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DESIGNING A MOBILE TRANSCRIBER APPLICATION FOR ADULT LITERACY EDUCATION: A CASE STUDY

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ABSTRACT

Functional illiteracy rates amongst 16 to 65 year-olds in the world's richest countries are alarmingly high. This research looks at the use of mobile technology to support experiential adult literacy education whereby adult literacy students are able to construct knowledge throughout their daily activities whilst being supported in their daily literacy challenges. This research has two primary goals: (a) to design a mobile application to support adult literacy education; and (b) to identify appropriate processes by which this design could be achieved given the nature and specific requirements of the target users. The means by which both goals were achieved, together with lessons learned, are discussed. A prototype mobile application to meet the needs of adult literacy students is also introduced.

KEYWORDS

HCI, m-Learning, Adult Literacy, Case Study, Participatory Design, Prototyping.

1. INTRODUCTION

The International Adult Literacy Survey (IALS) showed that the literacy skills of individual citizens are a powerful determinant of a country's innovative and adaptive capacity (OECD, 1997). It is therefore alarming that, as reported at the UN Education for All Conference in 2000, nearly 25% of 16 to 65 year-olds in the world's richest countries are functionally illiterate.

Although improving basic skills is "*a pre-requisite for enhanced capacity for individuals in employment, in education, in community participation, and as parents*" (European Basic Skills Network, 1999), adult education is typically underdeveloped because it is seen as marginal to compulsory schooling and is an invisible part of other activities. In an investigation into how education can help adults overcome the problems of social exclusion, the importance of community was emphasized and the requirement for literacy organizations to meet the needs of ordinary people in communities was stressed (OECD, 1999). Although this community approach often works well, some potential learners are being discouraged because the program structure does not accommodate other important aspects of their lives; barriers like job or money problems, lack of childcare, and transportation often prevent those who need the support from taking part in such programs (ABC Canada, 2005).

Flexible access to handheld technology has been mooted as the means by which children can be provided with tools to construct knowledge throughout their daily activities (Soloway *et al.*, 2001). The research presented in this paper looks at extending this philosophy to support *experiential adult literacy education*. We approached this research (essentially a case study) with two primary goals: (a) to design a mobile application to support adult literacy education; and (b) to identify appropriate processes by which this design could be achieved given the nature and specific requirements of the target users. Section 2 presents some background relevant to this research. Section 3 discusses the design process which was followed to achieve

our two stated goals. Section 4 briefly introduces the resulting mobile application design and Sections 5 and 6 conclude with a discussion of key observations and identified further work respectively.

2. BACKGROUND

As mentioned, attempts to address adult literacy education need to be mindful of the everyday context of the learners' lives. Mobile and handheld computers offer new community-based and context-sympathetic possibilities for adult literacy education.

Desktop e-Learning applications are usually unsuitable for wireless handheld devices (Mitchell and Doherty, 2003) and so a body of m-Learning research is emerging. To date, there are presently very few successful m-Learning implementations (Avellis *et al.*, 2004; Ramsey, 2003); much of the work on m-Learning applications has focused primarily on mobile-phone based delivery (e.g., Attewell and Savill-Smith, 2004; Colley and Stead, 2004; Kadyte, 2004) of situated learning.

The distinction between mobile phones and handheld computers is becoming less obvious (Attewell and Savill-Smith, 2004) with the result that many of the research findings for m-Learning delivery on the former can be applied to the latter. Indeed, handheld computers have been found capable of assisting learners' motivation, helping their organisational skills, encouraging a sense of responsibility, supporting independent and collaborative learning, acting as reference tools, tracking learners' progress, and delivering assessment (Attewell and Savill-Smith, 2004).

Research has shown that transcription can be used to help learners who find writing challenging (e.g., MacArthur, 1999; Raskind and Higgins, 1997; Reece and Cummings, 1996) by improving the quality of their written work; it has been proven superior to the use of dictation alone since it allows learners to see and edit the entered text. Most adults with low levels of literacy can communicate effectively verbally but find it difficult to convey ideas in writing. This difficulty may be caused by challenges in the traditional mechanics of writing such as handwriting or typing, spelling, capitalization, punctuation, and formatting (MacArthur, 1999); a mobile application based on speech-to-text transcription would be able to help such adult learners by supporting circumvention of these mechanics of writing. It has been suggested that interacting with mobile technology via their touch screens is an appropriate mechanism for people with limited literacy skills (Bridges.org, 2001). Together, touch screen technology coupled with transcription capabilities would seem to present the most appropriate interaction combination for adult literacy students using an m-Learning application whilst, at the same time, avoiding the many limitations found with interfaces that use speech alone (Huang *et al.*, 2001; Shneiderman, 2000).

