Improving Learnability: Lowering Barriers to Technology Adoption

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Abstract
Interactive computer technologies have the potential to support many older adults in their daily lives. However, older adults often find it difficult to learn to use many existing technologies. This paper describes our work on improving the learnability of computer technology – specifically mobile devices – for older adults. We present our investigation of three complementary design approaches that have not been well explored for older adults, and briefly discuss our findings to date.

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Introduction
Interactive computer technologies have much potential to help older adults in their daily lives. Existing technology such as desktop computers, the Internet, and mobile devices help older adults to be more connected. New technologies, such as health monitoring and home automation, are emerging to help older adults age more independently [6].

Although computer technologies have the potential to help older adults, older adults generally have more difficulty than younger ones in using and learning to use this technology. The natural decline in older adults' sensory, motor, and cognitive abilities makes it harder for them interact with computer user interfaces [3] and to learn new computer skills [2]. In addition, older adults are generally novice users and have limited experience to draw on. Difficulties in learning to use a new system often lead to more errors, which have been found to more negatively affect older users [1].

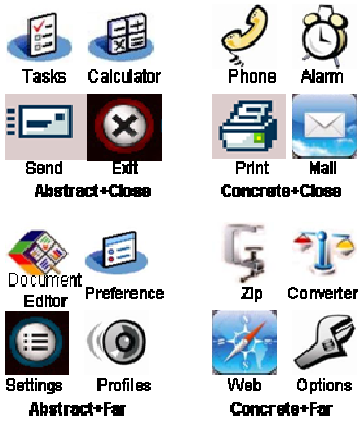


Figure 1. Graphical icons can differ in concreteness (abstract vs. concrete) and semantic distance (close vs. far). We investigated icons from existing mobile devices (e.g., Blackberry 7730, Nokia N95, HP iPaq rx3715, Palm® Treo™ 650, Apple iPhone). We found that semantic distance has a greater effect on an icon's initial usability for older adults compared to young adults, and that concreteness had little effect on helping older adults correctly interpret icon meaning.

Moreover, retired older adults do not have the support of work colleagues or an IT department, and may need to learn to use new technology on their own, perhaps with the help of friends/family or a user manual. All of these difficulties in using and learning to use technology create significant barriers to technology adoption by older adults.

While there has been much research studying older adults learning to use technology, many past studies have focused on how to provide better training. We take a complementary strategy by exploring design approaches to improving the learnability of technology. We define a computer system's learnability, a component of usability [5], as the degree to which it enables novices with no experience with the interface to achieve mastery in performing tasks on the system.

Three Design Approaches

Our overall research goal is to investigate different design approaches to improving the learnability of interactive mobile technologies for older adults. We are investigating three design approaches: improving graphical icons, using multi-layered interfaces, and augmenting the mobile interface. Each approach aims to improve learnability in different but complementary ways: 1) improving initial usability of UI elements, 2) temporarily reducing functionality, and 3) temporarily adding functionality.

Improving Graphical Icons

The first design approach that we investigated is improving graphical icons so that their functions are easy for older adults to understand, especially during initial use. Icons convey language and concepts that users need to understand in order to learn to use the application. We have conducted two studies to investigate whether existing graphical icons on mobile devices are more difficult for older adults to use than young adults and what types of icons are more usable for older adults [4].

We first conducted a qualitative exploratory study with 10 adults (ages 20-91). We found that older participants had stronger preferences for icons depicting something familiar or that closely resembled a real-world object, and icons with an obvious link between the depicted object and associated device function (see Figure 1 for examples). We then ran a controlled experiment to study more precisely the age-related effects of *concreteness* (i.e., how closely an object depicted in an icon resembles a real-world object), *semantic distance* (i.e., strength of association between an icon and its meaning), and presence vs. absence of *labels* on initial icon usability. We recruited 18 younger adults (ages 20-39) and 18 older adults (ages 65+) with similar computer and mobile device experience. Participants were shown icons/labels from existing mobile devices and were asked to identify objects depicted in each icon, and interpret the meaning of each icon/label.

The results showed that older participants had more difficulty than younger ones interpreting the icons they were shown. Specifically, icons with semantically closer meanings were found to be significantly easier for older participants to use. Concrete icons were found to help older participants identify more objects depicted in icons, but were not found to have an effect on interpreting icon meaning. Labels were found to help both age groups correctly interpret icons but did not help older participants more than the younger ones.

Layer 1: Reduced Functionality (and Content)

Layer 2: Full Functionality

Figure 2. We found that it was easier for older and younger adults to master basic mobile address book tasks on a reduced-functionality layer (top) than a full-functionality layer (bottom).

Based on these findings, we developed several icon design guidelines that took into consideration the abilities and technology experiences of older adults.

