Mobile Phone as Scaffolding Technology:
How low literacy groups learn computing?

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Introduction

Can the use of mobile phones by low computer literacy populations help them also learn computing? This paper argues that it can help. We are claiming that theories of metaphors and mental models, as well as the role of social networks in the diffusion of innovation, suggest that people with low computer literacy could use their experience with fixed line telephones to learn how to use a mobile phone, and that by the same scaffolding process, they can use their skills and knowledge gained from using mobile phones to learn how to use other computing systems, such as personal computers (Kavanaugh, 2004).

The mobile phone could act as a bridging (or scaffolding) technology in this learning process because people with low computer literacy, especially in developing countries, are more likely to own a mobile phone than a personal computer (Schement & Forbes, 2000; ITU, 1995-2004). Low literacy groups also have the social network built in to use a mobile phone for communication, as well as for informal learning and help with how to use their own mobile phone. Ultimately, mobile phone use could be very important in helping large segments of the world's peripheral population gain computing skills that provide myriad advantages, including: 1) allowing them to access resources that are increasingly available online, 2) securing better employment opportunities that require some computing skills, and 3) helping them generally reap the benefits of an information society and economy. Finally, in this paper we suggest various technology design modifications that help to support mobile phone use among low literacy groups.

Mental Models and Metaphors

Mental models and metaphors, among other factors, affect learning (Guntner, 1983) and thereby influence the adoption and effective use of information technology (Gurstein, 2003), as well as interface design (Carroll et al., 1988; Dearden & Walker, 2005). Analogical reasoning is essential for forming mental models for any concepts or domains that are abstract, unfamiliar, or subjective. Hummel and Holyoak (1997). summarize it this way "…use of analogy is ubiquitous in human reasoning and provides a basis for induction of complex relational knowledge such as schemas and rules" (p. 427).

Much of a person's current thinking concerns preparation for future learning (Bransford & Schwartz, 1999; Schwartz & Bransford, 1998; Schwartz & Martin, 2004). When people lack relevant prior knowledge or experience, they lack a mental model for assimilating or accommodating new knowledge. People try to make connections between new (or 'targeted') knowledge and what they already know. They do this by mapping the relational structure of a known or relatively familiar domain (i.e., the source domain) onto the targeted domain (Gentner, 1983; Gentner & Stevens, 1983). Selection of a source domain is usually dictated by pragmatic concerns (Holyoak, Gentner, & Kokinov, 2001; Holyoak & Thagard, 1989; Spellman & Holyoak, 1996). One first principle of instructional design and learning science concerns basing new learning upon relevant prior knowledge (Ausubel, Novak, & Hanesian, 1978; Merrill, 2002); instruction must help the learner to make connections between their existing knowledge (mental models) and what is to-be-learned. What happens is that the individual maps the relational structure of the known domain on to the source domain, inferring that the targeted

domain acts and responds analogously to the existing mental model (see **Appendix**).

Many people in developing countries and in underserved areas of developed countries still have low reading literacy. For people with low reading literacy, it is much easier to learn to use a mobile phone than a personal computer because of the similarity between the design and function of a fixed telephone and a mobile telephone. Both phones are used for voice communication functions. Both phones have similar interfaces, with a set of numbers used for dialing and for turning the phone on and off. These similarities make the mobile phone almost immediately usable for novices who have even only minimal experience with fixed telephones either in their household or in public facilities.

Social Networks and Innovation Diffusion

It has been well established by innovation diffusion studies that social networks are key to the processes of adoption and sustained use (Rogers, 1995; Wellman, 2001). In addition to the claims discussed above about mental models and metaphors for mobile phone use and computing, there are several important reasons why the social networks of people with low computer literacy would influence the use of mobile phones versus personal computers. While almost all computer users turn to family members, friends, co-workers and others in their social circles for help to learn computing, people with low computer literacy are typically in social networks with other people with low computer literacy. Therefore, most of the people in their social circle do not use the internet and do not have email and cannot provide help to teach others such skills. So, the people in their social circle are not likely to be able to help them learn of how to use a personal computer, since they do not have knowledge or experience with computers themselves.

People with low reading and computer literacy are more likely to own a mobile phone than a personal computer. In fact, there are currently more mobile than fixed phones in many developing countries, simply because fixed phone service and infrastructure has been under-funded by many governments for decades (ITU 1995-2004). In the US, over two-thirds of the adult population own cell phones (Rainie & Keeter, 2006), with growing ownership among the elderly and lower socioeconomic groups. Thus, people with low reading literacy can usually reach members of their social circle with mobile phones (because they are likely to have a fixed line or even a mobile phone) but cannot typically reach them with a computer, since they are unlikely to use the internet or email.

User centered design

Despite the exponential growth in computer networking and information technology adoption and use, the majority of the world population is not computer literate. People have low computer literacy for myriad reasons, from low reading literacy to an aversion to computing technology. User centered design is an important approach for this population because it emphasizes the needs and interests of the current and future users of a technology in order to optimize its usability and usefulness to them. User centered design also can take into account cross-cultural differences in mental models, interface design and testing (Vatrapu & Pérez-Quiñones, 2006). Cultural differences appear across socioeconomic strata as well as ethnicity and nationality. In the case of mobile phone users with low computer literacy, we need to consider the unique problems and opportunities for design modifications that this population presents. We are designing a study of how and why low literacy mobile phone users might gain computing skills and how well those skills can be transferred to other computing devices, such as personal computers. We are focusing on low literacy groups in the Appalachian region of the U.S

because they are a valid exemplar group. They also are accessible to us in terms of geographic proximity.

