Community Knowledge Sharing: An Internet Application to Support Communications Across Literacy Levels

by

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Submitted to the Engineering Systems Division
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ABSTRACT

This thesis presents Community Knowledge Sharing (CKS), an Internet-enabled asynchronous messaging system designed for use in the developing world. The system is motivated by a desire to expand the benefits of network connectivity deeply into rural areas, breaking down barriers within and between communities. Recognizing that large segments of the population in rural communities have low levels of literacy, CKS implements a multi-literate design in which the system can be customized based on the abilities and preferences of the user. Three research areas are explored. The primary research area is to understand whether multi-literate interfaces can expand access to technology. Second, the study explores concerns that users of the system have around security and trust. Third, the study identifies the types of information used and demanded by a sample user group.

An evaluation of CKS has been conducted in Bohechio, an agricultural town in the Dominican Republic. Participants were drawn to cover a range of ages, educational backgrounds and literacy skill levels. With regards to multi-literacy and access, it is found that low literate users prefer iconic interfaces, speech synthesis is not effective, and literate users are willing to create text and audio content. On security and trust, the study finds that in the context of networked message systems rural people have different security requirements, and need to trust both the communications channel and content. Lastly, in discussions on information it is found that health, news, commercial and family information is in the greatest use and greatest demand in the community.

CKS is a modest first step at developing an appropriate messaging environment for the developing world. Policy recommendations are drawn to inform future technology design and evaluation efforts. Developers of information technologies for use in the developing world should design iconic interfaces for low literate users, not rely on speech synthesis technologies, collaborate with communities, and balance cost, security and accessibility in their technology design. Evaluation of these technologies should take a longer-term approach in order to ensure that participants understand the application being tested.

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This thesis is dedicated to the people of Bohechio. It won't bring you the clean water you need or the land you deserve, but I hope it will help in its own way.

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1 Introduction

In its 1999 Human Development Report, the United Nations Development Programme stated "Knowledge is the new asset: more than half of the GDP in the major OECD countries is now knowledge-based" (United Nations Development Programme, 1999). The transition to knowledge-based economies, brought about by advances in information and communication technologies (ICTs), has had a dramatic impact on the economies, societies and cultures of the Western world. It has been argued that these changes have created an imperative for developing countries: deploy and benefit from ICTs or risk exclusion from the global networked economy of the future.

But what sorts of knowledge would most bring most benefit to people in developing countries, most of whom live in rural areas? Many require access to knowledge to improve productivity in their work, health practices, and enable them to learn about their environment (Bhatnagar, 2000). Examples abound of the types of information useful to such communities. Access to agricultural market prices is critical, since middlemen with highly asymmetric information often mediate agricultural trade between villages and markets. Another example is the "large number of innovations in farm practices, tool design, and use of indigenous medication [that] do not diffuse beyond local boundaries because of the isolation of rural communities" (Bhatnagar, 2000).

A field study in Bohechio, a rural agricultural community in the Dominican Republic, in July 2000 provided an opportunity to investigate these issues first hand. The government of the Dominican Republic installed a Little Intelligent Communities (LINCOS) community telecenter in Bohechio earlier that year. LINCOS introduced a wide range of services including computers, radio, telephone and telemedicine. In theory, it created new opportunities for the village, however its residents did not have the knowledge to utilize, manage and appropriate the technologies. Furthermore, it was not only Bohechio in this position; a total of five rural communities had LINCOS telecenters installed. How could they be connected such that the communities could learn about the technology together?

Inspiration is drawn from the extensive research in network news. Ever since the early days of networking, network-based news and discussions have become an effective means of sharing

information and ideas over computer networks. This project introduces Community Knowledge Sharing (CKS), a technology to extend network-based discussions as a means to share knowledge with villages like Bohechio. CKS supports asynchronous threaded discussions across the Internet. Recognizing that more than half of the low-income countries' population is illiterate, CKS introduces an interface usable across a range of literacy levels. The system supports four basic functions: logging in, navigating the bulletin board, reviewing content, and entering content. In each case, the interface is designed to operate in multiple modes to support a range of user preferences around reading, writing, and recording messages.

This study explores three research areas. First, the study asks whether the multi-literate interface design increases accessibility to technology. As information technologies are deployed wider in the developing world, it is critical that they are designed to be inclusive of all segments of the population. Second, the study will explore perceptions villagers have around security and trust. Networked bulletin boards are interesting in that participants login and interact through a digital identity in an unmediated space. Third, the study identifies information patterns in the community.

Evaluation of the system was conducted in Bohechio in March 2001. The evaluation instrument uses a range of tools to gather information around the three research areas. A literacy test has been developed in the local dialect to assess the literacy skills of interviewees. Interactive computer exercises are designed to allow the village members an opportunity to engage the technology and generate informed opinions about it. A series of both closed and open-ended questions are presented to probe deeply into what the rural villagers think about the technology and its implications.

1.1 Results at a Glance

In total, sixteen interviews were conducted in Bohechio, ten of which resulted in valuable quantitative and qualitative data. The results are summarized below.

1.1.1 Multi-Literate Interfaces and Equitable Access

Low literate users prefer iconic interfaces: Given the choice between text, iconic, and mixed interfaces, low literate users prefer to use a fully iconic interface. Care must be taken that the design of the multi-literate interface does not bias use against low literate users.

Speech synthesis is not effective: Speech synthesizers that aren't fluid and appropriate to the local dialect will not work when deployed in rural areas. However, their role in messaging systems in particular, and development informatics in general, is important.

Literate users are willing to create text and audio content: Recognizing the benefits of creating a technology for use community-wide, literate users are found to be willing to both type and record messages to the benefit of all. This type of participation should be promoted through the design of appropriate incentives in the interface.

1.1.2 Security and Trust

Rural people have different security requirements: In the context of messaging systems, villagers are not as concerned with a high-security login process as expected. Developers of software systems for rural areas should balance cost, security and accessibility in their designs.

Need to trust communications content and channel: Villagers are wary to discuss sensitive topics such as agricultural pricing on a public shared technology. Moderated newsgroups or filtering mechanisms can help alleviate concerns about inappropriate content.

1.1.3 Current and Future Information Uses

Demand basic information: Villagers are most interested in receiving information to improve the level of health of the community, keep the community informed of regional and national topics, advertise their commercial affairs and improve communications with their families. There is a strong demand for this last point, suggesting room for multi-literate interfaces that support personal messaging.

1.2 Overview of Thesis

There is limited research in the field of appropriate software systems for the developing world. Chapter Two provides an overview of three fields related to the study: technology and development, technology and literacy, and network news systems. A description of the LINCOS project and Bohechio is presented in Chapter Three. Chapter Four provides a detailed overview of CKS, from basic functionality to the interface and implementation. The methodology used in the evaluation is described in Chapter Five, with reference to the evaluation instruments included in the Appendices. Chapter Six details the results of the evaluation and Chapter Seven a discussion of these results. Conclusions and areas for future research are presented in Chapter Eight.

2 Literature Review

This section will review the literature in fields relevant to Community Knowledge Sharing. The body of engineering research on information technologies for development is quite small. The work in three related fields is presented. First is a review of the current thinking in the development community on technologies for economic development. A snapshot of ICT diffusion in the developing world is provided, followed by an explanation of the challenges faced when designing new technologies for development. Second, ideas from research into literacy, technology and development are discussed. A definition of literacy and its many roles is drawn, and examples of how information technology can be used to benefit low literate individuals provided. Third, a survey of the extensive body of research into networked news is conducted. Network news systems implement online communications through threaded asynchronous discussion groups, similar to CKS. A brief history of network news is provided, followed by a review of research into filtering, visualization and infrastructure. In each of these sections, projects that share ideas with or inform CKS are highlighted. The final section presents three current projects that cut across the fields of technology, development and literacy.

2.1 Technology for Economic Development

Efforts to deploy information and communication technologies in developing countries have been pursued since the 1950s (Hamelink, 1997). The early focus of these efforts was to develop capabilities in print and broadcasting, and later to deploy telephone and telex networks. The assumption was that these information and communication technologies that had increased wealth in the advanced industrial countries could do so in the developing world. We focus here on telecommunications and its role in the diffusion of information technology.

Historically, efforts to deploy national telephone networks have focused on urban rather than rural areas. It has been estimated that 80% of the worlds population has no access to reliable telecommunications (Heeks, 1999b).

Characteristics of rural areas that make installation and operation of traditional telephone networks difficult include (International Telecommunications Union, 1999):

- Severe climatic conditions
- Difficult topographical conditions
- Low level of economic activity and per capita income
- Low population density

As a result, the investment required to deploy and maintain rural networks is high. Villagers are left without a voice to speak to neighboring villages or their district towns (Pool, 1990)

With the advent of wireless cellular and low cost satellite telephony, new opportunities have emerged to connect rural areas at lower cost than before. The concept of technology 'leapfrogging' is often cited (Davidson, Vogel, Harris & Jones, 2000; World Bank, 2000). By investing in current wireless and satellite networks, developing countries can skip over entire generations of technologies. The social and economic benefits of connectivity will then quickly be extended to the people. A famous example is the Grameen Village Phone project in rural Bangladesh. Following the installation of a rural cellular network, cellular phones are sold to village women through micro-credit. The women in turn become telephone service providers in their local communities.

Once telephone networks are deployed in rural areas, connection to data networks become possible. Similar to global telephone connectivity, Internet connectivity is highly biased towards rich countries over poor ones, and urban areas over rural ones. In one estimate, 3.1% of the population in high-income countries uses the Internet, compared to .0002% in low-income countries (Uimonen, 1997). An area of practice in the development community that seeks to reduce this disparity is the telecenter movement. A telecenter can be defined as a "physical space that provides public access to information and communication technologies for educational, personal, social and economic development" (Hudson, 1999). It is a powerful concept to bring 'state of the market' technologies to traditionally neglected 'back of the market' communities (Fuchs, 1998). Telecenters are a means to equitably expand the telecommunications network and give rural communities a chance to adopt IT to their benefit, strengthen social ties within the community and economic ties with the outside world. The objective, size and configuration of a telecenter can vary widely from one implementation to the next. Common configurations range from Phone Shops, which provide public phone access, to Multipurpose Community Telecenters

(MCT), which provide voice and data connectivity together with public services such as tele-health and tele-education.

While much effort has been invested in deploying telecenters, a growing need has been identified for rigorous evaluation of their socio-economic impact on communities (Gomez & Reilly, 2000). Heeks (1999b) writes "there are far more one-line, rose-tinted vignettes of claimed success with ICTs than there are long-term analytical studies by independent researchers". A number of factors have been cited on the difficulty of evaluating telecenter impacts. These include the complexity of quantifying the impact of information on development, the lack of appropriate impact indicators, and the lack of adequate methodologies to conduct ICT impact assessment (Gomez, Hunt & Lamoureux, 1999).

While much attention has been given to deploying connectivity and computers, less has been focused on appropriate new software applications for the developing world. Many attempts to transfer existing software applications without thought towards localization fail for one of three reasons:

- Language: The majority of software and content available is in English.
- Literacy: More than half of the low-income countries' population is illiterate and are automatically disqualified from use of most software programs (Heeks, 1999b).
- Relevance: Computer programs imported from North America assume a view of the world based on values such as individualism, efficiency and rapidity. They are created in a different context to be used in ways that may not be compatible with existing needs in the developing world.

Section 2.4 presents examples of recent technologies that try to overcome these challenges.

2.2 Technology and Literacy

The literature on literacy differentiates 'basic' literacy from 'functional' literacy. Basic literacy relates to ones ability to read and write. Functional literacy is more holistic, and places literacy skills in a broader socio-economic context. In a report by the International Literacy Institute and the United Nations Educational, Scientific and Cultural Organization (2000), functional literacy

implies that "a person … can engage in all those activities in which literacy is required for effective functioning of his/her group and community and also for enabling him/her to continue to use reading, writing and calculation for his/her own and the community's development". The application of literacy skills results in the accomplishment of tasks, whether they be understanding ideas, socially interacting with others, making points of view, attaining services or effecting change (Fagan, 1996). It is a multidimensional entity, serving several purposes (Rassool, 1999):

- Social: The social function of literacy derives from literacy practices that feature in everyday life such as reading for information, learning, or pleasure.
- Economic: The relationship between literacy skills and knowledge demands made on people in their occupations.
- Political: Literacy practices help people engage in their multiple roles as citizens, activists, or community members allowing them to take up positions in relation to the social world.

Literacy acquisition differs greatly between developed and developing countries. Jeffries (1967) argues that in Western countries "industrial development demanded and caused an ever-widening diffusion of education, reaching out eventually to the agricultural populations of the countryside, as well as to the industrial workers in the towns". In contrast, developing countries until recently have been in a position where the spoken word has sufficed. The literacy problem in North America and Europe is one of dealing with a small residual of people with low levels of literacy, where the one in developing countries is of a far greater scale. Major sections of the world are not meeting the literacy demands generated by the printing press and skill levels generated by industrial development (Rassool, 1999). This is largely a result of countries that lack the infrastructure to support universal primary education and provision of higher education to instill the skills demanded of the modern world.

ICTs have been shown to have significant promise in literacy education (Wagner, 2000). From computer-assisted instruction to use of the Internet, technology for literacy education is growing. Hand (1999) explains that the introduction of ICTs into the education curriculum has changed how people read and write, and how educators teach reading and writing.

Both communication networks and software applications create new opportunities for literacy education (Duin and Hansen, 1994). Chandler (1985) writes that network connectivity brings an immediate audience to a writer; communications between students over the network brings feedback faster than that received from school. As students write, interpret and negotiate texts with each other via the network, they are participating within a context that promotes active learning (Duin et al.).

Software and digital media also bring new flexibility to education. Rose and Meyer (1996) write that 'the capacity of new media for multiple representations carries many pedagogical advantages'. Students can learn about language by acting on text and observing the effects. Multiple presentations of media can be derived from one electronic document, for example text read through a speech synthesis program while being displayed on screen. Speech synthesis is used extensively in technologies for literacy, as it helps people learn the relationship between spoken and written language. A popular application integrating multiple presentation modes and speech synthesis is WiggleWorks. Intended for early literacy education, WiggleWorks takes children through texts and allows them to control a set of speech parameters. The speed of the synthesized voice can be changed, as can whether it reads one word or one sentence at a time. Children can adjust these settings as their reading skills grow.

Another promising application of technology is in supporting Internet use. For example, the eReader developed by the Center for Applied Special Technologies (www.cast.org). eReader is an environment for people with reading disabilities or low literacy levels to access all types of electronic text, including web pages. It uses synthesized speech and visual highlighting to help users step through text. This type of audio browsing of Internet content has gained the attention of the economic development community. A study of implementing an audio browser in South Africa finds that "there currently exists a real possibility of enabling a new level of empowerment to be attained by otherwise severely disadvantaged people" (m-powa, 1997). However, the usefulness of audio browsing is constrained by the quality and organization of content on the Internet itself. An evaluation of audio browser with blind users, for example, shows that bad web page design makes navigation very difficult (Berry, 1999). In most cases web pages are not optimally designed for audio playback. For example, a page may contain many links that are hard to act on when played back sequentially. As web pages become more graphical and complex, it becomes even harder to identify the important content (Berry).

2.3 Network News

With a history spanning over two decades, network news has developed into one of the most popular means of social interaction on the Internet. It allows people the opportunity to read and participate in threaded asynchronous discussions. From its roots as a means for computer hobbyists to exchange information, it has become an expansive forum in which communities can form around common interests and concerns (Donath, 1993). This contrasts to previous channels of media distribution such as books, magazines, radio and television, where communities of common interest could form but there was no means for them to interact. It is estimated that by 1996, there were over 17000 newsgroups with three million users (Whittaker, Terveen, Hill & Cherny, 1998).

The current Internet-based news infrastructure utilizes the Network News Transfer Protocol (NNTP), published by Brian Kantor and Phil Lapsley in 1996. NNTP specifies a means for the distribution, inquiry, retrieval and posting of news articles. It improved the older USENET news distribution system by allowing news services to run over TCP, a general purpose networking protocol. With NNTP, USENET servers can connect with a wide range of clients that no longer require a dedicated USENET browser. NNTP has brought network news into the Internet age.

Much of the current research in the network news community is focused on how to navigate, manage and manipulate the huge volume of content accumulating daily in global news servers. Three prominent areas of research are filtering, visualization and infrastructure. Each is described below.

