Decreasing the digital divide: analysing the UI requirements of older Australians

Carolyn Seton  
*Southern Cross University, carolyn.seton@scu.edu.au*

Raina Mason  
*Southern Cross University, raina.mason@scu.edu.au*

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Analysing the UI Requirements of Older Australians

Carolyn Seton
School of Business and Tourism
Southern Cross University
Hogbin Drive, Coffs Harbour 2450, NSW
carolyn.seton@scu.edu.au

Raina Mason
School of Business and Tourism
Southern Cross University
Locked Mail Bag 4, Coolangatta 4225, QLD
raina.mason@scu.edu.au

ABSTRACT

This paper describes an intervention with older social housing tenants in a regional NSW town. The intervention used existing research-based guidelines on User Interface (UI) design, applied to the interfaces used for learning and using technology by older Australians, as part of the Digital Age Project.

The study found that adhering to standard UI guidelines is particularly important when designing for novice computer users over 55 and that, although tablets overall were an attractive option, some participants found touch screens and pens problematic. Discussion of participants’ preferences in devices and input methods, as well as other observations of UI design effects recorded during the project, is included.

CCS Concepts

• Human-centered computing → Human computer interaction (HCI) → HCI design and evaluation methods → User studies
• Human-centered computing → Interaction design → Interaction design process and methods → User interface design

Keywords

User interface design; HCI; Human Computer Interaction; Older users; application of Cognitive Load Theory.

1. INTRODUCTION

1.1 The Digital Divide

The popular advent of digital technology has heralded a new chapter of communication and social exchanges [7]. At the same time, it has created a further social divide, commonly referred to as the digital divide, where socio-economic divisions such as gender, age, ethnicity and disability are accentuated [12]. Government services, business transactions and social interactions are increasingly delivered through digital means, and communities with limited digital competency are at an increasing risk of disadvantage [31].

There is a growing reliance on online services. The Australian Public Service ICT Strategy has committed to make key priority transactions available online by the end of 2017 [2] in what is known as the 'Digital First' initiative. While it is intended that non-digital alternatives to these services will be provided, it seems reasonable to expect that the existence of accessible non-digital alternatives will decline, widening this divide.

While people of all demographics can be affected by the digital divide, older Australians and people with disabilities are typically at higher risk of being ‘left behind’ in such technology adoption, often facing a variety of challenges when using technology [43]. These two groups are strongly represented in social housing.

There are many issues that need to be considered in order to address the digital divide. Digital literacy is a multi-layered and complex concept which:

"[I]nvolves more than the mere ability to use software or operate a digital device; it includes a large variety of complex cognitive, motor, sociological, and emotional skills, which users need in order to function effectively in digital environments." [14].

1.2 Older Australians and Technology

Older Australians remain the lowest group of adoptees of ICT in Australia. For the purposes of this paper, ‘older people’ are defined as those over 55 years old. While the level of technology use in this group of Australians is increasing, generally advancing age and level of technology use are negatively correlated [1].

For older Australians, especially those living in public housing, cost and accessibility to technology has traditionally been seen as a barrier [5]. While the cost has decreased, many older people hold misconceptions about technology and need to be better informed about the benefits that technology and the internet can provide [28].

Many of these older Australians will need to learn and adapt to new technologies if they are to take advantage of online services, and to ensure they can communicate and connect with family and friends using digital means.

1.3 Barriers to Technology Use for Older People

Many older people are challenged by ICT and find it difficult to use [27].

1.3.1 Physical Barriers to the Use of Technology

Age-related declines in health vary, affected by genetics and lifestyle, and can affect how older people learn to use technology.

One historical barrier to use of ICT by older people came from the challenge of learning to use the physical equipment, in particular the keyboard and mouse [22, 44]. Loss of physical dexterity, disabilities and conditions such as arthritis can lead to particular difficulty using these as well as touch pads and other input methods. The use of on-screen keyboards - such as on a tablet - may be accessible, but adds another dimension of complexity to onscreen activity.
Poor vision, often associated with aging, can make it difficult to read on-screen text and to find or identify important on-screen elements [19]. Furthermore, on-screen distractions, such as advertising and unnecessary elements, may amplify these difficulties for older users [18].

### 1.3.2 Generational Effects
The ‘technology generation’, determined by birth year, rather than age, refers to the type of technology we learnt to use in our formative years (aged 10 to 25) which can continue to affect use of technology later in life [16, 34].

