Original Paper

Building an Age-friendly Digital Service System for Chinese University Libraries

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Abstract

As the aging process accelerates and information technology rapidly advances, the differences between the elderly and the digital society are becoming more pronounced. This highlights the need to bridge the digital divide and improve the quality of life for older people. University libraries play an important role in this. This study builds on the successful implementation of the Joint Information Systems Committee (JISC) digital capabilities framework in the United Kingdom (UK) to inform the design of digital services for Chinese University libraries. To improve these outcomes, university libraries need to prioritize three key areas: establishing a comprehensive strategic plan, developing a collaborative learning ecosystem, and innovative digital tools stirring together. Subsequent research will examine the efficacy of this system in a variety of settings and explore strategies for optimizing its visibility and effectiveness.

Keywords

age-friendly activities, Digital Literacy, JISC Digital Capabilities framework, University libraries, China

1. Introduction

1.1 Background to the Study

China's aging process is accelerating. According to data from the National Bureau of Statistics of China, by 2022, the population aged 65 and above had reached 209.78 million, accounting for 14.9% of the total population (National Bureau of Statistics, 2023). China is expected to become the country with the

largest aging population in the world by 2030. This significant demographic shift will have wide-ranging and profound impacts on the country's economy, healthcare system, pension schemes, and social services. To address the rapid growth of the elderly population, China urgently needs to make necessary adjustments in policy-making, resource allocation, and social services in the coming years to achieve sustainable social development.

Nowadays, the world has entered the digital era, and the rapid popularization of information technology is profoundly changing all aspects of society. The wide application of Internet, artificial intelligence, Internet of things and big data technologies has not only brought great convenience to the way of working, living and learning, but also reshaped the way people interact and access to information (Balsa et al., 2020). In addition, AI technologies are helping older people manage daily tasks and monitor their health (Moghadam et al., 2024). But problems such as vision loss, reduced mobility and memory loss that come with aging make it difficult for many older people to keep up with rapid advances in technology. Socioeconomic conditions such as economic restrictions may affect some older adults' access to necessary devices or Internet connections (Hargitt et al., 2019). Designing intuitive and easy to use interface, and provides corresponding digital literacy training, to help the elderly can more effectively deal with and adapt to technological change.

To address these challenges and promote the active use of digital technologies by the elderly, the National Committee of China has adopted the Master Plan for the Construction of Digital China. The plan clearly regards the elderly as an important target group for improving the quality of technology applications. By building a framework for digital services, the project promotes older people's adaptation to the digital society, personal development and satisfaction with digital services. This move is crucial in promoting the second demographic segmentation of the society, which is an important step to expand the consumer market to the elderly at the same time. "Key issues to improve universal digital literacy and skills by 2024", including the need to promote intelligent and efficient digital living environments (Cyberspace Administration of China et al., 2024). It is the responsibility of libraries to encourage citizens to use digital devices to access and use digital content to meet their livelihood needs in the most efficient and effective manner. This includes, but is not limited to clothing, food, housing, transportation, entertainment and recreation, e-shopping, online socializing, and health care. The Beijing Convention on AI and Education, endorsed by UNESCO, represents the first global consensus on AI and education (United Nations Educational, Scientific and Cultural Organization [UNESCO], 2019). This highlights the need to develop the necessary values and skills in the era of AI. Libraries are important sources of knowledge acquisition and information dissemination. They are best known for their potential to revolutionize adult education and digital literacy-based education (Pedrozo Campos Antunes et al., 2019).

The advantages of university libraries as age-friendly services are mainly reflected in the ability to integrate resources, advanced technical equipment and skilled staff. University libraries have specialized research departments and departments that combine teaching, research and social services.

These institutions are well positioned to conduct in-depth research on the information needs of older adults and to plan and implement targeted service programs based on research results (Huang, 2022). This advantage of academic research has enabled university libraries to constantly improve their information and service strategies in order to be scientific, systematic and all (Xie & Bugg, 2010) and others.

University libraries have the latest technology to make information accessible to adults. The use of technological devices is a key factor in increasing access to information among older adults (Pew Research Center, 2019). Additionally, university librarians participate in a sophisticated digital and information literacy program, which helps them develop basic technology skills for older adults and helps them develop mentoring and support (Xie, 2011)

1.2 Research Objectives and Implications

Due to rapid digitization, older people face greater challenges and incentives to join the digital society. Older adults express technophobia, uncertainty, and difficulty with complex interfaces when using digital technologies (Vroman, Arthanat, & Lysack, 2015). These challenges lead to older people using less digital technology in their daily lives and widening the digital divide, thus undermining the increased convenience and sociality that comes with digitalization. Adults have great potential and incentive to improve digital literacy as long as digital literacy training is introduced. For example. Therefore, it is important for older adults to understand the challenges they face in digital literacy and to take advantage of opportunities to improve their digital literacy. This is a fundamental problem for modern society.

