Use of Mobile Phones by Non-literate and Semi-literate People: A Systematic Literature Review

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***Abstract* - This paper reports on a systematic literature review conducted to discover the state of research concerning the use of mobile phones by non-/semi-literate users. This is an important and growing area of research because mobile phone users in the developing world represent 73% of global subscriptions, and, of the 796 million people around the world who cannot read or write, 98% live in the developing countries. Mobile phones offer low-literate people critical access to information and services. By understanding how these people currently use mobile phones, we can develop better ways to meet their needs.**

To learn what research has been done in this area, we conducted a systematic literature review to identify good-quality, evidence-based studies that included design recommendations. This paper will describe the detailed selection process and characterize the corpus articles along a number of dimensions: type of use, locale of the study, domain, research methodology, and design recommendations. Then the paper will present a thematic analysis of the usages identified in those papers and discuss the related design recommendations.

Index Terms - mobile phones, non-literate, semi-literate, systematic literature review.

INTRODUCTION

We face an increasingly urban and globalized world. The urban population has been growing rapidly over the past decade; in 2007, the United Nations Population Fund Association (UNFA) predicted that in 2008 more than half of the world's population would live in towns and cities and by 2030 almost 5 billion people would be living in the urban areas in Africa and Asia [1]. While mega-cities have captured much public attention, most of the new growth will occur in smaller towns and cities, which have fewer resources to respond to the magnitude of the change.

Even the world's rural populations are being globalized by access to technologies like mobile phones and the Internet that provide information and services (e.g., banking). A growing percentage of the developing-world population uses mobile phones, compared to 10 years ago. Data from the International Telecommunications Union, the United Nations agency for information and communication technology issues, shows that in the year 2008, the number of mobile phone users in the developing countries accounted for one-third of the world's total number of mobile phone users [2].

But in the developing world, non-literacy and low literacy continue to be big problems. UNESCO data indicates that 796 million people around the world still cannot read or write despite several initiatives motivated towards educating people [3], [4]. Among these, 98% live in the developing countries.

Non-literacy or low literacy can obviously be a barrier to the use of mobile phones, especially in the case of phone UI designs that are heavily dependent on text. Just considering the surface details of presentation of features, we can imagine numerous problems with storing numbers associated with names, choosing commands from a list, and identifying various other features such as customizing settings.

For us to live in a world where all have fair and equitable access to resources, employment, information, services, etc., we have to address the need for access to enabling technologies by non-literate or semi-literate people. Access to and effective use of enabling technologies, especially mobile phones, increasingly appears to be a key to improving the circumstances of this population.

One might attack the problem of access to mobile-phone technologies by non- or low-literate people from many perspectives (cost, durability, existence of infrastructure, etc.). As mobile user experience researchers and designers with a commitment to user-centered design, we narrowed our attack on the broad problem to two questions: How do non-literate or semi-literate people actually use mobile phones? And what design choices support their patterns of usage?

978-1-61284-779-5/11/$26.00 ©2011 IEEE

Our goal in undertaking this study was to provide designers of mobile phones with guidelines or recommendations for designing a mobile user interface that would be effective for non-literate or semi-literate users. To achieve that goal, we needed to investigate the current state of knowledge about the use of mobile phones by non-literate and semi-literate people globally, and the guidelines or recommendations for UI design that have been drawn from this knowledge. Given that this audience of non- or semi-literate users, its activities, and its contexts of use may feel very unfamiliar to many UI designers, we also wanted to provide reassurance that the findings were as credible and as trustworthy as possible. Therefore, we restricted our attention to evidence-based guidelines appearing in published scholarly research (operationally, articles that had undergone a blind peer-review process).

Work on mobile phone usage is being done in a very wide range of disciplines and in fact is very interdisciplinary. To limit the effects of any disciplinary myopia on our part, and achieve as comprehensive a review as possible, we decided to attack the problem using the method of the formal systematic literature review.

In the following paragraphs, we first describe the details of our method and process. We then characterize the corpus of articles that we identified and the studies that they report. We next provide a thematic analysis of the contents of the articles and summarize their answers to our research questions. (In a companion paper, "The Systematic Literature Review as a Research Genre," in this volume, we also comment of the strengths and limitations of the method itself.) Finally, we draw some conclusions about the current state of knowledge on this topic, and point out opportunities for further research.

DESCRIPTION

The methodology we selected, the formal systematic literature review, attempts to limit or remove the individual judgment or selectivity of the researcher from the process of defining the corpus of articles to be reviewed. The process begins by defining numerous rules that will govern the search: specific search terms to be used and the set of bibliographic databases against which they will be applied; the span of years to be covered; types of publications to be included; and so on. This process is in practice iterative; several trial runs are necessary to understand and correct problems with search terms, databases to be included, etc. But once the parameters are defined in final form, they are applied without exception in the search activity.