Filtering helps users find desirable information from the news network and eliminate undesirable information (Resnick, Iacovou, Suchak, Bergstrom & Riedl, 1994). An example of a powerful collaborative filtering system is GroupLens. Users are asked to assign evaluation ratings to each article they read. Ratings across users for a given article are correlated, and this information used to predict whether others might like to read the same article. News is accessed through a modified browser that displays messages sorted by this relevance ranking. An interesting discussion that has arisen out of GroupLens and similar research efforts is the role of interface design in promoting positive social behavior (Resnick et al., 1994; Smith & Fiore, 2001). Smith

et al. (2001) write that the "availability of [social] information provides incentive for users to improve their social standing as presented in the visualization by helping others, answering questions, performing other actions that contribute to the community". One challenge in promoting good behavior is determining what these appropriate incentives should be. In GroupLens, users are asked to rate individual news messages. There is an incentive for users to provide honest ratings since dishonest ones will lead to poor predictions for their own use. However, there is no incentive to rate at all since every user can benefit from others ratings.

Research into visualization seeks to build rich environments to navigate and understand the large quantities of news content. The text-based, semantically meaningless hierarchy of messages offers no insight into discussion groups' activity, structure, interconnection or content (Smith et al., 2001). Donath, Karahalios, and Viegas (1999) go further to explain that using text as a communications medium makes it difficult to convey social interaction and conversational tone. Users need access to an intelligent infrastructure that will build correlations and relationships between news articles and construct an environment to dynamically explore the expanding news base (Rennison, 1994). That most online conversation is conducted in text is partly due to the history of software technology (Donath et al., 1999). Text interfaces were the norm when email, newsgroups and chat-rooms developed. Graphical interfaces provide a way to see information that is hidden or unavailable in textual representation, the challenge is to identify the salient data and represent it accurately and intuitively. An example similar in spirit to CKS is the CommunityBoard (Matsubara, Ohguro & Hattori, 1998). The CommunityBoard represents an integrated view of participants, topic and time. Each message in the system is represented with an icon of the authors face. Icons of related messages in a discussion are arranged close together in a 2-dimensional space. As the time since the message is posted increases, the icon dims and eventually disappears.

Research into the infrastructure of network news seeks improvements in the storage and delivery of the growing body of content. An area of particular relevance to Community Knowledge Sharing is the integration of multimedia content into network news. With NNTP, binary audio or image files most be coded as text to be shared between news servers and clients. A constraint is placed on the size of such files by the USENET transfer protocols. Kowalchuk, Hilderman, and Hamilton (1996) introduce vnews, a multimedia news service that handles both binary messages and large messages. vnews acts as an alternative architecture to USENET. Clients run a vnews

browser to access the vnews server, which between them can share multimedia files. The server can also import and distribute USENET messages.

2.4 Related Systems

A small but growing numbers of projects in research or commercial development highlight the themes of discussed above. The Development Alternatives Group TARAhaat project seeks to deploy infrastructure and a range of services to rural communities in India. Simputer is a low-cost handheld wireless device to provide rural villagers access to the Internet. Lastly, AgI is a rich information and communications environment for agricultural support.

2.4.1 TARAhaat.com

The Development Alternatives Group in India, a collection of non-profit organizations concerned with development, environment, technology and governance, is developing an integrated infrastructure and content offering for villagers in rural India. They plan to deploy rural computer-based kiosks, content and services. The content will include news, commerce, governance, education, health and entertainment. A wide range of services will be on offer, from up-to-date crop prices to matrimonial searches. The first phase of the TARAhaat project is to deploy a small number of kiosks in the Bundelkhand region of Madhya Pradesh and Uttar Pradesh.

The TARAhaat web site is usable by people of all literacy levels (www.tarahaat.com). It uses a visual interface structured around a map of a village. By selecting a building in the village map users have access to services represented by that building. As seen in Figure 1, selecting the city hall opens up a set of government related options. Menu options are displayed as text in the local language and are repeated through audio in the local dialect. Selection of menu functions is done by mouse or voice recognition.

Figure 1 - TARAhaat Village Map

2.4.2 The Simputer

Another Indian effort to build appropriate interfaces for rural communities is the Simple Computer, or Simputer. The Simputer is a hand-held computer that will allow rural villagers wireless access to the Internet. The goal of the Simputer Trust, a collection of academics and technologists who drive the project, is to create an open platform for the development of handheld/wireless applications for rural users. The interface in development for the system is iconic and performs text-to-speech conversions of web content into local dialects. It allows user input through either touch screen or speech recognition, and contains a built-in smart card reader to be used for financial transactions and personalization. The creators of Simputer expect that it will be used as a shared device, and are creating a mechanism whereby people's preferences are stored on the smart card. There is a built-in modem for network access; future versions will support wireless networking.

The Simputer interface supports the Information Markup Language, designed for interface rendering on handheld devices. The operating system and software applications under

development are open source and based on public-domain software. The operating system is Linux, and development is done in perl/tk. A software development kit will be distributed to promote third-party development of new Simputer applications.

2.4.3 AgI: Agricultural Interface

AgI, in development in the Media Laboratory eDevelopment group, is a networked application that provides rural farmers with an integrated interface to agricultural support information and services (Figure 2). To be deployed in the LINCOS telecenters in the Dominican Republic, AgI will provide up-to-date market prices from the main markets in Santo Domingo, Santiago and San Juan. It will link farmers with regional and national agricultural support offices. AgI is designed to support use across a range of literacy levels, and integrates text-to-speech synthesis. It implements synchronous voice-over-IP communications between users, and optimizes the quality of voice to the bandwidth of the communication channel.

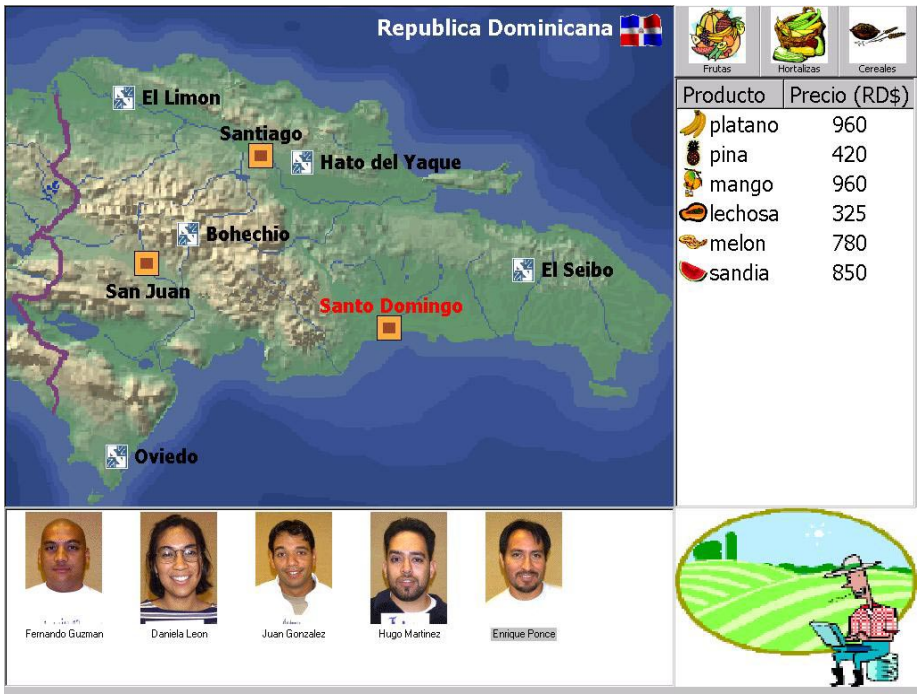

Figure 2 - AgI Prototype Interface

3 Community Background

The evaluation of Community Knowledge Sharing occurred in Bohechio, an agricultural community in the Dominican Republic. Bohechio was the first community on the island to establish a Little Intelligent Communities (LINCOS) telecenter. This section will introduce the LINCOS project and its work in the Dominican Republic, describe the town of Bohechio and its telecenter, and explain the inspiration behind CKS. The initial survey of the community on which much of the information is based was conducted in July 2000.

3.1 The Little Intelligent Communities Project

The LINCOS project is an initiative of the Foundation for Sustainable Development of Costa Rica. Founded by the former president of the country, Jose Maria Figuerez, the Foundation aims to promote social, cultural and economic development. Through a number of innovative projects, it works with communities to improve their immediate conditions and facilitate a transition towards rich and sustainable community life.

LINCOS is one of the Foundation's key initiatives, and seeks to redefine community life in the 21st century. The project has been developed in collaboration with a wide range of public and private sector institutions including:

- The Media Laboratory at MIT
- University of Rochester
- Hewlett Packard
- Instituto Tecnologico de Costa Rica
- Universidad Estatal a Distancia
- Universidad Autonoma de Santo Domingo
- Denver University
- Grupo AVINA
- Universidad Nacional
- University of West Florida
- Microsoft
- Becton Dickinson

LINCOS is an innovative multi-purpose community telecenter that integrates a variety of services and multimedia applications to empower community development. It is configurable for both wired and wireless operation, allowing it to be deployed in any part of the world.

The current LINCOS telecenters are housed in a standard 20-foot shipping container protected by a tension structure from storms and hurricanes (Figure 3). The container serves the dual purpose of safely housing the equipment and allowing for easy transport to rural locations.

Figure 3 - LINCOS Bohechio

One problem with the shipping container design is lack of space. The computer lab fits six computers, with hardly room for six students and an instructor. All new LINCOS centers will be implemented with a new design. The community will construct a LINCOS building for the facilities rather than use a shipping container. A detailed specification will be provided to the community, local contractors will build it. Under the new design the computer lab will be more spacious and will contain ten computers. Over time, the current containers will be replaced.

Deployment sites are chosen based on an analysis of the community's infrastructure and needs. Meetings with local leaders and community members are held to explain the project and determine their level of interest and commitment. Communities work with the Foundation to determine which services should be available in the telecenter. The choice of services include:

- A computer lab with office applications and internet connectivity
- A local wireless telephone network connection
- A business center with a printer, scanner and fax
- A telemedicine lab offering electrocardiogram and blood pressure testing
- Soil and water testing equipment to support local agricultural activities
- Community television, public phones, local radio and videoconferencing

Currently, five LINCOS centers are in operation in the Dominican Republic. LINCOS Bohechio opened in June 200, and the remaining four in the spring of 2001. Over the next several years the government hopes to deploy ten more units, mostly in rural communities along the border with Haiti.

The Foundation, together with the government, is investing in developing shared services and content for the LINCOS network. They are currently producing a series of educational radio programs for the communities, and establishing a broadcasting location in Santo Domingo. They have also implemented a management rotation program; LINCOS managers from each village are sent to other villages for a week to share their expertise and gain further insight into managing the centers.

3.2 Bohechio

Bohechio is located in the San Juan County of the Southern region of the Dominican Republic. The population of San Juan is 263,913, with 40% of the people living in urban and 60% in rural areas. This region consists of 3.2 million acres of land, occupying 25.7% of the total land area of the country. The primary economic activity is agriculture, and the main crops are coffee, tomatoes and rice. The region has experienced slow industrial growth compared to other parts of the Dominican; it contains only 2% of the total industrial parks. Current unemployment is estimated at 35%.

Figure 4 - Map of the Dominican Republic

Bohechio is located 40 kilometers from the regional capital San Juan, and 220 kilometers from the national capital Santo Domingo (Figure 4). Within the San Juan region, Bohechio is the center of a County of the same name, which includes the rural communities of Arroyo Cano, El Yaque and Montacitos. The current population of the County is approximately 18,000.

There are approximately 572 households in Bohechio town. It is structured in sixty blocks that form six neighborhoods: Los Luciano, Ensanche Castillo, Barrio Nuevo, el Manguito, el Tocón and el Lago de Sabana. Based on a recent poverty survey in the region: 15% of the houses need floors, 16% ceilings, 21% walls, 51% bedrooms, 65% water, 63% bathrooms and 53% electricity.

Bohechio is one of the least developed communities on the island. A priest in Bohechio estimated the current illiteracy rate to be 40%. An ongoing five-year project to decrease illiteracy in the town has produced small results, with 20% of the illiterate adult population learning to write their names. The church estimates that approximately 20% of the population is less than six years old, 20% between seven and 13 years old, and 60% greater than 14 years old. Approximately 60% of the population is living on one meal a day consisting of rice and eggs. It

is estimated that 90% of the households in Bohechio County live below the poverty line, with 50% living in extreme poverty.

In the July investigation, five issues were repeatedly mentioned as priorities for local economic development. While these do not form an exhaustive list, they provide insight into the current state of the town:

- **Improved water pump:** Water is pumped into the town for two hours every morning between roughly 8 and 10am, and one hour in the afternoon.
- **Stable power supply:** Short but frequent blackouts occur in Bohechio, as in the rest of the country. Every evening the power level drops.
- **Productive land:** Government expropriation of land near Bohechio to build a hydroelectric dam together with recent hurricanes has decreased the amount and quality of land available to farmers.
- **Road to Guanito:** The road to Bohechio intersects one of the main east-west highways at the town of Guanito. Parts of this 20-kilometer stretch of road are unpaved and difficult to drive.
- **Sources of employment:** The town has experienced an increase in migration to the cities in the past few years, and there is clear need for more employment in Bohechio.

3.2.1 Travel and Communications Infrastructure

The poor condition of the road to Guanito has had two impacts on travel through Bohechio. First, it has limited public transportation through the town. Daily buses to Bohechio have recently begun to operate, but the schedule is sporadic. Second, it has led to high prices for renting vehicles to transport agricultural goods to market.

Despite the road conditions, Bohechio receives a regular supply of mail and news. Mail is delivered from Santo Domingo three times a week. Two national newspapers, La Nacion and El Siglo, are delivered twice daily. Five copies of each are delivered and distributed to grocers in the town.

Prior to installation of the LINCOS box, a local business was the exclusive provider of phone and cable television service in Bohechio. LINCOS has introduced significant price competition for outgoing phone calls. Employees of the phone shop have estimated that the number of outgoing calls they serve has reduced by half because of LINCOS. The shop is still the only provider of incoming call service and cable television. Cable service is provided to approximately 60 houses in Bohechio, a small fraction of the total houses with televisions.

3.2.2 Education

The total elementary school population in Bohechio County is 2312 students. There are twelve elementary schools, two secondary schools and two centers for adult education. Every year approximately 30 to 32 students leave the town of Bohechio to study at one of the two universities in San Juan, or elsewhere in the country.

The previous President of the Dominican Republic established over two hundred school computer labs, none of which are in Bohechio County. The nearest computer lab is in San Juan; it offers training courses and Internet access. Over the years a number of locals have traveled to San Juan to study computers. Prior to LINCOS, one local church had been sponsoring students to take the computer course, and had to deal with students being stuck in San Juan overnight due to unpredictable transportation to Bohechio.

3.3 LINCOS in Bohechio

The majority of community members are very enthusiastic of the LINCOS project. One man has dubbed the time before LINCOS as "before Christ"; others consider it to be the best thing to happen to Bohechio for the past three years. Below this enthusiasm, however, there is little understanding of the LINCOS technologies, services and objectives. Few of the adults have visited the site for reasons other than making a phone call. Many have little understanding of how to operate the computers, Internet or fax, or the benefits that could derive from their use.

One major problem in the town is unemployment. The only sources of salaried labor are the school, city hall and police station. It is hoped that LINCOS will help create jobs for Bohechio,

either directly through positions to support the telecenter, or indirectly once users acquire useful computer skills.

Several common perceptions about LINCOS arose when talking with the community. Many felt that training was required before people could use the telecenter. Others believed that given the low-income level in the community, LINCOS would not be self-sustainable. The mayor and other leaders repeated several times that the LINCOS project was for the children in Bohechio, a means to provide greater educational and employment opportunities.

3.3.1 LINCOS Operations

It is estimated that in July 2000, roughly 150 people visit the container each day, of which 75 use the phone, 45 use the computers, and 30 use other services like the copier or scanner. The fax is not yet connected to the phone line. The majority of the 45 computer users are students, 23 of whom are regular users visiting every day, 14 semi-regular users, and 8 new users. Very few adults currently use the computer lab.

LINCOS operates seven days a week, from 8am to 6pm. Use of the power generator is required in the evenings when the supply of electricity begins to fluctuate. It costs 100ps to operate the generator for four hours and it is only used during the evenings on weekends. Eventually, the council would like LINCOS to be open daily from 8am to 9pm.