Broadly mapped, the ‘Baby Boomer’ generation, now over 55, who experienced new technology as the release of televisions and video recorders, are deemed part of an electronic generation while those now over 75, the Builders, are part of a mechanical generation. Both of these generations may experience more problems learning technology that is software driven. People now under 55 (Gen X), a digital generation, are more comfortable with software driven technology.

For example, older people will understand the purpose of a physical button or key used to perform a function but may have more difficulty understanding the same button if it is performing another function in a different situation. Older users who have had minimal experience with hierarchical structures will find it more difficult to build mental models to represent these concepts and apply them to technology, as is expected in a multi-layered hierarchical menu style where only sub-sections are visible [32].

The experience of interacting with technology during formative years can provide the opportunity for a person to fully immerse themselves in that technology and learn all facets of it [32]. Therefore, the strength of learned schema and mental models about how technology works, developed during these years of peak cognitive functioning, provides a robust knowledge base and highly automated set of skills related to this technology.

Most people in the electronic and mechanical generations will lack this depth of experience using software-driven interfaces, acting as a barrier to learning because their technology skills may not be transferrable to current and changing interfaces.

### 1.3.3 Attitudes to Technology
Perceived attitudes can also act as barriers to technology learning and use. Computers were historically more expensive than current models and, according to Morris [28], older people can have misconceptions about costs, the technical ability needed and perceived lack of benefit to them personally. Newer technology is arguably more accessible, using touch screens and simpler interfaces, yet older people often maintain these misconceptions.

Older people are more likely to consider they have insufficient technical ability to learn to use technology, resulting in lower self-efficacy [6] and this can potentially lead to the users experiencing ongoing technostress [38].

### 1.3.4 Cognitive Barriers
Age can impact negatively on a range of mental faculties. This can lead to older people being more likely to experience difficulties compared to a younger cohort, when faced with complex tasks [35] such as learning and using ICTs.

Current research indicates a reduction in our working memory capacity as we age. According to Salthouse [35], this flows from a reduction in the speed with which we process some operations. He indicates that during complex tasks, the slower processing times lead to a reduced ability to retain information while simultaneously processing other information. Other researchers propose that as a task becomes more complex with a greater number of steps, longer processing times associated with age will increase the likelihood of information loss with each step [29].

Furthermore, as we age, there is a reduced ability to distinguish and filter out irrelevant information [18]. Rather than age indicating a reduced capacity in working memory, Hasher argues that working memory can be overloaded with irrelevant information.

### 1.4 Cognitive Load Theory
Cognitive load theory (CLT) is based on the understanding that humans have a limited amount of working memory and argues that a primary inhibitor of learning, thinking and problem solving is the cognitive overload of this working memory [41]. CLT research indicates that a reduction in any redundant or irrelevant (extraneous) information in instructional materials, used during the learning of complex tasks, has major benefits in learning and retention [40, 42]. A number of CLT effects have been documented which can be applied to instructional materials, thereby minimising the cognitive load experienced by learners.

CLT principles also underpin Instructional Design (ID) guidelines which recommend that instructional material should include use of consistent layouts, common navigational structures, graphics and icons where possible to provide a scaffolding for learning without adding extraneous cognitive load [25]. Once the learner understands how an interface works, they rely on this knowledge or learned schema.

Given that reduced working memory is associated with aging, the core principles of CLT and ID may be applied to the learning of complex tasks in older people. Simplified user interface designs, which access and build on existing skills, or learned schema, are therefore critical to ensure ongoing skill retention and use, and eventual automation.

### 2. USER INTERFACE DESIGNS FOR OLDER PEOPLE
An overarching goal of an effective UI design is to provide users with an interface which is easy to learn, easy to use and navigate. Many current user interface standards have evolved which try to cater for the majority of users and adapt to different skill levels.

Therefore, prior to discussing the specific UI needs of older people, some of the standard UI guidelines and best practices will be reviewed.

#### 2.1 Existing UI Guidelines
Commonly cited guidelines for UI design [for example, 36] have led to logical and often now ubiquitous UI elements and interactions that many of us take for granted in current UIs. Some of the key guidelines - those which are discussed further in reference to older generational cohorts - are detailed below; specifically for navigation, screen display, interaction and feedback.