Literacy skills are like muscles – they are maintained and strengthened through regular use (ABC Canada, 2005). Continuous learning is therefore essential for the progress of adult literacy students (Kadyte, 2004). Although formal adult literacy education programs and associated software applications have a clear role to play in raising global literacy levels, adults with low literacy skills also need to be supported in their everyday tasks whilst they attain a more formal education. We therefore decided to focus on the investigation of a mobile application, built on transcription and touch screen-based interaction, to support *experiential* literacy learning. The remainder of this paper describes the process by which we investigated this design, and outlines the resulting prototype application.

3. THE DESIGN PROCESS

3.1 Focus Groups

We conducted a series of 8 focus group sessions with 6 adult literacy students and 3 literacy facilitators from a selection of local community literacy support organizations. The facilitators (who are distinguishable from teachers in both educational background and non-traditional style of instruction or support) met as a group separately from the students to avoid any intimidation or embarrassment the students might have experienced

having their educator in the same discussion group. Each focus group session lasted between 60 and 90 minutes and was audio-taped; all subsequent transcriptions were anonymized.

Our primary goal was to develop a profile of our target user group. We wanted to gauge the receptiveness of adult literacy students to the introduction of mobile technology to assist them in their daily activities; hand-in-hand with this, we wanted to provide the participants with the opportunity to talk about their personal perspective on what kinds of technology they felt would help them as individuals. We incorporated focus groups comprising literacy facilitators to obtain their feedback on the bigger picture of adult literacy as well as to elicit their ideas on beneficial applications to support their students.

3.1.1 Highlights of the Focus Groups

One of the key realizations to emerge from our focus groups was the fact that it is impossible to describe a typical adult literacy student. Unlike target user populations for 'mainstream' software applications which can normally be adequately homogeneously characterized based on their technological needs or goals, adult literacy students are so heterogeneous in terms of their ages, learning styles, literacy levels, technological literacy, and technological needs that to characterize them as a group is extremely difficult. That said, we were able to identify two common challenges which seemed to be 'universal': (a) adult literacy students often struggle with correct pronunciation which in turn affects their spelling capabilities; and (b) handwriting and keyboard skills are often very poor amongst this group.

The circumstances by which the adult literacy students came to have literacy difficulties varied considerably from person to person; all had, however, developed personalized coping strategies. Some tried to figure out as many words as possible in a new piece of text whilst ignoring unknown words and trying to infer the meaning of the text as a whole from the known words. Most talked about staying within comfort zones – always doing things the same way (e.g. always buying the same grocery products) so as not to be faced with literacy challenges. Many had incredible memories which they used to camouflage their lack of literacy skills – e.g., they would memorize the position and sound of a word on a page rather than learning to derive meaning from the constituent letters. From this aspect of the discussion, it became clear that a new mobile application to support these students would potentially have to be customizable to each of their coping strategies so that they could apply what is natural and comfortable to them to their literacy tasks.

Interestingly, facilitators place immense value on experiential – rather than formal, book-based – learning for their students. The facilitators all agreed that one of the most beneficial methods of learning for their students is the ability to acquire, through daily experiences, the skills necessary for addressing everyday life-centered literacy-based activities such as understanding ingredients on grocery packages. This was mirrored in comments from the students themselves and clearly indicated the direction our new mobile application should take.

When talking about their use of technology, it became clear that the frustrations of adult literacy students closely reflect those of most typical users – e.g., the unnecessary complexity of installing software, pop-up ads when browsing the internet, and reliance on obsolete technology. Frustrations were typically borne out of lack of *computer* literacy as opposed to *basic* literacy but some commented that computers' requirement for precise spelling was annoying. Although comfort levels with technology per se appeared to be more a factor of age than literacy level, most students had no problem using other ubiquitous technologies such as mobile phones and microwaves.

When asked whether they would be comfortable using a handheld computing device to assist them with daily literacy tasks, all students expressed keen interest provided it proved useful to them as individuals. All students could envisage themselves using a handheld device in public; some even commented that it would be something of a status leveler, putting them on a par with other members of the community.

In the most abstract terms, the focus group participants were asked to describe the kind of mobile application they could see being useful. In accord with the emphasis on experiential learning-support mentioned previously, the clear favorite amongst the students was some kind of mobile application which would allow them to 'dictate' to the device what they wanted to generate in text (in essence, a speech to text transcriber). They also expressed desire for the application to be able to read back to them what had been transcribed. The students cautioned that they felt any such application could only be successfully adopted if support from facilitators and peers was readily available, if error messages were easily understood, and that any tutorials for the technology were multimedia rather than text-based.