Demand for LINCOS telephone services has surprised many. Tricom, a local carrier, operates the phone line and sells time through prepaid phone cards. Most of the phone use is personal, although businesses in the area do seem to have an interest and need for the phone. The mayor plans to petition Tricom to install incoming lines to the LINCOS box, and he hopes eventually that residential phone service will be available to all in Bohechio.

Along with the phone, the radio station has proven to be very popular. Radio Bohechio plays Central and South American music downloaded from the Internet. It has a transmission range of roughly 10 kilometers and is listened to widely in the community. One of the local churches has begun using it to transmit a weekly religious program, which brings in $100US a month in revenues to LINCOS.

3.3.2 An Emergency Cleanup

At the same time as the CKS evaluation, the LINCOS leadership in Santo Domingo visited Bohechio to conduct a cleanup operation. While Bohechio seemed to be operating well compared to other LINCOS communities, many problems arose during the first six months of operation:

- **Politicization of the project:** The LINCOS foundation actively encouraged the town to self-organize a council to manage the container. Their mandate was to engage the community in the project, set prices for services, and establish training schedules. Composing the council proved to be a difficult and politicized process. When the national government changed in late 2000, community leaders belonging to the incoming political party began a takeover of the council. Eventually all leaders from the outgoing political party, including the town mayor, withdrew. This violated the rules set out by the Foundation that the council must represent all groups in the community.
- **Mismanagement of the telecenter:** Management of the LINCOS container was entrusted to one of the villagers, the only one with some experience using computers. Over time he took advantage of his position by allowing only his friends to use the facility.
- **Inappropriate computer use:** Contrary to the rules established by the Foundation, the computers were being used to author and distribute political materials and view pornographic content.

The cleanup operation involved hiring and installing a new management team, transitioning out the previous manager, educating the town council on the need for multi-party representation, reformatting the computer hard drives and reinstalling all software

3.4 The Inspiration for Community Knowledge Sharing

The idea for CKS goes back to the July 2000 survey study in Bohechio. At the time the community was starting to organize its leadership around the newly opened LINCOS container. Part of the difficulty in doing so was that nobody in the community understood the technology, how it could benefit the community, and what needed to be done to make it operational and

effective. Relative to the other four LINCOS communities, however, Bohechio was doing very well. The approach taken in Bohechio was first to begin service, and second to organize the leadership. This allowed for a certain amount of learning-while-doing, as the leadership had the opportunity to see demand quickly bubble up for phone, radio and computer services. The other communities chose not to open their LINCOS container until all leadership issues were resolved. This did not happen, eventually the LINCOS Foundation intervened nine months later.

Having the opportunity to watch the community try to understand, organize and engage LINCOS, led me to believe that Bohechio was not alone in this process. Investment in telecenters by the international donor community likely put many towns around the world in a similar position. CKS was conceived, initially, as a means for such communities to discuss how to make sense of these new technologies. Given the estimate by the priest that nearly 40% of the community was illiterate, it would be necessary to design a system that would be widely accessible. Starting with the Dominican Republic, the LINCOS sites could be linked together and discussions held by all members of the community. Armed with the power of network connectivity, together they would progress faster than any one could alone.

4 Technology Description

Community Knowledge Sharing is a multi-literate environment for threaded asynchronous discussions. It allows people to:

- Navigate a bulletin board of discussions and messages
- Review and enter messages into the bulletin board
- Customize the interface according to their preferences

An example session might go as follows. A farmer in Bohechio approaches the CKS terminal wanting to ask a question about corn prices. As his/her literacy skills are not strong, he likes to use the system in a mode that displays only icons. He logs into the system by putting his finger on the fingerprint scanner. A visual display of messages in the bulletin board is shown. The farmer navigates to the space where agricultural discussions are occurring. He may see a picture of a corn stalk on the screen, indicating an existing discussion on corn. Expanding the icon the farmer sees who is talking about corn and can listen to their messages. Interested in how much corn is selling for in the markets of Santo Domingo, he records a message, posts it to the discussion, and decides to return again tomorrow to check for responses.

This chapter provides a detailed overview of CKS. First, the design principles of the system are explained. Next, the basic functions of CKS are defined and described. A detailed presentation of the interface to each basic function follows. The technical components of the system are outlined and then described in some depth. Last, areas for future development are highlighted.

4.1 Design Principles

The CKS design has been informed by three principles. First, the system is designed to support use by people with a wide range of literacy skills. New information technologies intended for community use in rural areas must accommodate segments of the population with low literacy-levels. One phenomenon observed in Bohechio is that the vast majority of computer users are youth. In a discussion with a group of high school students they described how their parents were unlikely to use computers since they were unable to read and write. This segment of the population will remain excluded from computer use until appropriate interfaces are designed and

developed. Second, CKS is designed to not mimic the look-and-feel of standard Windows applications. Most keyboard and mouse-based Windows applications assume that users have a certain level of technical proficiency. CKS has no menu bar, it is not situated in an adjustable frame, there are no special keys or mouse mappings. Users are required to learn only a small number of actions. Third, all content on the system is to be accessible to all people. Users of CKS may choose to enter typed messages, which may not be understandable to others. Since one goal of the system is to reduce communication barriers within and between communities, CKS performs text-to-speech synthesis on all written content.

4.2 Basic CKS Operations

CKS presents five main functions to users of the system: registering to use the system, logging into the system, navigating the Bulletin Board, reviewing a message and entering a message. Each of these is described below.

4.2.1 Registering to Use CKS

Registration is conducted once for each user, with the help of a system administrator in each CKS site. Users provide information such as their name, village and interface preferences. The administrator takes the user's picture and captures their fingerprint. Once this information is gathered, the administrator sets up a digital identity for the user on CKS.

4.2.2 Logging In

A CKS session begins when the user attempts to login to the system. Similar to an email account, login to CKS associates users with their digital identities in the system. After the login, any messages posted by the user will be identified with the digital identity. During the login procedure, the system retrieves the users' interface preferences and configures the interface accordingly. For example, a user may wish to see only icons, not text, on the screen. Once logged in, this preference information will be retrieved, and the interface rendered so only icons appear.

4.2.3 Navigating the Bulletin Board

Having logged into the system, the user is able to view the Bulletin Board. The Bulletin Board is the store of all messages in the system. It is organized as a multi-level hierarchy, where discussions are classified by their subject area. In navigating the Bulletin Board the user can expand and collapse elements in the hierarchy, and move up and down between nodes.

4.2.4 Reviewing Messages

Once a message of interest in the Bulletin Board has been found, the user can review its contents. This can involve reading text or listening to audio clips associated with the message. All messages in CKS are publicly accessible; anything posted in the system can be read or heard by anyone.

4.2.5 Entering Messages

The last function implemented in CKS is entering new messages. Having navigated to a message of interest and reviewed its contents, the user may wish to post a response. To do this the new message window is opened, and the user either types or records the message contents. When completed, a choice is given to either post or cancel the message. If posted it is automatically added to the Bulletin Board and visible by all users.

4.3 The Multi-Literate Interface

For each of the basic operations, several interface panels have been developed to support a range of literacy levels and preferences. The specific panels that users see are based on their stated preferences. The interfaces associated with the last four basic operations are presented below.

4.3.1 Logging In

There are three possible ways for users to login to CKS. Multiple login modes have been implemented to support multi-literate access and investigate community views towards security. The Fingerprint mode requires users to login using a fingerprint reader. The Faces mode presents the portraits of all CKS users in the village on the screen, users click on their own face to login. The Id mode requires the user to fill in an id/password box similar to logging into an email account. Each mode varies in its accessibility and security performance (Table 1).

Mode	Accessibility	Security Performance
Fingerprint	High	High
Faces	High	Low
Id	Low	Medium

Table 1 - Login Modes

Of the three login modes, the Fingerprint mode is the most secure. It is also highly accessible since its use does not require reading or writing skills. A fingerprint reader is attached to the computer on which CKS runs. Upon approaching the CKS computer, the user sees a stoplight graphic (Figure 5). Initially the green light is on, indicating that a finger can be placed on the scanner. Once a finger is placed the red light goes on until an impression of the fingerprint is successfully captured. If the system determines that the user is a valid, the navigation screen is opened, otherwise the green light turns back on.

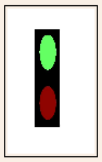

Figure 5 - Fingerprint Login Mode

The Faces mode displays portraits of all CKS users in the community (Figure 6). The user selects a face on the screen, and login proceeds under that identification. This is the least secure mode, no further validation occurs. However, like the Fingerprint mode, it is highly accessible.

Figure 6 - Face Login Mode

The Id mode presents a login box familiar to users of Internet email services (Figure 7). The user enters a username (*Nombre del Usario*) and password (*Contraseña*), and selects the login (*Entrar*) button. A message is displayed indicating whether the login was successful or not. Unlike the previous two modes, the id mode requires the user to have some reading and writing skills, or be able to get assistance logging in. It is more secure than the Face mode, as it requires knowledge of a password, yet less secure than the Fingerprint mode.

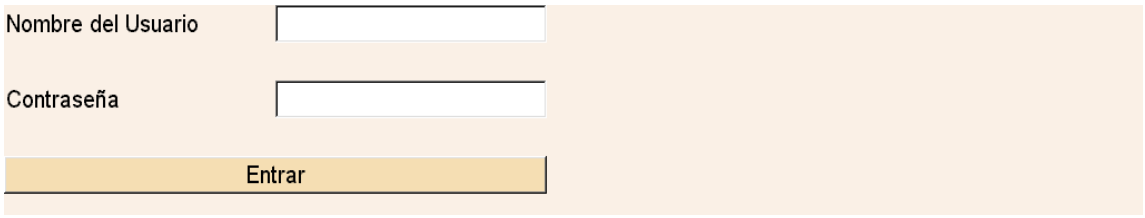

Figure 7 - Id Login Mode

4.3.2 Navigating the Bulletin Board

Once the user successfully logs into CKS the main application screen is shown. The top half of the screen displays the Bulletin Board Navigator, the bottom half displays the controls to review and enter messages. As seen in Figure 8, the Navigator can be rendered three ways: with text and icons, with text only or with icons only. This choice of interface mode extends to the entire interface. If the user prefers the text and icons mode, all buttons and titles in all panels will be displayed with text and icons. The sections following this one will only contain screenshots of the text and icon mode.

In the example below, a discussion on the price of beans is shown (*Precio de las habichuelas*), classified under Agriculture (*Agricultura*) and Products (*Producto*). The currently selected item (*Producto*) is highlighted with a box frame. Immediately below and to the left of the message list is a set of icons showing the face of the user, the current item selected, and if relevant, the author of the item. To its right are buttons to create new discussions (*Agregar*) and move up (*Arriba*) and down (*Abajo*) the tree.

Figure 8 - Bulletin Board Navigator: Text/Icon, Text and Icon Modes

The user navigates between messages by using a pointing device such as a mouse or touch screen, or using the up/down buttons. The message tree expands and collapses to minimize clutter. For example, if the user were to select Health (*Salud*) in the top-right image in Figure 8, all entries under Agriculture would collapse.

4.3.3 Reviewing Messages

Once a specific message is selected, users can review it in either its original form or in audio (Figure 9). The original mode shows the message as created by its author. If the author typed the message, the contents will be displayed in subject (*Tema*) and body (*Texto*) text boxes. If the author recorded the message the playback controls are displayed, play (*Tocar*) and stop (*Parar*). If both text and audio messages were entered, all of these controls are displayed. The audio mode will only show the message playback controls. For messages that were recorded by the author, pressing play will start the audio playback. For messages that were typed by the author, pressing play will start a speech-synthesized rendition of the text message.

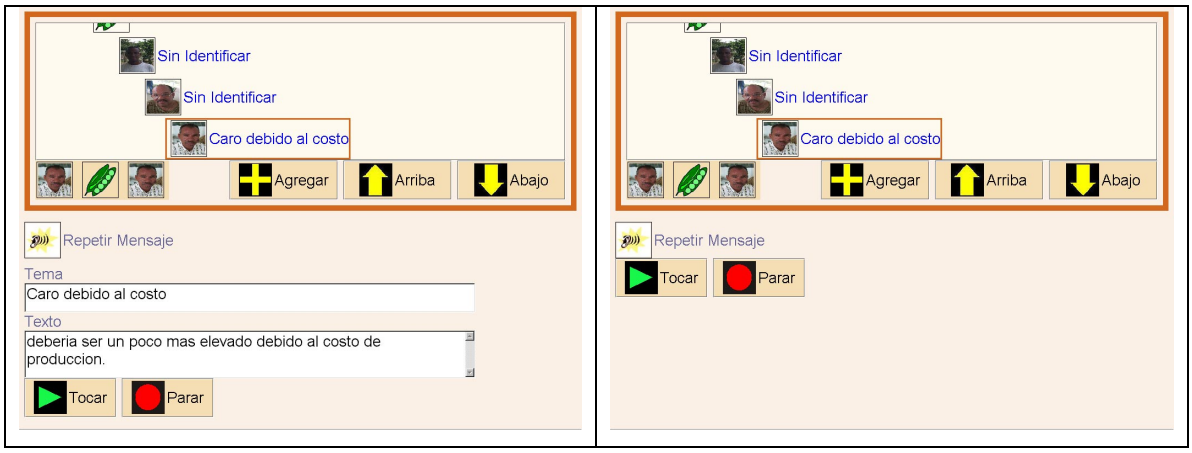

Figure 9 - Reviewing Messages: Original and Audio Modes

4.3.4 Entering Messages

To enter a message in the bulletin board system, users select the add button. This will create a reply to the currently selected message in the Data Navigator. Users can enter messages by either typing text, recording audio or doing both. Three message entry panels have been developed to allow this (Figure 10). The first allows users to both enter text and record messages. For text messages, the user types in a subject and body. For audio, a control panel is used to start (*Grabar Mensaje*), stop (*Parar*) and replay (*Tocar*) the recordings. Users can replay and rerecord messages until satisfactory. The audio mode displays only the audio controls, and the text mode only the text boxes.

On completion, users can choose to either add the message to the bulletin board (*Añadir*) or cancel it (*Cancelar*). If added to the Bulletin Board, the new message will appear below its parent, indented one level. The authors portrait will be displayed along with the subject line, or in the case of audio messages an indication that no subject was provided (*Sin Identificar*).

Figure 10 - Entering Messages: Text/Audio, Audio and Text Modes

4.4 Implementation Description

Having reviewed basic functionality and the interface, this section describes the implementation of the system. Community Knowledge Sharing consists of a Bulletin Board, a client and a server program. The Bulletin Board stores all messages and user profiles in the CKS system. It runs on a dedicated computer with an always-on Internet connection. The same computer also runs the CKS Server application, which facilitates communication between CKS Clients and the Bulletin Board. The CKS Client program, installed on any computer from which access to the system is desired, provides the user interface to the Bulletin Board. A typical configuration might be to use a computer with a high-speed Internet connection in a major city, with several clients deployed in rural areas.

Both the client and server utilize a number of custom-built and third party sub-components, shown in Figure 11. The client and server utilize the BioMouse Fingerprint scanner and software to support fingerprint login. The server makes use of a speech synthesis engine to create Spanish-language audio files out of text entered by users. Each of these components will be described below.

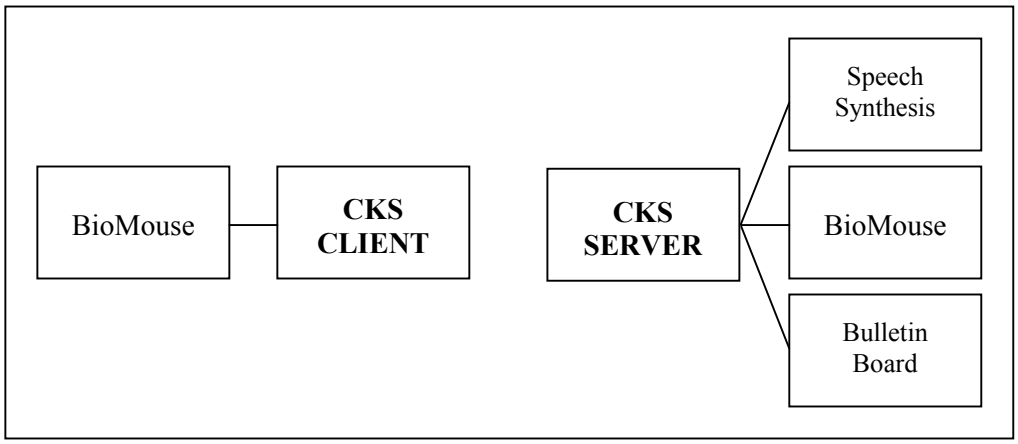

Figure 11 - CKS Components

4.4.1 Bulletin Board

The Bulletin Board is the physical store of all messages in the CKS system. It must be installed on a computer with an always-on Internet connection. A hierarchy is defined to organize the content:

- Genre: High-level description of a message group. For example, Agriculture or Education.
- Topic: Mid-level description of a subgroup of messages. For example, Agriculture might include the topics Beans and Seeds.
- Discussion: A user-initiated discussion relating to a certain genre and topic. For example, a user of the system might post a discussion under Agriculture and Beans asking about the current market price of a certain bean.
- Message: A specific message within a discussion.

