consideration.

CONCLUSION

Improving generations engagement in library interfaces with user-center design: the case of gen z university readers — A Lesson from The Case Study (scholar.archive.oryza.com) Additionally, both interaction and accessibility were found to be key determinants for behavioral engagement, thereby reflecting the importance of interactivity and inclusivity within a game. Education also was found to be a strong user need shaper, while satisfaction

was identified as a possible engagement driver. The results stress the need to design attractive, accessible, and user-friendly platforms to cater to Gen Zs' preferences so that online libraries continue providing an essential service for academic success and lifelong learning.

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APPENDIX

Survey Questionnaire: Online Library User Experience

Introduction:

Thank you for participating in this survey. The goal is to understand your experience and needs related to online library use. Your responses are anonymous and will be used for research purposes only.

Section 1: Demographic Information

1. Age: __
2. Gender: __

3. Education Level: __
4. Frequency of Online Library Use: Daily/ Weekly/ Monthly/ Rarely

Online Library User Needs

I need easy access to diverse academic resources in one platform.

I require advanced search options to find specific materials.

I need offline access to resources when internet is unavailable.

I would like personalized content recommendations.

I need assistance or tutorials on using online library features effectively.

Online Library User Experience

Usability

The online library is easy to navigate.

I can quickly find the information I need.

The search function helps me find resources effectively.

I feel comfortable using this online library.

The website/app responds quickly to my actions.

Design and Navigation

The design of the online library is visually appealing.

The layout of the online library is well-organized.

The icons and labels are clear and helpful.

I can easily switch between sections in the online library.

The library's interface is compatible with mobile devices.

Content Quality

The online library provides a wide variety of resources.

The content in the library is up-to-date.

I trust the quality of the materials available in the library.

I can find resources that meet my academic needs.

The library offers content in multiple formats (e.g., e-books, articles, videos).

User Satisfaction

I am satisfied with my overall experience using this online library.

Using the online library meets my academic or personal needs.

I feel that the online library improves my learning experience.

The online library saves me time in finding resources.

I would recommend this online library to others.

Accessibility and Personalization

The online library is accessible from any device I use.

I find the accessibility features (e.g., text size adjustment) helpful.

I can personalize my experience (e.g., saving bookmarks, setting preferences).

The library provides resources in formats accessible to users with disabilities.

I can easily access resources offline if needed.

Future Use Intentions

I plan to continue using this online library.

I will use the online library more frequently in the future.

I am likely to explore new resources within this library.

I am open to using additional features if introduced.

My experience with this library makes me interested in trying other online libraries.

Library User Engagement

Behavioral Engagement

I frequently use my university's online library to access academic resources.

I dedicate a significant amount of time to each session in my university's online library.

I explore various sections and pages within my university's online library whenever I use it.

I regularly make use of different features in my university's online library, such as search options and saved resources.

I often download or save materials from my university's online library for future use.

Emotional Engagement

Overall, I am satisfied with my experience using my university's online library.

I enjoy browsing my university's online library for research and study purposes.

I rarely feel frustrated while navigating or using the features of my university's online library.

I trust my university's online library to provide reliable and useful information.

I would recommend my university's online library to other students or peers.

Cognitive Engagement

I feel focused and engaged when using my university's online library.

I believe that the resources in my university's online library are relevant to my academic needs.

I frequently discover new and valuable content while browsing my university's online library.

I feel curious and encouraged to explore various resources in my university's online library.

Using my university's online library enhances my knowledge and learning on different topics.

Social Engagement

I often share resources from my university's online library with classmates or peers.

I discuss content or resources from my university's online library with others in my academic community.

I engage in any available community features, such as reviews or discussions, within my university's online library.

I feel a sense of connection to other students when using my university's online library.

I actively stay informed about new resources or updates in my university's online library and share them with others.

Visual Engagement

The visual design of my university's online library, including layout and typography, appeals to me.

I am more inclined to use my university's online library due to its visually engaging interface.

The icons, graphics, and other visuals in my university's online library help me navigate more effectively.

The design of my university's online library encourages me to explore and engage further.

I feel that the visual presentation of my university's online library contributes positively to my learning experience.