

Improving the Digital Literacy and Social Participation of Older Adults: An Inclusive Platform that Fosters Intergenerational Learning

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Abstract: In an increasingly digitalised world, many older adults face the choice of improving their digital skills or risking social isolation and exclusion from essential services. With older adults expected to represent 16% of the global population by 2050, there is a renewed urgency to improve their digital literacy. Although many in-person and online technology training initiatives exist, they are often not accessible or poorly optimised for older adults. Younger adults, who typically form older adults' support network, may be key to any solution. However, their help typically serves as a temporary fix until a new issue arises, leading to a cycle of dependency. This pilot study offers insights into the technology experiences of older adults, the ways in which younger individuals assist them, and how both groups stay connected. We conducted small-scale but in-depth user studies with older adults, and an online survey of younger adults, to understand how the technology support process could be improved to promote older adult autonomy and active ageing. Based on our findings, we propose an age-friendly platform that leverages intergenerational exchanges for a personalised learning experience that brings together younger and older adults. The final prototype was well received by participants in the user study. However, further exploration of other aspects of their lives and cultural differences in intergenerational learning, and larger studies of younger and older individuals are needed to co-create a solution that helps bridge the global digital divide while enabling older adults to have more fulfilling lives.


1 INTRODUCTION

The world is facing an unprecedented demographic shift with the number of older adults aged 65+ predicted to double over the next three decades to 1.6 billion in 2050, and account for 16% of the global population (United Nations Department of Economic and Social Affairs, 2023). At the same time, we face an increasingly digitalised world with services and resources migrating online at a rate accelerated by the COVID-19 pandemic (United Nations Conference on Trade and Development, 2021). Since older adults experience lower rates of technology adoption, acceptance, and use, with these levels negatively correlated with age (Mullins, 2022), there is a growing digital divide that can cause them to lose access to essential services such as healthcare, banking, shopping, and communication channels (Age UK, 2019), while also increasing the likelihood of social isolation. According to a 2019 Fundamental Rights Survey in the Euro-

pean Union, only one in five individuals aged 75 and older “at least occasionally engaged in Internet activities”, compared to 98% of those aged 16 to 29 (United Nations Economic Commission for Europe, 2021). Consequently, the digital divide is likely to widen as more services migrate online (Hashimi, 2021).

Older adults often turn to the younger people in their lives for assistance with technology. Yet, many younger adults lack the availability, resources, and training skills to effectively support their elders, resulting in little improvement in the older person's technology skills and frustration for both sides (Azevedo and Ponte, 2020; Yuan et al., 2016).

This pilot study, conducted as part of a wider research agenda of reducing the digital exclusion of older adults, explores two goals: to improve the digital literacy of older adults to enable continued independence, and to increase their social participation by facilitating digital use with family and peers. We adopt the definition of digital literacy as “the ability to use information and communication technologies

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to find, evaluate, create, and communicate information” (American Library Association, 2023). This research focuses on strategies to reduce the anxieties older adults may feel when interacting with technology, while addressing the motivations and pain points for both older adults and younger people to whom they turn for help. Our contributions include a survey of related work, user studies with older adults, a survey of younger helpers, prototype user interfaces reflecting findings, an evaluation of these prototypes, and insights from the work.

The rest of the paper is structured as follows. The background for the work on the digital literacy of older adults and existing approaches to address this issue are described in Section 2. An outline of our methodology to gather insights for potential solutions is provided in Section 3 followed by the main findings from the user studies in Section 4. The description and evaluation of two prototype solutions are included in Sections 5 and 6 with possible limitations outlined in Section 7. We provide some conclusions and thoughts on future work in Section 8.

2 RELATED WORK

2.1 Digital Literacy Barriers for Older Adults

As well as the traditionally acknowledged physical and cognitive factors of ageing, older adults also face significant social barriers such as limited motivation, lack of support, and anxiety stemming from the fear of “breaking” the technology they use (Helsper and Reisdorf, 2013; Friemel, 2016; Bolton, 2010). Studies have shown the lack of compelling reasons and interest in digital technologies as a significant factor in internet non-use (Hashimi, 2021; Helsper and Reisdorf, 2013). Moreover, older adults may be discouraged from going online due to the unavailability of and lack of support from family members, including the belief that their family members are uninterested in the same technologies. The barrier to digital literacy is exacerbated by their reliance on others for training and technical support, physical challenges, and lack of confidence in their ability to learn to use the technology (Czaja, 2019; Yuan et al., 2016).

The lack of support and the low technological self-efficacy of some older adults can further create anxiety around technology due to fears of breaking it and causing errors (Bolton, 2010; Flynn, 2022; Friemel, 2016). Such concerns stem from the uncertainties of utilising new technologies with which they have limited experience (Han and Nam, 2021; Mullins, 2022).

