Help Kiosk: Augmented displays help older adults use mobile phones

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ABSTRACT
Older adults have difficulty using and learning to use mobile phones, in part because the displays are too small for providing effective interactive help. Our work explores the use of a larger display to augment the small phone display in support of learning. We conducted a comprehensive survey of 131 respondents and analyzed a sub-sample of 94 response sets to identify what learning resource features and qualities older adults, as well as younger ones, rate as important for learning mobile devices. The results show, among other things, that when learning older adults prefer using manuals by contrast younger adults who prefer a trial and error approach. Using our survey findings and design guidelines from the literature, we propose five design principles for creating an augmented display system for older adults. We put these principles into practice in our Help Kiosk, a system to facilitate learning to use a smart phone. A preliminary evaluation with 6 older adults showed that presenting instructions using a variety of media formats and at different levels of details, and minimizing working memory demands helped older adults perform new mobile device tasks.

Author Keywords
Mobile phone, online help system, augmented display, UI design.

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION
Mobile phones have become pervasive in developed countries. They offer benefits that may be especially valuable for maintaining the quality of life of older adults (ages 65+) by, for example, keeping them connectedwith loved ones, maintaining contact information, and providing reminders about important events. Despite such potential benefits, older adults have been relatively slow to adopt mobile phones and services [Smith, 2010, Ofcom, 2009]. This finding has been attributed to age-related difficulties with using and learning to use mobile phones [ ]. A 2008 UK survey of 2481 mobile phone owners (ages 16+) [Ofcom, 2009] found that, compared to younger adults, older respondents (ages 60+) had more difficulty and were less confidence about performing common mobile device tasks . Ziefle [2005] found that older adults took twice as long as younger adults and were less successful in performing common mobile tasks. The difficulties experienced by older adults can be attributed to several factors, including i) natural declines in their sensory, perceptual, motor and cognitive abilities [Fisk], ii) the small screen and buttons on mobile devices iii) a lack of experience with computers and other mobile devices[Ziefle 2005].

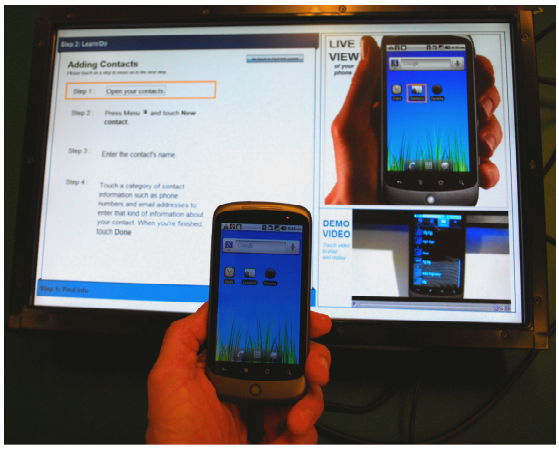

Figure 1. Help Kiosk augments a mobile phone's display with a larger one to help older adults learn to use the phone

Our research focused on the second factor, more particularly, on how the small screen and controls affects learning to use a mobile phone. A small screen makes it difficult to provide effective interactive help, which is the cornerstone of many desktop applications today. On a small screen it is impossible to simultaneously display both the application to be learned and the help content which may be required for learning. To address this limitation, we propose

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to leveraged the mobile's small display with the large display, for example a of desktop monitor or a wall display. Current mobile and web technologies allow mobile phones to connect wirelessly at relatively high-speeds (now over 1 Mbps) with web services and other devices. Researchers have already begun using mobile devices together with larger screens (e.g., [,]), but to our knowledge no research has explored how the extra display can be used to facilitate the learning of mobile devices. The core idea is for the larger display to temporarily augment the device's small screen during learning, offering a type of supportive scaffolding [Quintana et al.]. The key question for our research is: How should this display space be used to support learning?

The literature offers some principles for the design of online help, manuals and other resources (e.g., [Morrell, Echt, Duffy, Carroll, Hawthorn, Kelly), but it is unclear whether these principles are relevant to today's mobile phones (past work has generally focused on learning to use desktop computer applications), or whether they address the unique needs of older adults. Past studies generally only involved university students and office workers, and not older adults [Carroll]. Further, of those studies that did involve older adults, many did not include younger adults, and consequently the findings do not give insight into the unique needs of older adults [Morrell, Echt].

The research we report makes two key contributions: findings about the unique learning needs of older adults from a survey study and insights from the informal evaluation of a Help Kiosk, a prototype for facilitating older adults' learning of mobile device applications. We first ran a comprehensive survey study to better understand what learning resource features older adults rate as important for learning to use everyday mobile devices, such as mobile phones. The study included participants from three age groups (ages 20-49, 50-64 and 65+) and probed various aspects of mobile device learning. The results showed that older adults primarily want help with learning the exact steps of a mobile device task. We also found that older adults generally prefer using manuals while younger users prefer learning by trial and error. We used the findings from the survey, as well as design guidelines from the literature, to create *Help Kiosk,* a learning system prototype that augments the mobile phone display. Help Kiosk incorporates six design principles for creating augmented display systems for older adults. An informal evaluation of our system with 6 older adults showed that presenting instructions using a variety of media formats and at different levels of details, and minimizing working memory demands helped older adults perform new mobile device tasks.

RELATED WORK

A quotation from Czaja [] provides an informative context for the present study. Czaja reminded us that "There are general guidelines regarding the design of training programs for older adults … however, these guidelines do not indicate what type of training technique is best suited for a particular task, technology or application" [p.346]. Our study focused on using a large screen for supporting learning of mobile phones applications, and the literature provides minimal insights into this specialized domain.