3.2 Participatory Design Sessions

The focus groups highlighted clear support for a mobile application designed to support experiential adult literacy education, consensus on the characteristics of an application that might be useful, and an indication of the constraints that would likely be placed on such an application in order for it to succeed. We therefore proceeded to design an initial prototype of an application that met the mooted requirements.

Development of learning environments is typically characterized by a teacher-centered perspective (Danielsson *et al.*, 2004) based on teacher practice or technical constraints. Danielsson et al. (2004) propose a shift to a learner-centered perspective focusing on design of learning environments that support an understanding of the learners' social context and capitalize on the dynamics of students' use of personal technologies. They argue that in user-centered design (UCD) participants are considered to have experience in their work practice and mainly need tools to support their implementation of their work; in contrast, they suggest that learners are qualified as experts in their use of technology but are novices in their work practice and the tools to be developed are not explicitly to support task performance. They advocate learner-centered design (LCD) based on the use of scenarios as an effective means to bridge the conceptual gap between learners and their work. Although the LCD approach, which views learners as a heterogeneous group, is consistent with our focus group observations, we disagreed with the perspective that adult literacy students should not be considered 'experts' in their work practice. As mentioned, each adult literacy student we spoke with had developed a coping strategy which enabled them to function on a daily basis. Since it was not our intention to build a formal learning application, but rather a *support mechanism*, we felt that the adult literacy students *did* represent expertise in their own work practice. Furthermore, it was this range of contextual work practices that we hoped to support at the experiential level whilst providing some scaffolds for learning. Thus, as articulated by UCD approaches and in light of our focus group discussions, we viewed the adult literacy students as experts who were determined to accomplish a specific task but recognized the need for an educational guide in so doing.

As commented by Kadyte (2004), mobile applications only prove effective if users feel they add value or bring new freedom. Furthermore, typical mobile device users are part of multiple, overlapping contexts which are each influenced by cultural parameters. We therefore felt that a scenario-based approach to our application design process would allow our adult literacy students to represent their individual needs, culture, and context in a tangible, understandable way.

Given the limited literacy skills of our 'experts' in the design process, we selected the PICTIVE – *P*lastic *I*nterface for *C*ollaborative *T*echnology *I*nitiatives through *V*ideo *E*xploration – (Muller, 1992) participatory design method, the goal of which is to empower users to act as full participants in the design of systems that will have an impact on their daily lives. It establishes an 'equal opportunities' design environment where people who are not familiar with software prototyping can contribute on a par with the technology experts in the design team. It does this via the 'imaginative' use of everyday office supplies to generate a paper prototype of a system. Design sessions are video-taped to visually and audibly capture design decisions (and eliminate the need for the design team to take notes). Given the visual nature of our adult literacy students, we felt that this was an ideal method to adopt for our design activities. Furthermore, the PICTIVE participatory design method has been found to be *enjoyable* by designers and users alike; we felt this was important for our participants given their propensity to stay within known comfort zones.

3.2.1 Design Environment Set-Up

On the basis of group dynamics and availability, we invited 4 adult literacy students and 1 facilitator from the focus groups to take part in a PICTIVE-based participatory design process. Together with the researcher leading the team in the role of designer, the team comprised 3 men and 3 women. The researcher met with the participants to obtain consent and explain the process to them prior to a series of 5 design meetings, each lasting between 60 and 90 minutes (meetings were generally short to ensure maintenance of attention and maximum productivity). The design team met in a room with the set-up as shown in Figure 1. A Logitech Quickcam Pro 4000 was suspended from the ceiling above the design workspace to capture a video/audio design document of the design activities and results; the area captured by the camera was delineated in blue tape (shown as bold line in Figure 1) on the design surface to ensure all relevant activities took place in view.

Participants were asked to think of scenarios from their daily lives in which they felt the introduction of a mobile application might meet their literacy-based needs. These scenarios formed the basis of discussions in

the early design meetings and focused the design activities in later meetings. They also formed the basis of 'walkthroughs' of the design during the final meeting.

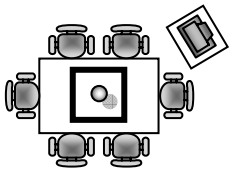

Figure 1: Design Environment Set-Up

The design team participants identified a core set of support mechanisms which the application should incorporate to assist them in their everyday lives. Firstly, the application needs to be able to help them understand and pronounce written words that they do not know how to read; this includes finding definitions and phonetic breakdowns for words. Secondly, the application should help users spell words that they can say and understand but do not know how to spell. Thirdly, the application should assist users to find, for any given word, similar and opposite words in order to help expand the users' vocabulary. Finally, the participants felt that the application should be able to incorporate rules or explanation for spelling, grammar, and pronunciation.