The lack of experience combined with declining motor skills and the significant cognitive requirements of trial-and-error learning can cause older adults to spend more time on tasks (Brajnik and Giachin, 2014; Yoo, 2021). As a result, older adults are more negatively affected by mistakes and experience a stronger psychological effect than younger users, leading to increased anxiety over potential negative outcomes due to operational errors (Brajnik and Giachin, 2014; Tsai et al., 2017; Yoo, 2021). These fears not only stifle the exploration of new technologies but also decrease their motivation to learn and willingness to use them (Atkinson et al., 2016; Brajnik and Giachin, 2014; Patrício and Osório, 2011).

2.2 Digital Literacy Motivators for Older Adults

Older adults are motivated to embrace digital technologies (Han and Nam, 2021) and more inclined to learn and use them with higher levels of satisfaction if these technologies are perceived as valuable and easy to operate (Tsai et al., 2017; Tyler et al., 2020). In addition, any benefits from such technologies must relate to the older adults’ personal and social needs (Martínez-Alcalá et al., 2018). Another key motivator, self-efficacy through learning, has been found to improve perceived usefulness and ease of use by raising the confidence of older adults in using digital technology and reducing their technology-related anxiety (Han and Nam, 2021; Tyler et al., 2020). Older adults are more likely to wish to learn specific tasks and require content that is designed with their learning styles, interests and expectations in mind, instead of generalised learning (Martínez-Alcalá et al., 2018; Mitzner et al., 2008). Studies have shown that tailoring a learning activity to the preferences of older adults can increase their motivation to participate (Hashimi, 2021; Tyler et al., 2020).

Measures to reduce cognitive load and improve system support can enhance error prevention and recovery, which improves the learning experience. Strategies such as training at an accessible pace, step-by-step instructions, repetition of content, visual aids, and digitalised note-taking can also address various age-related challenges including poor memory (Mullins, 2022). The provision of quick, efficient, and accessible pathways to system support can help users avoid making errors when interacting with digital technologies and reduce their annoyance from searching for advice to deal with their difficulties (Tsai et al., 2017; Tyler et al., 2020). In addition to encouraging them to engage with digital technologies, a friendly space for trial and error serves as an important fa-

cilitator for the learning experience of older adults (Barnard et al., 2013; Tsai et al., 2017). Likewise, user guidance has a direct impact on the perception of usefulness and learnability and an indirect impact on end-user satisfaction (Tsai et al., 2017).

Studies have shown that social support plays a significant role in improving the digital literacy of older adults (Hashimi, 2021). Ongoing support from trusted sources is essential in enabling older adults to overcome their anxieties and challenges, build skills, and develop confidence in the ever-changing landscape of digital technologies (Bolton, 2010). This leads older adults to perceive the usefulness and ease of use of digital technologies (Han and Nam, 2021). In particular, older adults value social connection and are intrinsically motivated to adopt and regularly use digital technologies when they are personally relevant, useful and supported by members of the older adult's family (Martínez-Alcalá et al., 2018; Tyler et al., 2020).

2.3 Leveraging Intergenerational Learning

Family members are often the preferred source of support with digital technology among older adults, with children influencing technology adoption and use (Flynn, 2022; Friemel, 2016; Fausset et al., 2013; Tsai et al., 2017). The intergenerational approach, involving younger family members as tutors, can provide effective support through its informal nature, accessibility, and understanding of any special needs (Atkinson et al., 2016; Flynn, 2022; Tsai et al., 2017). By creating a supportive learning atmosphere and addressing technical challenges, the younger generation plays a crucial role in alleviating demotivating emotions like anxiety and confusion. Their encouragement also sparks a newfound interest in digital technologies among older adults, while fostering stronger familial bonds (Hashimi, 2021).

As well as increasing the self-esteem of older adults and their trust in digital technologies, the reinforced social connection between younger and older family members can mitigate physical absence, promote independence and autonomy, and enhance family communication regardless of geographical distance to combat loneliness and social isolation (Azevedo and Ponte, 2020; Flynn, 2022). While younger adults appreciate the value of social connection and consider it important to assist older family members with their technical issues (Flynn, 2022), they may also feel social pressures to do so (Azevedo and Ponte, 2020). The intergenerational approach offers reciprocal learning opportunities for younger

adults who develop increased patience and understanding when teaching older relatives the digital technologies they take for granted (Flynn, 2022). This interaction strengthens family relations, reduces barriers, and breaks “negative stereotypes between generations” (Hashimi, 2021). In addition, these younger adults gain improved leadership abilities, self-esteem and confidence (Hashimi, 2021).