With the potential to disseminate knowledge and information, university libraries are ideally suited to increase digital literacy among adults. In addition to their extensive collection of digital resources and high-tech capabilities, university libraries also provide high-quality teaching and learning services that can support holistic learning in digital literacy for adults (Huang, 2022). In partnership with local communities and government agencies, libraries can develop programs and learning materials for adults to progressively improve their digital skills. At the same time, a welcoming and inclusive library environment can provide a safe and stress-free environment where adults can engage in digital skills acquisition and receive support and guidance throughout their education. In addition, learning platforms and research opportunities in university libraries can facilitate adult participation in higher education, increasing their desire and confidence to learn and participate in the digital society.

UK universities have overwhelmingly adopted the Joint Information Systems Committee (JISC) digital capabilities Framework. This study makes a unique contribution to the field by investigating the applicability of this framework in age-friendly projects in Chinese higher education libraries. JISC offers numerous programs focused on individual digital literacy and organizational support programs to help library staff and patrons develop digital literacy skills (Beetham & Sharpe, 2013). By conducting an in-depth study of the JISC digital lcapacity framework within UK higher education and its application in practical cases, this research aims to propose a digital service system tailored for elderly

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users, with the goal of advancing the innovation of age-friendly services in Chinese university libraries. This system is expected not only to be practically applicable in teaching older adults fundamental digital skills, but more importantly, to enhance the effectiveness of library services by establishing a sustainable support and technology ecosystem. Ultimately, it aims to empower older adults with greater autonomy and promote their social participation in the digital era.

2. Literature Review

2.1 Overview of The JISC Digital Capabilities Framework

Digital literacy, which refers to the ability to effectively access, process, and communicate information in digital formats, involves not only the use of knowledge and technical skills as a crucial component (Ridsdale et al., 2015), but also encompasses the development of critical thinking and problem-solving abilities alongside the acquisition of technical proficiency. JISC (Joint Information Systems Committee [JISC], 2024a) emphasizes that, in order for individuals to operate effectively in their daily lives and work within a rapidly evolving digital society, where technology plays an increasingly central role in communication, problem-solving, and decision-making, digital literacy is essential.

The UK has set the standard for promoting digital literacy, and is ahead of many countries in terms of its adult population. The UK has been promoting the digitization of higher education through the JISC since the 1990s, with great success. In addition to leading innovative research and education in the field of computing, JISC plays an important role in the development of data sharing platforms and software (Joint, 2024). Not only in the UK, but also across the EU, these policies have had a profound impact on the development of strategies and policies for research and teaching computing.

The JISC digital capabilities framework has been developed to improve the digital competence of higher education organizations and individuals in the higher education environment. The six main areas defined in this framework: ICT skills, information and computing skills, digital creativity, digital communication, digital learning and development, and digital identity and well-being can be divided into these categories, which can divide the skills. The JISC program focuses on developing individual digital skills, such as supporting organizational support and motivation. This includes policy development, digital culture development and infrastructure improvements. These roles aim to work together to continuously improve digital capabilities across the organization. By using an integrated approach, organizations will identify gaps in digital capabilities and fill them with learning opportunities to ultimately enhance the overall digital transformation (JISC, 2024b).

Organizational digital culture, content and information management, research and innovation, communication, learning, training and assessment, and ICT infrastructure are the six key organizational areas addressed by the JISC strategy. The adaptation of the JISC system to the specific needs of different organizations provides considerable flexibility and convenience. The adaptation of the JISC system to the specific needs of different organizations provides considerable flexibility and convenience (JISC, 2024c; JISC, 2024d).

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2.2 Digital Literacy Initiatives Supported by JISC

Developing digital literacy is now a key policy issue in UK higher education. With the rapid advancement of technology and the increasing importance of digital literacy, universities are adopting great strategies to ensure their staff and students have the skills to thrive in the digital age. JISC supports a range of programs designed to enhance digital skills, leadership experience, student experience and engagement. Such programs not only help develop individual digital skills, but also foster a culture of continuous digital improvement in universities (JISC, 2024e). The table below provides an overview of the major digital literacy projects currently supported by JISC.