In defining our search parameters, we first considered the problem of currency; mobile telephony is a rapidly evolving field. For that reason, we restricted our scope to articles published between 2002 and 2010. We wanted to choose articles that were widely accessible; at present, publications in English are the most widely disseminated, so we restricted ourselves to articles published in English.

Our topic of research being multi-disciplinary, we included databases that covered a wide range of disciplines, including HCI, CSCW, education, business, psychology, sociology, and information science. The databases we searched in were: ACM (HCI, CSCW, information science, and computer science), Academic OneFile (across all societies), Academic Search Complete (Business, Psychology, Education), IEEE (across all societies), and ISI Web of Science (across all societies).

To ensure that we retrieved as exhaustive a list as possible of research articles related to our specific topic, we spent a substantial amount of time standardizing the set of search terms to be used in the search. Because different databases have different search behavior, this process was very challenging. For example, the use of Boolean terms (AND, OR, NOT) and special characters such as *, ?, and ^ that help in obtaining more accurate search results are not the same across all databases. Through an iterative process, we were able to arrive at a common set of search terms for use across all of the databases. In order to review a wide set of all related articles, we used generic search terms that related to our area of interest. We also used synonyms of words to ensure that the index words/keywords assigned by authors would not limit our success in locating articles. The following are the search terms that we first formulated, in response to database characteristics:

- mobile phones AND non-literates
- illiterate* AND mobile phone*
- mobile phone* AND "uneducated"
- mobile "phone" interface illiterate use*
- mobile "phone" interface design illitera*
- ICT*D mobile phone non litera*
- mobile UI "phone" *litera*

As we progressed with the process, we found that we needed to modify the set of terms somewhat. Specifically, to reduce false negative scores, we broadened terms and added synonyms. For the literacy dimension, we added 'semi' literacy to 'low' literacy, and included articles that made a reference to education. For "mobile phones", we broadened the terms to include 'telephones', 'voice', 'audio', 'wireless', 'SMS', 'SIM', and spoken language/spoken interface.

Also, we used the advanced search features in ways that allowed us to maintain consistency across all databases. As we wanted to include as many articles as possible for our initial review, we chose 'full text/entire document' or 'any field' in the index field, so that the search engine would look for our search terms throughout the document. No other filters were applied because options available in advanced search are not the same across different databases. After compiling the results

from all search terms in all the databases into an Excel spreadsheet, we excluded all duplicate listings to yield an initial corpus for further analysis.

We also formulated inclusion/exclusion criteria to be applied to the set of articles identified by the keyword search strategy and duplicate suppression described above. These criteria were also iteratively developed; we formulated pilot versions of the criteria, then tested and refined them until they were sufficiently precise to support clear decision-making. The criteria were applied at three levels of analysis: first, we applied the criterion requiring blind peer review (based on inspection of the policy of the publishing journal, article revision data, etc). Next, to the remaining set of articles, we evaluated the title and abstract using the criteria related to content (see below). And third, to the remaining set of articles, we evaluated the full text using the criteria related to content. Finally, working with the resulting set of nine articles, we recursively applied the same process to the citations in these articles that had not appeared in our original search result.

The criteria related to content specified that the article had to address our two key ideas of mobile phone usage and low- or non-literacy. It had to be concerned with the user interface of the devices in question, and had to focus on usage patterns and behaviors as opposed to the technology itself. It had to be based on empirical research, and had to describe the research methodology in sufficient detail to demonstrate that the study met the minimal standards of research and that the findings were drawn from an analysis of evidence. Specifically, we looked for a description of a user study and some description of the user profile of the participants; indication of the site of the study; and some level of detail about the procedure followed and data collected. We also required a discussion of the design implications of the findings.

Figure 1 provides details about the size of the corpus and the effects of applying the inclusion/exclusion criteria at each stage.

DISCUSSION

In the following paragraphs, we characterize the corpus of nine articles that we identified and the studies that they report according to the domain they address, the location where the study was conducted, the level of literacy of the participants, the research methodology used, and the type of use of the mobile phone by users.

I. Domain

Six of the nine articles were domain-specific and the remaining three of the nine articles dealt with general characteristics of phone usage and not usage within a specific domain.

Of the six domain-specific articles, five focused on a single domain and one was multi-disciplinary. The single-domain articles dealt with health (3), finance (1), and agriculture (1). The multi-domain article focused on agriculture, health, professional services, and distance education. Figure 2 shows the domains covered in the articles.