##### 2.1.1 Navigation Guidelines
According to Schneiderman [37], navigational guidelines include:

1. **Standardise task sequences.** Allow users to perform tasks in the same sequence and manner across similar conditions.
2. **Ensure that embedded links are descriptive.** When using embedded links, the link text should accurately describe the link’s destination.
3. **Use unique and descriptive headings.** Use headings that are unique from one another and conceptually related to the content they describe.” [37]

### 2.1.2 Screen Display Guidelines

The screen design requirements of different applications often vary dramatically in terms of how content is displayed and how it operates. Common techniques used to improve the readability of content follow design principals such as the grouping of items, use of spacing, white space and graphics to deliver effective UI designs.

A set of high level goals and principles of the display of data were established [39], including the following guidelines that are relevant for older users:

1. **Consistency of data display (on-screen content).** Ensure consistent use of terminology, graphics, fonts, colours and layouts used, adapting content and feedback according to its use.

2. **Format of content aligned with the task.** Ensure that content is logically displayed, aligned and formatted in line with the task. Related data should be grouped, labelled if not clear and aligned according to the content; such as currency using $'s with aligned decimal places.

3. **Minimise memory load on the user.** Provide continuity of content where tasks have multiple screens; repeat and/or autofill key details so users do not have to remember from previous screens. Given limitations of working memory, menus and lists should not include more than seven items.

### 2.1.3 Interaction & Feedback Guidelines

According to Shneiderman & Plaisant [37], the rules of interface design which are applied to interaction include:

1. **Strive for consistency.** As for navigation and screen designs, interaction and feedback should be consistent wherever possible. If a user can re-use their knowledge of how one task works to try another, confidence is increased and the new skills are automated more readily.

2. **Permit easy reversal of actions.** Where possible, actions should be easily reversed, giving users confidence to explore actions.

3. **Offer information feedback.** The user should get consistent visual and/or aural feedback so they get confirmation, good or bad, about the status of their interactions and to be able to logically see what is expected next. Furthermore, users should be able to find out more without committing to actions.

On web pages and many applications, it has been traditional to allow a user to hover over a link or screen element to display the URL, more information or a text alternative to images and other web page elements. This feedback is not only helpful to the novice user but provides confirmation to users of all levels. Furthermore, if web page elements are programmed to display the feedback using common methods, this can enable ‘accessibility’ features of the website.

### 2.1.4 Accessibility Guidelines

As discussed in 1.3.1, older people may experience barriers to using technology created by physical problems and disabilities. To minimise some of these barriers, applications and websites can be designed and coded to enhance usability. For example, users who have poor eyesight can have the screen read to them and can apply magnification. These ‘accessibility’ features can be activated at the operating system settings level or within some applications and browsers and these can provide a variety of ways to enhance user interaction with technology.

**Operating System Accessibility:** Generally, operating systems provide accessibility features which can be applied to most applications running in that environment. For example, Microsoft Windows provides ‘ease of use features’ to allow for magnifiers, display of applications and colour themes in high contrast, and provide screen readers and allow the user to use voice recognition to give commands and dictate typing.

In addition to these general accessibility features, many more specialised products also exist to address a broad range of physical disabilities.

**Application Accessibility Standards:** For application developers, the operating system developer will provide instructions on how to code applications in order to enable the accessibility features. Some development environments also provide assistance with accessibility.

**Web Accessibility Standards:** Web Browsers provide some standard functionality such as Zoom to enhance readability. However, standards have also been established for website development in an attempt to facilitate further accessibility, given the variability in website design. The Web Content Accessibility Guidelines (WCAG 2.0) have been established by W3C, an organisation setting web standards [21]. Where followed, this will enable the technology support required to maximize the use of Assistive Technologies such as screen readers, magnifiers, text to speech software and the use of highlighting and alternate pointers, making it easier for older people, and in particular, those with vision problems.

To assist developers in meeting the guidelines, W3C provide checking tools and quick reference guides [21]. Some of the core guidelines are included below:

1. **Text Alternatives.** Provide text alternatives for headings, links and images on hover so that these can be used to enlarge print, or to provide braille or speech output;

2. **Distinguishable.** Ensure contrast and clarity of graphics, fonts and sound to ensure adequate and clear feedback is given;

3. **Predictable (consistent).** Provide consistent layouts and ways of operating the site.