The structure of the Bulletin Board is similar to that of USENET. USENET defines a number of top-level newsgroups such as alt, comp or news. These are divided into more specific discussion subjects, for example alt.music. Below these are threaded discussion structures where users can post new messages and replies. Genres, topics and discussions in CKS perform identical functions; they divide a potentially large message space into something easier to navigate.

The hierarchy is implemented in the Bulletin Board as a directory structure. Figure 12 summarizes the organization of directories and subdirectories. Genres are created one level below the root directory, topics two levels below, etc. Each directory is named by a unique integer. For example, the first genre is stored at "//root/0", the first topic below it at "//root/0/0", the first discussion below the topic at "//root/0/0/0". This sequence of integers constitutes the unique key of each item.

Figure 12 - Bulletin Board Directory Structure

A number of concepts lie behind the file system design. First, the directory structure is easy to maintain and requires little memory overhead on the server. An earlier implementation of CKS used a database rather than a file structure, which was slower, more complex, and harder to distribute and install. Second, the structure is scaleable from small message systems to very large ones. Third, there is a direct mapping between messages in memory by the system and their location in the directory structure, which makes message retrieval operations fast.

Each directory contains a description file with information on the creator of the item, date created and date last accessed. Depending on the type of item, directories may also contain an icon for display on the client screen, an audio recording of the title of the item, a set of pre-selected icons from which users can choose to create child items, and message text. When a user of the CKS Client selects an item in the Bulletin Board, these files are sent over the network.

Profile information for each user is stored in a set of files under the users directory. During initial registration users are asked to specify their proper name, user name, place of residence, occupation, age, gender, interface preference, message input and message output preference. A picture of the users face, recording of their name, and impression of their fingerprint are also captured and stored.

4.4.2 Server Application

The Community Knowledge Sharing Server retrieves content from the Bulletin Board, posts new content to the Bulletin Board and validates user login information. A server installation requires: the Java Runtime Environment (JRE), CKS server classes, BioMouse libraries and the speech synthesis toolkit. The server must run continuously on a Windows computer with an always-on Internet connection. Unlike the network news systems described in Section 2.3, the server does not support the NNTP protocol. It is a closed system that can only communicate with CKS clients over a TCP/IP network.

The architecture of the server is outlined in Figure 13. There are four main components, each encapsulated in a Java class. The BBS Manager controls all access to the directories and files of the Bulletin Board. It also initiates speech synthesis operations. The Client Listener identifies when clients on the network are trying to connect to the server, and creates an instance of Client Connection that processes all of the client requests. The Finger component accesses the BioMouse libraries to validate user fingerprints.

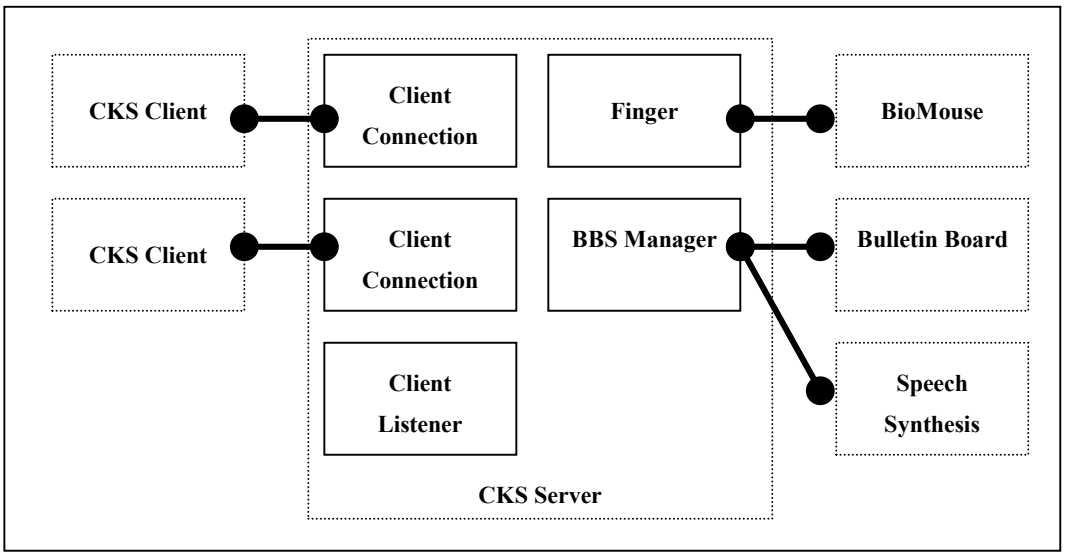

Figure 13 - CKS Server Architecture

Together these components perform all tasks required of the server: passing messages, connecting to clients, validating users, posting content and retrieving content from the Bulletin Board.

Passing Messages

All communications between the client and server are processed by Client Connection and follow a standard dialog. Requests from the client consist of a header string identifying the operation to perform, a tokenized list of parameters to the operation, and an end-of-request marker. All requests involve some form of access to the Bulletin Board; the message is parsed and passed onto the BBS Manager for processing.

Error checking is performed during each exchange of messages between client and server. Corrupt messages, where parameters are missing or inappropriate, are thrown away and the information is requested again.

Connecting to Clients

When the server is started, Client Listener opens a socket connection to a local port used for CKS communications. When a client tries to connect to the port, Client Listener creates a new Client Connection object and processing thread to serve the client. Data input and output streams are opened for communications with the client, and a request is sent to the client for the login information of the user. If the login information is received and validated, Client Connection waits for further requests from the client.

Validating Users

Users can login to CKS with one of the three login modes: Fingerprint, Face or Id. Each one provides a different set of information to the server for validation.

When a user logs in with the fingerprint reader, Client Connection receives a series of roughly six hundred integers representing a compressed encoding of the users fingerprint. The server uncompresses this information and begins a validation loop. The fingerprint is compared against each one registered in the Bulletin Board until either a match is found or all pairs been compared. If a user logs in with the Id mode, Client Connection receives the id and password from the client. The user password is extracted from their profile in the Bulletin Board for comparison. The third way login method is the Face mode, which requires no validation. The users name is sent by the client and login proceeds under that identity. Once a user has been successfully validated, his entire profile information record is sent to the client.

Posting Content

Client requests to post content to the Bulletin Board are intercepted and processed by the Client Connection in three stages. First, the client sends descriptive information on the new element to be posted to the Bulletin Board. This includes the title of the item, author and unique key of the parent. Requests to post information are passed onto the BBS Manager, which processes each request sequentially ensure there are no conflicts when naming new directories. The BBS Manager creates a new subdirectory under the parent, assigns the sequential index for the directory, and creates and populates the item description file. The index is then sent back to the

CKS client. Second, the server requests the client to send an icon. If one exists and is sent successfully, it is written to the newly created directory. A case where an icon would exist, for example, is when a new genre is created. A case where it would not exist is when a new message is created, since messages are associated with a portrait that already resides on the server. Third, the server requests the client to send a sound file. If one exists it is written to the directory, otherwise an instance of the speech synthesis module is initiated to create a sound file from the text.

Retrieving Content

Retrieving content from the Bulletin Board is a less involved process. CKS clients send two types of requests: for specific items in the system or for sets of items. In the first case, a client may request the audio file of a certain message. This is passed to the BBS Manager, which reads the audio file into a bytestream, passes it to the Client Connection object that transmits it back to the client. In the second case, a client may request all items below a specific item, for example all topics below Agriculture. The BBS Manager locates the parent item, reads in the description files of all children directories, and passes this back to the client.

Client Application

The CKS Client application is used to access the Bulletin Board system from networked computers. The installation requires the JRE, Java Media Framework (JMF), CKS client classes, and the BioMouse libraries. For full functionality, the client must run on a Windows PC with Internet access.

The architecture of the client is described in Figure 14. There are four main components, each encapsulated in a Java class. Server Connection manages all communications with the server. The Interface Manager handles communications between panels in the client interface. The Message Manager takes care of the in-memory and cached Bulletin Board content. Lastly, the Finger component accesses the BioMouse libraries to capture user fingerprints.

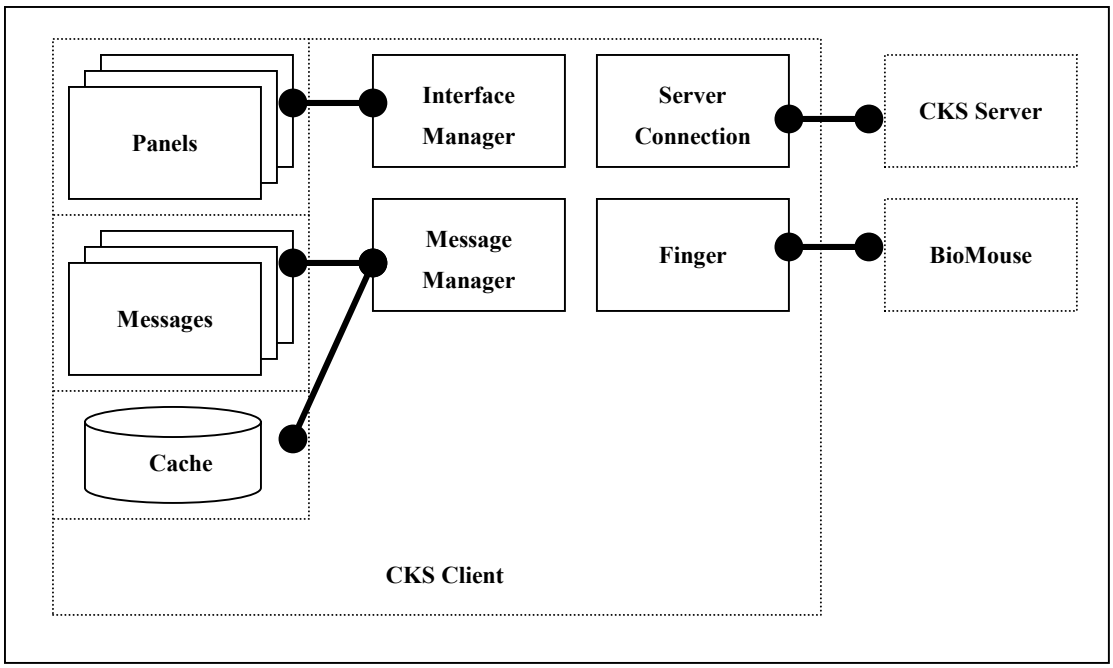

Figure 14 - CKS Client Architecture

Together these components perform all tasks required of the client: connecting to the server, logging in users, navigating, reviewing messages, entering messages, and switching interface panels.

Connecting to the Server

Each client machine stores the IP-address of the CKS Server. Connectivity to the server is established when the client is started. Server Connection attempts to make a socket connection to the server. If successful, data input and output streams are opened for communications with the server, and the client receives a request for the login information of the user. Once a user successfully logs into the system the client interface is initialized and displayed according to the users interface preferences.

Logging In Users

The choice of login modes is specified on the command line when the CKS application is started. If the client is started specifying the Fingerprint mode, the Finger component initializes the BioMouse reader and libraries. The client polls the BioMouse every few seconds for the presence of a fingerprint. Once a finger has been placed in a stable manner, an image is taken, coded, compressed and sent to the server. If the client is started with the Id mode, the login box is shown, and the username and password entered by the user sent to the server for validation. If the client is started specifying the Faces mode, the username corresponding to the portrait selected by the user is sent to the server. In all three cases, once the server validates the login and sends back the user profile information, the interface panels are initialized and displayed.

During the course of a session with CKS, the communications channel between the client and server may be broken or communications may time out. In either of these cases Server Connection attempts to login again to the server by sending the username of the current user. The process of reestablishing a connection is transparent to the user.

Navigating Messages

When the interface is opened, the Bulletin Board Navigator and Message Review Panels are shown, as in Figure 9. The client initializes the Bulletin Board Navigator by requesting the top-level genres from the server and displaying them on the screen.

The process of receiving and displaying messages on screen is quite involved. Server Connection sends a request for descriptive information of the content. For example, when the Bulletin Board Navigator is opened it displays the top-level genres. To do this, Server Connection specifies that it wants a list of all genres from the server. Once this is received, the list is parsed into individual items, and added by Message Manager to a list of active messages in memory. This list stores descriptions of all genres, topics, discussions and messages received from the Bulletin Board. Items are added to the end of the list as they are received.

For each item received, the Message Manager checks the local cache to see if the icon exists. If an icon is found in the cache it is loaded into memory, otherwise it is requested from the server, saved to the cache, and loaded into memory.

Once the text and icon is in memory, a new node is created for the item at an appropriate location in the message tree. The tree is implemented using the Java JTree class, a customizable tree interface. Each node in a JTree has associated with it an icon, text content and hash code. The icon is set to the appropriate image or portrait, and the text to the name of the item.

Message Manager uses the unique key of the item and the hash code of its node in the tree to create a series of indexes. Two hash tables are maintained to facilitate access to the list of active messages. One hash table relates the unique key of each item to its list position. The second one relates the hash code of the node representing an item in the JTree to its list position. CKS uses these to locate items based on their id or user selections in the JTree.

The tree is built dynamically; new nodes are added as the user expands branches of the tree for the first time. Every time a new node is expanded, the above process is repeated.

Reviewing Messages

When a user navigates to a message, Interface Manager notifies the Message Review Panel to display the message. If the user wishes to see text, it is shown on the panel. The audio file is then retrieved in preparation for playback. This is done in a similar way as the icons. Message Manager checks if the message has an audio file associated with it in the cache. If found, the file is loaded in memory. If not found, the audio file is requested from the server, loaded into memory and saved to the cache.

Entering Messages

Messages are entered by the user and sent to the server as text, audio or both. Text is the simplest case. Server Connection sends messages typed by the user to the server. Audio messages make extensive use of the JMF to record and replay the message in advance of transmitting it to the server. When the user opens the Message Entry panel, JMF queries the computer for devices that

are ready to capture audio. If a device is found, a JMF processor object is created which can process the data from the device, and a file opened to store the audio input. The processor is responsible for converting the raw audio input into the wave (.wav) file format used by CKS. JMF implements an asynchronous notification system. When the user presses the record button a command is sent to the processor to start listening on the capture device. CKS waits until completion notification before opening the file for writing.

After entering the contents of the message, the user has the choice to add it to the Bulletin Board or cancel it. If added, a description of the message is sent to the CKS Server, which in turn replies with the new id for the item. The client then waits for the server to request audio and image files. If the message is deleted, the text is discarded and the audio file removed.

Switching Interface Panels

During a CKS session the user has the ability to change the interface, message review or message entry modes. For example, the user may decide to change their message review preference from audio-only to original form, or the interface style from text to iconic.

One challenge in implementing a multi-panel design is managing method calls between the panel classes and the rest of the application. The Interface Manager does just this, it knows at all times which panels are visible on the screen and has access to their methods. Every time a panel is drawn on the screen the Interface Manager saves a pointer to it. If the user switches modes of a panel, the Interface Manager removes the old panel and calls the main application class to create a new one, which then registers its pointer with the Interface Manager.

When the application requires information from the screen it always queries the Interface Manager, which passes the command on to the appropriate panel. If, for example, a user clicks on a new message in the Bulletin Board Navigator, a request is sent to the Interface Manager to update the current Message Review panel. The Interface Manager checks its pointers to all the different Message Review panels, and calls the update method on the one that isn't null.

4.4.3 BioMouse Fingerprint Scanner

The fingerprint login mode is implemented with the BioMouse fingerprint scanner and software development kit. BioMouse is a high-resolution fingerprint scanner that connects to a Windows PC parallel port, available from Ankari Incorporated (http://www.ankari.com). The software development kit exposes an Application Programming Interface (API) library that allows programs to capture, compress and compare user fingerprints. The API library is used on the client application to capture a fingerprint, and on the server to compare this fingerprint with the ones registered in the bulletin-board system.