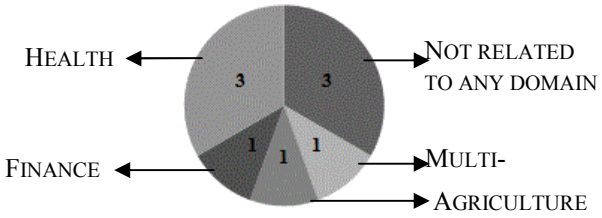

FIGURE 2: THE DOMAINS COVERED BY THE ARTICLES

II. Location

All but one of the nine studies took place in a single country; the other one was conducted in multiple sites. The single-site studies were conducted in India (6), Pakistan (1), and South Africa (1).The multi-site study opened with data collection in two cities in India, one city in Kenya, one city in the Philippines, and two cities in South Africa, and concluded with design and prototype testing at a new site in India. Figure 3 shows the locations where studies were conducted.

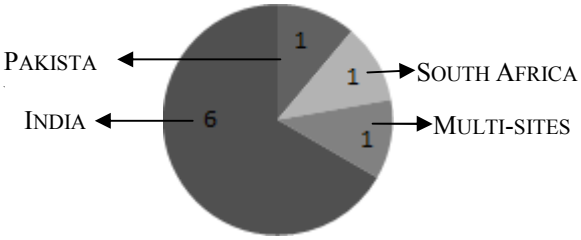

FIGURE 3: COUNTRIES IN WHICH THE STUDIES WERE CONDUCTED

III. Level of literacy of participants

Six of the nine articles reported that they recruited semi-literates for their research, one of the nine articles reported recruiting only non-literates, and two articles included both non-literates and semi-literates. The description of semi-literates differed in the nine articles. Six described participants who were educated up to eighth grade as semi-literate. Two articles made no mention of their education but referred to them as semi-literate based on their profession such as farmers, cleaners, and plumbers. Another article described the participating blue collar workers as non-literate. It was not clear in every instance what standard of literacy the researchers had used.

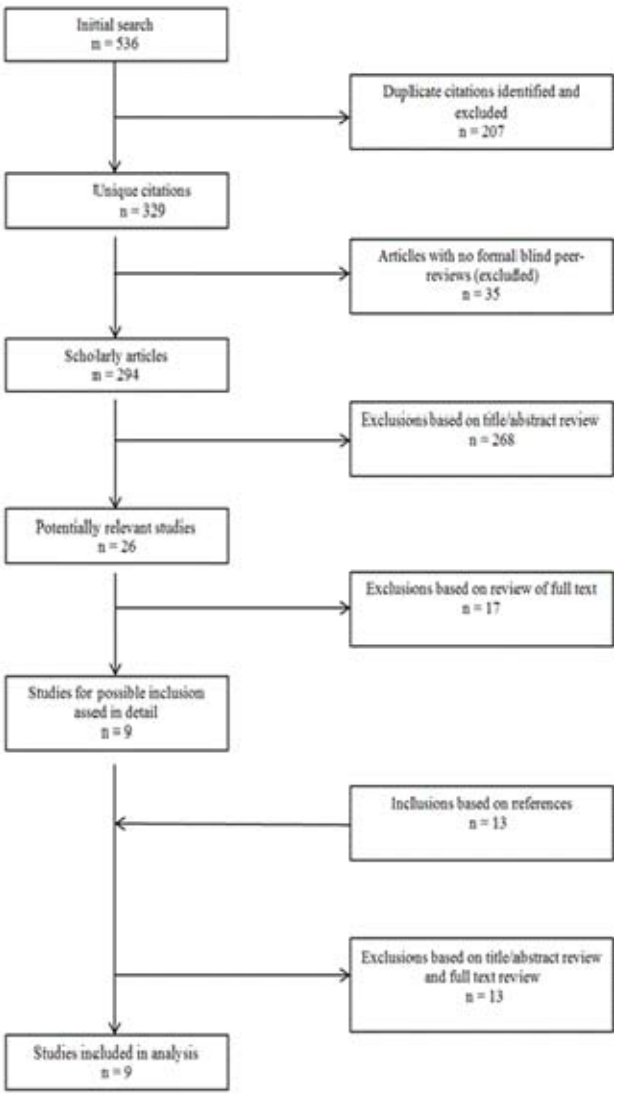

FIGURE 1: NUMBER OF ARTICLES IN EACH STAGE BASED ON INCLUSION/EXCLUSION CRITERIA

IV. Research methodology

All articles reported that they used at least two or more types of research methods. Two of the nine articles used two methods and the rest used more than three methods. All nine articles reported that they had conducted a usability study of the system being evaluated.