Design and use of manuals

Research from the late 1990s to the early 2000s focused on new users learning to use desktop computers and their applications [Duffy, Carroll]. Manuals from that era, which instructed learners to proceed step-by-step through sequences of drill and practice exercises, did not fit well with how users were learning to use computers, and as a consequence, we ended up with the Minimal Manual []. Apart from the fact that the MM was shorter, it was specifically designed to help learners perform actual tasks, as well as to recognize and recover from errors [Carroll 1987]. Today's manuals follow many of the MM design principles []. More importantly, studies have found that fewer of today's computer users rely on manuals due to the improved learnability of their UIs and the availability of embedded help which reduces the need for a manual [Novick]. As a consequence, manuals are typically not even included with today's computing devices. However, older adults may still want to use manuals, as they have more difficulty learning new computer skills [Fisk] and may still benefit from manuals. Our survey investigates whether there are age-related differences in manual preferences. However, it is not clear whether past findings apply to older learners or helping people to use mobile devices.

Design of Online Help

Research has also focused on developing better online help systems. Online help systems support task performance rather than the more conceptual learning that is often provided in courses, tutorials and training materials. Many design guidelines have emerged from this work, including the proposal that online help content needs to target the task, be easy to access, and lead to efficient transfer from help system to task [Duffy et al.]. However, this work is primarily based on user testing with university students and workers (ages < 65). Few studies have looked at whether online help systems need to be designed differently for older adults, whose cognitive abilities decline naturally with age, making it harder for them to learn new computer skills [Fisk]. In addition, past online help guidelines may not generalize to mobile devices as their small screens limit the amount of help that can be shown along with the main application.

Training Older Adults

There has been much research on how training material can be better designed to help older adults learn to use computer technology, and a number of guidelines have been recommended (e.g., [Fisk] suggests at least 30 guidelines). However, it is unclear which of these guidelines might be applicable in the design of our help Kiosk. For example,

should the system focus on helping older adults learn to perform tasks, build a correct mental model of the UI, or both? As another example, should the system primarily support trial & error, a common strategy for learning mobile devices, or provide training, a strategy more researched in the literature? A design cannot practically include all features that have been found to help older adults acquire new computer skills, in case this overwhelms the older learner's cognitive resources. Thus, we must first understand the learning needs and the preferences of older adults, our target users.

Older Adults' Learning Preferences

A few recent studies have investigated the learning resources older adults prefer when learning various kinds of technology: ICT (computers, television, video game machines) [Selwyn 2003], technology items used in the home (technology not further specified) [Mizner] and mobile phones [Kurniawan 2006]. While these studies have generally found a preference in favor of a trial & error approach, findings are mixed on preferences for other learning methods. Mitzner [2008] and Kurniawan [2006] found that older adults strongly preferred to use the manual, in addition to trial & error (Selwyn [2003] did not look at whether older adults use the manual). Selwyn [2003] also found that friends, family and work colleagues were rarely used for ICT support, while Mitzner found that older adults prefer asking family, peers, and domain professionals for help. In addition, it is unclear how the findings from the studies on ICT [Selwyn] and home technology [Mitzner] generalize to learning to use mobile devices. Further, one limitation of these studies is that they did not compare their older participants' responses with data from younger adults, making it difficult to determine whether preferences were due to age or perhaps to other factors, such as technology experience or social support.

SURVEY STUDY

Methods

We created a questionnaire to survey both older and younger adults on what helped them most in learning to use a mobile device. We chose to create a comprehensive questionnaire, rather than one that just focused on designing the augmented display system, in order to obtain more generalizable results. We broadened our focus to look at how people learned to use mobile phones and other everyday mobile devices (e.g., digital cameras, cell phones, and electronic organizers).

Our questionnaire survey had four sections. The first three sections posed questions related to i) participants' experiences learning to use mobile devices; ii) the qualities/features in a learning resource that are important to them (see Table 1); and iii) their reasons for or against using particular learning methods (see Table 1). In the fourth section, participants were asked to give feedback on using an hypothetical augmented display learning system (described more below).

To increase the accessibility of our survey, we created both an online version and a paper version. Questions were worded the same in both versions. The questionnaire took approximately 20-40 minutes to complete, based on pilot studies. Data Analysis

We analyzed our (non-parametric) Likert and demographic data using Kruskal-Wallis tests unless specified otherwise. Whenever a statistically significant effect was found, we conducted follow-up post hoc Mann-Whitney U tests (with Bonferonni correction). The alpha was set to 0.05. Medians are reported unless specified.

In addition to analyzing the quantitative data, we coded and analyzed respondents' qualitative answers. Two of the authors created a coding scheme, based primarily on the literature but also on the data, which was refined over five iterations. Each text response was given a single code to represent the dominant idea expressed in the response. Responses that were ambiguous, blank or incoherent were coded as not answering the question. The coding scheme and instructions were found to be reliable: the two authors who created them each coded the free-form responses from a random 20% sample of the surveys, and found the inter-rater reliability to be $K=0.80$ ($p<.001$), which can be considered as substantial agreement [Landis]. All remaining text responses were coded by a single authors.