The library defines a number of parameters for capturing fingerprints:

- False Rejection Rate: Ranges from 1 in 500 to 1 in 1000000.
- Touch Sensitivity: Controls how sensitive the BioMouse is when recognizing that a finger is placed on the scanner. The lower the value, the lighter the touch required.
- Motion Sensitivity: Controls how sensitive the BioMouse is when determining that a finger is placed stably on the scanner. The lower the value, the longer the finger must be held on the scanner.

Each of these variables must be given close consideration when deploying the BioMouse in rural areas. They should be calibrated to allow the successful capture and validation of the fingerprint of the average user.

The CKS client and server applications do not require the BioMouse software or scanner to run. If the client is started in either the Face or Id login mode, the system does not try to access any BioMouse technology. Thus CKS can be deployed without purchasing the BioMouse hardware and software.

4.4.4 Center for Spoken Language Understanding Toolkit

Spanish text-to-speech synthesis in CKS is done with the Center for Spoken Language Understanding (CSLU) toolkit, a suite of speech-processing tools developed and distributed freely from the Oregon Graduate Institute of Science and Technology (http://cslu.cse.ogi.edu). The toolkit provides libraries for integrating speech synthesis, speech recognition, and animated conversational agents into applications. The Center has developed a male and female Mexican

Spanish voice set, utilized by CKS. Access to the synthesis library is through the tcl/tk scripting language. The script developed for CKS takes as input a text file containing the text to be synthesized, and provides as output an audio (.wav) file. Parameters to the script include sample rate, speech rate and gender of output voice.

All speech synthesis occurs on the server. When new content is posted, both message titles and entire messages, the server initiates an instance of the toolkit to perform the synthesis. Due to a limitation in the synthesis application, only one synthesis request can be processed at a time, multiple simultaneous requests are queued and executed in turn.

4.4.5 Choice of Platform

The CKS client and server has been written and implemented in the Java programming language. Java has number of strengths:

- Java code is fully portable, the core client and server programs can be run on different operating systems
- Java is well-suited to interface implementation as it provides a wide range of useful interface classes
- Java takes care of memory management, which would otherwise be difficult given the amount of information passed between the CKS client and server
- Java code can easily be shared with other developers and the open source community
- Java easily supports networked applications

The most significant weakness in using Java is performance. The CKS Client runs quite slowly, even on moderately fast Pentium computers. Audio operations have been implemented with the Java Media Framework (JMF), a set of classes that support the recording, presentation and manipulation of digital media.

The BioMouse and CSLU toolkit are both solely developed for Windows. If stripped out of the CKS, the code will be fully portable to other operating systems.

4.5 Areas for Continued Development

Continued development of CKS is required if it is to be deployed as a robust discussion environment. Some areas that warrant further development are:

- *Security:* Currently no security structure is in place. User profile information and the bulletin board information should be stored securely on the server.
- *Streaming media:* Audio files retrieved from the server are sent in entirety to the client before playback begins. A better design, supported by the Java Media Framework, would be to stream media content from the server. This would significantly reduce the time users spend waiting for audio files to play.
- *Asynchronous File Transfers:* All files transfers between the client and server occur synchronously, no other operations begin until the transfer is complete. This degrades performance of the client application, as users must wait for file transfers to complete. A more robust implementation would support asynchronous file transfers.
- *NNTP Support:* Currently, CKS defines its own communications protocol between the client and server. If the system can be built to support NNTP, it can be used as to access and distribute the large body of existing network news discussion content.

5 Evaluation Methodology

This section outlines the methodology and instruments used in the evaluation of CKS in Bohechio. The three research questions posed by the study are reviewed, followed by the evaluation principles and a detailed description of the instruments.

5.1 Research Questions

The evaluation of CKS in the Dominican Republic will explore three sets of questions. The primary research goal is to understand if multi-literate interfaces can increase access to technology by people with a range of literacy levels. Beyond this, the study will explore security and trust concerns community members have when using a system under a digital identity. Finally, the study will identify important types of information that community members use and desire in support of their daily lives.

5.1.1 Multi-Literate Interfaces and Equitable Access

The first research area is to explore the efficacy of multi-literate interfaces in increasing access to information technologies. In Bohechio and other rural communities, the introduction of computers risks creating a digital divide between those with the skills to use them and those without. Keniston (1997) writes that "typing instructions on a keyboard, or using a mouse, pointer or joy stick to click on desired options, is not a 'natural' human activity; it requires literacy, which by no means can be assumed in many nations; it also requires a grasp of how a computer works, the ability to type or enter instructions from a keyboard, the ability to create and locate files, etc". The purpose of CKS' multi-panel design is to give users the choice of a wide-range of interaction modes with the system. In doing so it is hoped that the skills required using CKS, both literacy and technology skills, will be minimized. Through the evaluation in Bohechio, the research will investigate correlations between literacy skills and preferred interaction modes, specific opinions towards the interface modes, and general opinions towards multi-literate technologies.

5.1.2 Security and Trust

As seen in CKS and the systems described in Section 2.4, many software applications for rural communities are being designed for shared-use. Thus, users will be required to login under a secure digital identity. This study will investigate the security and trust concerns community members have when using digital identities. Understanding this will help inform the future design of CKS and other identity-based software systems. The study will also explore issues around the public nature of information on CKS, and the use of CKS in a shared physical space.

5.1.3 Current and Future Information Uses

While CKS does not constrain the types of discussions people can hold, it is interesting to know what topics people in the community wish to discuss. The study will explore the information that the interviewees currently use, and the information that they would like to use to support their lives. Knowing this will help tailor CKS and similar systems in a way that it is attractive to community members. Explaining that a new software application is available where people can hold discussions may be less effective in attracting users than explaining that the software allows people to discuss job opportunities. Understanding the types of information people use and desire will also help validate the idea of CKS as an effective communications system, and can inform design of other information systems for community use.

5.2 Evaluation Methodology Principles

Currently, there is little in the way of formal literature that addresses software evaluation in rural communities. The methodology in this study draws concepts from two fields: software usability evaluation and telecenter evaluation. Software usability evaluation is primarily concerned with "gathering information about the usability or potential usability of a system in order to improve features within an interface … or to assess a completed interface" (Preece, 1993). Telecenter evaluation, a recent field in the economic development community, is concerned with measuring the social, economic and cultural impact of telecenter interventions in both developing and developed countries. The principles of the CKS evaluation methodology reflect thinking drawn from both fields, and are summarized below:

1. **Work with Local Partners.** Local partners provide a necessary interface between the project and community. In the CKS evaluation, two partnerships are critical. The first is with the LINCOS Foundation who manages all LINCOS sites on the island. LINCOS has played a key role in facilitating the visit to Bohechio and helping staff the research team. They keep the Media Lab researchers informed of the politics around the LINCOS container in Bohechio, which directly impact the evaluation effort. The second partnership is with universities and research institutions in the Dominican Republic. In an earlier study of Bohechio, the research team included Prof. Brigida Garcia-Romero, a social scientist from the Latin-American Faculty of Social Scientists (Facultad Latinoamericana de Ciencias Sociales – FLACSO). Having conducted social science research in rural parts of the island, Prof. Romero was able to communicate in an appropriate and effective way with the locals. She gathered more rich information through her interactions than the other non-specialist Spanish speakers on the team. Similarly, the CKS evaluation benefited from the help of Prof. Santiago Samanna from the National University of Santo Domingo. He acted as the primary interface between the research team and the community, and was able to help frame participant responses in the context of the socio-economic conditions in Bohechio.

2. **Use a Range of Data Collection Instruments.** The software evaluation literature describes a wide range of methodologies to use in software evaluation (Mehlenbacker, 1993). In thorough evaluations of systems, "observation, hands-on experience, and questionnaires [are] useful evaluation techniques" (Rose, Shneiderman & Plaisant, 1995). These methods, however, have not been used for software evaluation projects in rural communities where participants may have never touched a computer, however, is new. It is not clear what types of instruments will yield the most insight. Therefore, it is prudent to prepare and deploy a range of them.

3. **Maintain Flexibility in the Field.** Related to the use of several instruments, they should each be sufficiently flexible to allow modification in the field. The research team must be attuned to the quality of data collected by each instrument, and adjust the use of them accordingly. The intention is that the interviewer will have the discretion to approach the interview in a semi-structured fashion, using the questions in the instrument as a guide, and probing for interesting information as the interviews progress (Lindgaard, 1994).

4. **Analyze Successes and Failures.** In a description of telecenter evaluation principles, Gomez and Reilly (2000) describe the need to analyze both telecenter successes and failures. They go on to state, "[in evaluation the] emphasis needs to be placed on honest sharing for the sake of learning". The same holds true for the CKS evaluation methodology. Since one goal of the study is to derive lessons for future software evaluation efforts, documenting both what works and what does not work is critical.

5.3 Evaluation Instrument

The evaluation instrument used in Bohechio has five sections: Participant Information, Literacy, Information Usage, Multi-literacy Experiment, Security and Trust Experiment. The questionnaires are provided in the Appendices. The objectives and contents of each section are described below. Where specific questions from the appendices are referred to below, their numbers are provided in quotes.

5.3.1 Participant Information Section

The first section in the test collects basic information about the participant. This includes information on age, occupation, education, reading and writing abilities, use of LINCOS, and use of computers (Appendix A). The literacy questions ask whether the participant can read/write correctly, with difficulty, only their name, or not at all (C1, C5). Asking this up front allows the interviewer to tailor the interview process to the participant. For example, participants who state that they can neither read nor write will not be interviewed about the text-only interface mode.

As described above, one of the research areas of the study is to understand information patterns in the community. The first survey study of Bohechio revealed that the flow of new text-based materials in the community was small. The library was in disuse, few magazines were available for sale, and only ten newspapers were delivered to the community of ten thousand. This section of the questionnaire revisits this issue by asking participants who can read the types of materials they select, and those who can write about their use of mail to communicate with friends and family (C3, C6, C7). Several questions are asked about participant's use of LINCOS and computers. These questions cover whether the participant is familiar with LINCOS, has visited

the center, and if so for what purposes (D1 – D5). It goes on to ask if the participant has used computers and for what purpose, if he/she has taken computer courses and the skills gained (D6 – D11).

Along with providing insight on the background of the participant, this information will be used to analyze results from the experiments below. All questions are coded as nominal variables. Pair-wise statistical correlations will be calculated with gender, age, occupation, reading ability, writing ability, and computer experience as independent variables, and the interface and security preferences of the respondents as dependent variables.

5.3.2 Literacy

The objective of the literacy test is to directly measure the ability of each participant in reading and writing, as this is expected to yield more accurate results than the self-assessment of their skills (ILI & UNESCO, 2000). The test was developed by Prof. Santiago Samanna of the National University of Santo Domingo. Prior to choosing this test, several existing literacy evaluation instruments were reviewed. These included the Peabody Picture Test for Spanish vocabulary, and the Woodcock-Muñoz word reading and reading comprehension tests.

There was a tradeoff in choosing one set of instruments over the other. These latter instruments have standardized scoring methodologies that accurately map from score results to educational levels. The National University of Santo Domingo test has a scoring methodology that can be used to compare and rank results among the sample group, but does not have an established correlation with education levels. On the other hand, this test is written in Dominican Spanish using phrases that are appropriate for people in Bohechio, unlike the standardized ones written for Spanish-speakers in the United States. Weighing these two options it was decided to use the locally developed test and correlate the results with the self-reported literacy results to estimate literacy skills.

The literacy instrument applied in Bohechio consists of a short reading and writing test, each with an evaluation scorecard (Appendix B). Literacy tests are only applied to participants who self-report skills beyond reading/writing their own name. The reading test has five sentences for the participant to read, increasing in length, grammatical complexity, and vocabulary difficulty. The sentences are written in the local dialect about issues that people in the community are familiar

with. A copy of the testing page is given to each participant to read, with a copy kept by the interviewer on which to make notes. The participant is asked to read each sentence. Following completion of a sentence the participant is asked to comment on it, this provides an opportunity to evaluate whether or not the sentence was understood. The reading is evaluated for clarity, fluidity and comprehension, each on a pass/fail basis (A1-A3). The test is stopped if the participant does not pass at least two of these criteria for a given sentence; otherwise the next sentence is tested. A final score is tabulated as the total number of sentences passed. A scorecard is provided to match the score against an approximate literacy level, ranging from those with strong reading skills who get all five sentences correct to those with very little skills who get two or less correct (F1). For the writing portion of the test, the interviewer retrieves the testing page and asks the participant to write a paragraph describing the content of the five sentences. This is marked for grammar and spelling correctness. Another scorecard is provided to match the total number of errors with a skill level, where strong writers make less than one error and weak writers more than eight (G1).

5.3.3 Information Usage Section

The information usage section is a simplified version of an instrument used by UNESCO, ITU, IDRC and the Pact Institute (Pact Institute, 1998). The original instrument was developed, tested and deployed for telecenter evaluations in Mali and Uganda. Participants are asked about four categories of information in their lives: information they currently send, information they would like to send, information they currently receive, and information they would like to receive (Appendix C). Within each category, the participant is asked to discuss different types of information, such as commercial, news, or social information. The objective is to draw out the types of information a given person uses and values, and identify trends in information use across the community.

The first section asks the participant to discuss what types of information he/she currently receives, what importance they attach to it, with what frequency they receive it and where they receive it (A1 – A4). The interviewer explains the questions and gives an example to help the participant understand what is being asked. The description questions are open-ended; the participant is encouraged to freely discuss information types of interest to them. All others have coded answers. A similar set of questions is asked about the information that the participant currently sends (C1 – C4). With regards to information that the participant wants to receive and

send, the interviewer asks the participant to describe each different type of information and attach a degree of importance to it (B1 – B2, D1 – D2).

5.3.4 Multi-literacy Experiment

The Multi-literacy Experiment section of the evaluation is the first opportunity for the participant to use CKS (Appendix D). It provides a thorough overview of the system, an opportunity for participants to interact with the technology, and a context within which to elicit their preferences regarding desired modes of interaction. The experiment covers three system functions: Interface Preference, Message Review Preference and Message Entry Preference.

A mix of closed and open-ended questions is used. Opinions about the ease/difficulty of using a specific aspect of the system are coded as very easy/easy/difficult/very difficult. Opinions about how well an aspect of the system is understood are coded as understood well/understood/understood with difficulty/not understood. Opinions on preferences are both coded and open ended. When a user is asked to state a preference between text, text-iconic, and iconic modes, for example, their response is coded for future analysis and their explanation written down by the interviewer.

Two sections of questions are associated with each system function, the first is a demonstration of the section and the second an exercise. For example, to administer the Interface Preference section of the instrument, the interviewer shows the participant each of the interface modes and how to navigate the Bulletin Board in them. The participant is then asked which one they would prefer to work in and to explain their choice (A1, A2). Following this hands-off portion of the test the participant is asked to perform a simple task. By having participants use the system, it is hoped that they will be in a better position to answer questions on preferences and identify issues in the design of CKS.

For the first exercise the three discussion genres are collapsed down to their roots, so no messages show, and the participant is asked to find a message. The interviewer asks, for example, ‘Could you please find the discussion on telemedicine’ or ‘How would you find the discussion on telemedicine’. Assistance is given as needed to help the participant achieve this task. Once completed the participant is asked to comment on how easy or difficult it was to use different elements of the system, such as finding a message, moving around the message structure, and

reading the message subject (B1 – B3, B6). The participant is also asked how well he understood the message icons, button icons and where to look for the discussion (B4, B5, B7).

For the Message Review Exercise the participant is shown the two modes: original and audio. They are asked to state a preference between the two and explain it (C1, C2). For the exercise, the participant is told to review several messages, one that is recorded voice and one that is text (for participants that read). The participant is then asked to comment on how easy or difficult it was to review the message, read the text, hear the audio and use the controls (D1 – D4).

The final section asks about message entry preferences. The participant is shown the three message entry modes: text, text/audio and audio. They are asked to state a preference and explain it (E1, E2). By this point, the participant will have seen many of the discussions through the previous exercises. They are then asked to choose a discussion of interest and enter a message into the system. If the participant has no computer experience and expresses an interest in typing a message, the interviewer provides a short introduction to using the keyboard. Once the message is entered the participant is given the choice to either add the message to the Bulletin Board or cancel it. If added they are shown the new entry in the Bulletin Board Navigator. The participant is then asked to comment on how easy or difficult it was to add the text or audio, use the microphone and use the recording controls (F1 – F5).