### 2.2 UI Designs for Older People

Websites and applications do not always consider the needs of older Australians [17]. If the standard UI guidelines discussed in 2.1 are applied to UI designs, this could contribute substantially to assisting this older cohort to learn and use technology.

#### 2.2.1 Navigational Structures

For all users, providing a consistent navigational layout is an essential part of UI design. The importance of consistent navigational structures for older people during learning of complex tasks, such as ICT, has been confirmed in research applying cognitive load theory and instructional design principles in UI designs for older users. UI designs which maximise an older person’s ability to learn and use technology should aim to minimise irrelevant information as well as provide a consistent navigational scaffold for use [15, 25, 26].

Having adequate mental models of structures and spatial abilities are keys to successful navigation of computer interfaces [4] and older people benefit substantially from use of visual cues and
spatial elements within the UI. A clear navigational structure, which provides a consistent scaffold for features and menus, is key to providing these locational cues required for older users.

2.2.2 Interaction Design
Ensuring that standard interaction guidelines are met, such as those provided by Shneiderman & Plaisant [37], is especially important for an older, novice user. As for navigation and other onscreen UI elements, interactions should be consistent with user expectations, providing visual cues and other feedback to the user.

For example, moving a mouse over a link or menu item should provide more information to indicate what will happen if clicked. Providing an icon or a menu description only is insufficient for an older novice user who will not automatically be familiar with meanings, terminology used or even the action of the function, given the technology generation of older users [16, 34] and their lack of exposure and experience with technology.

Novice and older users are often looking for onscreen and visual clues to make sense of technology. Interaction which offers clear and consistent feedback at each step, as discussed by Shneiderman & Plaisant [37], is therefore a critical part of UI design for older people, giving them immediate feedback that provides them with a better understanding of their interactions.

2.2.3 Handling Change in UI Design
For older people, the building and retention of new concepts, mental models and skills, when learning ICT, is more difficult than for their younger cohorts. As discussed in 1.3.2, older people typically take longer and work harder to build the appropriate mental models and need practice to automate these skills. This is due in part to their technology generation’s lack of exposure to software-driven technology with multi-level hierarchies and new styles of interaction [32] which is typically compounded by slower cognitive processing speeds linked with aging [33] as well as a potentially reduced working memory area.

However, not all cognitive abilities are affected by age. Our long term memory holds three types of memory or knowledge: episodic, procedural and semantic. Episodic knowledge is about a specific event and procedural knowledge includes details of the steps required to accomplish a certain task. Semantic knowledge deals with the meaning of things [24].

According to Howard and Howard [20], both episodic and procedural knowledge can decline with age unless the knowledge is meaningfully, highly practiced and well learnt by the individual. Furthermore, once that information or skill is fully automated, it will be much harder to unlearn and more difficult to adapt to a change [19, 45]. This means changes in navigational structures and interaction design can be very frustrating for older people. Frequent changes to their procedural knowledge can result in schemas never becoming fully automated, causing confusion to the user. However, if the task has been well practiced and a schema is fully automated, it is harder to unlearn and the user will have more difficulty trying to make sense of new procedures by using their outdated schemas [24].

2.2.4 Previous Studies
In the Australian context, previous studies which investigated user interface design for older people have confirmed some of the above findings.

In a study investigating interface designs for older people, Reddy [33] found that designs which use the person’s prior knowledge were the most intuitive to use, reducing the time taken to complete tasks. Additionally, the older people did not recover from mistakes as well as the younger people and the older people also had a tendency to become anxious when the task increased in difficulty or they made a mistake.

In further studies comparing older people’s use of interfaces, it was found that for people over 65, redundant interfaces, which used words-and-graphics were not ideal. For this group, a words-only interface was faster than a words-and-graphics (redundant) interface [3, 8]. It was also reported that for older people, using an interface which relied extensively on graphics use, without prior understanding of its functionality, was found to have a negative impact on the time taken to complete tasks, when compared to younger people.

3. THE DIGITAL AGE PROJECT
3.1 Introduction
The Digital Age Project is a research project which took place during 2014 and 2015 within three public housing communities in the North Coast region of NSW. The purpose of the research was to investigate digital literacy strategies for older people - defined as over 55 - living in public housing.