However, the intergenerational approach can be inhibited by limits to the availability of family members and their teaching abilities. One of the greatest barriers older adults face is family members being busy with their work, families, and social lives. While, along with geographical distance, this can make communication difficult (Yuan et al., 2016), family members are still mostly supportive whenever possible (Tsai et al., 2017). Increased digital literacy with Internet usage could offer more opportunities to make communication easier and more flexible for older and younger family members (Azevedo and Ponte, 2020).

Even if a younger family member has the technical experience and readiness to help, they may not have the required teaching skills (Azevedo and Ponte, 2020). Without an understanding of older adults' slower learning pace of due to the physical and cognitive limitations of ageing, younger adults may lack the patience to teach them (Azevedo and Ponte, 2020). This can lead to a situation where younger people demonstrate solutions too quickly to be useful. The quick fix is for the younger person to simply perform the task themselves rather than persisting with the learning process (Renaud and van Biljon, 2008). This not only discourages older adults from improving their digital skills but can also increase confusion and intimidation by such technologies, leading to frustrations for both older adults and their support network due to the older adults' ongoing dependence on their younger peers for completing tasks (Flynn, 2022). Only when these limitations are addressed can intergenerational learning offer new opportunities for older adults to improve their digital literacy, while bringing them and their younger family members closer together.

2.4 Evaluation of Existing Solutions

Older adults can now access a range of online services to improve their digital literacy. Platforms such as *Learn My Way*¹, *TechBoomers*², and Google's

¹<https://www.learnmyway.com/>

²<https://techboomers.com/>

*Applied Digital Skills*³ offer online help guides and courses for older adults who are struggling with technology, or want to expand their understanding of it. There is also preliminary research into an age-friendly online learning system within the context of informal family learning (Vaswani et al., 2023), which motivates this work.

In some cases, an easy-to-use interface, for example, with information clearly laid out or requiring a few simple steps to complete a task, with a single search bar and step-by-step guides may be sufficient for older adults to learn about the digital technology they require, especially when they are accessed through a desktop or laptop. However, with the rising adoption of touchscreen devices among older adults (Faverio, 2022), many may struggle to use platforms that are not optimised for touch interfaces. For instance, text and interactive elements such as buttons and links may appear smaller and harder to read or tap on (Kane, 2019), and menus may be hidden behind icons that are unfamiliar.

Moreover, these platforms often have a separate user registration process requiring the creation of an additional account, the details of which need to be remembered, offer limited error prevention and recovery measures, and lack system support such as product tours and help on every page. Given that many older adults tend to experience a slowdown of cognitive processes as they age (Caprani et al., 2012), these limitations can make completing tasks on such platforms more stressful and challenging. Since older adults are particularly sensitive to making errors, such experiences may increase their apprehension and decrease their motivation to learn and use such platforms (Brajnik and Giachin, 2014; Yoo, 2021).

There are usually limited options in existing systems to personalise the learning process based on one’s abilities and impairments (such as vision levels or motor skills), and their goals and interests. This can reduce the accessibility, perceived usefulness, and ease of use of such platforms, which are pivotal factors for engagement (Han and Nam, 2021). In addition, the lack of note-taking features (other than the option to print guides) and an isolated training environment, along with memory issues, may hinder the ability of older adults to retain information, while also feeling unsupported. Existing platforms frequently fail to consider the perspectives of the younger family members and acquaintances, who provide support, by either involving them in the training process or offering them guidance on how to help the older adults with their technology-related enquiries. Since older

³<https://applieddigitalskills.withgoogle.com/s/en-uk/home>

adults frequently mention family members as their preferred source of digital technology support (Flynn, 2022; Friemel, 2016; Mitzner et al., 2008; Tsai et al., 2017), this is a missed opportunity for them to play a significant role in creating a supportive learning environment, especially to address feelings of anxiety or confusion during the older adult’s training process, and to be the stimulus for engaging with learning.

3 METHODOLOGY

Our approach to improving the digital literacy of older adults involves both older adults and their support network, who are usually the younger people in their lives. Therefore, user studies with older adults (more likely to be available in person) and an online survey of younger individuals (typically with more time commitments) were conducted to better understand how intergenerational learning can be leveraged to increase digital literacy among older adults and foster social participation between the generations. Ethics approval from the authors’ institution was obtained prior to this work.