5.3.5 Security And Trust Experiment

The final experiment in the instrument is around security and trust issues (Appendix E). It gives the participant an opportunity to learn about and try the three login modes: Fingerprint, Face and Id. Also, issues of privacy, comfort with publicly shared information and the usefulness of CKS are explored.

Similar to the multi-literacy experiment, a mix of closed and open-ended questions is used. When a user is asked to state a preference between login modes their response is coded and their explanation documented. Opinions about the ease/difficulty of using a specific aspect of the system are coded as very easy/easy/difficult/very difficult. Opinions on whether they feel the mode is secure or not are coded as yes/no.

The first section begins with a demonstration of the three modes and a discussion with the participant about their preference (A1, A2). Then, for each mode, the participant is asked to try logging into CKS with it. If there is sufficient time to add their user profile, fingerprint and portrait to the system during the interview, this will be done and the login exercise will be real. Otherwise, they will be asked to login under an existing user's profile. Participants are first asked to try the fingerprint reader, and are then are asked how difficult it was to use (B1 – B3). To explore participant's views on the security provided by the fingerprint reader, they are asked if they believe that others can use the fingerprint reader to enter under their personal identification (B4, B5). The intention of this question is to gauge to what depth community members understand and are concerned with the security characteristics of the login modes. Finally, they are asked if they feel they will need assistance using the device (B6). The same sequence of questions is repeated for the Faces and Id login modes (C1 – C6, D1 – D6). It is expected that having tried and learned about each login mode the participant will have a better understanding of the security characteristics and usability of each. They are asked again to state a preference between the three (D7).

The current LINCOS container offers little individual privacy; computers are placed in close proximity side by side against the container walls. Since CKS is a multimedia system where people can listen to and record messages, it is interesting to know if the participants have reservations doing so in LINCOS. The next section of the instrument asks the participant whether they would be comfortable using CKS to enter and review messages in the LINCOS container (E1 – E5). All responses are coded as yes/no.

The last section probes issues around the public nature of information in the system. CKS offers a new way for community members to interact. Participants are asked if they are comfortable posting publicly readable messages and if they would like the system to support direct messaging between users (F5, F6). They are also asked if they can get the types of information they need through CKS, and if there are any subjects that should not be discussed on the system (F3, F4). All questions are left open-ended for the interviewer and participant to discuss.

6 Evaluation Results

This section summarizes the results of the evaluation trial in Bohechio. It describes the statistical reporting methodology, evaluation preparation phase, participant group, highlights key results from the multi-literacy, security and information use discussions, and concludes with remarks on the evaluation instruments and process.

6.1 Preparing for the Evaluation

The evaluation of CKS was conducted from March 27th to 30th, 2001 in Bohechio. The research team set as an initial goal to conduct twenty interviews, five to test the instrument and fifteen to gather the data.

6.1.1 The Research Team

The research team consisted of three people: Hani Shakeel, Santiago Samanna and Juan Garcia. Hani Shakeel is the leader of this study. Professor Santiago Samanna is the head of the department of Social Sciences at the University of Santo Domingo. Prof. Samanna came on the recommendation of the LINCOS Foundation. He has previously worked with the Foundation to do community assessments in Costa Rica and the Dominican Republic. His primary role on the team was to develop and administer the literacy test, and administer the information usage tests. Juan Garcia is a LINCOS employee. His job with LINCOS is to facilitate communications between several LINCOS sites and the head office in Santo Domingo. As he is fully bilingual, his primary role on the research team was to act as a translator. Marco Escobedo of the Media Lab also provided significant support in helping translate documents and facilitate some of the more technical communications between Hani and Santiago.

6.1.2 Preparing the Instrument and Test Cases

Prior to arriving in Bohechio, several sections of the evaluation instruments were translated with the help of Prof. Samanna. Given his experience in conducting social science studies in rural areas, he was able to translate the questions such that they would be understandable to the people of Bohechio. The first day of interviews was used to test the literacy and information usage sections of the questionnaire. The following evening the research team made adjustments to

these two sections and translated the remaining ones. Given the tight time constraints, there was no opportunity to test the remaining sections of the instrument prior to the first interviews. On the second day, the research team made adjustments to the format and content of the questionnaire, and printed the questionnaire booklets.

Upon arriving in the community a number of local volunteers were gathered to record discussions of local issues for the system. These provided interviewees with concrete examples of what sorts of discussions could occur within CKS, and also gave them interesting debates in which they could participate. In total five discussions were recorded across three subject genres: Agriculture, Health and LINCOS.

6.1.3 Interview Format

The original design of the interviews was for all three researchers to work together to conduct each interview. Prof. Samanna would conduct all sections of the test in one and a half hours, with Juan Garcia and Hani Shakeel ready to provide assistance as necessary. As preparing both the instrument and CKS for the interviews took longer than expected, the number of days devoted to interviewing was reduced from three to two. Furthermore, the initial test of the literacy and information usage sections showed that they required one hour to administer. A decision was made to change the interview structure. Prof. Samanna conducted one half of the interview away from the computer. He was given one hour to conduct both the literacy test and information usage section. Juan Garcia and Hani Shakeel conducted the second half of the interview at the computer. They were given one hour to work through the multi-literacy and system access experiments. In this shortened timeframe several changes were made to the technology interview script, summarized in Section 6.7.2.

Interviews were conducted in pairs, with one interviewee starting with the first section and continuing to the second, and the other doing the opposite. In this way two interviews were completed every two hours. The basic information section was completed by whichever interviewer first met a given participant.

6.1.4 The Evaluation Station

The evaluation station had two working areas. One was a desk with chairs where the literacy test and information usage questions were conducted. The second was a table with the hardware: a Pentium laptop, 15" touch screen display, BioMouse Fingerprint scanner, microphone, speakers and keyboard (Figure 15). The station was situated on the LINCOS grounds, in front of the telecenter.

Figure 15 - Front and Back View of the Testing Station

6.1.5 Selecting Participants

The goal in selecting participants for the evaluation was to get a range of age, education, and literacy levels. A minimum age of twenty was set for the participants, as younger members of the community already tend to use the LINCOS computer lab.

In discussions with Rowland Espinoza, director of the LINCOS Foundation in Santo Domingo, a strategy was agreed on for selecting participants prior to arriving for the evaluation. Rowland would approach the town council, explain the project objectives and describe the type of people sought for the study. The council would propose a list of roughly forty community members that fit the criteria. A random sampling would be taken from the list, and an interview schedule set up for each selected participant.

In actuality, the participant selection strategy was changed. A tour by a senior government official of the LINCOS sites just prior to the evaluation occupied Rowland's time. When the research team arrived in Bohechio, only the first two participants were selected and ready to go. It was necessary to adopt a more flexible strategy since the LINCOS team was busy with the cleanup of the facilities. It was agreed that interviewees would be selected during the day as interview slots opened up. Rowland committed to help bringing in participants from the community. As he is well known and respected in Bohechio, his participation helped establish a level of trust with the participants.

6.2 Sample Characteristics

In total, sixteen interviews were conducted. Results from the demographic information gathered are summarized below.

6.2.1 Quality of Participant Response

Of the sixteen interviews conducted, four were not informative: one participant was unresponsive to all questions, one arrived to the interview inebriated and two did not seem to understand the questions being asked. Furthermore, due to time constraints the final two interviews were cut short and several sections were not completed. The quantitative responses of these six participants are not included in the results below. Where valuable qualitative results were gathered, they are included in the analysis.

6.2.2 Demographics

The characteristics of the ten remaining participants in the CKS evaluation are as follows:

- *Gender:* Four were men, six were women
- *Occupation:* Three were farmers, Four were housewives, three were students
- *Age:* Three were between twenty and thirty years old, one between thirty and forty, two between forty and fifty, and four above fifty
- *Education:* Six began but did not complete primary school, three began but did not complete secondary school, and one was attending a teachers college

6.2.3 Literacy Level

The reading and writing skills of the participants were evaluated in two ways. First, the participant was asked to self-report his/her literacy skills (Figure 16). Second, the literacy test was administered (Figure 17).

The self-reporting question asked if the participant considered themselves able to read/write: correctly, with difficulty, only their name, not able. For both reading and writing, approximately half the participants responded that they could do so correctly. The remaining half responded that they had little or no abilities. This is broadly consistent with literacy levels in the community; a local priest estimated that 40% of the adult population has very low literacy skills.

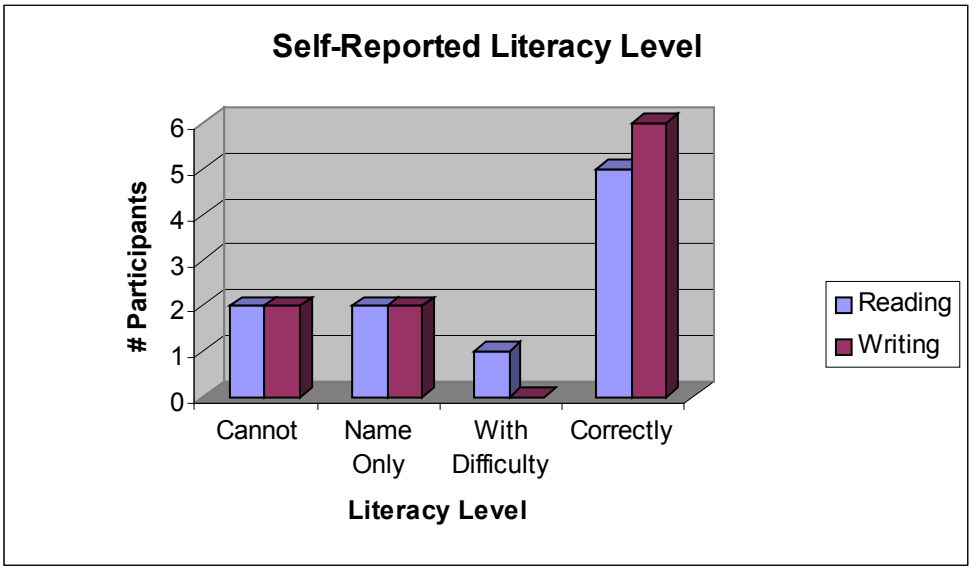

Figure 16 - Self-Reported Literacy Level

The literacy test was applied to participants whose self-reported ability was greater than reading/writing their own name. None of the participants expressed any awkwardness or concern taking the test. The reading test results corresponded closely with the self-reported skill levels. Those who had a strong result had responded that they could read correctly ($\chi 2 = 10$ $p = 0.02$), those who had a weak result had responded that they could read with difficulty. All six participants with strong writing results had responded that they could write correctly ($\chi 2 = 10$ $p = 0.01$).

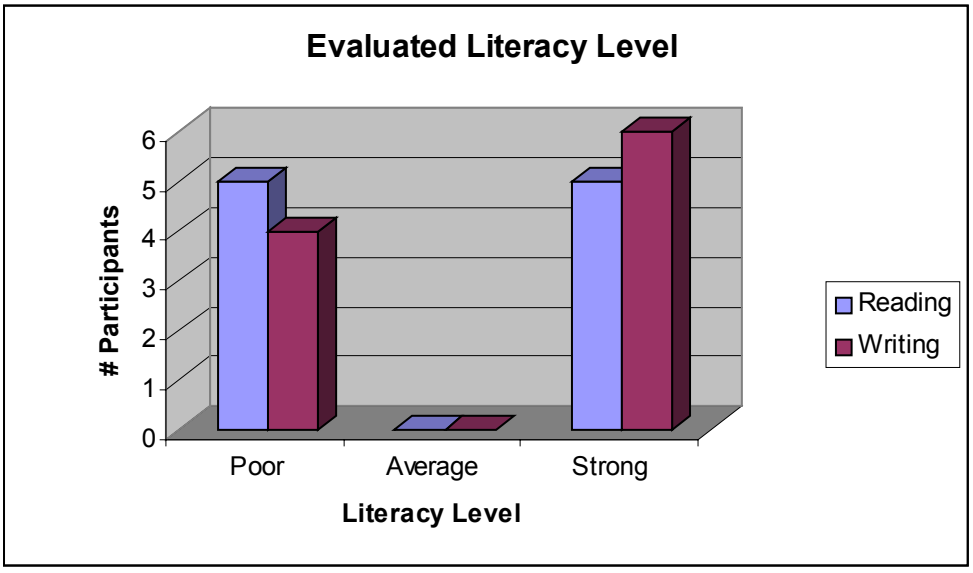

Figure 17 - Evaluated Literacy Level

A strong correlation is noted between education level and reading test results ($\chi 2 = 6.7$ $p = 0.04$), and a slightly weaker correlation between education level and writing test results ($\chi 2 = 4.5$ $p = 0.11$). The education level of the six strong writers ranged from primary school to university.

6.2.4 LINCOS Usage

All ten participants had previously visited the LINCOS box, mostly for use of the telephone and radio (Figure 18).

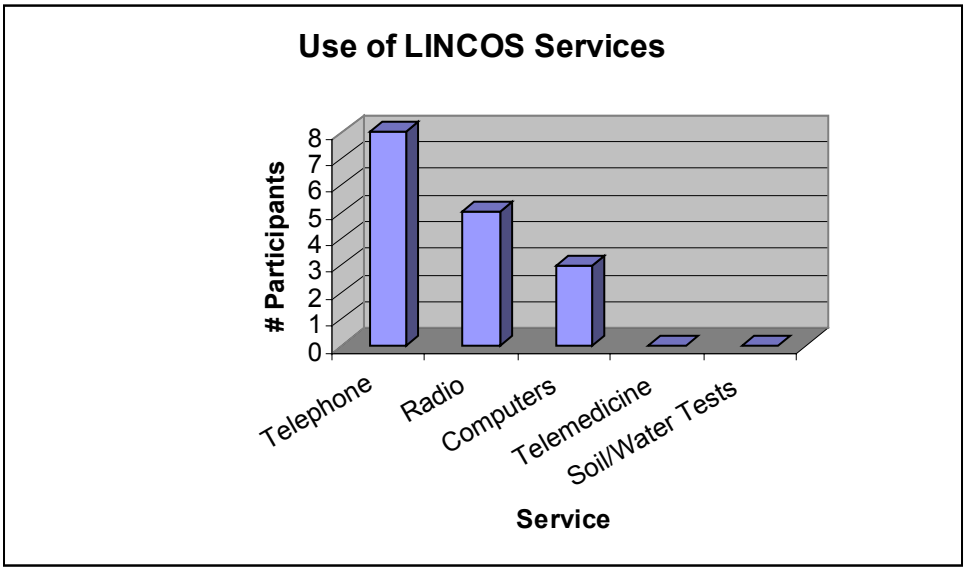

Figure 18 - Use of LINCOS Services

Since the LINCOS container offers the lowest rates for outgoing phone calls, phone service has attracted significant demand. The radio station is also very popular in Bohechio since residents use it to request songs and broadcast announcements.

Three of the ten participants have had computer experience. Two of them are the youngest participants in the survey, both students. The third is one of the village elders, a member of the *patronato* that oversees management of the container.

6.3 Statistical Reporting and Analysis

Non-parametric statistical analysis is performed to study correlations between participant characteristics and their preferences. The chi-squared test can be used on both nominal data, such as the yes/no questions, and ordinal data, such as the difficulty rankings. Other tests exist that could be used on ordinal data, such as the Spearman Rank Correlation or Kendall Rank Correlation. In order to maintain a consistent style of analysis, however, all results will be analyzed using the chi-squared statistic. Both the chi-squared value and the p-value of the relationship will be reported in the results, denoted as $\chi 2$ and p respectively. The chi-squared value calculates the discrepancy between the observed data, which might be related, and a null

hypothesis that assumes that there is no relationship in the data. It is included for completeness. The p-value reports the probability that the correlation calculated by the chi-squared value can be obtained by chance. So, for example, correlations with a p-value below 1% are considered far stronger than those with a p-value of 20%.

Pair wise correlations have been calculated between all dependent and independent variables gathered. The dependent variables in the study are: gender, education, age, used a computer, reading test score, writing test score. The independent variables are all the opinions gathered during the interview. No statistically significant correlations were found between gender and age with the independent variables. All significant results are described below.

6.4 Multi-literacy Experiment

The multi-literacy experiment was conducted in three stages. Participants were first asked for their opinions on interface modes, followed by their preferences when reviewing and entering messages.

6.4.1 Interface Preference

Participants were shown the three interface modes and asked to select the one they would be most likely to work in: image, image/text or text (Figure 19). A significant correlation can be observed between reading skills and interface preference ($\chi 2 = 4.8$ $p = 0.09$).