Six articles reported that they combined quantitative and qualitative methods. Typically, these "mixed methods" studies combined interviews with quantitative performance measures and/or opinion data. The qualitative methods used in this group included card sorting (one study), contextual inquiry (one study), interviews (two studies), focus group discussions (three studies), participatory design (one study), and descriptive usability testing (six studies). The quantitative methods included descriptive statistics expressed as averages (three studies) or percentages (one study) and/or inferential statistics expressed as t-tests (two studies) and ANOVA (one study).

Three of the nine articles reported using qualitative methods only. These studies typically combined interviews and observations with usability testing (yielding qualitative data). The methods included contextual inquiry (one study), interviews (three studies), task-based studies (two studies), participatory design (one study), and usability testing (three studies).

V. Type of use of mobile phone by users

The use of mobile phones can be classified based on the type of usage: information access, storage, creation, and dissemination. Three of the nine articles focused exclusively on one type of usage – information access (two studies) or information storage (one study). One article covered all types of usage. The remaining five articles focused on two or more types of usage: .

- one article explored information access, information creation, and information dissemination.
- two articles looked at information access and information creation
- one examined information access, information creation, and information dissemination
- one looked at information creation and information dissemination

THEMATIC ANALYSIS AND SUMMARY OF THE CORPUS ARTICLES

For our discussion, the nine articles in the corpus have been divided into two sets, one focused on the study of phone usage itself (three articles) and the other based on the interaction medium used (e.g. voice) and application domain (e.g., banking) (six articles). The discussion of each set begins with the common themes of the articles in that set, a description of the methods used, and a summary of the design recommendations derived from the set of articles; it concludes with a brief summary of each article.

I. Set 1: Articles grouped by focus on phone usage

Of the three articles that discussed general phone usage, Joshi et al. and Bhamidipati et al. investigated only the use of the address book by non-literate users. Lalji et al. looked at the use of address book along with the overall design of the mobile phone, including navigating through the phone menu and making calls.

Overview of the findings in the three articles

The combined findings of the three articles that investigated how non- and semi-literate users use their mobile phones for making calls are as follows:

- Basic features such as (obviously) sending a text message, but also storing phone numbers, appear complex and are not suitable to the non-literate or semi-literate users.
- Non- or semi-literate users tend to use mobile phones in the same way they would use a landline phone, i.e., mobile phones are used only for making calls.
- The phone numbers of their contacts are either memorized or noted in a notepad (often referred to as telephone diary) by a more literate family member. These phone numbers are later annotated with symbols by the non-literates for easier identification.
- Non- or semi-literate users tend to have much smaller number of frequently used contacts in their mobile phones

Overview of research methodologies in the three articles

Lalji et al. [5] and Joshi et al. [6] conducted user research studies (contextual inquiry and interviews) to understand calling habits and needs; A. Bhamidipati et al. [7] reported having conducted surveys and observations to understand the use of the address book. All three research teams reported that they created a user interface and evaluated the design using usability studies. Lalji et al. [5] and Joshi et al. [6] included the target audience in the design process through either participatory design or card sorting. Joshi et al. [6] reported using quantitative data for analysis (time on task and errors) while the other two articles reported using qualitative data.

Overview of design recommendations in the three articles

Non-/semi-literate users want a UI that has graphics, colors, icons, and numerals but with minimal or no text.

Article summaries

The following section provides a brief summary of each of the three articles.

1. Designing new technologies for illiterate populations: a study in mobile phone interface design, Zereh Lalji and Judith Good [5]

Lalji et al. [5] conducted a two-phase study in Mumbai, India. Phase 1 focused on understanding the features that the participants would want on their phone and then designing the user interface of the phone. In this phase, five participants were interviewed about their calling habits and need for mobile phones. The participants were asked to perform tasks such as dialing numbers using a landline, a cordless, and a mobile phone to understand their comfort levels with each type of phone. Later the participants were involved in a participatory design session to create low and medium fidelity prototypes of a physical mobile phone. Phase 1 revealed that the participants were not able to relate to some of the existing user interface elements such as graphics and buttons. For example, the speaker icon on the phone was mistaken for a flashlight; also, the use of highlighting to indicate a selection was not intuitive. In phase 2, 22 participants were interviewed to understand the context of use, usage patterns, and ownership of mobile phones.