Thematic coding of the responses from both groups of users was conducted using Work Activity Affinity Diagrams (WAADs), which is a hierarchical bottom-up technique that places similar feedback together to highlight common or shared themes (Hartson and Pyla, 2018). As shown in Figure 1, this included key strategies, pain points, and areas of improvement within the technology support process for both younger and older adults. The results were then

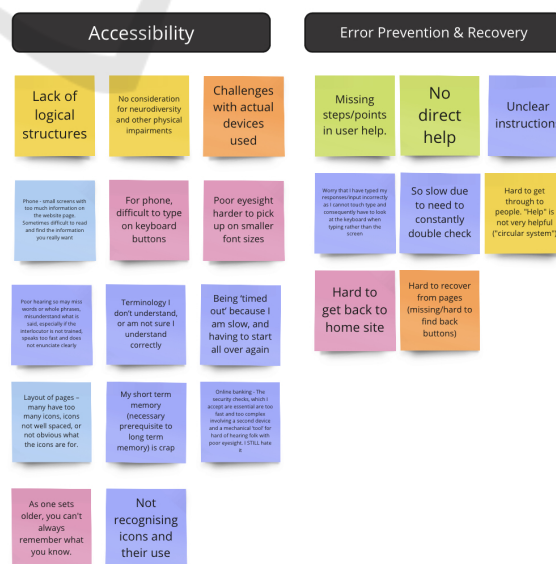


Figure 1: Sample Older Adult Interview WAAD for their Key Digital Technology Challenges and Frustrations.

used to develop prototypes of the *EldersOnline* platform discussed in Section 5.

3.1 User Studies with Older Adults

6 participants (4 women and 2 men) aged 70 to 79 were recruited from the UK through snowball sampling and split across 3 rounds of in-depth user study sessions. For the first part of the study, in-person semi-structured interviews were carried out to explore the motivations and challenges for older adults using digital technology, their preferred means of support with technology issues, and ways to increase their social connectedness with younger generations. The second part involved a think-aloud session where users completed tasks on a prototype tablet application (produced as a high-fidelity on Figma⁴) and another semi-structured interview to explore participants' experience using the prototype, with the prototype being updated after each round of feedback as part of an iterative user-centred design process.

3.2 Survey of Younger Individuals

An anonymous online survey of younger adults between the ages of 18 and 64 was conducted to gather feedback on the methods used, motivations, challenges, and areas of improvement in supporting older adults, as well as ways to increase engagement between them and older adults. Participants were recruited through social media and snowball sampling. In total, 50 responses were collected with 39 aged 18-24, 7 aged 25-34, 2 aged 45-54, and 2 aged 55-64 (Figure 2). 70% of the respondents were comfortable with using and teaching others to use information and communication technology (ICT) devices and online services, 26% were comfortable using them, and 4% required assistance with them.

4 DISCUSSION OF INITIAL FINDINGS

In this section, we outline the findings from our studies with older adults and their younger helpers.

4.1 Findings from the First User Study with Older Adults

Our participants appeared more digitally literate than typical in literature from the past decade (Friemel,

⁴<https://www.figma.com/>

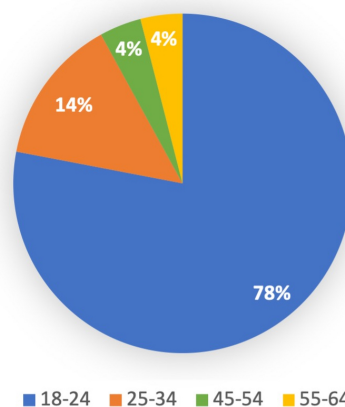


Figure 2: Survey Respondent Age Demographics.

2016; Czaja, 2019; Yazdani-Darki et al., 2020; Martínez-Alcalá et al., 2018), with all 6 using the Internet daily. All participants primarily use a laptop/desktop, and own a tablet and smartphone, thus having access to a range of devices. The following themes were identified from their experience with different online interfaces:

- **Accessibility.** 5 participants highlighted accessibility challenges, including limited consideration for neurodiversity and physical impairments, poor content layouts, and unfamiliar terminology and icons. Phones, due to their smaller display, posed usability issues for 3 participants. Cognitive declines mentioned by 2 participants led to difficulty with tasks timing out and having to restart due to the time taken to complete them.
- **Error Prevention and Recovery.** A recurring theme among 5 participants was the lack of error prevention and recovery methods: inadequate user help, including unclear instructions and missing steps (3 participants), and challenges with recovery due to missing or hard-to-find “back buttons” that caused delays and frustrations (2). Effective help and user control are needed to alleviate the impact of these issues (Nielsen, 2020).
- **Online Security.** 5 participants had concerns about online security, including scams and hacking. 2 mentioned worries about privacy due to weak protections and data leaks. Text/email verification delays caused access concerns for one participant. Overall, participants shared a cautious and vigilant approach to online navigation.
- **Fear of Making Mistakes.** Limited digital familiarity led 2 participants to express fear of damaging or permanently altering the digital technologies they use, aligning with literature (Bolton, 2010; Flynn, 2022; Friemel, 2016; Hashimi, 2021; Mullins, 2022; Tsai et al., 2017).