Participants

We recruited participants from senior homes, community centers, libraries, and online classifieds, and recruited mobile device users or those who used them in the past. 138 completed surveys were returned, but 7 were discarded due to duplicate and incomplete submissions. We grouped respondents by age, creatingone group of younger adults (ages 20-49), and two groups of older adults (ages 50-64, 65+). We conducted separate analyses on the data from the latter two groups because they are likely to differ in the proportion of those still employed and thus possibly in

Table 1. Learning Resource Qualities/Features and Learning Methods Surveyed

Learning Methods
I try working it out for myself by trial and error
I use the device's help feature
I use the device's instruction manual
I phone customer or IT support
I search the Internet for help
I take a class (e.g., at library, community centre)
I talk to:
my partner/spouse
my children
family/friends from my generation
family/friends from a younger generation
my work colleagues
Resource Qualities
Is very affordable (e.g., free)
Is easy to access (e.g., convenient, readily available)
Is easy to understand (e.g., clear, simple language)
Is friendly and patient (e.g., not condescending or intimidating)
Is it interactive (e.g., gives feedback, answers your questions)
Does it allows me to learn by myself
Does it allows me to learn in a group (e.g., with friends, classmates)
Does not require much time to use
Resource Features
Demonstrates how to perform task
Explains how the device and programs work
Provides detailed information
Provides opportunities to practice task
Provides step-by-step instructions

access to resources, and this difference may have affected their survey responses..

As expected, more of the younger adult respondents reported being "advanced" mobile device users (12 out of 22) compared to the older adults, and the vast majority of self-reported "beginners" (14 out of 15) were older adults. In order to maximize the discovery of age-related differences, we used the data only from respondents who reported being "novice" and "intermediate" mobile device users (N=94). Of these surveys, 74 were completed online and 20 were completed on paper.

After the exclusion of the beginners, the three age groups were similar on many levels (see Table 2). There were no significant group differences with respect to gender, education, housing status, reported computer expertise, and years experience with mobile devices. There was a significant difference with respect to work status (χ^2=16, df=2, p<.001); as expected a larger number of younger respondents were students, while a larger number from the oldest group were retired. Even after our attempt to minimize differences in reported mobile expertise, there was still a significant difference among the three groups (χ^2=6.4, df=2, p=.041), with more younger respondents classified as "intermediate" mobile device users than "novice" users. We argue that this difference in mobile device expertise is minimal, but it needs to be considered when interpreting the results.

Table 2. Characteristics of the three age groups (N=94)

		Younger Adults	Older Adults	
		ages 20-49	ages 50-64	ages 65+
	N	28	34	32
Age*	mean (SD)	27.7 (7.7)	57.1 (3.9)	73.1 (5.5)
Gender	# male	8	11	15
	# female	20	23	17
Work status*	# student	11	0	0
	# working	17	23	2
	# retired	0	11	30
Computer expertise	# "novice"	2	4	3
	# "intermediate"	18	23	26
	# "advanced"	8	7	3
Mobile expertise*	# "novice"	7	19	16
	# "intermediate"	21	15	16
Mobile experience	# 0-5 years	7	11	25
	# 6-10 years	18	13	11
	# 10+ years	3	10	6

**: significant difference among age groups*

Results

We key survey findings presented here are those focusing primarily on age-related differences.

Learning task steps is more important for older adults

We sought to older adults' learning needs through two different survey questions. Respondents were asked about how important it was for them during the learning process to figure out the exact steps required for a task versus gaining a general understanding of how the software works. Older adults reported that figuring out the steps was very important and significantly more important than gaining a general understanding (Wilcoxon signed ranks test, ages 50-64: Z=-3.63, p<.001; ages 65+: Z=-3.83, p<.001). In contrast, younger adults reported that both options were similarly important (Z=-0.18, p=.86). The top chart in Figure 2 highlights this pattern of preferences across the age groups.

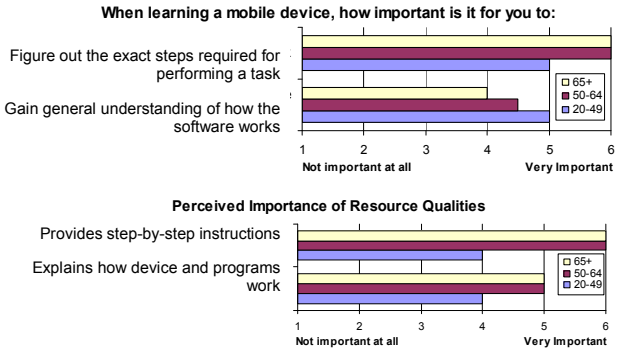

Figure 2. Figuring out exact steps to perform task is more important to older than younger adults (X-axis: 1=not important at all; 6=very important) (N=94).

Respondents were also asked to indicate how important it was for *learning resources to provide* step-by-step instructions and explanations on how the device and software work. Consistent with the above results, these results showed that older adults felt it was very important for learning resources to provide step-by-step instructions (6/6), and that it was less but still important for learning resources to explain how the device and programs work (5/6). Younger adults reported less importance for having learning resources provide step-by-step instructions and explanations of how the software works. These findings suggest an age-related difference in learning need and that learning resources for older adults should be designed primarily to helping them to figure out the exact steps required for performing a task.

Older adults want more learning support

Respondents were asked to indicate how important various learning resources qualities and features are to them (see Table 1). The results showed that older adults, compared to younger ones, would like resources that offer more learning support. As shown in Figure 3, older versus younger respondents placed significantly more importance on having learning resources which demonstrate how to perform tasks (χ^2=17, df=2, p<.001), and provide opportunities for practicing tasks (χ^2=29, df=2, p<.001). Older more than younger respondents also placed significantly more importance on the interactive nature (e.g., getting feedback, having their questions answered) of a learning resource ($\chi^{2=}$19, df=2, p<.001). By contrast to this expectation, our older respondents, as well as younger ones, placed little importance on learn with others (e.g., with friends, classmates; median of 2/6 for all age groups).