Based on all findings, three different versions of a high fidelity mobile phone prototype were created; the prototype provided basic features of making and receiving calls, as well as the use of an address book, radio, camera, and flashlight. Participants were provided step-by-step oral instructions on how to use the phone, as well as context sensitive help provided through voice-over. The prototype was tested with 18 participants, using a within-subjects design; to reduce possible effects of memory, only one version of the prototype per day was tested. A think-aloud protocol was used to assess the versions.

The design suggestions derived from the findings included creating a non-textual interface with graphics and buttons that the users can relate to.

2. Rangoli: A Visual Phonebook for Low-Literate Users, Anirudha Joshi, Nikhil Welankar, Naveen BL, Kirti Kanitkar, and Riyaj Sheikh [6]

Joshi et al. [6] explored creating a user interface for a phone address book for non-literate users to store and access phone numbers. They conducted contextual interviews in two villages in Mumbai, India with 11 participants who were either semi-literate or non-literate. The researchers investigated how the participants stored contact information such as phone numbers, names, and addresses in a physical address book, which was the primary source of contact information, and how the users stored numbers in their mobile phones. In the physical address book, frequently called numbers were annotated with circles and stars.

Based on the findings, the researchers explored the option of using colors and icons in mobile phone address books to design an interface for storing and retrieving numbers. They conducted a card sorting exercise with seven users in Mumbai using suggested categories and subcategories such as relations (friends, families, etc), age (kids, adults, elders), colors, tastes, and icons to group and store numbers. For the card sorting exercise, the participants were asked to think aloud as they organized their stored phone numbers. Based on the feedback, a functional prototype was created that had a numerical keypad with icons and colors, and a pilot design evaluation was conducted with six users in two villages in Mumbai. They measured performance in terms of time on

task and number of errors while looking for contacts. Also a comparison test was conducted to test the performance with a traditional phone. Based on the findings, the interface was redesigned and another usability session was conducted with nine participants in the same villages.

The design suggestions derived from the findings in this study included using icons and colors along with using text to support graphics.

3. Sym AB: Symbol-Based Address Book for the Semi-literate Mobile User, Anuradha Bhamidipaty and Deepak P. [7]

Bhamidipati et al. [7] conducted a survey with 20 participants in Bangalore, India to understand the use of mobile phones. Based on the survey results, they designed a symbol-based user interface for the keypad with little or no text. The keypad had symbols suggested by the target users, which included icons such as home, family, etc, and optional icons such as a square or circle. A qualitative usability study was conducted with 10 participants to evaluate the design. The participants were asked to perform two tasks - store and retrieve contacts - and were asked to describe their experience.

The design suggestion derived from the findings was to create a user interface with symbols and graphics with little or no text.

II. Set 2: Articles grouped by interaction medium and application domain

This set of six articles focused on the interaction medium (audio, text, multimedia, or video) to be used in the mobile-phone UI for a diversity of domains (e.g., agriculture or health). Five of the six articles evaluated the use of speech/spoken/voice interface to provide information access to non-/semi-literate populations. Among these five articles, four of them based their research on the premise that a voice-based user interface is beneficial to the non-/semi-literate population. The fifth article evaluated the preference of non- and semi- literate users for a text-based versus voice-based versus rich-multimedia-based user interface. The sixth article focused on the use of video on a mobile phone.

Overview of the findings in the six articles

The combined findings of the six articles that explored different interaction media (voice, text, multimedia, or video) in diverse domains are as follows:

- Non-literate and semi-literate users have difficulties navigating through a textual interface.
- Use of videos or providing dramatic stories is useful for educating non-literate and semi-literate users.
- When interacting with a voice-based UI, non-literate and semi-literate users prefer keypress/touch-tone over voice (in three of the four studies that addressed this issue).
- When navigating through a voice-based UI, non-literates and semi-literates can navigate through three levels of menu without much difficulty.

Overview of research methodologies in the six articles

To understand the user needs, Agarwal et al. [11], Sherwani et al. [8], and Patel et al. [12] consulted with Non-Government Organizations (NGO). Agarwal et al. [11] relied only on the data collected by the NGO whereas Patel et al. [12] conducted user interviews as well. Medhi at al. [10] evaluated existing applications through usability studies and interviews. Grover et al. [9] and Ramachandran et al. [13] conducted interviews and field visits. Medhi et al. [10], Patel et al. [12], and Grover et al. [9] conducted user interviews to collect demographic information about the users.

All six research groups reported that they created a user interface and evaluated the design using usability studies. While Medhi et al. [10]'s research design involved between-subject comparison, Sherwani et al. [8] and Grover et al. [9] compared within subjects. Patel et al. [12], Agarwal et al. [11] and Ramachandran et al. [13] examined usage logs to analyze user behavior and performance. Five research teams (all except Agarwal et al. [13]) conducted trainings or demonstrations on the capabilities of the system to the participants before evaluating the design.