Although we initially envisaged the mobile application as something that would be lightweight and support adult literacy students in note taking type activities, the participants saw a more expansive use of the application to include writing letters, journals, and other compositions. They did not feel that the size and interaction style of a mobile device precluded them from using the application in a comprehensive manner.

During the course of the participatory design sessions, the participants iteratively generated a paper prototype of an application which met the requirements identified above. Centering on a larger than life template of a handheld device (see Figure 2), the design team used a variety of office supplies (e.g. paper, pens, highlighters, Post-it™ notes) to mock-up the graphical elements of the interface which were then used to work out the interaction needed to accomplish the tasks identified in the participants' usage scenarios.

4. THE INITIAL PROTOTYPE

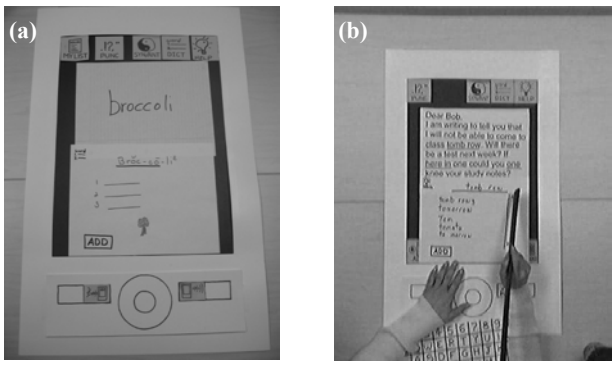

Figure 2: Paper Prototype Showing (a) Word Look-Up Facility and (b) Word Correction Facility

At the end of the final design session, the team had established a fairly comprehensive paper prototype of a mobile application which they felt would be useful to them in their daily lives.

In general terms, text is input to the application via a variety of mechanisms including speech-based entry of phrases and/or spelled out words, soft keyboard-based entry for those users who can spell well, and thesaurus- or help-based word entry. Similarly, users can receive feedback regarding their input text in a variety of ways: text can be visually represented on screen with grammatical mistakes and un-transcribed words highlighted or text can be read out by the application with words or word fragments highlighted as they are read to allow the user to identify those words which have been incorrectly transcribed.

The application comprises a range of tools. A dictionary facility (see Figure 2(a)) includes, for any selected word, a definition, a breakdown into syllables and phonetic symbols, and links to images (where applicable) and/or examples of the word in use. A thesaurus is provided to list synonyms and antonyms of any selected word. A comprehensive help facility is incorporated which provides suggested words or phrases that would be suitable to correct selected text (including words that 'sound like' the selected text – see Figure 2(b)). A punctuation tool allows users to enter punctuation marks using the touch screen and stylus. Finally, a 'my word list' facility allows users to select and record words that they want to work on in the future.

Figure 2 highlights just two examples of the many scenarios that were discussed during the design sessions and the associated functionality which was incorporated into the application prototype as a result. Figure 2(a) shows the prototype's word look-up facility. In this scenario, the user has come across the word 'broccoli' and needs help understanding how to pronounce it, and what it is (or means). The application shows the pronunciation, defines the word, and shows an image of the item (to support the users' visual dominance).

The video-still of the prototype shown in Figure 2(b) was taken from the final walkthrough conducted during the last design meeting. It shows a more comprehensive use of the application to write a note to someone. In the middle of the text, the transcriber has misinterpreted 'tomorrow' as 'tomb row' on the basis of poor pronunciation. The user is endeavoring to correct this. The application presents a set of words that might have been intended instead of 'tomb row' and the user is able to select 'tomorrow' from the list.

5. DISCUSSION

Were we correct in our insistence that our adult literacy students were 'experts' in their work practice? Was the PICTIVE method the right choice for adults with limited literacy skills? The outcome of the PICTIVE participatory design sessions was a comprehensive paper prototype of a mobile application which adult literacy students felt would help them experientially gain literacy skills during their everyday activities. In this regard, the process was a success and we feel strongly that the participants' role as 'experts' was indeed valid. We found it extremely valuable to have people with a range of literacy skills work together with a literacy facilitator in the design team; many of the challenges experienced by the participants in everyday life were surprising to the researcher and it was only these 'experts' (in terms of the challenges) that could adequately have informed the design process.