Within the three communities, 72% of residents were aged over 55 and many residents had disabilities. The digital literacy strategies applied during the intervention were designed using a number of theories. Cognitive load theory (CLT) principles, instructional design techniques [11, 15, 30] and related research on older computer users [10] was applied to all materials and activities. The UI recommendations for older users, described in this paper, were applied to user interfaces used during the intervention, described in Section 3.2.

Additionally, the intervention activities applied the principles of social exchange theory [9, 23] in order to promote community connections, encourage participants to help each other with technology and continue to provide ongoing support.

Only the parts of the study relevant to human computer interaction, and specifically UI design for older people, have been reported in this paper.

3.2 Methods
The research applied qualitative assessments to determine the impact of a tailored, place-based, digital intervention provided at one of the communities. The other two communities were used as control groups as part of the project’s wider research into the effect of technology on community and well-being.

The study was designed to observe the effect and outcomes of an intensive on-site training intervention - held over eight months - and ongoing technology provision and monitoring for a further 16 months. Baseline surveys relating to access and use of technology, sense of community and individual well-being were collected from participants from all three communities and used to determine changes and outcomes.

All residents in the three communities were invited to participate in the study. A baseline survey was delivered to all three communities which was used to establish participants’ demographics, background experiences, technology usage, experience, skill levels, and attitudes and self-perceptions about using and learning technology.

The baseline survey was followed by the on-site digital intervention within one community. The intervention comprised both learning
activities and methods to test their success. Of the total 33 residents living at Group 1 community where the on-site intervention were held, 12 completed the baseline survey. Seven of these participants completed the on-site digital intervention. This subset group is called intervention Group 1A in this paper. The remaining 5 participants in Group 1B did not attend the onsite training intervention. Groups 2 and 3 were used as controls for the wider study, with no onsite training intervention.

A final survey was delivered to residents in all three communities approximately 14 months after the start of the project. The survey was completed on an anonymous basis to collect data about the technology use of non-participating residents in all communities and offered some insights into barriers in technology acceptance.

### 3.3 Resident Demographics

All residents live alone and 78% were over 55 years old. Low income level was assumed, given they were public housing residents. In the participant groups, there were more females (approx. 80%) than males. However, the non-participant group was split with 50% male and female.

### 3.4 The Residents & Technology

Of the total of 39 residents who either participated in the baseline survey or responded to the final survey, 23% had never used a computer and 55% owned their own computer.

#### 3.4.1 Internet Use

Well over 50% of all respondents had used the internet in the past, or currently used it. Those who used the internet were also asked about their frequency and range of use.

Figure 1 shows most of the baseline participants used the internet infrequently (55%) but the vast majority of non-participants use the internet frequently (83%), for limited or a range of activities.

Further to these results, residents who did not use the Internet, used it rarely, or only used it for limited activities, were asked why, with reasons shown on Figure 2. The most common reasons concerned lack of skills/abilities and not trusting the internet.

This is consistent with other Australian research into the reasons for non-internet use. CSIRO reported that, in 2013 [13], 64% of non-users gave lack of skills or confidence as the main reason for non-use, with 59% also saying they weren’t a technical person.

#### 3.4.2 Technology Skills Levels

When asked about their skills using computers, only 22% of people in the baseline groups (intervention and non-intervention) considered themselves to be competent, as shown in Figure 3 below. However, in the non-participant group 40% considered themselves competent.

#### 3.4.3 Non-participating Residents

When asked why some residents did not participate in the project and intervention activities, the most common reasons given were that they already used a computer and did not need more training or were not interested in computers, (both 31%). In addition, 25% said it was difficult to attend or said they ‘kept to themselves’. A further 13% have a disability that made it difficult for them to use computers or were simply a private person.

### 3.5 The Intervention – General Strategies

The full onsite digital intervention was held in the common room of Community 1 only and comprised the following key features:

**Technology:** 24/7 access to computers and Wi-Fi was provided. At the start of the intervention, two desktop computers, both with large 23” monitors, and a printer were installed in the common room of the community. As part of the on-site intervention, participants were also given access to hand held devices in the form of computer tablets with 10” touch screens with attached keyboards and access to stylus pointing devices.

