A Novel Approach to Improving the Digital Literacy of Older Adults

***Abstract*—The 21st century is characterised by two defining trends: the rise of ubiquitous computing and population ageing [1]. Digitalisation offers opportunities for older adults (OA) to retain an active role in their lives and alleviate the 'burden of care' associated with ageing. Yet, digital engagement is consistently cited to be inversely related to age. Although interventions to enhance the digital literacy of OA through formal in-person training have emerged, there has been little evaluation of their effectiveness. This paper presents insights into the attitudes, needs and challenges of OA in becoming digitally literate. We conducted preliminary user studies with OA and a survey of younger adults (YA) to understand their role as an informal support system. Based on these insights, we propose an innovative approach to digital literacy training for OA by combining a senior-friendly learning management system with informal inter-generational learning. A preliminary evaluation of the system yielded positive feedback and indicates a need for a more extensive exploration of the digital experiences and requirements of OA and the influence of social support systems in their digital engagement process.**

***Index Terms*—digital literacy, continuing education, digital divide, androgogy**

I. Introduction

The global population is living longer. By 2036, it is estimated that 25% of the UK population will be over 65 [2]. Several studies have demonstrated that the accessibility of digital technology from the home presents tremendous potential to help older adults (OA) improve their quality of life, and preserve their independence and social connectivity [3]. However, over 79% of the UK's digital exclusion occurs among those over 65 [4]. Digital exclusion is linked to wider inequalities in age, gender, geography, educational attainment, socioeconomic status, occupational choice, social connectedness, and household composition, among others [6]. Early discussions on the digital divide focused on the first-level divide of material and financial access to the Internet and devices, but recently, significant strides have been made to address this [7]. The second-level divide, with issues of digital literacy and motivation, affecting how people use, perceive, and can benefit from using Information and Communication Technologies (ICT) [8], is harder to close because ICT remains so complicated that access does not equate to adoption [9]. OA have not had lifelong exposure to ubiquitous computing like younger generations, yet they are expected to constantly adapt to an increasingly digital world on their own using the very skills they lack. With COVID-19 accelerating digitalisation, from communication and shopping to banking and healthcare, there is greater risk of a widening digital divide that promotes opportunities for some but exacerbates existing inequalities for others [5].

In this work, digital literacy refers to the "set of skills associated with the use of ICT that every individual should develop to be able to perform in a computerised society," [10] including the physical aspect of using technology. OA are not a homogeneous group in their abilities and attitudes, but a decline in functional capacities is a feature of ageing that commonly affects technology adoption among OA [8]. Age-related physical limitations such as vision decline, hearing loss, and motor skill diminishment make interacting with devices challenging. Cognitive limitations in memory capacity, perceptual speed, text comprehension, attentional function, and spatial memory [11] affect their ability to focus, absorb and retain new information, limiting learning speed while increasing errors and time taken to complete tasks [12]. This often results in feelings of anxiety and low self-efficacy that demotivates OA from trying to use ICT [13].
It is often argued that the pattern of low digital engagement among OA will disappear as future generations gain experience with digital technologies. However, future generations of OA are not exempt from the physical and cognitive changes of ageing. Even if technology usability is improved today, the problem will keep resurfacing as technology changes and advances [14]. Hence, until all products, services, and content can be made universally accessible at the outset [14], there is a critical need for older adults to become digitally literate. OA must understand the benefits of digital engagement and learn how to continuously integrate ICT in their lives for accessibility to ensure adoption.
This paper presents our early results of exploring the issue. From literature, we identified the distinct characteristics and learning styles of an adult learner and identified gaps in current UK-based digital literacy initiatives, particularly the need for informal family learning. User studies were conducted of two interdependent groups - OA and younger family members - to validate the problem from juxtaposing perspectives. Insights were translated into a prototype Learning Management System (LMS), which was evaluated to verify its usability and utility. Initial user evaluation studies support our hypothesis that a blended learning approach combining a senior-friendly online LMS with inter-generational family support to deliver digital literacy training for OA is possible and conducive to learning.

II. Related Work

In his theory on andragogy, Knowles outlines six principles fundamental to designing educational programs for older adults (OA): intrinsic motivation, need to know, self-concept, experience, readiness to learn, and problem orientation [15].