Participants mentioned the following as the most appealing aspects of different online interfaces:

- **Good Design and Usability.** Participants valued well-designed and intuitive interfaces. This included a clear structure, identifiable “home” options, and a streamlined process.
- **Personalisation.** Participants emphasised the importance of providing plenty of personalisation options, with customisable font sizes and the ability to remove distracting elements to enhance information focus.

The following themes were highlighted in addressing technology-related struggles:

- **Frequency of Issues.** In general, participants do not struggle with major issues often, with the frequency ranging from 1-2 issues weekly to once or twice a year.
- **Sources of Support.** Participants predominantly turn to four support channels for technology assistance: family, friends, customer support, and video tutorials. Notably, grandchildren play a heightened role, with some participants preferring them over their children due to their increased availability. “Tech-savvy” friends and video tutorials are also highlighted as important resources.
- **Increasing Awareness.** For 4 participants, a recurring theme was raising awareness about their physical and cognitive challenges, gaps in their knowledge, and learning styles within their support network. Participants emphasised the need for empathy, supported practice, opportunities to practise in real life without feeling inadequate, and more relatable help facilities. These answers highlight the importance of a learning environment that offers accessible, empathetic help and regular practice.

On engagement with younger family members, the resulting feedback showed variances as indicated below:

- **Bonding Through Technology Support.** Participant views varied on whether receiving technology support from younger family members would strengthen their relationships. 3 participants expressed concerns about feeling burdensome or being mocked, and noted that their slower learning pace could reduce the willingness of younger members to assist. Others saw it as a means of mutual support that broke traditional norms. While 2 participants acknowledged the potential for enhanced connections, they pointed out that the busy schedules of their younger family members might affect the feasibility of such support.

4.2 Findings from Online Survey of Younger Adults

The following insights were gathered regarding supporting older adults with their technology-related issues:

- **Supporting Older Adults.** 94% of respondents had helped older adults around them with their technology issues in the previous six months, with 26% doing so more than ten times (Figure 3). 46 respondents were intrinsically motivated to help because they: wanted to enhance the lives of their older peers, were approached for assistance, wanted to show their appreciation, or felt obligated to do so. 3 mentioned how doing so prevents them from being asked about issues “again and again”. 2 respondents shared the increased satisfaction and self-confidence from helping, and another 2 remarked on how it improved family connections.

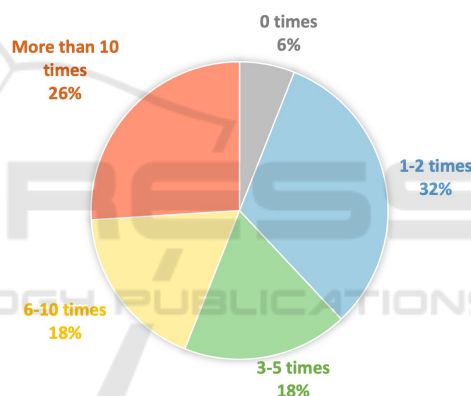


Figure 3: Frequency of Technology Support within the Last 6 Months.

- **Common Frustrations.** There were frustrations with explaining basic concepts (29 individuals), repeating solutions (9), and the time-consuming nature of supporting older adults with technology issues (2). Challenges also arose from the reluctance of older adults to learn (7) and their concerns about scams and privacy (2).
- **Enhancing the Support Process.** Respondents suggested clear and understandable tutorials (10 individuals), a platform for any initial queries (7), and screen-recording facilities for demonstrations (9) to enhance support. 7 respondents also emphasised the importance of having more patience when teaching older adults.
- **Connecting with Older Adults.** 72% of respondents contacted the older adults in their lives at least once a month (Figure 4). Among the respon-

dents, 20 enjoyed hearing about life experiences and advice from their older family members, 16 wanted to receive updates about their health and daily life, 4 on their shared hobbies/interests and general chat, and 2 respondents liked to explore the views of older adults on current events.

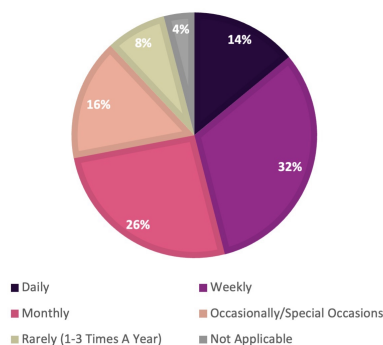


Figure 4: Frequency of Contact with Older Adults.

- **More Intergenerational Interactions.** While 22 respondents were unsure how to increase engagement with their elders, 11 proposed more frequent interactions based on shared interests. 6 respondents mentioned the idea of reminders, 4 suggested encouraging older adults to use social media to improve communications, and 3 suggested the ability to exchange pictures and memories. One respondent expressed the wish to let older adults know they are in their family's thoughts and to keep them updated on their lives.