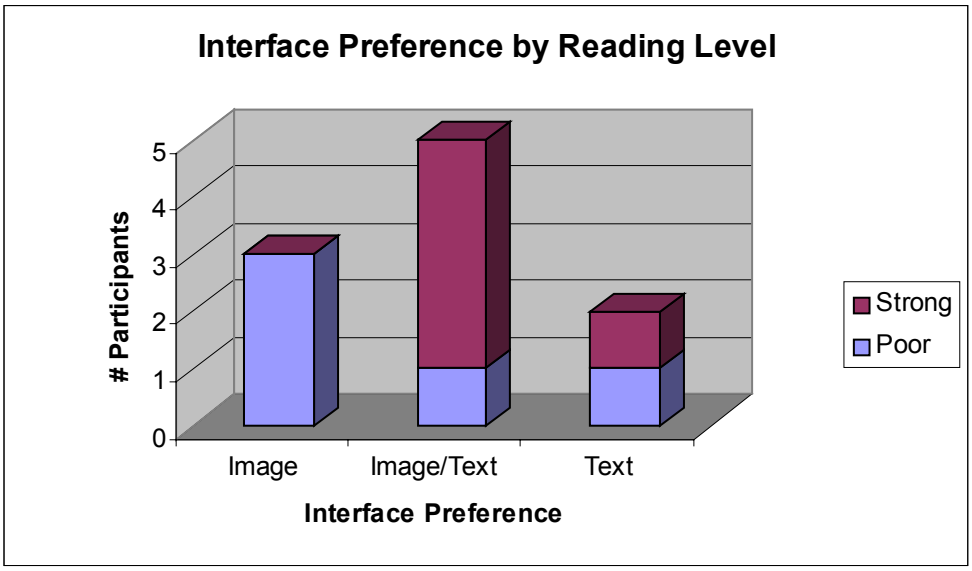

Figure 19 - Interface Preference by Reading Level

Three of the ten participants, all having extremely low literacy skills chose the image-only mode. Two of them stated that having the text on the screen was 'confusing', making the interface more difficult to use.

Five of the participants, four of whom have strong reading skills, preferred the mixed image/text mode. When showed the interface without the text, they felt that it was more difficult to understand.

Two participants preferred the text-only mode. One had very strong reading skills and felt the icons were a distraction. The second was low literate and believed that education would be provided to him in both reading skills and software use.

With the exception of these last two participants, response to the usefulness of icons was unanimously positive. The specific implementation of icons, however, was not well received. Certain images were hard to decipher (the farmer representing agriculture), and others did not hold the association with the participants that was hoped (the right pointing triangle for play). Several participants strained to make out the images, and would move very close to the screen. Others, particularly the low-literate community members, referred back to the icons by their color

rather than shape or function. For example, the button to play the audio file was referred to as the 'green one'.

Navigating the tree structure proved to be a challenge for most of the users, as was understanding the organization of discussions under multiple layers of description. In one part of the exercise each participant was asked to find a specific discussion, for example the one relating to telemedicine. This proved difficult for two reasons. First, many participants were not able to grasp the organizational structure of the information in the relatively short time period of the interview. Some did not understand where to begin among the high level genres to find a specific discussion; many did not know how far to drill down into the structure to find the discussion. Second, the example discussions could have been classified under different discussion genres. For example, the topic telemedicine can equally belong to the Health genre or the LINCOS genre, since the LINCOS container has a telemedicine unit.

6.4.2 Message Review Preference

Unlike interface modes, opinions about message review modes did not split clearly by reading ability (Figure 20, $\chi 2 = 1.6$ $p = 0.21$).

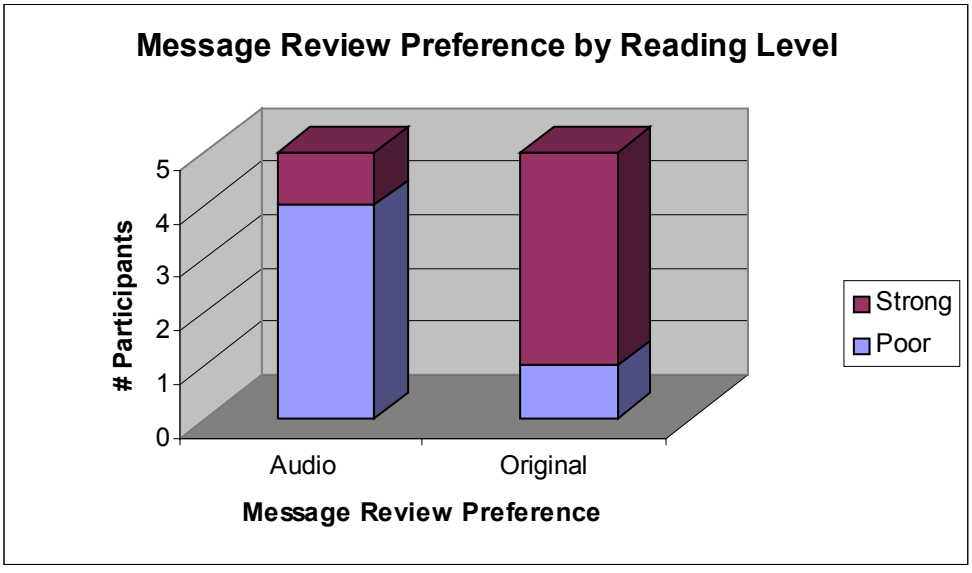

Figure 20 - Message Review Preference by Reading Level

Five of the ten participants, predominately those with poor reading skills preferred to use the audio-only mode. The remaining five participants, predominately with strong reading skills preferred the mixed text-audio mode. One of these was a participant with poor reading skills, who stated that the text might be useful if he has problem understanding details of the recorded message.

Each participant was asked to listen to and comment on a speech-synthesized message. Reactions to the computer voice was mixed; most participants stated that the voice was not clear and was difficult to understand. Similar results have been seen in other software studies of technologies that integrate speech-synthesis (Petrie, Morley, McNally, O'Neill & Majoe, 1997). Several were able to understand the message after several playbacks. One participant stated that the computer voice was preferable to a human voice, possibly because he found it novel.

6.4.3 Message Entry Preference

The correlation observed between writing skills and preferred message input mode is weak (Figure 21, $\chi 2 = 0.97$ $p = 0.32$).

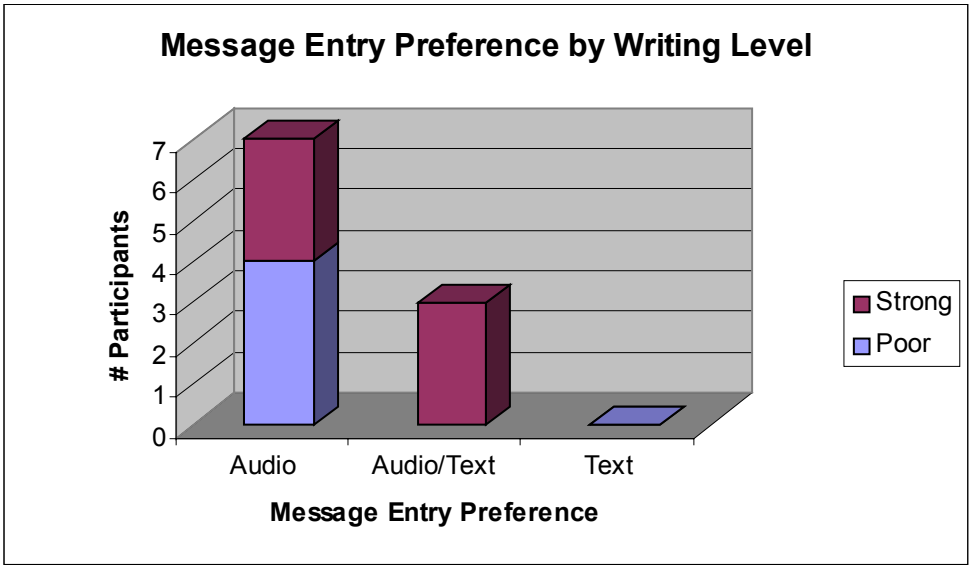

Figure 21 - Message Entry Preference by Writing Level

Three participants, all with strong writing skills, stated the text/audio mode as their preference and that they would be interested in both writing and recording messages. The reason cited was to ensure accessibility of the messages to the community. None of the three liked the voice synthesis, and preferred to provide their own recordings for the benefit of other users.

The remaining seven preferred recording messages. Three of these had strong writing skills, and four had poor writing skills. Of the first three, two had not previously used a computer, and found the microphone easier to use than the keyboard. The remaining four did not have strong writing skills.

6.5 Security and Trust Experiment

6.5.1 Security Perceptions and Preference

For the system access experiment, participants were shown each of the login modes, asked to state a preference, given an opportunity to try each one and queried about how secure they perceived each to be. If the participant did not understand the security characteristics of any mode, it was explained to them. Finally, participants were again asked to state a preference. Initially half the participants stated a preference for the Fingerprint mode, and the other half split between the Face and Id modes. After the various modes were tried and security considerations explained, six participants preferred the Face mode, and the remainder the Fingerprint mode (Figure 22).

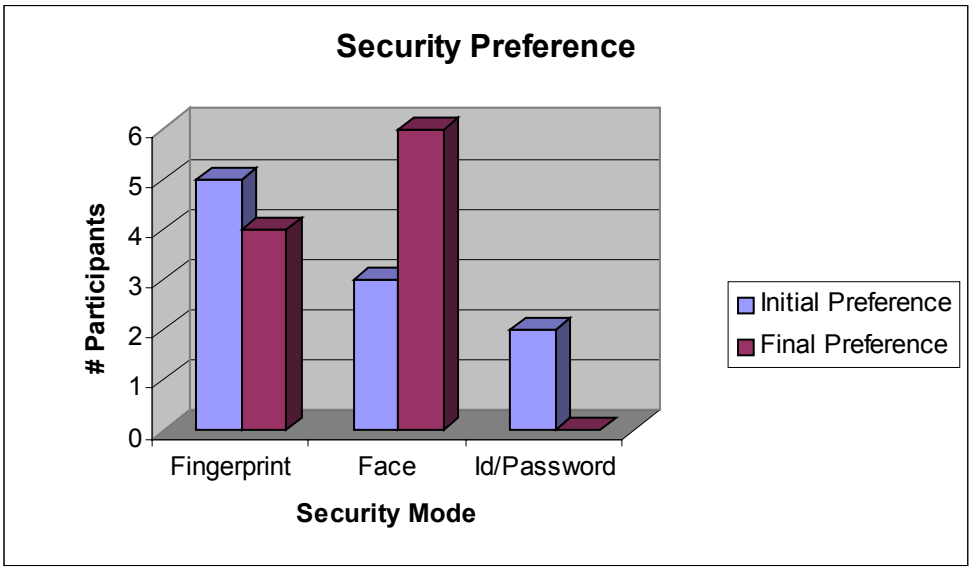

Figure 22 - Security Preference

A significant number of participants did not correctly identify the security characteristics of the system access modes (Figure 23).

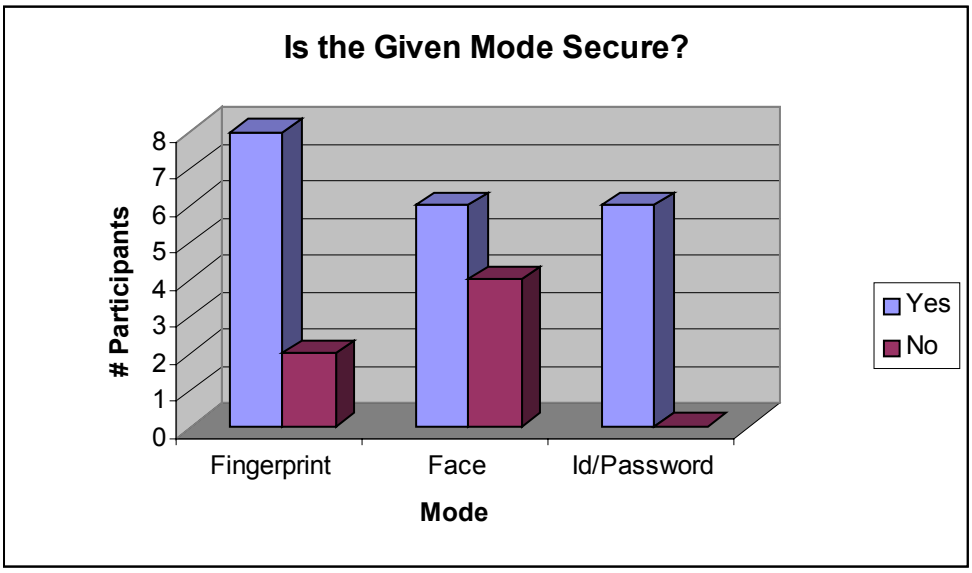

Figure 23 - Is the Given Mode Secure?

Most participants understood that their fingerprint was unique, and thus that the Fingerprint mode was secure. All were familiar with the technology since they were required to have their fingerprints taken for their national identity cards. Participants identified with the ease of use and speed of using a fingerprint reader to access the system. One stated that it was 'like a computer button'.

A common misperception among the participant group was that the Face mode was secure. Many explained the security of the Face mode in the same was as that of the Fingerprint mode: 'nobody has a face like mine'. Of the six participants who believed it was secure, four correctly identified the fingerprint mode as secure. Participants were led through an exercise of logging into the system by pressing another users face. In most cases this did help clarify the lack of security. It, however, did not change the preference of many participants. Only one person later switched preference towards a more secure access mode. Common reasons provided why the face access mode was preferred include:

- People will not enter with a face that is not their own
- The face mode is easy to use
- Participants like to see their face on the screen
- Participants don't mind if other people enter under their personal identification

An interesting comment frequently stated by those who preferred the fingerprint and faces mode is that they are easy to use and fast. Thus, even people who have never touched a computer value usability and speed.

Only the six participants with some writing skills were asked about the login id/password mode. After trying all three modes, none stated it as a preference.

6.5.2 Public Versus Private Information

Following the demonstration of the system access modes, participants were asked about concerns with publicly shared information on CKS. Most participants were interested in using the system to send personal messages to family members rather than using a discussion format. Several others, however, expressed a strong opinion that all information on CKS should be public and of benefit to the whole community.

An interesting theme recurred through the comments around the quality and nature of information on the system. Several of the farmers were uncomfortable openly discussing agricultural price information over the Internet. They were concerned that the government would, in some way, be listening to the conversations. Other participants were concerned that the system could be used to propagate lies and gossip. In one case, a farmer listened to a recording that quoted the current market price of beans in Bohechio, and was angered due to what he perceived to be inaccurate information. Such responses led to comments like 'some things should not be broadcast on the system'.

6.6 Information Usage

The results on information patterns highlight common information uses in the community (Tables 1 through 4). The most common type of communication was with family members outside of Bohechio, predominately by telephone. Relatives lived in other villages, Santo Domingo or in the United States. Many participants claimed that they would like to be able to talk to/hear from family members more often than they currently do.

Improved health information was sought due to the many illnesses in the community. People felt that they needed more information and education than was available in the rural clinic.

News of local and national issues figured highly in information usage. Participants liked to keep informed of local issues. Some examples are updates on the construction status of a new hospital in Bohechio, and information on diseases affecting the community.

Finally, many of the participants actively used or sought information related to their personal businesses. Farmers almost unanimously wanted better market price information for their crops. Housewives wanted to find a market for their cleaning services or the handicrafts they produce.

Type	Description
Health	Community health issues, Updates on construction of new hospital
News	Local and national news, politics and sports
Social	Family news

Table 2 - Information Currently Received

Type	Description
Health	Greater information on diseases in the community
Commercial	Prices of inputs/outputs for individual businesses

Table 3 - Information Want to Receive

Type	Description
Commercial	Description and prices of goods/services offered
Social	Family news

Table 4 - Information Currently Sent

Type	Description
Health	Common illness symptoms in the community
Commercial	Products/services on offer
Social	Family news

Table 5 - Information Want to Send

6.7 Performance of the Evaluation Instruments

6.7.1 Problem Areas

As described above, the correlation between users self-reported literacy levels and their performance on the literacy test was high. However, that all participants given the writing test were judged as strong indicates that the writing test may not be sufficiently sensitive to different levels of writing ability. Future iterations should revisit and modify the evaluation scheme of the written test.