**Learning Activities/Training Sessions:** A training intervention was run over an eight month period. Once access to the computers in the common room was established, participants were instructed how to login and encouraged to attend standard government-funded
Following this, on-site training sessions were held in the community common room. The first block of sessions ran for eight weeks, with two sessions each week. Wednesday sessions, lasting 3-4 hours provided training on computer essentials, such as common websites, email, video calls and finally online banking, shopping and social media. On Fridays, the sessions lasted 2-3 hours and focused on playing computer games. Following the eight week onsite intervention, there was a four week break, then a further four week block of Wednesday and Friday sessions to provide a review of computer essentials and more games.

Other Resources: a community website was built with a simple interface and navigational design. This had two goals. Firstly, the website acted as a hub for training, communication and IT activities as well as being a 'scaffold' for reuse between training sessions, allowing participants to communicate with each other and the researcher for support. Secondly, it provided an example of layout, graphics and symbols used on many websites, familiarising participants with UI elements and methods of interaction consistent with other commonly-used sites.

Social Content: social and group activities, community gardening and some digital storytelling took place during the intervention. Activities were designed to promote social interaction and to nurture the ownership and ongoing development of the community website.  

3.6 The Intervention – UI Strategies

3.6.1 Device Choices and Security Setup
A consistent user interface was required on both the PCs and tablets which allowed participants to switch between both types of devices with minimal interface and operational differences.

Microsoft Surface tablets and Windows PCs were chosen. As both device types were able to run the same operating system (Windows 8.1), they were operationally the same and this also allowed users to run the same applications on both device types during the interventions.

The two PCs installed in the community common room were installed with large 23” monitors (not touch), keyboard and mouse. Additional reasons for choosing the Surface tablets included their relatively large touch screens, the 10” format being on the larger size for tablets, and the attached keyboard which, while being in a compacted format (¾ scale), provided the user with a more traditional typing experience than onscreen and other keyboard options.

The aim of the device choice and security infra-structure was to have device-independence, allowing users to use both PCs and tablets. A Microsoft account was assigned to each participant and these accounts were used to login on the provided devices, ensuring consistent access to installed applications, as well as Family Safety protection.

3.6.2 Application Choices
Applications for use during the on-site intervention were chosen carefully, with essential skills being gained by communicating, using online services and playing games to develop skills and confidence. Only applications that were consistent with, or built on, existing application UI schemas were chosen.

Only one new application or website was introduced during each session. The main applications chosen for communication were Outlook and Skype and, while these were not the same in terms of UI, their interfaces followed some consistency in comparison with other choices. Web sites with less consistent interfaces, such as Facebook, were introduced in the later weeks of the intervention.

The games introduced in early sessions were also chosen based on consistency in their UI. The prior experience of the participants was also considered. For example, the first games played were those that participants had played before, without computers, such as Solitaire. As participants already knew the game rules, this allowed them to focus on using the computer to play the game.

Not all application choices were ideal. Some essential websites, relevant to older people, were necessary in sessions and could not be controlled. This included Department of Family and Community Services and government sites which were not always consistent in their UI.

3.6.3 Other User Interface Choices
Accessibility: Participants were provided with instruction and helped to use Accessibility features within Windows 8.1. These tools, such as larger font sizes and zoom, were not used to advantage. The researcher observed that after initial use, participants had to be reminded to use them. 

Website: The community website provided as part of the intervention was very simple and endeavoured to provide a consistent navigation structure and where possible, followed UI guidelines for older users.

4. RESULTS AND DISCUSSION

While the sample size of participants (n=7) who completed the on-site intervention was small in terms of statistical reporting ability, there were other benefits. The study was designed as an intensive intervention, with small numbers facilitating the group's cohesiveness and promoted trust and social interaction.

The in-situ nature of the study allowed researchers to make observations and gain insight into some of the real-world challenges this group of users face when learning to use new technology.

4.1 Device Preferences
It was anticipated that the use of touch technology, combined with simplified interfaces, would have the capacity to increase the uptake of ICTs by older Australians. It was anticipated that touch screens would offer a more “natural” mode of interaction, compared to the use of keyboard and mouse.

However, survey results showed an overwhelming preference for laptops over tablets. It was observed that the physical portability of the tablet was seen as a positive factor, but the smaller screen format was restrictive for the older users.

4.1.1 Baseline Survey Results
It should be noted that most participants had not previously used tablets and, for the study group, the tablets were introduced after the baseline survey.