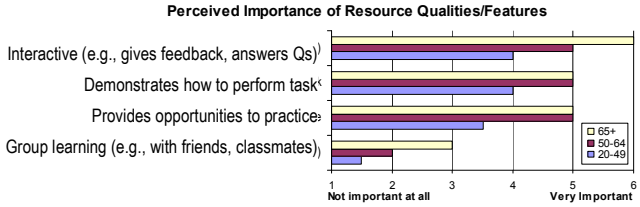

Figure 3. Older adults place more importance on certain learning features (*N*=94).

Our survey also revealed that respondents from all age groups felt that it was important for a learning resource to be accessible (6/6), understandable (6/6), be friendly and patient (5/6), not require time or money to use (5/6), allow individual learning (5/6) and provide detailed information (5/6). These findings are consistent with the literature, and none showed any significant effects due to age.

Older adults prefer manuals; younger adults prefer trial & error

Respondents were asked a number of questions related to how likely they are to use any of a number of learning methods. One key finding was that older respondents preferred learning to use mobile devices with instruction manuals, while younger respondents expressed preference for learning through trial & error. Respondents were asked to choose from the list of learning methods (see Table 1) their three top 3 choices (i.e., if you had access to all of the listed methods, which 3 methods would you chose); they were also ask to identify the 3 methods that would best support retention of what they had learned. The majority of older respondents identified the manual as one of their top 3 learning methods, as well as for supporting long term retention (see top chart in Figure 3). In contrast, the vast majority of younger respondents identified trial & error as one of their top 3 learning methods and top 3 methods for retention. Overall, respondents' likelihood to picking the manual as a learning aid and for facilitating retention increased with age, while the opposite patterns occurred for the trial & error method (see bottom chart in Figure 3).

Participants' qualitative responses shed additional light into older and younger adults' preferences. One key reason older respondents gave for preferring to use the manual was because it supported their learning style. One older respondent age 59 explained, "If I have directions I can usually figure it out", and another age 72 wrote "I'm print-oriented - like to read to understand." The key reason why older respondents gave for not using trial & error is because of negative past experiences with this method. Older adults often get frustrated when using trial and error: "I get frustrated when it 'doesn't work' at once!" (age 72) or feel they can change the device's settings and data in unwanted ways, "I don't have the confidence & think I could 'mess it up' (age 74).

Like our older respondents, younger respondents stated that they use trial & error because it supported their learning styles. One younger respondent age 25 wrote, "I like to test things out for myself", and another age 26 wrote, "You

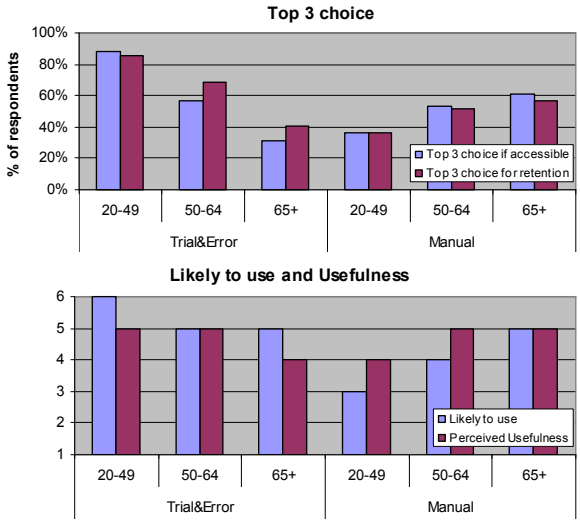

Figure 4. Older respondents reported a preference for learning with manuals while younger respondents preferred learning through trial & error (*N*=94).

learn better from failure than success." The key reason why younger respondents do not use the manual is because of poor content (e.g., "difficult to comprehend", "insufficient details", "sometimes way too wordy"). Older respondents who do not use the manual also gave a similar reason.

Older adults would use augmented display to learn to use a mobile device

We asked respondents whether they would use a help system that could guide them step-by-step through the kinds of mobile device tasks that they would want to carry out. The vast majority of older participants (89% of responses) responded that they would try to use such a system. In sharp contrast, the majority of younger participants (65% of responses) responded that they would not, based on the conviction that they would not need such help to learn mobile device applications.

We also asked respondents whether they thought it would be easy to operate both the mobile device and the desktop computer software. Half of the respondents felt it would be easy to operate both the device and the desktop computer software, while one third of the respondents thought that this would depend on a number of factors, such as the type and complexity of the tasks being learned, the overall usability of the system, and the ease in connecting the device to the desktop computer. Responses were similar across age groups.

Respondents were asked to comment on the perceived benefits and drawbacks of this hypothetical system. The ability for more control over the learning process was a key benefit; one respondent age 71 wrote that the system would allow one to "go @ your own speed & repeat if necessary". Similarly, older respondents also indicated that learner control might be an issue with using this hypothetical system, particularly being able to communicate their questions to get to the desired learning content.

Summary of Findings

The survey study revealed that older adults primarily want to learn to perform tasks, step-by-step, on the mobile device. Older adults also appeared to prefer to learn to use mobile devices by themselves, rather than with other learners, which suggested to us that we should focus on a non-collaborative design. Older adults placed more importance having extra guidance, such as demonstrations, opportunities to practice and more feedback.