Your passage is well-written but requires a few minor corrections related to capitalization, phrasing, and punctuation. Here's the revised version:

Table 1. Principal Digital Capabilities Projects

Project Name	*Timeline*	*Project Content*
Digital Experience Insights Service	*Provides tools and insights to help institutions understand and improve digital experiences.*	*Improve digital learning environments.*
Digital Leadership	*Develops digital leadership skills among senior staff.*	*Empower leaders to drive digital transformation.*
Enhancing the Digital Student Experience	*Offers guidance on improving students' digital learning experiences.*	*Optimize digital learning environments.*
Digital Literacies in the Disciplines	*Focuses on embedding digital literacies within specific academic disciplines.*	*Tailor digital skills to disciplinary needs.*
JISC Digital Capabilities Framework	*Provides a framework to guide digital skills development.*	*Build structured approach to digital literacy.*
Digital Student	*Explores how students use digital tools in their learning.*	*Improve support for digital learning.*
Digital Assessment	*Examines the impact of digital tools on assessment practices.*	*Enhance assessment through digital means.*
Digital Inclusion	*Ensures equal access to digital resources.*	*Bridge the digital divide.*
Supporting Digital Transformation in Higher Education	*Provides strategic support for digital transformation in universities.*	*Facilitate adoption of digital technologies.*

Table 1 shows that JISC-funded projects cover a number of broad areas such as leadership, student experience, professional skills development and digital engagement. It provides a comprehensive

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framework for developing digital skill. In addition to enhancing individual digital capabilities, these initiatives will also contribute to the digital transformation of higher education through different levels and sectors.

The data presented in Table 1 clearly show that the Digital Leadership framework focuses on the need for active leaders to advance digital transformation, ensuring that organizations maintain a clear strategic direction and successful implementation released in the digital age. Second, the table also shows that digital inclusion policies are designed to address the digital divide and promote equity in education by ensuring that disadvantaged groups have equal access to digital tools.

Table 1 shows that Digital Competence in Disciplines programs develop students' digital skills in response to the diverse requirements of different educational institutions. This approach increases their ability to use digital technology in their specialties.

In addition, numerous student-centered programs, such as *Digital Learners* and *Enhancing the Digital Learning Experience*, aim to improve digital literacy and foster the development of independent learning skills. The "Digital Assessment" program improves assessment methods that use digital technologies to improve the efficiency and quality of instruction. The Digital Transformation Support for Higher Education program strategically drives higher education by providing institutions with the tools and resources necessary to remain competitive in a rapidly changing digital environment.

2.3 Digital Literacy for Older Adults: Necessities and Challenges in the Context of Active Aging

The World Health Organization in 2002 for the first time puts forward the concept of "active aging" (World Health Organization, 2002), emphasize the elderly should be regarded as active participants and valuable member of the society, and not only is the object need to be taken care of. The idea of promoting the elderly in the aspects of physical, psychological and social participation, cooperative development, encouraging them to remain independent, and actively participate in social activities, in close connection with the community and family. The United Nations has been launched multiple global initiative to promote the application of digital technology among the elderly, improve their digital literacy levels. The use of digital tools has multiple benefits for older adults: it can help improve cognitive function, improve mental health, and effectively reduce loneliness (Heo et al., 2015).The elderly can on the digital platform to actively participate in social activities, access to key health information, as well as participation in lifelong learning (Tirado - Morueta et al, 2023). Meanwhile, the promotion of digital education and training is also important to alleviate the social isolation that older age groups may experience due to digital exclusion (European Electronic Platform for Adult Learning [EPALE], 2021).

There is a growing trend towards the challenges that older people face when using digital tools. They often experience difficulties operating digital devices due to vision loss, decreased finger flexibility, and cognitive degradation (Hunsaker & Hargittai, 2018).Weakened the memory loss and problem solving skills and makes old people to learn new technology of confidence, and increased anxiety (Mitzner etc., 2010). Emotional distress and reduced self-esteem further deepen psychological barriers

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and weaken their willingness to adopt new technologies (Rosen et al., 2013). In addition, the phenomenon of social isolation reduces older people's access to help and resources, which in another way limits their possibilities to develop digital skills, further increasing their distance from the digital world (Schulz et al., 2015).