Figure 5 below shows participants’ preferred or favourite device type.
It is interesting to note that no participant chose a tablet as their preferred device, given that touch was expected to provide a simplified means of interaction. When participants were asked to rank device types in order of their preference, the tablet was chosen at a lower rank. The reasons for this are discussed further in 4.1.3.

4.1.2 Intervention Survey Results
At the end of the intervention, participants ranked their preferred input types as shown in Figure 6:

Figure 6: Preferred Device Types after Intervention

After the intervention and having had more experience using the tablets, participants also commented:

"Each device has beneficial use in different circumstances for me that enable me to do my jobs in an easier manner”

"I like touch screen”

4.1.3 Observations
The tablets appeared to offer instant success on a number of levels. New skills could be practiced in their own time and there was a level of ownership (long-term loan) and trust extended.

However, a number of UI design factors, other than touch, were observed to have influenced their choices. Feedback from participants indicated that having the bigger screen of the laptop was more important to them than having a touch screen. The tablets are a smaller device and included a tighter keyboard layout which provided more difficulty for some users. The screen on the tablets also had a high resolution and very small fonts. Even after font size was adjusted with Accessibility tools, the text was still difficult to read for some participants. Use of the touch screen and other gestures also proved more difficult to learn to use than expected and this is discussed further in 4.2 below.

4.2 Input Method Preferences
Participants were asked about the different input methods, independent of the device type.

4.2.1 Baseline Survey Results
A majority of participants (73%) indicated that the mouse was easy to learn to use, as shown in Figure 7 below. Interestingly, nobody considered the touch screen difficult to learn to use.

Figure 7: Input Methods – Easy to learn?
4.2.2 Intervention Survey Results
While there was an increase in acceptance of touch screens, as shown in Figure 7 above, they were never the users’ first choice.

The participants' attitudes towards input type changed during the intervention. There was a novelty value associated with tablets and this is shown in how easy they initially felt the touch screen was to learn, not long after the tablets were first introduced.

Figure 8 below compares participants’ attitudes about how easy it was to learn to use the touch screen at the baseline, mid-way and after the intervention. The percentage who agreed touch was easy dropped and, in fact, some disagreed with this by the end of the intervention.

There is a potential bias mid-way through the intervention due to having a positive experience with technology, also reflected in the mouse results. While this optimism could be seen to bias the results, increased self-efficacy can also lead to improved performance in using technology [6].

During the intervention, participants also made the following comments:

"The touch screen is easy once you know how to use it.”

"I much prefer using touch screen and voice recognition as I find these much easier. The reason I brought this computer was that the print is larger and as time goes by I/we will be a 'paperless' world.”

At the end of the intervention, participants were asked to rank their preferred input methods:
4.2.3 Observations
Some participants found it hard to use the touch screens. The touch/hit area for some functions was very small and novice users found it required practice to be accurate. Cold finger tips during winter meant some participants found touch difficult. Also, unsteady touch movements were often misinterpreted by the tablet, making success more difficult and frustrating the learner.

Initially, a few participants chose to use a pen/stylus with their tablets which helped them overcome the issues using touch. For most participants, the use of the pens was not continued past the first month.

Lastly, the high resolution and scaled down format of the 10” tablet meant that the onscreen size of applications and website content was reduced. Participants were shown how to increase the size of web pages and, while this was used, a number of the participants said they preferred to use the laptop screen or full size monitor on the desktops.

4.3 Adapting to UI Changes
Change to the UI is an ongoing issue for all generations, but is magnified for older users [19] given other inhibitors. For these users, there is often less overall use of technology, less repetitive use of functions, and therefore reduced automation of these tasks.

When the UI of a website or application is updated, the new UI will sometimes be more confusing, needing additional work for the older user to interpret and often unlearn the older methods. Some interfaces do not make it clear where to find menus and more options and do not use consistent and commonly understood icons, such as a question mark or menu graphics.

4.3.1 Survey Results
Figure 10 below shows the participants’ responses to how they felt about changes in technology and UI design.

Given that there was a mix of skill levels in these responses, it would appear that all novice users found it difficult to adapt to changes in technology.

4.3.2 Observations
During the course of the onsite intervention, when participants were working on the same application, the interface could appear differently on different versions of the software. Generally, these were using a desktop application compared to an online version, such as Outlook, Skype and Facebook. Additionally, having two versions of Internet Explorer within Windows 8.1 (metro vs. desktop versions) also created confusion.