Table 1: Average Subjective Responses to Post Design Interview Questions

Question	Average Response
Did you enjoy the design sessions?	4.5
How understandable was the aim of the design meetings?	4.5
How easy were the steps in the design process to understand?	4.0
How easy was it to understand what a handheld computer could and could not do?	3.2
How easy was it to come up with scenarios?	4.75
How easy was it to contribute to the paper prototype design?	4.75
How important do you feel your contributions were to the design?	4.75
How useful were the office supplies in terms of letting you show the team your ideas?	5.0
Was your time in the meeting sessions well spent?	5.0
What do you think about the quality of the design?	5.0
Do you think the final design meets the needs of the literacy students in the team?	5.0

We tailored the participatory design meetings to be sensitive to the fact that our participants were essentially outside of their comfort zone: participants were regularly reminded that they were part of a design team and their ideas were continuously validated; we relied heavily on pictorial explanation of aspects during communication with the participants; and having the participants outnumber the 'technical designer' helped make the students feel more comfortable. Following the final design session, a member of our research team (not the researcher who had acted as 'designer') interviewed each available participant to obtain subjective

feedback regarding their experience as part of the design process. Participants were asked a series of 11 questions, worded sympathetically to their literacy comprehension levels, and the participants were asked to rate each question on a five point scale (with 1 = lowest score; 5 = highest score). The questions and average responses are shown in Table 1.

As can be seen, the participants viewed their experience and the value of the resulting prototype design very highly. Having little experience with mobile devices such as PDAs, the most difficult aspect of the design process for many participants was understanding the capabilities of mobile technology; we feel this might also be due to the inevitable cognitive disassociation between the larger-than-life non-portable paper prototype and real mobile technology. That said, this did not seem to prevent the participants from actively engaging in the design process.

Anecdotally, the following comments from the participants would seem to reinforce their positive opinion of the design experience:

> *"as a group, we achieved something good that will help a lot of people"*
>
> *"*[I liked] *the discussions, making something out of nothing, and being around people"*
>
> *"*[it was a] *safe place to talk about issues,* [I liked] *being listened to, it was a friendly group, easy going, and learning about others"*
>
> *"*[I liked being able to] *help put down things that apply to our lives into the design"*

All participants expressed disappointment when the final design session drew to a close. They would have been happy to have continued with the process. They were all anxious to see "their" prototype implemented and put to practical use.

Our results point to this having been a positive, successful experience both for the research team and for the adult literacy students and facilitator who took part in the design sessions. Evidence would suggest that the PICTIVE participatory design method is a valuable tool for design activities involving participants with limited literacy skills; it would also seem to be adaptable to design activities for mobile applications.

6. CONCLUSIONS AND FURTHER WORK

As mentioned previously, we had two primary goals associated with this research: (a) to design a mobile application to support adult literacy education; and (b) to identify appropriate processes by which this design could be achieved given the nature and specific requirements of the target users. In terms of the latter, we have shown that adult literacy students can be successfully incorporated as 'experts' into a participatory design process and that a visual-centric, low-resolution method such as the PICTIVE participatory design method is very well suited to the design activities of such a group for mobile application development.

The outcome of our focus groups and participatory design sessions is a paper-prototype for a mobile application to support experiential learning for adult literacy students. In this regard, we have achieved at least the initial phase of our first goal; we acknowledge there are still many challenges to be faced.

Petta and Woloshyn (2001) conducted a recent study of adults with limited literacy skills and found that the training required by two over-the-counter speech recognizers, together with their associated recognition accuracy, affected participants' comfort using speech recognition software. Their study found the training process demanding and labor intensive for both tutors and adult literacy students; although the recognition software supplied multiple texts to read as part of the training process, all texts required reading levels that were beyond those of the adult literacy students. This suggests that, for our application, we need to look closely at effective training mechanisms which are tailored to the specific capabilities of adult literacy students. Petta and Woloshyn (2001) also noted that when students noticed an increase in recognition errors, it was hard for them to determine whether the errors were caused by their own pronunciation, incorrect microphone placement, ambient noise, or other technological phenomenon. This uncertainty contributed to increased anxiety and frustration amongst the users of the technology. By introducing speech transcription into a mobile application, we are undoubtedly compounding these issues and so will have to look to ways to address recognition error representation as well as maintaining acceptable levels of recognition.

We propose to conduct extensive evaluation of our mobile adult literacy application, both on the paper prototype as it stands as well as later implementations of the application. Effective evaluation protocol

design for our target audience will take careful consideration and will be required to accommodate the heterogeneity of adult literacy students. This, in itself, is an interesting and exciting challenge.

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