Overview of design recommendations in the six articles

For voice-based information systems, non-literate and semi-literate users:

- Benefit from the use of a voice that meets local language needs, when using voice as a mode of interaction with the UI.
- Can handle a depth of three levels of menus without much difficulty.

To educate non-literate and semi-literate, using videos or providing dramatic stories helps them in comprehension.

Article summaries

1. A comparison of mobile money-transfer UIs for non-literate and semi-literate users, Indrani Medhi, S.N. Nagasena Gautama, and Kentaro Toyama [10]

In this article, Medhi et al. [10] explored the preference of type of user interface among non-/semi-literate users using a banking application. For the initial user study, the authors evaluated the usability of existing mobile banking applications in four countries (India,

Kenya, the Philippines, and South Africa) through a qualitative usability study. For the study, a total of 90 interviews were conducted in participants' homes to collect demographic information and understand the use of financial services and access to mobile phones. Participants were also asked to perform some tasks using the existing systems. Based on the interviews and observations, usability issues were identified: navigating through the menus, identifying a function, and understanding of banking terms such as "view last transaction." Based on the findings, they created three different UIs: text-based, voice-based, and rich-media-based. For the graphics in the rich-media UI, icons were designed through iterative cycles. To test preferences for the interfaces, usability studies were conducted in Bangalore with 58 participants. Each participant was tested on only one of the three interfaces. Prior to evaluating the design, the participants were trained on the capabilities of the system. Verbal explanation of the system capabilities were shared for text-based and voice-based UI participants. And for rich-media UI participants, voice instructions demonstrating the capabilities of each screen were included on screen load. Data consisted of notes taken by the researchers while the participants were performing a task, total time taken, and the number of prompts required for completion. The results showed that task completion rates were higher in the rich-media UI, but the performance in terms of speed and prompts with the voice-based UI was better than with the rich-media UI. The text-based UI was not successful.

2. Content creation and dissemination by-and-for users in rural areas, S. Agarwal, A. Kumar, A. Nanavati, and N. Rajput [11]

Agarwal et al. [11] conducted their user research study in four villages (Vandaram, Juvvala Palam, Cheukumilli, and Ibhimvaram) in Andhra Pradesh, India to evaluate the need for building an information system that the non/semi-literates can use to create and access locally relevant content. They worked with an agency called Byrraju Foundation, an NGO, to collect the initial information on user needs. Based on the interactions with the agency, they designed a voice-interaction-based system called VoiKiosk, built on IBM Research's Spoken Web platform. VoiKiosk could provide users with information in four areas: agriculture, health, professional services, and distance education. To interact with the information system, a user had to dial in using a mobile phone and use their voice for providing instructions. The researchers noted that voice was preferred over keypress by the users.

The designed system was tested with four users; this process of usability testing was referred to as participatory design by the researchers. Based on the feedback, the researchers modified the instructions required for interacting with the system and then ran a longitudinal pilot study with 30 users in one of the villages (Juvvala Palam). They noted that the participants were not provided any active training on how to use the system. The system was open to the users for four months; the researchers monitored usage regularly. During this study, design changes were again made to improve navigation (although the article did not specify the trigger for making changes).

This was a quantitative study based on an analysis of usage logs; data used for analysis included duration of calls, the number of calls made by each user, and the number of calls made to the different information areas. Descriptive statistics (averages and percentages) were used to compare usage patterns.

3. Avaaj Otalo: a field study of an interactive voice forum for small farmers in rural India, N. Patel, D. Chittamuru, A. Jain, P. Dave, and T. Parikh [12]

Patel et al. [12] conducted research in Gujarat, India to examine the need for an information system that the non-/semi-literate village farmers could use to create and share information related to agriculture that would be relevant locally. They worked with an NGO called Development Support Center (DSC) that runs educational radio programs to help farmers with agriculture-related information. The initial user research included interviewing the DSC staff to understand the needs of the farmers. The researchers also conducted interviews with farmers to gather demographic information and information about access to phones, as well as technical capabilities such as the ability to make calls and send text messages. Based on the interviews, they decided to include three features in the information system: a discussion forum, announcement board, and radio archive. The discussion forum would allow users to record questions, provide an answer to the questions posted by fellow users, and browse through the existing list of questions and answers. The announcement board was for DSC to broadcast messages related to agriculture, weather, and market prices. The radio archive was a repository that provided access to all archived radio programs hosted by DSC. To interact with the information system, users could either press a key or use voice. The system was built using VoiceSite, based on IBM Research's Spoken Web platform.