We also found that older adults prefer to use manuals as it fits their learning styles. Older adults are less likely to use trial & error because they are often frustrated in the process or afraid to "mess up" the device. However, it appears that older adults see the value in using this method and may use it more if some of the issues were addressed.

Limitations

Our study focused on subjective preferences, which helped us understand what why older adults use certain learning methods. However, it should be noted that these subjective responses may differ from our respondents' actual behaviour.

HELP KIOSK

Design

We next present the design of the Help Kiosk help system, which we have prototyped and informally evaluated. The Help Kiosk design is based on findings from our survey and guidelines from the literature. The Help Kiosk, a stationary computer system with a large display that a smart phone can connect to, is designed primarily to help learners perform new tasks. This system could theoretically run on any computer (e.g., home, library) increasing opportunities to learn when needed. It is a supportive scaffold as it is meant to temporarily help users during the learning process with the aim that users will eventually be able to use their mobile phone without the support. The Help Kiosk design is based on the concept of an instruction manual and builds on it by providing additional real-time guidance and feedback.

Use Case Scenario

Mary, age 60, is retired and lives alone. She met a new friend at the community centre and wants to store this person's name and phone number on her smart phone but is not sure how. She connects her phone to her desktop computer (e.g., through a USB cable; see Figure 1). The Help Kiosk software launches on the desktop computer and attempts to determine what help Mary wants. The Help Kiosk identifies that the smart phone is currently running the applications launcher tool and presents a number of words related to the various applications on the phone (see Figure 4 left). She selects "Contacts" and Help Kiosk lists a number of related tasks. She then selects from this list "Add contact", which directs her to a page that lists all steps required to add a contact entry (see Figure 4 right); if Mary did not see a word that was related to the task she wanted to

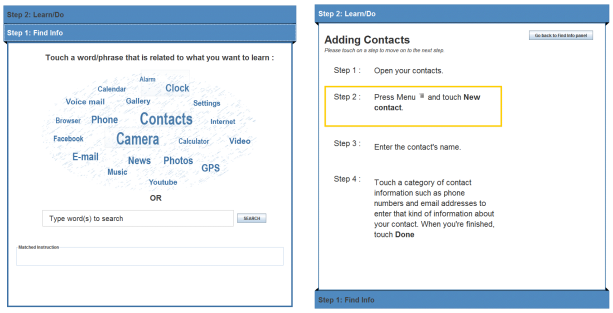

Figure 4. Help Kiosk: Find Learning Info panel (left) and Learn/Do Task panel (right)

perform, she could search on any words she had in mind (e.g., "change", "update", "edit").

Once on an instruction page, Help Kiosk offers Mary different types of support to help her perform each step. Mary reads the text instruction for a step (e.g., "Press Menu and touch "New Contact"). She is not sure where to find the "Menu" UI control and looks to a real-time screen capture of the device that highlights the specific UI controls on her device that Mary needs to interact with to perform the step. Mary think she knows how to perform the step but plays a 10 second video demonstration to make sure.

Mary progresses through the steps but becomes concerned that she might make unwanted changes to her contact information by accident. To address this concern, she switches to an "exploratory mode" on the Help Kiosk to attempt to finish the step. She makes a few mistakes in exploratory mode but eventually learns how to complete the task properly. Once she is able to complete the task, she exits the exploratory mode, which reverts the device back to its state (e.g., device settings, data) before entering this mode, and performs the Add Contact task correctly.

Design Principles

We followed a number of principles when designing the Help Kiosk.

Support Authentic Tasks and Self-directed Learning: Help Kiosk supports learners in performing tasks on the smart phone through its UI controls. We chose not to emulate the device UI on the kiosk, because as [Fisk] recommends we wanted users to gain experience and confidence in using the actual device, so that this knowledge and confidence would be better retained when the phone is used without the scaffolding. Thus, when using Help Kiosk, learners operates the device to perform mobile tasks as usual, while the additional display provides guidance and feedback, , To our knowledge, no such augmented display system for learning to use mobile devices has been developed..

Help Kiosk gives learners much control over the learning process so that they can lead the learning process and learn more actively. For example, when learning the steps for performing a task, the learner must step through the steps, in contrast to a system stepping through automatically as it detects users correctly perform each step. Users are able to

repeat content as much as they want. Unless an instruction step has a dependency on an earlier one, Help Kiosk allows users to skip ahead to subsequent steps and go back one or more steps.

Utilize Device State Information to Personalize Experience: The Help Kiosk can keep track of the smart phone's state, such as what application is running and being shown on the screen, and can use this contextual information to personalize and improve the user's learning experience.

For example, the Help Kiosk can use this information to help the user more quickly find desired help. Our design addresses survey respondents' concerns that a computer system may not be able to answer questions they had, due to their difficulties coming up with the "correct questions" and words to ask, and also the perceived inability of a system to answer open-ended questions. Help Kiosk is designed to help learners access desired information through browsing suggested topics or searching on words provided by the learner (see Figure 5 left). Help Kiosk uses the device's state (e.g., Camera application running in foreground) to suggest relevant topics for browsing (e.g., viewing photos, video, taking pictures), and increase the accuracy of search results.

As another example, the Help Kiosk can also use the phone's contextual information to keep track of what the learner is doing, and whether or not the learner has followed the instructions properly. Carroll [1987] observed that users often fail to coordinate their attention between the training material and the computer being learned, and keeping track of the device and instruction states will allow Help Kiosk to provide suggestions to the user on how to return the device state back in sync with the instructions.