2.4 University Libraries in the Digital Technology Revolution: Role and Mission

In the context of accelerating global aging, libraries, as hubs of cultural and educational resources, are gradually becoming key social institutions serving the elderly. The library is a "third space" with social functions and is a channel for the elderly to obtain information. To help the elderly better integrate into the modern information society. Relying on its rich academic resources, advanced digital technology, professional library team and educational advantages, university libraries can tailor personalized and systematic digital technology training programs for elderly users to help them master modern information technology skills.

However, the vast majority of university libraries do not adequately consider the specific needs of the elderly in the learning environment and other aspects. Older users may encounter technical barriers to accessing digital tools, such as complex user interfaces, small fonts, or lack of voice navigation (Ahmad et al., 2022). In addition, older users have a slower learning curve and often require more support and guidance, a need that is often overlooked in existing university library service models (Fletcher-Watson et al., 2016). Most college librarians receive training mainly for students' information literacy courses and lack relevant experience and guidance in serving the elderly. While the digital literacy level of the elderly is generally low, librarians need more patience and skills to help the elderly master digital technology and acquire basic digital skills (Oh et al., 2021).

2.5 The Necessity of Learning from The JISC Digital Capabilities Framework and Its Potential Implications

Although the JISC system was originally developed for students and university staff, its structured, multidisciplinary approach and flexibility make it highly flexible for improving adult digital literacy. The six core components of the JISC program go beyond education, providing practical and practical support for adults to navigate the complex digital landscape (Biggins, Holley, & Zezulkova, 2017). These areas of basic digital skills, understanding and information management are critical to helping adults integrate into the digital society, as well as supporting their educational goals.

The key strength of the JISC Digital Literacy Competency Framework is its ability to build comprehensive organizational support systems. This includes upgrading digital infrastructure, creating a supportive organizational culture, and developing effective processes to improve the digital environment. This framework is particularly important for Chinese university libraries as they need to redesign their services, especially in terms of the needs of older users. In addition, university libraries can adopt targeted strategies to optimize existing resources, such as improving user interfaces and integrating voice input technology, so as to effectively meet the actual needs of elderly users (Banwell et al., 2004).

The flexibility of the JISC system enables university libraries to tailor their service models to meet the unique needs of older adults. The action plan *Improving Digital Literacy and Knowledge for All* recognizes the challenges faced by the country related to digital ethics, so digital literacy policies should take precedence over ethical standards and codes. In addition to developing digital skills, it is important for users to be aware of the ethical standards and legal responsibilities associated with the use of digital content. According to JISC guidelines, these programs not only support the acquisition of technological skills by adults in university libraries, but also encourage them to think about responsible digital practice, including ethical and legal issues is also considered (Huang & Feng, 2022).

3. Methodology

3.1 Designing the Survey

This study uses a survey methodology to identify key features of the JISC initiative and its potential to promote digital literacy among old adults in Chinese university library services. The study examines examples of digital literacy practices in UK universities with the aim of identifying key aspects of the JISC digital capabilities framework that are relevant in this context. The study begins with a comprehensive review of the implementation of the JISC in UK higher education through a systematic literature review. It will also highlight the extent to which individuals and organizations are using digital literacy goals. The foregoing will help to identify key factors for increasing digital literacy among adults, allowing the development of a comprehensive framework tailored to the specific requirements of Chinese higher education libraries. In addition, this study used a systematic approach to examine the applicability of these materials in the context of Chinese university libraries. That is, how these materials can be adapted and adapted to better serve older users in different cultural and educational settings in China (Littlejohn & Margaryan, 2014).

3.2 Collection of Data

This study draws on a range of case studies, drawn from the JISC database, that provide insights into the role of digital skills education, institutional support and technology tools in UK higher education. In addition, educational databases such as Google Scholar and Web of Science were used to collect literature on the JISC program, digital literacy, and adult education (JISC, 2024f). These articles are helpful in two ways. It often provides a theoretical basis for research. Second, it made it easier to compare and validate across studies. Thus, the results of the selected case studies and studies are relevant for both academic research and practical applications.

4. Depending on the Practice

4.1 An Examination of Digital Literacy Practices in UK Universities

This study examines the practices of 12 UK universities in implementing the JISC. The course focuses on three main areas: vision and goals, strategy and implementation, and outcomes and challenges. The final phase focuses on the implementation of individual digital skills training, the integration of

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technology tools and organizational support and policy implementation.