The system was launched for a longitudinal pilot study with 51 users for seven months. Prior to the launch, the participants were briefed on the features of the system, and demonstrations were provided through role-plays about how to use the features. The goal of the study was to understand the functionality and benefit of the system. For this, both qualitative and quantitative data were collected through usage logs and interviews. Descriptive statistics (averages) were used for analyzing system usage: the number of calls made by each participant, the number of calls made to access each feature of the

system, the number of errors (no input when the system prompts for an input, or hanging up without providing any inputs), and the number of questions posted and the number of answers provided by each participant. In the interviews, the participants were asked about content quality, content organization, preference of features, and overall satisfaction.

The study found that the users liked the discussion forum the most because they could learn from the experiences of the fellow farmers. However, they placed higher value on the responses from the experts rather than from the fellow farmers. Though not a primary focus of the research, the researchers also noted that the keypress was preferred over voice as an input among the uses.

4. Speech vs. Touch-tone: Telephony Interfaces for Information Access by Low Literate Users, J. Sherwani, S. Palijo. ,S Mirza, T. Ahmed; N. Ali, and R. Rosenfeld [8]

Sherwani et al. [8] conducted a pre-pilot study to evaluate the initial design of a health information system that provided information on malaria, diarrhea, and hepatitis to community health workers in Sindh, Pakistan; the system was developed in Sindhi, the local language. The community health workers are usually non-or semi-literate and are trained in basic health services for a few months, and then sent back to provide health services in their communities. The participants for the study were recruited by an NGO, Health and Nutrition Development Organizations (HANDS). The voice used for the system was of a doctor that the users of the system were familiar with. The pre-pilot study session began with the researchers introducing the system verbally and then asking the participants to go over a tutorial. Participants were then asked to perform a set of three tasks for each input method (keypress and voice). Task completion rates were collected (the task completion rate for the second task was zero). At the end of study, they were asked to rate each input method and then take part in an interview. Demographic information was also collected.

Based on the pre-pilot study, the researchers made changes to the study design and conducted a pilot study. They increased the time for tutorials and reduced the number of tasks from three to two. For administering the test, they adopted the "Bollywood Method;" this method involves providing a dramatic story to convince the user of the urgency of the problem.

For the pilot study, they recruited 18 participants. Information about education level, language proficiency, and telephone usage was collected. During the study, the task success for each input method was noted and user preference for each input method was also elicited through post-test interviews. Quantitative data was analyzed using ANOVA. The study found that the task success rate using voice was higher than touch-tone. However, the non-literate users preferred touch-tone because they found the speech interface harder. But the low-literate participants preferred the voice interface over touch-tone.

5. HIV Health Information Access Using Spoken Dialog Systems: Touchtone vs. Speech, A.S. Grover, M. Plauche, E. Barnard, and Kuun, C [9]

In this paper, the researchers evaluated the preference for touchtone versus speech for accessing information from a HIV health information system by caregivers. The study was conducted in Botswana, Africa. To understand the existing system, 17 participants of different roles (caregivers, nurses, and doctors) were recruited. The existing system supported the situation in which a caregiver of a HIV child visited a childcare center for medical treatment of the child and to obtain training on HIV treatment and medication. Interviews and discussions were conducted with the participants of different roles to identify their day-to-day tasks and their needs. The researchers also made field trips to understand typical situations encountered and tasks performed by the caregivers and also to acquaint themselves with HIV domain-specific knowledge used by the caregivers in different scenarios.

The next step was to design the content and structure of the information system. To design the system, the researchers conducted interviews with experts such as nurses and doctors, and focus group sessions with 27 caregivers. Based on the findings, a system providing information on Hygiene & Cleanliness, Nutrition, and HIV was developed in Setswana, the local language. The system had three layers of menu; level 1 constituted the main topic, level 2, a subtopic, and level 3, the content. And to interact with the system, the user could use either of the two modes of input, voice or keypress. The voice used for the system was that of a nurse that the users of the system were familiar with. To test the user preference of the input mode, 27 new caregivers were recruited. The session started with each participant viewing an educational video of a scenario typical of their work. The video highlighted the benefit of the information system and also demonstrated how to use the system. In addition, the participants were given demonstrations of how to use the system. After the introduction, they were given two sets of tasks to interact with the system. Each task required a different mode of input. The researchers noted successful task completion and response time (time taken to respond to the system for each menu item). Post task questionnaires that collected qualitative data were administered verbally; responses were noted on a five-point Likert scale. Information about demographics, familiarity with technology, and use and ownership of phones was also collected.