Provide Both Generic and Specific Instructions: Many older adults find manual instructions difficult to understand, partially because the instructions may not be presented in a way that suits their learning style or written at their specific level of expertise with the technology. One approach is to design a separate help system for each expertise level, but Duffy et al. [1992] argues that help systems based on expertise are impractical.

Instead of having a separate system or version for each expertise level, Help Kiosk presents each instruction step in three distinct ways, differing in media format and levels of details specific to the learner's device (see Figure 6). First, Help Kiosk presents text instructions for performing the steps for a task (see Figure 6 top-left); content not directly related to performing the steps is put aside in the "More Help" area that can be accessed if desired (see Figure 6 bottom-left). Second, demonstration videos show the step being performed on a similar device (see Figure 6 top-right. Third, Help Kiosk *Live View* area shows the screen contents of the learner's device in real-time to highlight the specific UI elements the learner should interact with to perform a particular step (see Figure 6 bottom-right). A similar technique, highlighting actual physical controls, has been used in Augmented Reality systems to help people learn to use kitchens (*CounterIntelligence* [Bonanni et.,]) and fold origami (*Origami Desk* [Ju et al.]). Although it was technically possible to allow the learner to control the mobile phone remotely through Live View, we decided not to implement this remote method of interacting with the device; all interactions with the phone are performed on the device itself so that the learning tasks remain as authentic as possible.

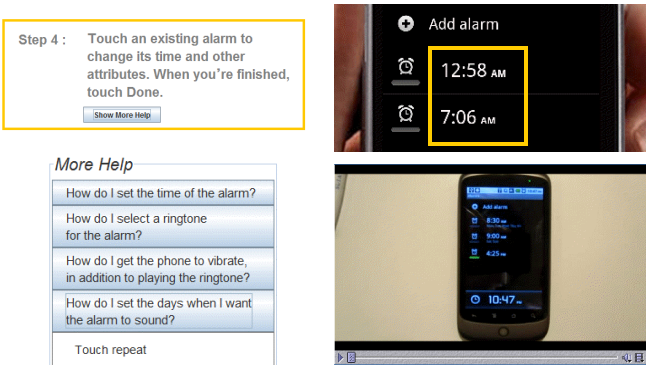

Figure 5. Help Kiosk presents instructions in three ways: text (top-left), Live View highlighting (top-right), Demo video (bottom-right); more help on performing the step is offered

Having instructions presented at different levels of details accommodates learners of varying expertise, allowing learners to get more details specific to their device if the text instructions are difficult to interpret, or to ignore the additional information if the text instructions are sufficient. We expect that showing learners exactly where they should look and interact with the device will reduce the learner's cognitive work needed to follow the instructions. In addition, having the instructions presented in a variety of media formats will accommodate both text and visual learning styles.

Table 3. Instructions by level of details

Type	Specificity
Text	*Relatively generic*, applicable to several similar smart phone models
Demo Videos	*More specific* than text instructions as user interactions using the same or similar UI are demonstrated. Unlike other two types, demo videos show the expected result of the step, helping learners confirm that step was performed correctly.
"Live View" Highlighting	Instructions given through highlighting is *very specific* to the UI of learner's device.

Furthermore, Thus Help Kiosk offers extra information to support anticipated needs, including potentially problematic sub-steps (e.g., entering symbols in a text entry step), what a particular UI control on the device does, and definitions/synonyms for technical terms.

Offer Opportunities to Explore and Practice Safely: Older users often express a concern that they will break the device or cause some unwanted change to the computer and stored data. Help Kiosk allows users to enter an *exploratory mode* in which users can perform actions on the mobile device

and have the option to return to the state that the device was in before entering the exploratory mode. The exploratory mode allows learners to try performing tasks or any unfamiliar operation without the fear of causing unwanted changes to data on the device and its settings. We expect this mode will help older adults to explore the UI and practice tasks more freely.

Minimize Demands on Working Memory: We sought to minimize demands on working memory, as recommended by [Fisk]. Help Kiosk UI elements stay in place as much as possible to reduce the demands on users' visuo-spatial working memory. For example, regardless of whether the learner is using Help Kiosk to find desired information or follow a set of steps, the three panes (instruction, demo, and live view panes) remained in the same place. Each text instruction step also stayed in the same place on the screen.

Help Kiosk shows the contents of the mobile device in real-time in order to minimize demands on the working memory. Hawthorn [19] argued that both manuals and interactive CDs may not actually be very suitable to older users in part because older adults may find it difficult to swap between the page or screen containing the tutorial and the application being learnt. Swapping requires remembering instructions, and perhaps changing glasses if instructions are presented at a different viewing distance than the application. We address this potential difficulty by showing the mobile device's screen contents on the large screen to reduce the need for visual swapping between the device and the large screen, and using large font sizes on the large screen to make it easier to swap when needed.

Prototype

Our Help Kiosk prototype consisted of a 19" touchscreen monitor and a desktop computer. The prototype connects to an Android smart phone via USB, and currently supports a Google Nexus One (Android OS 2.2) touchscreen smart phone. Other than enabling the debugging setting on the device, no additional software was installed on the smart phone to make it work with Help Kiosk. The program was written in Java. We prototyped support for three tasks: take photo, add contact entry to contact application, and set an alarm.