Table 2. Implementation of the JISC Digital Capabilities Framework in UK Universities

Strategy: Discovery Tool

School	Key Implementation, Outcomes & Challenges
University of Wales Trinity Saint David(UWTSD)	*The "big bang" strategy was put into practice by hiring user success specialists and consultants for digital skills. For self-evaluation, the Discovery tool was employed. More than 200 workers saw an improvement in their digital skills, and employee satisfaction rose from 60% to 75%.*
Leeds Trinity University	*Established clear milestones and integrated the Discovery tool into HR processes, including annual reviews and staff development discussions. Staff skills improved significantly, particularly in terms of efficiency and creativity.*
University of Derby	*Launched the Discovery Tool, used customized questionnaires, organized focus groups and collected user feedback. Staff attended four bespoke digital skills training sessions.*
University of Westminster	*Participated in the Discovery Tool project, engaging staff through VLEs and workshops. 500 staff and 2,000 students participated in digital skills training initiatives.*
Gloucestershire College	*Launched the Discovery tool, implemented feedback-based training programs and set clear targets for digital skills development. Over 100 employees participated in digital skills assessments.*
Cardiff and Vale College	*Launched the JISC Discovery Tool and Digital Experience Survey and integrated them into the TEL strategy. Increased staff engagement with the digital learning program, with a focus on sustainable support and cultural change.*

Strategy: Customized Questionnaires and Workshops

School	Key Implementation, Outcomes & Challenges
University of Southampton	*Developed bespoke questionnaires, workshops, videos and courses in collaboration with JISC to build communities of practice. Engaged over 600 international students in blended learning initiatives.*
Weston College	*Implementation of the Discovery Tool and creation of a SharePoint site to provide digital resources and guidance for students. More than 350 staff and students participated in these initiatives, with resources tailored to their specific needs.*

Strategy: Digital Experience and Community Engagement

School	Key Implementation, Outcomes & Challenges
University of Hertfordshire	*Established a working group, led by Library and Computing Services, to promote the use of JISC tools. A total of 156 staff from 14 disciplines participated in digital skills programs, helping to raise awareness of digital skills development.*
University of York	*Introduced a digital literacy assessment strategy and provided tailored training programs, with a particular focus on the use of VLEs. However, pilot programs showed limited participation, requiring further outreach.*

Strategy: Digital Transformation

School	Key Implementation, Outcomes & Challenges
University of Leicester	*The digital partnerships project, which employed the Discovery tool, concentrated on the development of leadership skills and the implementation of cultural change. In order to achieve sustainable growth, it was necessary to provide the project with ongoing institutional support.*
Cardiff and Vale College	*A digital transformation strategy was integrated, combining LinkedIn Learning with organizational policies to create role-based learning pathways. The initiative was adopted by more than 4,000 staff and students, with over 10,000 active users on the platform.*

Strategy: VLE Adoption & Digital Capability Support

School	Key Implementation, Outcomes & Challenges
University of Hertfordshire	*Library and Computing Services led a group to promote JISC tools. 156 staff from 14 subjects took part, improving digital skills.*
University of Derby	*Launched a Technology Enhanced Learning(TEL) strategy and formed the Digital Derby Steering Group. 322 staff provided feedback, with additional support required for those unfamiliar with digital tools and terminology.*

Strategy: Pilot Programs & Digital Adoption

School	Key Implementation, Outcomes & Challenges
University of York	*Worked with HR to integrate digital skills assessments into ongoing programs. However, limited participation highlighted the need for increased outreach and engagement.*
Gloucestershire College	*Launched pilot training programs based on the Discovery Tool, gathering feedback to refine and improve digital adoption strategies across the institution.*

Based on the analysis of Table 2, different universities, under the guidance of the JISC digital capabilities Framework, have adopted diverse implementation strategies to advance their digital literacy initiatives.

Several case studies in the table highlight the critical importance of feedback mechanisms in digital literacy programs. Multiple universities rely on the "Discovery Tool" to systematically conduct self-assessments and gather feedback. For example, the University of Derby utilized customized questionnaires and focus groups to collect user feedback, followed by organizing four dedicated digital skills training sessions for staff. Similarly, Gloucestershire College collected feedback from over 100 staff members using the Discovery Tool and based on this feedback, established specific digital skills development goals.

Creating personalized learning pathways is essential for the success of digital literacy programs, especially when addressing the unique needs of different groups. The University of Derby customized its skills training to align with staff needs, improving both their digital competencies and participation rates, which in turn boosted program effectiveness. Cardiff and Vale College combined external platforms like LinkedIn Learning with internal policies to develop role-specific learning paths for their staff.