Multi-layered interfaces

The second design approach that we investigated is using multi-layered (ML) interfaces to improve learnability. In multi-layered interfaces, novices learn to use the application by starting with a reduced-functionality layer that only allows them to perform basic task functions [7]. Once these users feel that they have mastered this layer, they can transition to other layers and learn to perform more advanced tasks.

To evaluate the effects of a ML interface on learnability, we ran a controlled experiment with a prototyped two-layered mobile address book application (Figure 2). Representative address book tasks were identified and classified (as basic or advanced) through an informal survey of mobile phone users. We recruited 16 younger adults (ages 20-39) and 16 older adults (ages 65+) for the experiment, who were asked to perform tasks on either the ML interface or a non-layered control interface. We measured participants' performance over four different phases of learning on a ML interface: mastering basic tasks on an initial reduced-functionality layer, performing these basic tasks after a 30-minute break, transition to the full interface (performing basic tasks but on a second more complex full-functionality layer), and mastering advanced tasks on this full-functionality layer.

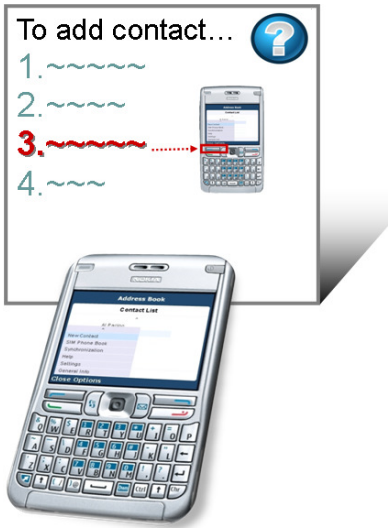
We found that the ML interface's reduced-functionality layer, relative to the control's full-functionality layer, better helped users to master a set of basic tasks and to retain that ability 30 minutes later. Although transitioning to a full-functionality interface layer negatively affected participants' performance on previously learned tasks, no negative impact was found on learning new, advanced tasks. Overall, the ML interface provided greater benefits for older participants than for younger participants in terms of task completion time during initial learning, perceived complexity, and preference.

Augmenting the Interface

We are currently investigating our third design approach, which is providing additional real-time interactive guidance and feedback to help novices learn to use mobile applications. Manuals and online help offer additional guidance, but these resources do not offer any real-time interactivity or feedback, which may better help older adults learn [2]. The application itself could provide such guidance, but the device's small screen limits the amount of additional information that can be shown with the application. Instead, we propose augmenting the mobile interface with an additional display, temporarily during the learning process, to provide interactive guidance and feedback (Figure 3).

We will begin our investigation by conducting a questionnaire survey to better understand why older adults (ages 50+) use certain methods and resources to learn to use mobile technologies and why some methods/resources are perceive to be more helpful. Based on these findings, we will design and prototype a computer system using our augmented interface approach. We will then evaluate the approach using a controlled experiment in which younger and older adults learn to perform tasks using either the mobile device with the external display or the mobile device alone. We are particularly interested in whether older adults will be

Large screen display



Mobile device

Figure 3. We propose augmenting a mobile device interface (below) with a larger screen (above) that provides interactive guidance and feedback to help the novice learn to perform tasks with the mobile application.

able to benefit from the guidance and feedback provided by the external display despite its added complexity.

Many Approaches to Improve Learnability

Our work to date has explored a number of ways to improve the learnability of a mobile application for older adults through three complementary UI design approaches; these approaches may also be suitable for other interactive computer technologies. We have found that reducing the semantic distance between an icon's meaning and the objects shown in the icon can improve its initial usability by older adults. To reduce this semantic distance, we suggest that the interface designer use icons that are more familiar to older adults, use labels, and allow the user to personalize their icons by selecting from sets of alternative icons.

We have also found that older adults can benefit from learning on a reduced-functionality version of a mobile application interface. The reduced complexity can help older adults during the initial learning process to perform tasks with fewer errors and in less time. If a ML interface approach is used, additional learnability-related design decisions need to be considered, such as how many layers to implement and which functions should reside in each layer.

There are other proposed design approaches to improving learnability beyond those that we have investigated. For example, in a study that found that older adults (ages 40-55) react more negatively to computer errors than younger adults, Birdi and Zapf [1] suggested that error messages be better designed for older users. They suggested that error messages could be improved by providing more motivational and emotional support (e.g., "Don't worry, you can't break the computer"), suggesting the next course of action, and/or referring the user to a relevant section of the manual for more information. Future work should investigate these other design approaches.

Conclusions

This paper describes our investigation of design approaches to improve the learnability of mobile technologies for older adults with the aim of lowering barriers to adoption by this population.

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