Many models of technology adoption emphasise motivation as the fundamental predictor of technology use in OA. The Senior Technology Acceptance and Adoption Model (STAM) lists the perceived usefulness and the usability of digital technology (software, hardware, Internet and Internet-based services) as factors impacting technology adoption [16]. For OA to be motivated, the utility of a technology must outweigh the effort of learning to use it [17]. For OA who are already motivated to use technology, ease of the learning process will determine the actual use [18]. Social Cognitive Theory (SCT) postulates that an individual's knowledge acquisition occurs within a social context of reciprocal interactions between the person, their behaviour, and their environment. While personal factors such as the individual's "self-efficacy, desire to learn, adventurousness, or desire to explore," [19] dictate their behaviour, their environment determines the outcome of that behaviour [20]. As fewer formal learning opportunities exist for OA [19], the social milieu of caregivers, peers, family, friends, or (perceived) influential people affect the actions that OA choose to perform, the effort they are willing to exert, and their persistence despite inevitable obstacles [21]. Thus, the two key components in the adult learning process are: the distinct needs of the adult learner, and the importance of informal learning via social support systems. We evaluate existing UK digital literacy initiatives against this knowledge to identify opportunities.

Learning Management Systems (LMS) are typically used in formal or institutional learning for the young or workforce training. No such system exists for the elderly. Current online resources for digital literacy training, such as the Learn My Way website [22] created by the Good Things Foundation or e-guides created by Digital Unite [23], are not designed for the capabilities of OA. They provide the basic functionality necessary for learners but lack awareness of the content, accessibility, and functionality needs of OA. The national charity, AgeUK, and the global movement, University of the Third Age (U3A), focus exclusively on OA but neither centralises educational resources to practice outside of class, necessary to encourage self-paced, independent learning [21]. AgeUK delivers in-person one-to-one and group digital training, which is neither scalable nor accessible for a large, dispersed elderly population, especially those in remote areas or with restricted mobility. U3A runs offline and online member-led learning through formal classroom lectures and discussions, which may not cater to the varied abilities and needs of OA. Existing initiatives also underestimate the informal learning that happens through social networks, especially family.

III. Proposed Approach

This study extends existing work by proposing a blended learning approach that involves a senior-friendly learning platform teaching real-world digital skills delivered in multiple formats for access anytime, anywhere. A key feature of the approach is access to the informal social support system. Research indicates that family, particularly younger members, are consequential to technology adoption [23] although there is a "scarce body of literature" on why or how they exert influence [24]. As the digital world is all they know, younger generations naturally surpass their older family members in this regard. Hence, this study examines not only the experiences of OA but also digitally native young people and their role as informal educators.

IV. Methodology

The first phase consisted of two user studies: interviews with OA to gain first-hand insights into experiences, attitudes, and competencies in ICT use and to understand the conditions for facilitating learning; and a survey of YA to understand their perspectives as informal educators in the technology adoption process. For both studies, A thematic analysis of clustering responses, quotations and observations was conducted to discern broader trends and patterns that represent the most interesting aspects of the data gathered. In the second phase, findings from phase one were translated into design features for a prototype LMS and early usability studies were conducted. Ethical approval for both phases of the work was obtained from the authors' institution.

Interviews with Older Adults (OA): The study included ten OA from the UK (8 females, 2 males) in the age range of 74 to 91 years, who were healthy, and could read and speak. Four OA were recruited from public adult community centres and six through word-of-mouth. One-on-one, in-person semi-structured interviews were carried out in two parts. Firstly, perceptions were evaluated through open-ended questions on ICT ownership, access, and usage followed by questions about experiences, frustrations, and learning styles. Secondly interactions with the Learn My Way (LMW) platform [22] were observed. Although LMW is not designed specifically for OA, it provided a baseline to identify relevant features and design challenges to inform development of our LMS. Interviews were video recorded and transcribed verbatim.

Survey of Young Adults (YA): An anonymous online survey composed of nine questions was administered using Qualtrics to YA aged 18+ with experience providing informal technical assistance to an older family member (parent, grandparent, aunt or uncle). The survey was designed to understand the activities involved, frequency and types of tasks, frustrations, and the overall sentiment of being an informal educator. Two demographic questions (location and age) were included to examine the socio-cultural aspect as sentiments on providing family assistance may vary by community. YA were recruited via social media. Of the 24 responses collected, most respondents were from UK (10) and Indonesia (9), and the age range was 18 to 60 years.