The case studies in Table 2 illustrate the importance of collaboration across departments and widespread participation in effectively implementing digital literacy programs. At the University of Hertfordshire, staff from 14 disciplines came together to participate in a coordinated digital skills development initiative. Likewise, the University of Westminster used its virtual learning environment (VLE) and workshops to involve 500 staff members and 2,000 students in its digital literacy training efforts.

Support from leadership and a shift in organizational culture are essential for the long-term success of digital literacy projects. The University of Leicester case emphasizes how leadership's commitment to skill development and cultural change can drive the success of digital literacy initiatives.

Several universities have integrated digital tools with existing HR processes or teaching support platforms, enhancing the operational effectiveness and sustainability of their projects. Leeds Trinity University successfully embedded the Discovery Tool into HR processes, particularly in annual staff reviews and development discussions. Weston College established a dedicated SharePoint platform to provide digital resources and guidance, ensuring that both staff and students have continuous access to relevant learning materials.

Successful digital literacy programs require not only attention to the implementation during the pilot phase but also the potential for sustained promotion and large-scale development. Cardiff and Vale College combined LinkedIn Learning with its Technology Enhanced Learning (TEL) strategy, impacting over 10,000 active users, showcasing its successful experience in large-scale adoption. In contrast, the University of York faced challenges with low participation rates during the pilot phase, highlighting the importance of effective promotion strategies and incentive mechanisms for broad

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engagement and the long-term development of the project.

4.2 Analysis of the Application of the JISC Digital Capabilities Framework in Chinese University Libraries

4.2.1 Strengths and Limitations of the JISC Framework

Many UK universities and communities have adopted the JISC Digital Competency Framework in practice with positive results. The unique strength of the framework is its multi-layered, systematic design, which fully supports digital empowerment at both the individual and organizational levels. At an individual level, the JISC framework provides a clear, progressive learning path for users at different levels of digital literacy, ranging from basic digital skills training to the development of advanced critical thinking and information management skills. Through JISC's digital Skills self-assessment tool, users are able to identify skill areas that need improvement in the short term and tailor a personalized learning path accordingly. In addition, the framework offers online learning modules, workshops, and certification programs to help individuals gradually build up their digital capabilities. From an organizational perspective, the JISC Digital Competency Framework helps organizations create a digital cultural environment for all groups by optimizing infrastructure, integrating emerging technologies such as voice input, and improving user interfaces. In particular, the elderly group has a high demand for friendly and intuitive digital interfaces and voice technologies. The key to increasing the digital engagement of the elderly is not only to upgrade the technology, but also to create a convenient and inclusive digital culture (Biggins et al., 2017).

JISC digital capabilities framework provides practical strategies for Chinese university libraries to better serve the elderly users. Libraries can adjust service models according to the specific needs of elderly users, optimize operational processes, and design a digital environment suitable for this group. However, cultural differences, limited technical infrastructure, and the unique needs of the elderly pose significant challenges for libraries. To address these issues, libraries must implement localized solutions to ensure that technology tools are both accessible and widely available (Bawden & Robinson, 2012). In addition, the National Action Plan for Digital Literacy and Knowledge Enhancement emphasizes the importance of ethical standards and codes of conduct in fostering digital literacy. Therefore, it is also necessary to help older users understand and comply with ethical standards and legal responsibilities when using digital content (Huang & Feng, 2022).

4.2.2 How to Apply the Core Elements of the JISC Digital Capabilities Framework to Age-Friendly Services in Chinese University Libraries

An in-depth analysis of these cases reveals several key factors contributing to the success of digital literacy projects. These factors have not only demonstrated significant effectiveness in university practices but also provided multi-dimensional insights.

At the University of Southampton, the use of surveys and workshops promoted the widespread adoption of digital tools across various departments. Weston College, on the other hand, optimized interface design and provided personalized support to meet the diverse needs of users from different

backgrounds, effectively enhancing their digital capabilities. This highlights the importance of personalized design in addressing diverse needs.

Pilot projects at the University of Derby and online training at Weston College demonstrate that continuous technical support and regular updates to resources are crucial for helping users overcome technical challenges. At the same time, timely feedback and guidance have improved the user learning experience.

4.3 Recommendations for Chinese University Libraries

4.3.1 Developing an Integrated Strategic Plan

To enhance digital literacy among adults, university libraries could develop a four-phase strategy based on four key components: defining vision and goals, formulating and implementing policies, evaluating and refining practices, and providing ongoing support while accommodating specific needs. As illustrated in Figure 1, this approach is designed to offer a customized and personalized pathway to digital literacy for old adults.