INFORMAL USER STUDY OF HELP KIOSK

Methods

We designed and conducted an informal user study to gain some insights to begin validating our design principles. The user study focused primarily on assessing how well Help Kiosk helped older adults perform new smart phone tasks. Users could use most of the Help Kiosk features mentioned in the above principles except for the context-aware browse and search UI, which was mocked up to demonstrate to learners how one might access desired content, and the exploratory mode.

To evaluate Help Kiosk, we chose to compare it to the Nexus One's user from Google [ ], which is representative of a comprehensive, manual written for a wide variety of users. Text instructions in Help Kiosk were sourced from the Nexus One manual to promote a fair comparison.

Participants were asked to learn to perform two tasks: A) add a new contact to the Contacts application, and B) change the setting of an existing alarm in the Clock application. Half of the participants learned Task A using Help Kiosk and Task B using the phone's printed manual [Google] (an online PDF version of the manual was offered but no participants used it). The other participants learned Task B with Help Kiosk and Task B with the manual. Further we balanced the order which participants used the scaffolding: half of the participants first learned with Help Kiosk while the other half first learned with the manual. Qualitative data for analysis consisted of think-aloud comments, answers to interview questions. Quantitative data consisted of perceived usefulness of various Help Kiosk features and perceived workload (six NASA-TLX subscales on a 6-point scale: 1=very low, 6=very high) when using the scaffolds. Medians are reported unless specified

We recruited 6 older adults (ages 55-75) from our survey respondents that self-reported being beginner or novice mobile device users (4 beginners, 2 novices). In the study session, participants were first given a demonstration of using the smart phone and were given chances to perform a task (taking a photo) to familiarize themselves with how to touch the device to interact with it. Using either Help Kiosk or the manual, participants were first asked to perform Tasks A and B, and then perform the tasks again. Participants were not given any help by the experimenter unless they were clearly stuck or lost for a few minutes. Participants then went through a short semi-structured interview on their experiences using Help Kiosk and the manual. Participants were then asked to perform Task A and B without the manual or Help Kiosk, and were given another semi-structure interview. The study took 1.5 to 2 hours and participants were given a financial honorarium.

Results

Varied Usage of Help Kiosk and Manual

Participants were asked to use the Help Kiosk and manual as much as they wanted, and were observed to use these two scaffolds to varying degrees. For Help Kiosk, two of the participants (P3, P6) used this scaffold at each step, touching the kiosk and referring to the various instructions before performing the step. Two other participants (P1, P5) interacted with Help Kiosk only when they were stuck and the text instructions were unclear. The two remaining participants (P2, P4) read the steps offered by Help Kiosk, but used the demo videos and Live View highlighting very few times throughout the session; these two participants appeared to prefer working out problems on their own without Help Kiosk. For the manual, half the participants (P1, P5, P6) used the manual about as much as they used Help Kiosk, while the other participants (P2, P3, P4) only

used it a little because of difficulties using it (we discuss this below).

Help Kiosk helped participants at least as much as manual

Help Kiosk appeared to help participants at least as much as the manual. During the learning process, half of the participants were able to complete both tasks using either Help Kiosk or the manual. Two of the six participants (P4, P5) were only able to complete the tasks using Help Kiosk but not the manual, and one participant (P2) was not able to complete either task.

Participants generally found the workload (mental demands, temporal demands, own performance, effort, frustration) they experienced using the Help Kiosk was lower compared to using the manual (average ratings of these 5 subscales: 2.5 and 3.6, respectively; 1=very low). Participants only found using Help Kiosk slightly more physically demanding than the manual (2/6 and 1/6, respectively; 1=very low), as we expected. Participants found it easy to use the smart phone at the same time as Help Kiosk (4.5/6; 6=very easy to use).

How Help Kiosk helped older adults learn

Help Kiosk appeared to offer better support than the smart phone's manual, and we attribute this in part to the design principles we implemented as features in our prototype. Note that we have not yet prototyped the exploratory mode or context-aware browse and search, so we have not yet assessed their usefulness.

Support Authentic Tasks and Self-directed Learning: Like the manual, Help Kiosk supports authentic tasks by helping learners perform tasks on their device. Both scaffolds also promote self-directed learning as users have to find help for their learning needs, perform the task for themselves, and can practice and repeat as much as they want to at their own pace. Learning on the device that they will be using seemed to help learners retain what they learned. Almost all participants were able to complete both tasks without the scaffolding.

Minimize Demands on Working Memory: Help Kiosk's presentation of text instructions were designed to reduce working memory demands. A number of participants were frustrated when using the manual because they felt they were wading through contextual information that did not directly help them perform the task at hand. One participant noted, "[the manual is] talking about unrelated stuff I don't want" (P3). As mentioned earlier, the text instructions used in Help Kiosk were sourced from the smart phone's manual and while the wording and step order were preserved as much as possible, we separate the core procedural information from the other information. As seen in Figure X Help Kiosk presents the core steps (e.g., "Touch an existing alarm to change its time and other attributes") on the main pane, and places optional steps (e.g., "Touch Vibrate to have the phone vibrate, in addition to playing the ringtone") and the supportive information (e.g., "About Alarms") in an accordion panel off to the side. Thus Help Kiosk users could focus on the steps to completing the task at hand and could access optional steps if they wanted.