5 THE EldersOnline PLATFORM

We developed prototypes of a platform called *EldersOnline* to implement the insights gained from the initial user studies, which were organised and prioritised using a MoSCoW Analysis in the order of “Must”, “Should”, “Can”, and “Won't” have requirements. This included features that facilitated and stored intergenerational exchanges through an accessible user interface as well as error prevention/recovery measures to reduce barriers to using technology.

Before the proposed interface solution was developed, a consistent visual design and style guide was established through an extensive literature review for the system's visual elements, including:

- Well-contrasted colour options of magenta or purple (alongside light/dark modes) with distinct hues (Farage et al., 2012) and a minimum contrast ratio of 4:5:1 (Anagnostou, 2020).
- The use of Helvetica typeface (Farage et al.,

2012), adjustable font sizes starting at 16 pixels (Campbell, 2015; Universal Design, 2020), and the use of plain language for maximum readability (Guimarães et al., 2022).

- Icons with descriptive text (Farage et al., 2012), minimum 15.9mm x 9.0mm button size, and spacing of interface elements (Gao and Sun, 2015).
- Simple and uncluttered interface to make the content clear and easy to find (Guimarães et al., 2022; Universal Design, 2020).
- Web Content Accessibility Guidelines (WCAG) Level AAA compliance (Who Can Use, 2023).

5.1 EldersOnline Features

Initially, lower-fidelity prototypes were developed based on the survey of existing work. Two high-fidelity Figma prototypes were then created and refined through user studies to form the *EldersOnline* platform. This included a tablet application to support the digital literacy and social participation of older adults and a smartphone version for younger adults to better assist and engage with their older peers. The interface for older adults includes the following features:

- **Passwordless Login/Registration.** The elimination of passwords for a more streamlined authentication process that addresses the issue of forgotten passwords due to poor memory. This mitigates any feelings of confusion, frustration, and decreased confidence that might discourage use.
- **Personalisation.** To maximise accessibility for a diverse user demographic, personalisation options to change the text size, system theme, and background colour were implemented.
- **Question Sharing.** Older users can search or view all their existing technology-related questions and resolution statuses, or ask a new one to their younger contacts with text, audio, and photo/video input options (Figure 5).
- **Question Answering.** Intergenerational exchanges are facilitated by enabling older adults to view and respond to questions posted by younger adults. As well as encouraging older adults to engage more with the platform, this allows younger adults to draw on a lifetime of experiences and wisdom. At the same time, this feature can alleviate an older adult's feeling of being burdensome to their younger peers by giving them a chance to offer meaningful contributions, all while improving intergenerational social participation.

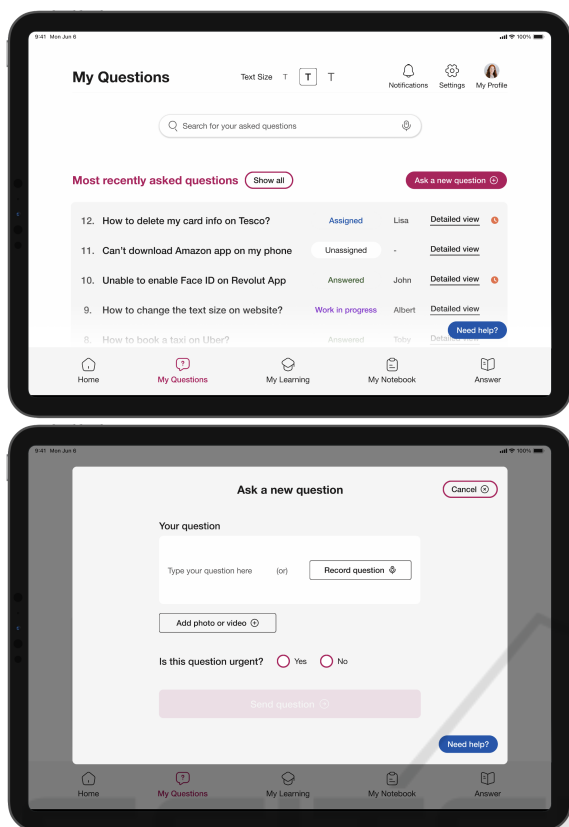


Figure 5: Question Sharing Feature.

- **Action Preview.** Users are shown what happens next before proceeding with their inputs. This was implemented for various creation actions to improve error prevention and recovery (Figure 6).