Over time, libraries must develop proactive programs that include structured instruction and outreach efforts. These programs should aim to equip adult users with essential digital skills and familiarize them with the technologies they encounter in their daily lives. Additionally, it is important to train librarians to acquire the necessary skills to effectively promote digital literacy among adults. Developing curriculum requirements is equally critical to ensure flexible, targeted learning programs that can be adapted to meet the diverse needs and skill levels of adult learners.

The research and contextual phase involves integrating digital literacy education into existing service designs while allowing for the flexible adaptation of service content based on insights gained from current users. Libraries can utilize self-assessment tools to enable old adults to evaluate their digital literacy skills and provide customized learning support that aligns with their specific needs.

In support and promotional activities, libraries must develop long-term strategies to regularly assess the progress of early-stage users. This approach serves two primary purposes: first, to enhance the likelihood of users successfully accessing and utilizing services; second, to create replicable service models that can be adopted by other libraries. Additionally, building internal and external support networks is crucial, as these networks will facilitate communication and collaboration with existing users, ensuring continuous service improvement.
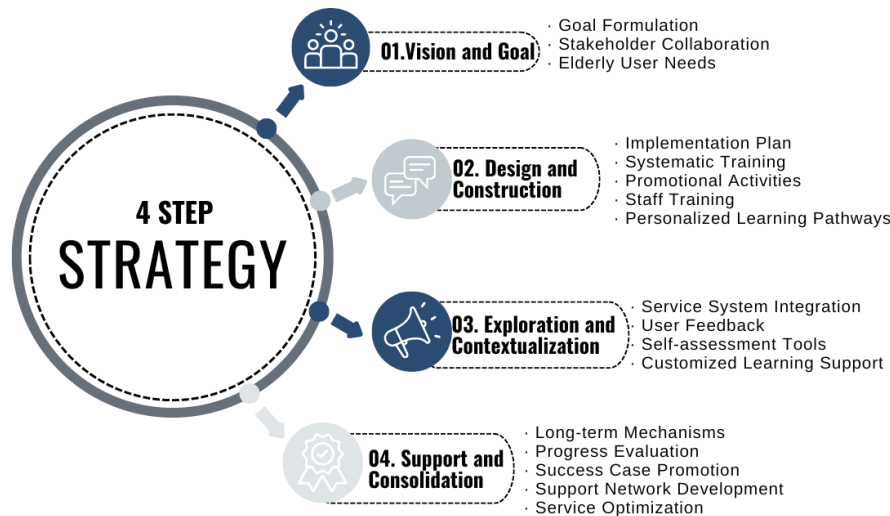
Figure 1. Four-Phase Strategy for University Libraries

4.3.2 The Creation of an Interactive Learning Ecosystem

Building a learning ecosystem centered on enhancing digital literacy for older adults holds significant and far-reaching implications for sustainability. A systematic learning model can help older adults adapt to the continuously evolving digital technologies over the long term, addressing the ongoing challenges they face in the digital age. Practical cases indicate that older adults often lack long-term effective support and continuous learning resources when confronting new technologies. By establishing a sustainable learning ecosystem, libraries can collaborate with other institutions to provide older adults with long-term technical support and learning opportunities, enabling them to continuously enhance their abilities as technologies evolve.