Provide both generic and specific instructions: We found that instructions presented in different media formats and levels of details were helpful in understanding how to perform a particular step. We observed participants having difficulty following a small number of text instructions that participants found unclear. An example of these instructions was "Touch an existing alarm"; no UI was labelled in the instructions as "existing alarm" or "alarm" nor did the instructions explicitly state what UI control "existing alarm" referred to. Thus participants using the manual as scaffolding for this step spent several minutes stuck trying to interpret this command. One participant stated: "I found [the manual] a bit incomplete. I was looking for guidance to a next step a couple of times" (P2). In contrast, Help Kiosk presented the instruction using the identical wording that participants found unclear, but participants used the suggestions offered by the Live View highlighting and the demo video to determine which UI controls to interact with to follow the instruction.

Participants generally felt that both the videos and highlighting helped them to follow the instructions (video: 4.5/6, highlighting: 4.5/6; 6=very helpful). We observed that participants generally only needed to use the suggestions once to interpret a text instruction; Help Kiosk was not used much after the first time the learner completed the task. Overall, participants felt that it was much easier to follow instructions on Help Kiosk than the manual (5/6, 2.5/6, respectively; 6=very easy). A participant summarized this finding, "it takes more effort to interpret [the manual than Help Kiosk]" (P3).

Utilize device state information to personalize experience: To help learners coordinate their attention between the training material and the technology being learned, Help Kiosk restricted learners from accessing help for instruction steps that they could not yet perform on the device. However, participants did not use this feature as they generally accessed help only for steps that they were trying to perform.

Limitations

Our study had a number of limitations that need to be considered in interpreting the findings. First, this informal evaluation was a small and preliminary study to assess how well Help Kiosk supported learning. A larger, more systematic study is needed to confirm our findings. Second, participants' learning process was somewhat artificial in our study making it more difficult to learn naturally. Participants in our study learned in an experiment room filled with unfamiliar and perhaps intimidating technology and in the presence of unfamiliar experimenters who recorded their actions and statements. Understandably, some participants expressed experiencing some nervousness during the initial learning process. Older adults

may learn more easily with Help Kiosk and the manual in a more comfortable environment (e.g., home) and with access to help from their social circle.

DISCUSSION

Help Kiosk helps older adults perform tasks

Our informal evaluation of Help Kiosk showed evidence that an augmented display help system incorporating a number of our design principles can help older adults learn to perform new tasks on a mobile phone. At the end of the study, our participants, who had very little prior experience with smart phones, generally reported being encouraged that they were able to learn to use a smart phone and a few participants even suggested that they would consider buying one afterward.

Participants' successes in learning to perform mobile phone tasks with a learning resource and minimal help from the experimenter suggests that older adults do not need a great amount of help to learn to use mobile devices. Most participants were able to perform both mobile phone tasks without help after only performing it only twice with scaffolding. In fact, participants did not seem to rely much on the scaffold during the second time they performed the task. When participants often only needed help on one or two steps and could learn the rest from reading and interacting with the devices UI. Help Kiosk demo videos and Live View suggestions also helped some participants confirm that they were performing the task correctly, but these participants may not have needed this confirmation to learn the tasks. Mobile device tasks are generally shorter and simpler compared to desktop computer tasks, so there are fewer steps to get stuck on in performing a task. Thus, it appears that older adults' process for learning to use mobile phones and other devices does not require an extensive amount of training, which is often necessary for learning to use some desktop computers applications.

Helping older adults succeed in the initial attempts

Our evaluation of Help Kiosk revealed the importance of helping older adults perform tasks on their initial attempt. Older adults need help in cases when they get lost in navigating the mobile UI, which happens more for older adults [Ziefle?], or get stuck on a task step. It is crucial to help older adults quickly recover from errors as errors have been found to more negatively affect older adults [Birdi] When older adults try to learn a mobile phone task, many will try once or twice, but will quit the learning process if are not making progress within a few attempts. Helping older adults progress through and complete a task will build their confidence in using the device.

FUTURE WORK

Future work includes prototyping more Help Kiosk features, such as exploratory mode, browse and search, and refining the UI design and text instructions. User study participants suggested making the demo videos larger. A larger study is also needed to confirm our findings.

Augmented displays may be used to support learning in a number of other situations. Augmented displays may be use to support learning in a number of other situations. Help Kiosk supports self-directed learning, but could also be designed to present a tutorial or course that directs the learning process. Augmented displays may also be particularly useful at an attraction (e.g., museum, art gallery) or new environment (e.g., airport in foreign country, unfamiliar work site) to help visitors quickly learn a new software application. Augmented display systems that use very large displays (i.e. several meters wide) may also be suitable for training a group of learners to use new mobile devices and applications. For example, a trainer could teach a group of learners (students, salespeople, customer support employees) to use new mobile devices and applications through an augmented display system that incorporates a classroom projector. A UI layout similar to Help Kiosk that includes text instructions, demo videos and Live View highlighting could help learners at varying expertise learn at the same time, offering more details to help beginners learn along with the group.

CONCLUSION

We ran a comprehensive survey study to better understand what learning resource features older adults rate as important for learning to use everyday mobile devices, such as mobile phones. We found that older adults primarily want help with learning the exact steps of a mobile device task and compared to younger adults want learning resources to provide them with more support. We also found that older adults generally prefer using manuals while younger users prefer learning by trial and error. We used the findings from the survey, as well as design guidelines from the literature, to create *Help Kiosk,* a learning system prototype that augments the mobile phone display. Help Kiosk was designed and prototyped following 6 principals, and evaluated by 6 older adults. Our informal evaluation showed that Help Kiosk better supported older adults than a manual and shows promise as a system to help these users learn to use mobile device.

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