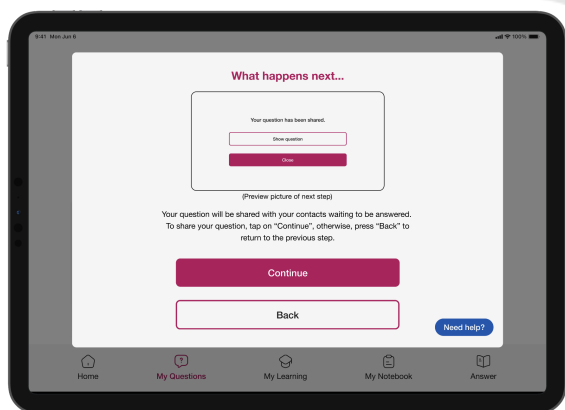


Figure 6: Action Preview Feature.

- **Online Learning.** Users can search for and view online tutorials/guides (including those recommended by their contacts) with options to add annotations and save specific tutorials/guides to their digital notebook, which is a place for them to add

new notes or access any previously saved ones.

The smartphone version of *EldersOnline* has similar design and functional features as the tablet version, but it differs in the following features to better cater to the needs of the younger user base.

- **Offering Support.** Users can assist their older peers with their technology issues by accessing the older contact’s posts or getting in touch directly by voice/video call or chat (Figure 7).

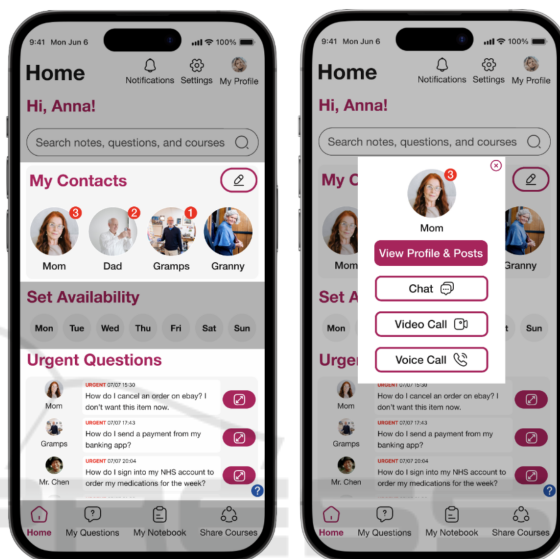


Figure 7: Ways to Identify and Support Older Adult Technology Issues.

- **Support Guidance.** Both the "Accessibility" and "Support Tips" sections raise awareness of the challenges faced by older adults, while guiding younger users to provide tailored support for optimal learning outcomes (Figure 8).
- **Setting Availability.** Given the busy schedules of younger adults and the concerns of older adults about making requests of them when they are busy, *EldersOnline* allows users to set the times when they are free to help with technology-related questions, alleviating the concerns of older adults.
- **Check-In Reminders.** Users can set reminders to encourage more frequent interactions.
- **Share Courses.** A place for safe and age-friendly solutions that younger users could share with their older peers immediately with minimal effort. This is also an opportunity for them to encourage their older peers to grasp basic technology concepts/knowledge that could improve their long-term digital literacy.

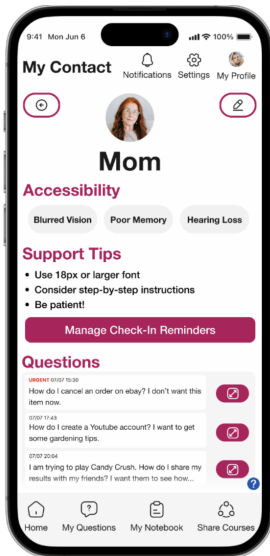


Figure 8: Tips for Helping Older Adults.

6 EVALUATION OF EldersOnline PLATFORM

The in-person evaluation of the *EldersOnline* high-fidelity tablet prototype for older adults consisted of two stages: a think-aloud product testing session and a post-session semi-structured interview about their experiences of using it. We also include a comparison of *EldersOnline* with existing solutions mentioned in Section 2.4.

6.1 Think-Aloud Evaluations

Think-alouds require participants to continuously verbalise their thought process as they perform a series of pre-determined tasks (Birch and Whitehead, 2020). This protocol was specifically chosen for its value in identifying usability problems (Fan et al., 2020). Participants were given an iPad with the prototype loaded for a more realistic experience for this session. Given the iterative nature of our design process, we began our first think-aloud round with three tasks and gradually extended them with additional features and updates. We also included metrics such as a 1-5 ease of use rating, task success, task time, and the number of errors to better understand how easy or hard it was to use our prototype for each task.

In general, participants found the interface easy and straightforward to use, especially once they were familiar with it. They frequently used a trial-and-error approach to navigate around the platform and its functions. There was constructive feedback on

the size, colour, and placement of buttons, the option to directly get in touch with a specific contact to pose a question instead of “troubling” or “bombarding” everyone, and the wording of different interface elements, which highlight the ongoing need to eliminate “technical jargon” that many take for granted and which can prove confusing for older users.