This system is centered around "elderly learners" and is structured around four key components: learning environment, social support and feedback, learning activities, and expected learning outcomes (as shown in Figure 2). The learning environment forms the foundation of the system, offering older adults a supportive physical and virtual space that allows them to access and utilize digital resources more easily. The design of physical learning spaces should take into account the specific needs of older adults, ensuring accessibility features and a comfortable learning environment. In contrast, virtual learning spaces should be optimized through digital platforms and tools, such as large fonts, simplified interfaces, and voice navigation, to reduce the barriers older adults face when using digital technologies.
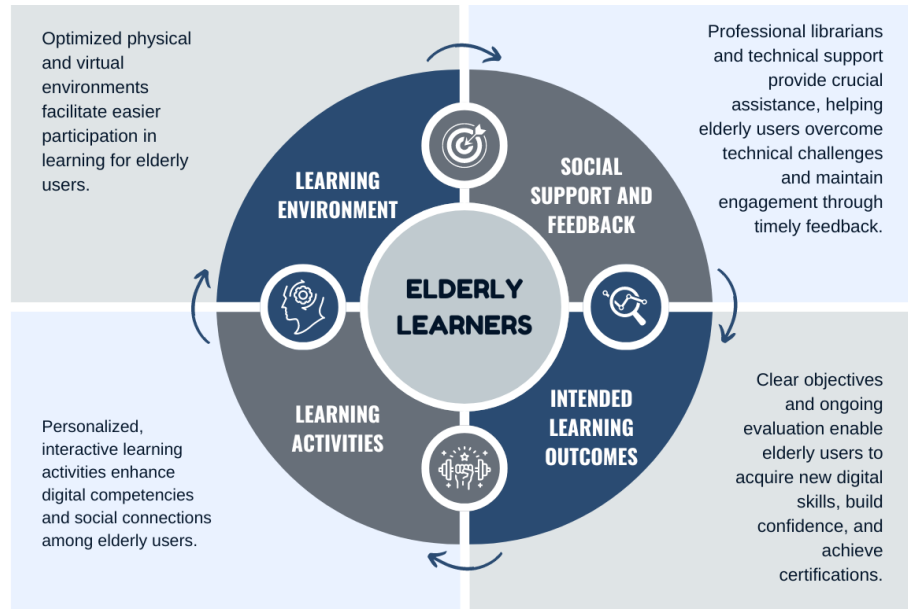
Figure 2. An Interactive Learning Ecosystem

Social support and feedback provide crucial and ongoing assistance to older learners. Social support primarily comes from professional technical staff and peer interactions. Peer interactions, through experience sharing and mutual encouragement, help older learners maintain their motivation, fostering emotional support and knowledge exchange. Technical staff provides guidance to help learners overcome and resolve technical issues they encounter. Feedback and evaluation are processes of self-reflection and improvement for older learners. Through self-assessment and evaluation, learners can recognize their progress, identify areas that need improvement, and receive targeted support to enhance their skills. The design of learning activities emphasizes interactivity and personalization, ensuring that each older adult receives appropriate training and guidance based on their individual needs and learning pace, thereby improving learning efficiency. Finally, expected learning outcomes are achieved by setting clear learning objectives and conducting continuous evaluations, allowing learners to experience a sense of accomplishment at each stage while feedback is used to continuously improve the learning experience.

Figure 2 also illustrates the close connections between the various components, forming a sustainable learning cycle. Learning outcomes, in turn, drive the improvement of the learning environment and learning activities, while the social support and feedback mechanisms ensure the smooth operation of the entire process. This systematic and cyclical design enables older learners to continuously enhance their digital skills within a sustained support system, allowing them to better adapt to and integrate into the rapidly evolving digital society, thereby achieving long-term participation and autonomy in the digital age.

4.3.3 Integration of Innovative Digital Tools

Research shows that digital tools such as data analysis, virtual reality (VR), augmented reality (AR)

and social media can effectively improve the engagement and learning outcomes of older learners. The advantage of these tools is that they can track learning progress and behavioural data in real time and flexibly adjust learning content based on user needs.

Digital tools can be integrated into all parts of the senior learning ecosystem. Libraries can use digital tools to automatically recommend personalised learning content and resources based on learners' behavioural patterns, preferences and learning progress. Intelligent design and voice assistants further simplify the learning process, track the progress of senior learners, identify learning difficulties, and provide targeted support and feedback. The use of these technologies not only makes digital tools easier to use, but also enhances learners' sense of achievement and engagement, thus promoting the continuous optimisation of the entire learning ecosystem.

5. Conclusion

This study investigates the potential utility of the JISC digital capabilities framework for providing e-learning services in Chinese university libraries, revealing important opportunities to create personalized learning pathways, building organizational support systems, and learning strategies they collaborate on and shared use of new technologies. However, successful implementation of the scheme will require careful consideration of cultural and technological differences between China and the UK, as well as adaptation to the specific requirements of Chinese university libraries.

Future research should promote empirical assessments of the effectiveness of the service program, including methods, learning processes and tools, in a variety of settings. The framework calls for further consideration of the impact of traditional users on learning. Fieldwork and long-term follow-up studies on the actual impact of policy implementation in Chinese university libraries may produce inconclusive results. In addition, the study should address potential implementation challenges, including cultural differences, limited technology resources, and adoption of the technology by traditional users. In resource-constrained situations, it is important to see how the system can be adapted to local requirements and identify the most appropriate solutions. In addition, future research should investigate the impact of emerging technologies, such as artificial intelligence and virtual reality, in this process to improve flexibility and user experience increase while addressing data security and user privacy concerns.

Acknowledgement

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