V. Discussion of Findings

A deductive data analysis strategy of the interview data uncovered four themes **Motivation and technology use:** This study did not find any significant correlation between socio-demographic variables, such as age, education, past profession and household composition, with digital literacy of OA. All OA expressed positivity about the pace of technological

advancements and their benefits to social connectedness, efficiency, and digital hobbies such as photography, cartography, and music workshops. Findings indicate that OA are driven to learn by intrinsic factors such as fulfilment and personal development. Irrespective of their digital competency, five of the youngest OA (74-85 years) wished to continue learning to achieve a sense of pride and accomplishment whereas five of the oldest OA (86-91 years) expressed a lack of interest in engaging with ICT because they find it challenging to "learn anything new" or they can perform everyday tasks without ICT through a proxy of family or friends. Yet, all OA recognised that digital literacy has evolved rapidly from being an option into a necessity for functioning in modern society. They expressed fear of ubiquitous digitalisation with examples cited including self-checkout kiosks at supermarkets, online parking payments, and online banking. Feelings of isolation, narrowing of options and lack of support from authorities were mentioned. The lack of exposure to and support in using ICT might explain the participants' general discomfort and helplessness when confronted with an ICT-related problem. This is supported by the respondents of the YA survey who attributed the lack of digital literacy in their older family members to the complexity of technology (22), a lack of access to training or support (10) and a lack of interest in ICT (9).

Family Support: An inductive sub-analysis of the data revealed the fundamental importance of family in technology adoption. Participants were not explicitly asked about support systems, yet themes around family assistance emerged from every interview even though some OA were affiliated with organisations such as AgeUK and U3A. While friends and spouses were mentioned, children, grandchildren, nieces and nephews were cited as the first point of contact for technical assistance (10). Most YA believed they possessed a normal (10) to high level (11) of influence in the technology adoption process. Ironically, while all OA expressed challenges in preserving their autonomy and independence, seven OA expressed reluctance at asking for help, especially from their family. Five OA reported that their children become impatient when they fail to comprehend basic instructions or when they frequently forget what was taught. Their children assume they possess prior knowledge of technology or technical jargon. This is validated by findings from the YA survey, where no correlation was found between geography and sentiment in providing technical assistance. Some YA found the teaching process rewarding (2) or viewed it as a responsibility (2) but most YA expressed frustration at having to repeatedly explain basic technology tasks and the slow teaching process (24) whether in-person or virtually. Three YA cited patience as an important quality but ten admitted they often succumbed to setting up the technology for the OA rather than teaching the OA. These findings suggest that OA need more time to absorb knowledge, make more mistakes and more support is needed in the learning process; this is not feasible for younger family members who do not live in close proximity (15), do not have the time (10), or simply find the process hard and frustrating (8). Thus, the OA's desire to learn may not always match their younger family members' capacity to teach them. The imbalance in expectations demands a solution based on a shared-responsibility model.

Age-related challenges: Seven participants cited a decline in working memory as one of their biggest life challenges - inability to hold extended conversations or remember simple habitual things like names and locations evokes feelings of anxiety. Participants commonly cited note-taking on paper as a coping mechanism. Other limitations include hearing impairments (9) and restricted mobility which prevents them from using public transportation (9). This suggests that usability barriers can prevent OA from starting the digital learning process even though it may alleviate many of the challenges OA face in tasks such as setting reminders, finding directions, and accessing essential services remotely.

Learning styles: OA perceived in-person classes as ineffective because of their short attention span (8) and the lack of undivided attention (3). OA generally expressed a strong preference for self-paced learning relevant to solving real-life problems without relying heavily on a formal educator to promote self-practice and experimentation. All OA strongly preferred software and hardware to be set up for them, and learning material to contain step-by-step guidance. This is validated by the survey of YA whose primary activities involve setting up and walking through basic tasks. OA tire easily because they view learning as homework and feel the need to memorise steps and processes rather than understanding the rationale behind actions. Concerning the Learn My Way platform, all participants appreciated the minimalist interface, logical information presentation and clear language. Five OA were curious about the array of topics, clicking on topics that piqued their interest. The more tech-savvy OA preferred to explore more advanced topics or to refresh their skills with hands-on activities. A number of features on the interface are not suited to older users such as: large bodies of text; cartoons rather than realistic images, distraction caused by ambiguously worded buttons. Introductory lessons on computer basics (OA) and follow-along video tutorials (YA) were proposed by participants as improvements.

VI. Pilot Evaluation of Elderlearn

We developed Elderlearn as a prototype to enable knowledge-sharing between OA and YA. Adult learners, as primary users, can learn independently at their convenience but still seek intermittent guidance as needed from younger family members, who, as informal educators, are secondary users of the system. Elderlearn (1) integrates an onboarding questionnaire to personalise learning to the competencies and interests of the learner (2) recommends learning materials on a variety of relevant real-life skills (e.g. Internet and device basics, online safety, healthcare, and banking) ordered by increasing complexity to reduce the cognitive load associated with remembering (3) delivers bite-sized lessons in various formats (video, audio, text) to accommodate differing abilities and preferences, and (4) incorporates communication tools