For quantitative data analysis, the researchers used descriptive statistics (average of time taken) for comparison. The researchers noted that the performance

was similar in both types of inputs. However, the participants preferred touch-tone interface over voice.

6. Mobile-izing Health Workers in Rural India, D. Ramachandran, J. Canny, P.D. Das, and E. Cutrell [13]

The last article of the corpus focused on evaluating the use of videos on mobile phones to help maternal health workers persuade pregnant women to use health services. Ramachandra et al. [13] conducted this study in Orissa, India. For user needs analysis, they conducted qualitative activities such as field visits, observation of health workers in training sessions, and interviews with 10 health workers, patients, and family members. Their research revealed that village and household power dynamics and the lack of knowledge on the part of the health workers were the main challenges. Using the principles of persuasion and motivation, they identified using videos as a potential solution. Two types of videos were identified as beneficial - educational videos described by the authors as persuasive videos to help health workers in their consultation, and testimonial videos from villagers who had benefited from the health workers. They designed a prototype through iterative design and conducted usability studies. The prototype had a four-minute video on the dangers of anemia and the actions that can be taken for prevention. It also included a testimonial video. (The design changes resulting from the prototype tests were not provided in the paper.). The researchers reported to have created seven one-minute educational videos that highlighted the danger signs during pregnancy and actions to be taken.

A usability test was conducted with seven health workers. The test involved focus group sessions with the health workers and six house visits. In the focus group session, they were tested on the content of the videos. For the house visits, they were tested on their ability to use educational videos during consultation. They were also encouraged to record their own videos. The usability test was conducted in two phases and each phase lasted for four weeks. At the beginning of each phase, the participants were pre-tested on the content of the videos; a post-test was also done. Their ability to use videos during consultation was also tested in each phase. In the first week, the health workers were trained on how to use videos during consultation and on how to record videos on mobile phones. At the end of phase 1, video logs were examined to understand their usage patterns. The results revealed that only two were able to access the videos without assistance.

At the end of phase 1, they were trained extensively on how to use videos. At the end of phase 2, the researchers reported that number of video views increased (although the details on the number of views was not discussed). The researchers reported that the measure of knowledge of the content was made using quantitative data. Mean and t-test values were used for final analysis and the test showed that post test performance was better than pre test.

Overall Summary of the Findings from the Total Corpus

Based on the findings from the nine articles reviewed here, we can reach the following conclusions about mobile phone usage by non- and semi-literate users:

a. Non-literate and semi-literate people use mobile phones very differently from literate people
b. The key differences in usage between non- and semi-literate users and literate people are as follows:
    - Non-literate and semi-literate users primarily use voice for communication
    - Non-literate and semi-literate users do not use the full functionality of phones because of lack of awareness of the features
    - They prefer non-textual user interface and tend to perform better in voice-based interactive systems
    - They cannot relate to the interface icons available in mobile phones that are an extension of computer interfaces
    - They cannot navigate through menus that have more than three levels of information
    - They do not tend to explore a new system by themselves and need to be trained

Overall Summary of the Design Recommendations from the Total Corpus

Based on the analysis of the corpus articles, the following design conclusions can be identified:

- For input, non-/semi-literate users want a non-textual based UI that is easy and succinct with minimal interactions through voice or/and graphics.
- Users prefer multimedia based UI (both image and voice) though their performance with purely voice UI is better than multimedia UI.
- The UI for data storage must use icons/graphics with minimal or no text.

Conclusion and Further Research

This paper lays the groundwork for an understanding of the special needs of semi-literate and non-literate people with regard to the design of mobile-phone user interfaces. As discussed earlier, non-literate and semi-literate users prefer multimedia over voice based UI. Given the lower performance of multimedia-based UI over voice UI, it would be interesting to explore the drivers behind the low performance in a subsequent research study. Also it would be interesting to explore whether familiarity with a rich-media interface over a period of time changes their preference. The preference of mode of interaction with voice-based UI can further be investigated to understand in what circumstances users

prefer voice over touch-tone or vice versa. It may be interesting to see if use of automated voice has any impact on their preference.

Further research is called for to investigate a wider range of features, applications, and user-interface functionality that can be helpful for non- literate and semi-literate users. Also, currently, most of the research seems to be centered on how voice can be used for navigation. Further investigation should be done to evaluate the use of video and rich-media user interfaces to match the intuitive workflow of non-literate and semi-literate population. Finally, more consideration is needed to discover under what circumstances, if any, we can extend this knowledge of usage patterns of and design requirements for non-literate users to the case of literate users in certain constrained circumstances.

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