In a final case, one participant was learning Outlook in Windows 8.1 at the same time as using a different email application on an Android tablet. This caused confusion because, while the email applications have common functionality, the user interfaces were inconsistent and neither were mastered successfully.

These additional versions made the process of learning more difficult, especially when users were helping each other, only to see that their versions were different.

A number of participants also spoke of frustration when a UI changed, often with no additional help, and not being able to find certain features in the new interface.

4.4 Distraction and Other UI factors
A number of other factors were considered that could affect their use of technology, shown in Figure 11.

Many older users experience distractions and difficulties which are affected by a number of these UI-related factors.
4.5 Personal Goals and Technology Benefits

Participants were asked about personal goals or benefits that they wanted to achieve by using technology, shown in Figure 12.

![Figure 12: Perceived Benefits from using Technology (n=17)](image)

The vast majority of participants felt that using technology would help to keep their brains active and for most, keeping in touch, having fun and feeling more connected were goals and benefits.

4.6 Project Outcomes – Beyond Intervention

After the onsite training intervention was finalised, participants continued to utilise the PCs, tablets and the Wi-Fi provided, and their usage continued to be monitored. Three months after the intervention, a drop-off in usage was seen, however participants have continued to use the provided technology on a regular -typically daily- basis. Ten months after the intervention, two users have purchased their own laptop. These two users, both over 85, had not used computers prior the intervention.

Furthermore, participants reported increased levels of optimism, and feelings of connectivity and support. They have continued to meet socially every week, in the common room.

5. CONCLUSION AND RECOMMENDATIONS

It should be noted that this research investigating user interface designs for older users was not, in itself, a controlled study. While there was a level of experimental design in the larger project, no controlled testing of UI designs was attempted. There was also the potential for investigator bias, due to the fact that the same researcher who ran the workshops also made observations.

A further limitation of this in-situ study is the small number of participants who received all of the digital literacy intervention. This limitation, however, along with the extended timeframe of the study, allowed the researchers to gain many valuable insights into issues faced by older people when learning and using new technology.

Current research and observations of this study have confirmed a number of specific barriers to digital literacy for older users in regard to user interface design. However, many of the issues faced by this cohort can be alleviated by UI designers following the existing UI and Accessibility guidelines.

Therefore, recommendations for UI designs which will assist older people to become digitally literate include:

Strive for consistency in all aspects of UI Design wherever possible, keeping in mind that the easiest UI to use is one that the user already knows.

Navigation methods should be predictable. Menu and navigational structures which use conventional layouts should be used, such as positioning of menus, or a menu button, at the top or left hand columns or by following the conventions provided within the operating system itself, allowing the user to understand navigation by using their existing schemas.

If navigation is non-linear, consider other help, such as adding a list of recent functions used. For older users who do not use some functions very frequently, this would be better as a timeline of full history of features used - those not used frequently are the ones they often have trouble finding.

Accessibility by following WCAG guidelines. The core WCAG guidelines should be followed, at minimum always providing text alternatives and using common tags and methods to provide feedback. In this way users can always find out more and may take advantage of some of the accessibility features and browser extensions available such as magnifiers to enhance visibility and other interactions for people with disabilities.

If UI designs are specifically for older users, designs may include larger base fonts, or offer a ‘see in big print’ button, so the users do not have to rely on activating the accessibility features. If designs are to be used by those from the mechanical generation, consider using words, rather than relying on graphics only.

Never assume that a user understands. If using icon-only buttons, make sure that tooltips and feedback on hover is present, and is descriptive enough to explain what the button will do.

When features change or move, help users. Consider using help to show changes in the UI. User help which shows where a feature has gone and confirms understanding will contribute to minimising frustration.

New simplified UIs, and less is more’ designs, will benefit most novice users by minimising distraction, especially if reducing distractions such as flashing advertising to further help this cohort. It is critical, however, that these simplified UI designs and their designers, do not make the assumption that they are easily understood by novice users. UI designs should lead novice users into doing and learning more, rather than providing less.

A wide variation in operational complexity on devices and user interface designs is available today. There are many established standards and similarities between designs for navigation and interaction. UI designers should continue to follow these standards for older users, rather than trying to invent revolutionary designs.

6. REFERENCES