(video calls with screen-sharing, bookmarks, and in-app note-taking) for learners to seek remote or in-person support from informal educators. The interface design adheres to the web content accessibility guidelines for the elderly as outlined by the National Institute of Ageing (NIH) [25]. **Procedure:** Studies with OA were conducted to evaluate the usability and utility of Elderlearn. Four OA (3 females and 1 male) aged 75 to 86 years were selected from the participant pool of OA from phase one on the basis of availability. One session involved a pairing of a participant and their nephew - they simulated a scenario in which Elderlearn could be used within the desired informal learning context. After OA were briefed on the study objectives and relation to the initial interviews, they were introduced to the system on a tablet and asked to perform tasks to assess their understanding of the system with minimal assistance from the researcher to evaluate if the system was simple enough to use without an educator present. Discussion, feedback and suggestions for improvement followed. **Results:** Observations and direct quotes from the study were categorised by system usability or utility. When OA were attentive, they were able to perform the tasks and identify the system elements effectively with minimal assistance and no prior training, likely due to the uncluttered interface, restricted and explicitly worded actions. All OA navigated the onboarding questionnaire easily and expressed positivity about the functionality, as it made them aware of their knowledge gaps and provided a structured pathway for improvement. Two OA indicated a preference for visual rather than textual content, and information about skills they lack and which lessons address these shortcomings. All OA found the course topics comprehensive. Three OA found the ability to bookmark courses useful. Some of the functionality received more mixed feedback. For instance, a minimalist aesthetic was harder in lesson content which consisted of step-by-step textual guidance, text alternatives (video, audio) and sub-features (e.g. bookmarks, note-taking, quiz). As a result, all OA took longer than the estimated thirty minutes per lesson and often became distracted. All OA also encountered difficulty overcoming the default browser permissions for video calls (microphone, camera, screen-sharing). While three OA found the screen-sharing feature useful, demonstrating a mobile-device problem via a video call on a tablet was impractical for OA. Despite concise and prominent instructions, all OA consistently overlooked them and were uncertain how to perform tasks, causing many erroneous selections. OA were made aware of their mistakes by the researcher (or nephew), after which OA would re-read the text, and successfully perform the task. Three OA explicitly attributed this behaviour to the researcher (or nephew) who instinctively intervened to help users recover from mistakes rather than encouraging experimentation, which they felt would have forced them to read instructions and was the preferable approach for all OA. This suggests that OA are capable of independently navigating the system; guidance is critical but must be provided sparingly to encourage experimentation and build confidence. Finally, OA were asked to describe the system to someone who has never seen it. It was evident that OA understood the main aim of the system and cited its utility, with OA using words such as 'exciting,' 'useful,' 'fascinating,' and 'brilliant.' They offered feedback on aesthetic and usability suggesting that specific functionality and workflow were not issues. While OA acknowledge the need for skills development and acknowledge the usefulness of the system, this intention to use many not necessarily translate into usage. Reasons mentioned were tiredness associated with complexity and anxiety about retaining knowledge and requirement to learn another technology.

VII. Threats to Validity

The main limitations in this work are the size of the studies and sampling bias. As sample sizes for both user studies are small with more women than men taking part, they may not be representative of the population. Attempts to reduce sampling bias included maintaining a narrow research goal and asking each participant the same open-ended questions. Saturation in the form of overlapping themes was achieved across all studies. Another potential limitation is interviewer bias. The evaluation used a carefully crafted task list but it is possible the researcher, a young adult, inadvertently used unfamiliar technical jargon. These studies allow initial conclusions to be drawn but more work is required to obtain conclusive results.

VIII. Concluding Remarks and Future Work

Little is understood about how OA acquire knowledge of technology and suitable learning formats and strategies for teaching them [42]. To the best of our knowledge, this is the first study to propose a blended learning approach, combining a senior-friendly LMS with inter-generational family learning, to encourage a shared responsibility between the adult learner and their informal social support system. Our preliminary user studies indicate that this approach presents substantial potential in helping older adults cross the digital divide but there is a long road ahead. The pilot evaluation of Elderlearn suggests that the fear and insecurity of technology felt by older learners must be reduced for the perceived utility of the system to translate into usage. Current design and accessibility guidelines do not adequately capture the multifaceted challenge of ageing, which is unique, gradual, and personal. Thus, further quantitative and qualitative usability testing is required to reduce the effort and complexity associated with learning a new system like Elderlearn. Avenues for further research include employing OA as researchers to alleviate interviewer bias, using technology probes to understand the inter-generational interaction between OA and younger family members while they engage with the LMS to compare the efficacy of our approach with existing initiatives, examining socio-cultural aspects and factors such as household composition and social connectedness, which may influence behaviour, and support from non-family social relations. We hope our study will encourage a more extensive exploration of designing digital experiences to better support the digital citizenship of older adults.

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