6.2 Post-Session Interviews

Participants appreciated the accessibility, password-less login, and error prevention/recovery measures within the prototype. They praised the simple, clear layout with contrast and text-resizing options. They noted that being able to see what happens next before initiating an action can be “rescuing”, prevent the perception of causing serious damage, and offer a simple and well-delineated escape route for people, making it easy to recover from errors.

At the same time, they recommended enhancing the clarity and navigation of certain pages by simplifying them. They emphasised the need for a system guide/tutorial and suggested rewording certain interface elements to be more understandable. Overall, our prototype garnered a mixed response from participants. Two expressed intent to use, one saw value if accessible on their phone, and three showed disinterest. When asked about the reasons for their interest, participants mentioned the advantages of learning to access specific digital technologies and online services. Notably, a participant highlighted the potential safety and reassurance this prototype offers to older users compared to searching on Google. Conversely, reasons for non-use included favouring existing social connections and using Google for queries.

6.3 Comparison with Existing Solutions

EldersOnline shares a number of key features with existing solutions, such as having an age-friendly interface, step-by-step tutorials that are printable, course recommendations, and a single search function.

Building on existing work and making use of the insights gained from older adults and younger helpers, *EldersOnline* offers its users a more accessible authentication process, enhanced error prevention measures such as action previews, touchscreen optimisation, a more personalised learning experience, including customisable interface elements and digitalised note-taking, and greater involvement from older adults’ support network, including sharing questions, knowledge and resources, and facilitating interactions.

At the same time, as a prototype solution to the

problems identified earlier, *EldersOnline* focuses on touchscreen use and currently lacks an onboarding process and desktop optimisation found in some existing solutions. This can impact the experience of some users, especially those who become anxious with new technologies or primarily use a computer to access the internet. Adding these features is part of the future work planned for *EldersOnline*.

7 THREATS TO VALIDITY

While even a few older participants can provide valuable insights in this context (Budiu, 2021), a key limitation of this preliminary investigation is the small sample size in terms of the diversity of age, abilities, and cultures, as all were recruited locally and may not be fully representative of this demographic. In particular, there is a lack of input from participants over the age of 79, which combined with the fact that digital engagement is negatively correlated to age (Mullins, 2022), can lead to a gap in this research.

8 CONCLUSIONS AND FUTURE WORK

Existing work in this area emphasises the development of accessible experiences. However, there has been limited consideration of the potential of an older adult's immediate support network to encourage a dignified two-way exchange of knowledge in support of active ageing and stronger intergenerational bonds.

Key findings of this pilot study include the importance of designing interfaces for older adults that promote accessibility, customisability, simplicity, error prevention and recovery, confidence in use, and trusted support. Effective intergenerational support is vital, and requires a greater awareness of the challenges of ageing and empathy for older adults' learning style and their concerns among their support networks, as well as learning platforms that provide mechanisms to reduce teaching frustrations. Such measures can allow older adults to develop greater self-reliance and break the cycle of dependency on their younger peers.

At the same time, there is an opportunity for older adults to further contribute to the intergenerational learning process by sharing their experiences with their younger peers. As well as encouraging two-way engagement, this can lead to improved social participation and reduce the risks of social isolation.

The study led to the development of two pro-

totypes that attempted to implement these findings. While the evaluation yielded mixed responses, the prototypes show potential in addressing the issue. User studies indicate that the "action preview" concept could be applied to destructive actions like "delete" across different platforms to mitigate the negative impact of errors. The proposed solutions can be extended to support general enquiries older adults may have about their daily lives. Expanding its usage scenarios may encourage older adults to use *EldersOnline* to maintain their independence as it is able to meet more of their needs.

There are many avenues for further research. The prototypes need to be evaluated with younger adults to determine their efficacy from that perspective. A popular sentiment among older participants was that *EldersOnline* could not fully replace face-to-face interactions. Hence, it may be less useful to users with younger families close by, highlighting the need to facilitate a greater variety of interactions beyond a 'question and answer' experience. Likewise, this solution may not fully apply to older adults without younger people who can help. Additional research is required to determine alternative ways to engage with them and support their digital literacy.

Another area for further research is how intergenerational learning can be applied across different cultures, since each may approach such exchanges differently. Support mechanisms for digital literacy need to be re-evaluated regularly to take into account the rapidly changing technology landscape. By considering the above factors, platforms such as *EldersOnline* can inspire innovative and impactful solutions that effectively bridge the digital divide, foster social participation through stronger intergenerational ties, and enhance the overall quality of life for older adults.

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