One design possibility is that a person's computer interface is literally their phone interface but enlarged to a full screen. That is, rather than a mouse, it could have a touch screen interface. Some of the buttons could be a bit larger, still occupying the edges of the screen. The lists could be in larger font, but not proportional to the screen size, so users would get a lot more information on the lists. But the interaction would be essentially the same as the mobile phone: users select items from menus that take them to different selections. The added interaction benefit would be that the larger screen real estate would allow for more information visible at once, so there would be less scrolling. If people have this interface on their phone and don't use a home computer, they will benefit from having a common interface on both of them, it would allow them to use the device for internet browsing, media, videos and other tasks no matter where they are.

Another clear design direction is the recently announced iPhone from Apple. It has functionality that resembles a personal computer (with video and music player, calculator, web broswer, email, and calendar) in the form factor of a phone and a touchscreen. Users of the iPhone cannot help but be exposed to the web, and web browsing functions. The transition from such a phone to a desktop computer should be along the lines of the metaphors presented on the phone itself.

Discussion and Future Work

In our testing of these claims in Appalachia we will be using primarily qualitative techniques, including observation, archival records and interviews with users, to investigate how low computer literacy groups use prior knowledge and experience to learn new tasks of computing. By comparing populations with and without experience with mobile phones, we will study how new users of desktop computers manage (and talk out loud about) basic computing tasks that we ask them to do. In addition to standard design and usability testing, such as timing a task, checking for accuracy and tracking clicks and drags on both mobile phones, we are looking for the mental models and metaphors that they might invoke as they work, either out loud or through recall in exit interviews. We are building on preliminary interviews conducted in 2005 to develop appropriate protocols and concept maps (derived from the Concept Table shown in the **Appendix**).

Appendix: Concept Table

We applied a set of phone bridging analogies to the desktop computer: from fixed line phone to mobile phone and from mobile phone to desktop computer (Table 1) for low literacy populations whether in periphery socioeconomic areas of developed or developing countries. We selected some concepts from the target domain and then constrained the source domains to support them, starting with the computer functionalities we wanted to support and working backward.

Concept*	**Fixed phone**	**Mobile phone**	**Desktop Computer**
Data input	Voice	Voice	Keyboard
Data input	Keypad	Keypad	Keyboard (or touchscreen)
Data input	Finger	Finger	Mouse and cursor (or finger if touchscreen)
Data view	No display	Small screen display	Larger screen display
Technical help	Social network	Social network	Public access site
Communication	Social network	Social network	
Information seeking	Limited to voice	Voice, text, images	Multimedia

Table 1. Concept Table of Fixed to Mobile Phone to Desktop Computer

*In HCI we might use the term 'work' (functionalities or affordances) for this category

The concept table is part of the exploration process preliminary to mapping inter-domain relational structure. It aligns the three devices (conceptual domains) for functionalities (or forms of work a device might accomplish) that would be relevant for a new user. The greater the alignment of the relational structure from one domain (device) to another, the more likely people are to construct valid inferences of the target domain by projection of source domain relational structure. A series of domains that share relational structure can serve as a set of bridges that carry an individual from a familiar domain to domains that are progressively less familiar, more abstract, and more complex domains. It appears that the mobile phone could serve as bridge between the preliminary source domain (fixed phone) and the final target domain (the computer).

It is clear in Table 1 that the analogies between fixed and mobile phone are closer than those between mobile phone and personal/desktop computer are more distant. Under the concept category "Communication" we *do not** list "social network" for the computer because someone with low literacy probably does not have other people in their social network who use computers and therefore they would not be able to communicate with them using a computer. So, what we get in this category is structural alignment (Gentner & Markman, 1994) with alignable differences (Markman & Gentner, 1993) where the two more familiar – and simpler – domains have functions (i.e., communicate with social network) that are not analogous to the computer.

However, if the personal computer were a touch screen, for example, the differences in the mental models between the mobile phone and desktop computer would be less, making it easier for people with low literacy to use a desktop computer more effectively. The more accessible the desktop computer is to low literacy groups, the more people within their social network adopt it, and become available through desktop computing, thus, increasing the value of using such technology in order to communicate with members of their social network. A variant of this design direction toward a touch screen

desktop (or public kiosk type) computer is that the networking capabilities of the mobile phone extend so far into the domain of the desktop computer (with electronic mail, web browsing, etc.) that mobile phone users do not need to make a transition from mobile telephone to desktop computing.

The perspective of cognitive science structure mapping metaphor theory deals with the user learning the interface through mapping the relational structure from one domain (source-relatively familiar) to another. Here it would be from one technology to another in a series of bridging metaphors. The eventual domain specifications (concept maps) would show where the source domains are non-isomorphic with the target domains -- in each case because the target domains have greater functionality.

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