The member of the research team conducting the interview on information usage felt that this section of the interview was hard to administer. Participants had difficulty understanding the difference between information they currently send/receive versus information they want to send/receive. Furthermore, he felt that richer information could have been gathered if the interviewees felt more comfortable in the interview situation. Some of the comments that were raised during the interview, such as the need for information on disease in the community, relate to sensitive topics. If the interviewer was a member of the community, the participants may have felt more comfortable discussing other such sensitive issues.

An observation made by the same researcher in the context of the information use section, but which applies equally to the rest of the study, is that Dominicans are not likely to admit when they do not understand something. This is particularly true when interacting with people they do not know. When asked about CKS functions and usability, participants may not have felt comfortable asking questions or for clarification, particularly in front of a research team assembled from organizations in the capital city and abroad. This further points to the usefulness of local interviewers when gathering sensitive information.

6.7.2 Changes to the Instrument

As mentioned in Section 5.2, the research team was encouraged to take a flexible approach in the interviews. The instrument would be used as a guide, sections that were not effective would not be administered, and sections that yielded interesting insight would be expanded.

It was the case that when interviews began changes were made to the instrument, all within the multi-literacy and security experiments. The following changes were made:

- **Elimination of exercises across all modes:** The original plan was to have the participant try every panel in the application. For example, they would be asked to enter text messages, audio messages and mixed text-audio messages. The intention was to give the participants a detailed overview of the system through hands-on experience in order to stimulate thought on the technology and elicit well-considered preferences. Following the first two interviews it was clear that this would take far too long, and would not be interesting to the participant.
- **De-emphasis on usability questions:** The first few participants responded almost identically to all questions around the usability of the interface, stating that everything was easy to use. Even in cases where a participant clearly had difficulty completing an exercise they would state that it was not difficult. Only one of the early participants seemed to give thoughtful responses to these answers, she was a student and the youngest in the group. There are two reasons why the usability questions may not have been effective. First, it is possible that the participants did not have enough of an opportunity to understand and use the interface. Second, their positive responses may reflect a prevailing social norm rather than their true opinions.
- **Removal of questions on using CKS in LINCOS:** All participants on the first day responded that they would use the system in LINCOS with little hesitation. The exception

was the same student from before, she gave thought to the question and discussed issues of privacy when listening to and recording messages.

- **Removal of questions on where information resides:** Questions F1 and F2 in Appendix 5 ask the participant where they think that the messages in the system reside. This question was confusing to participants. It possibly was one of the more uncomfortable questions since many of the participants had not used computers before and thus did not have a strong understanding of how they work.
- **No proper login:** It was originally planned that each user would be properly registered into the system, their picture taken and fingerprint scanned. It was not possible to do this and conduct the two experiments in one hour, so these plans were dropped.

Several additions were made to the instrument as interesting responses came up in the interviews:

- **Opinions on speech synthesis:** The instrument itself doesn't specifically probe participant's opinions on speech-synthesized messages. However, a number of interesting comments regarding these messages, discussed in the Results section, were made by the first few participants. Thus all following interviewees were asked to listen to and comment on speech synthesis.
- **Interest in talking with strangers:** The instrument asks whether participants would use the system to satisfy their information needs and whether they feel that information on CKS should be publicly shared (Appendix 5 F3, F5). It does not investigate, however, whether villagers are interested in discussing issues with people they don't know. One interviewer asked this to some of the early participants, and got an interesting set of responses. Thus it was added to the question list.

6.8 Reflections on the Interview Process

While the research team was satisfied with the quality and quantity of data gathered during the two days of interviews, there were a number of areas ways in which the process could have been improved.

Few problems were encountered in relations between the research team and interview participants. The participant group was patient and very gracious over the two days. Coordination between the LINCOS staff bringing participants to the testing station and the research team being ready to interview them was not ideal. The reason was that the participant pool was not determined in advance, as was originally planned. People were solicited and brought to the interview site whenever the interview schedule began to open up. In some cases, interviewees waited up to an hour before their interview would begin. Each interview required two hours of the participant's time, which was long. A more reasonable length would have been one or one and a half hours. Some asked to leave early to attend to other priorities, others seemed to lose interest towards the end. In future efforts, maintaining and enforcing a structured schedule of interviews would be advisable. All interviewees were given a small gift at the end of the session, which was well received.

A host of technical problems had to be addressed before the interviewing could begin. This shortened the number of days the research team could spend on interviews from three to two. The biggest challenge was installing CKS on a more powerful laptop for purposes of the interview. On the new laptop CKS ran significantly faster, however, several software drivers required by the system failed. The end result was that the fingerprint scanner did not work, so a live demonstration of it was not possible. These technical issues should have been tested and resolved prior to departure to the field.

An issue that arose upon arrival in Bohechio was that the electricity provider had cut off the supply of power in the community. As a result, the evaluation could only take place near the LINCOS container, which had its own power supply. Given that power fluctuations are not uncommon in Bohechio, it would have been prudent to transport a small generator, and thus have the freedom to run the evaluation in a location of our choosing. An unfortunate consequence of working at the telecenter was that some interview participants confused the CKS evaluation with the LINCOS project, and understood questions about CKS to be questions about LINCOS.

Conducting interviews through a translator proved to be a challenge. The member of the research team who facilitated much of the technical interviews and translated my questions was not familiar with formal interviewing techniques. In certain instances his comments would lead the participant to certain conclusions, invalidating the results. However, his easy-going demeanor

was well received by the community and he was able to make the interviewees feel comfortable in front of the computer.

7 Discussion

This section returns to the three research questions posed in the study on: multi-literate interfaces and equitable access, security and trust, and information usage. The results from the evaluation are discussed in the context of each question, followed by a review of problems that participants had using CKS.

7.1 Summary of Results

7.1.1 Multi-Literate Interfaces and Equitable Access

The original inspiration behind CKS was to create a forum where all community members could discuss issues of local importance. Implementation of a multi-literate interface was central to this end; any community member could use the system without bias. During the evaluation trial we saw the system come to life. Example discussions entered for the purpose of demonstration grew into live and vigorous debates. Results from the evaluation in Bohechio show that low literate users prefer iconic interfaces, speech synthesis is not effective, and that literate users are willing to create both text and audio content.

Low Literate Users Prefer Iconic Interfaces

Conducting the CKS exercises with a range of people in Bohechio showed that those with low literacy skills prefer iconic interfaces. The comment from several people that text makes the interface ‘confusing’ suggests that purely iconic interfaces are essential in increasing the accessibility of technology.

Commenting on the multiple interface modes, several participants with strong reading skills stated that the iconic one was the most difficult to use. This suggests a disparity in usability between modes in precisely the wrong direction. As the interface is switched from text to icons, the designer should ensure that it does not become harder to use. Text on the screen is often less ambiguous than icons. When the text goes away, one has to compensate for any loss of context. This can be achieved through well-designed icons that users can easily learn to recognize. Another way is to provide audio prompting. Intermediate interface modes can be designed with

varying degrees of audio prompts to help users navigate through the iconic interface. As a simple example, when the Bulletin Board Navigator displays a set of messages in iconic mode, it can highlight each message in turn and automatically playback its audio recording. If people are given control over the interface style, they can switch from an iconic mode with audio prompts, to an iconic mode without audio, and on to text as their comfort with the system grows.

Speech Synthesis is not Effective

Reactions to the speech synthesis recordings were mostly negative. The sample size is too small to draw meaningful correlations between demographic characteristics and speech synthesis opinions, however the older participants and those with less exposure to computers seemed to have more difficulty understanding the recordings.

It is important to note that there is a wide range in quality of speech synthesis systems. The CSLU synthesizer produces sounds somewhat monotone audio clips, and is trained to sound like Mexican Spanish. There is no speech synthesis system trained with a Dominican accent. This points to an interesting engineering question, how does one create high quality speech synthesis systems for rural areas where there may be a range of local accents or dialects? Ideally, a system deployed in Bohechio should sound like a Bohechian speaker. Such a system would be less alienating to the locals and, like the eReader introduced in Section 2.2, could be used to provide access to a wide range of text.

Literate Users Are Willing to Create Text and Audio Content

All participants with strong literacy skills expressed an interest in using text and audio input, text as their personal preference and audio to ensure that their messages were clear to all users of the system. This suggests that mobilizing the participation of the literate user community might be a powerful complement for automated speech synthesis. Hearing local voices rather than a synthesized one would help create a feel of a living online community. However, such participation would likely be a complement to, not substitute for, high quality speech synthesis. Speech synthesis is fully scalable, as the system grows and more types of users join, the probability that speech synthesis will be required to translate content will increase.

The challenge of promoting good behavior in discussion systems, introduced in Section 2.3, is to design appropriate incentives. In CKS, it may be the case that incentives can be used to encourage those who type messages to also record them. To continue exploring this, it is useful to identify whether people are willing to create text and audio on an ongoing basis, or whether over time they will slip into one of the two modes. If all users converge on audio input then the interface would require significant redesign.

7.1.2 Security and Trust

The goal of the investigation into security and trust was to identify issues when designing shared-use technologies where people interact under digital identities. The evaluation in Bohechio demonstrated that villagers think differently about security in messaging systems, and they need to trust both the communications medium and content to have confidence in the system.

Rural People have Different Security Requirements

Very few participants in the evaluation were concerned with the prospect of others logging into the system under their identities. On one hand, the opinion of these participants could genuinely reflect a different conception of security consistent with a high level of trust among community members. While computer users in North America are extremely sensitive to the privacy of their information, the same may not hold true in rural communities, at least within the confines of networked messaging systems. On the other, however, it is possible that users did not have sufficient time to understand the impact of others entering the system under their identification. The interviews moved quickly and for most of the participants it was their first time thinking about security of information.

When building security into software systems for rural use, system designers should consider tradeoffs in various login designs.

Mode	Security	Accessibility	Cost
Fingerprint	High	High	High
Id/Password	Medium	Low	Low
Faces	Low	High	Low

Table 6 - Characteristics of Login Modes

While fingerprint readers are both high security and very accessible, they are expensive. Pure software solutions such as the id/password login or faces mode are low cost, but are either not accessible or not secure. This is by no means an exhaustive list of login modes, however it does highlight the type of issues that should be considered when designing access modes to shared technologies.

Future investigations into security should probe deeper into what rural people understand of digital identities, and at what point are they no longer willing to use a low-security regime. For example, it is possible that for messaging systems little security is required, but for financial transactions people would want very secure systems.

Need to Trust the Communications Channel and Content

Issues of trust came up during the interviews in comments about 'lying' and 'gossip' on the system, and concerns about government surveillance. This highlights an issue in deploying bulletin-board systems to communities new to this form of interaction. In order to benefit from the information in such a system, users must trust both the authors of the information and the communications medium (Heeks, 1999b). Distrust of the motivation of other users can lead to under-use of the system. If concerns about surveillance of discussions or the truthfulness of the content are serious, it may undermine the benefits intended by the use of CKS.

It is not clear where the concern for surveillance comes from. The government is a major purchaser of agricultural products in the Dominican Republic, and it tends to buy at above-market rates. It is possible that farmers are careful about what they say in order to not anger the government.

In order to further pursue these questions of trust, it is necessary to identify what the roots of the concerns are. All comments around trust were made by farmers in the context of agricultural pricing discussions. It would be useful to know in what other domains of discussion this is an issue. One approach taken to minimize questionable content, seen in the administration of USENET, is to have moderated discussion groups. Another approach would be rating schemes such as that implemented in GroupLens (Section 2.3), distasteful articles would be voted out of favor.

7.1.3 Current and Future Information Uses

The questionnaire on information use highlighted the communities' need for information on health and news, and a desire to communicate with their families and about their businesses. All are basic needs that one would expect in most rural communities. It is possible that the design of the tool, or the administration of it by an outsider to the community, inhibited a richer discussion of these issues.

Inquiry into information use was motivated by a desire to evaluate whether CKS would be an effective communications medium, and suggest other information systems for community use. During discussions on system security, several participants stated that they were interested in direct messaging functionality. This is reinforced by the results on information use, where nearly all participants expressed a desire for more frequent communications with their family. Thus, there is reason to extend the multi-literate approach of CKS to a direct messaging environment to support low-cost text and voice messaging. Doing so would go a long way towards making residents of isolated communities like Bohechio feel connected to their family in the rest of the world.

7.2 Problem Areas

The interest in CKS expressed by the participant group was high. This can either be because people were genuinely interested in the system, or people answered in a way they felt was appropriate given the interview situation. For some participants, it is hard to determine on which end of this spectrum their responses lay. Several, however, showed a strong understanding of the concept, could articulate the benefits of using the system in their own terms, and could describe immediate uses to which they would put it. For example, one farmer explained how he would like to start a discussion on the market price of crops he grows and periodically check to see if other users of the system had posted replies. Such responses give an indication that there is genuine interest in and need for CKS.

Several participants had difficulty completing the navigation exercise, as some examples could be classified under several genres. For example, one of the discussions entered into the system was about telemedicine, which could be classified accurately under either health or LINCOS. This can be considered a fault in the design of the test cases; clearer topics and discussions could have been created. However, it is likely that in a real discussion system such cases will arise. Again, the younger participants in the study were better able to enumerate the possible locations of the discussion and search through the alternatives. Thought should be given on ways to help users classify their conversations. One can think of several approaches to this problem. One approach would be for the system to initiate a dialog with the creator of a discussion to help classification. Another would be for CKS to study the contents of the discussions and dynamically classify or relate them. This is similar to the design of CommunityBoard (Section 2.3), where similar messages are grouped visually on the interface. Such an approach may not be feasible, however, until speech-to-text software that can run with high accuracy on shared systems is available.

While the system used for the evaluation was sufficiently robust to draw such opinions of the participants, some weaknesses in its design were identified. Many of the users discussed how:

- The tree navigation interface was hard to use
- Having multiple layers of hierarchy for information was confusing
- Some discussions were hard to find since they could be classified under several genres
- Several Bulletin Board icons were hard to decipher
- The computer voice was not clear

As a general comment, the younger participants seemed able to use the interface more easily than the others. Collaboration with the community earlier in the project cycle could have identified these elements long before implementation. The process followed by the project was to identify a technology need in the community, design a system with a range of interface modes, build a prototype and evaluate it. The design of multiple modes increased the chance that some would be usable by the community. As discussed above, this was the case, but there was a disparity in ease of use between the modes. A more appropriate process would be to identify the concept, conduct collaborative design sessions in the community, build a prototype and then evaluate it. In this way, the opinions of the community are wrapped into the process early, and the chances of creating a useful technology increased. All of the concepts discussed above could be tried in design sessions using either simple tools, such as interface mock-ups, or interactive prototypes.

8 Policy Recommendations

As little formal research has been done around information technologies for rural communities, the paper presents policy recommendations to inform future technology design and evaluation efforts. The recommendations are derived from the results and discussion, and are summarized below.

8.1 Technology Design

Design iconic interfaces for low literate users: Given the choice between a text-based, iconic or mixed text-iconic interface, low literate users prefer to use a fully iconic interface. Design of interfaces combining icons and text, an approach seen in several current development informatics systems, can confuse low literate users and deter them from using the systems. System designers should implement fully iconic interfaces for use by low literate people, ensuring that the interface provides rich audio and visual content to allow for easy use.

Do not rely on speech synthesis technologies: Many recent efforts to create appropriate technologies, including CKS, utilize text-to-speech synthesis technologies. These systems are potentially powerful, as they can open up a world of electronic text content to low literate users. However, the study finds that speech synthesizers that aren't fluid and appropriate to the local dialect will not be well received in rural areas. This has two implications. First, system designers using speech synthesis must conduct extensive user acceptance tests to ensure that the audio is understandable to users in target communities. Second and more generally, there is need for research on how to develop very localized speech synthesis systems, which can reflect the wide range of accents and dialects found in rural areas.

Collaborate with communities: It is important to recognize that technologies like CKS are being developed to aid rural communities like Bohechio. For this to happen the communities must themselves participate in designing and building the technologies. Early collaboration with communities will ensure that system designers understand the requirements of the user community. Currently, little work has been done on formal software design methodologies for rural communities. Research to extend the methods of software design and participatory

development to this end will accelerate the quality of research in the field, and the benefits to the underserved communities of the world.

Balance cost, security and accessibility in technology design: In the context of messaging systems, the study finds that villagers are not interested in high-security login procedures. Rather their preferences are driven by both security and accessibility. An easy-to-use low security login procedure is found to be more popular than a more sophisticated and secure one. Thus, designers of shared-use software systems must balance cost, security and accessibility in their technology designs. The login regime implemented should be appropriate for each given application. It is possible that for messaging systems little security is required, but for financial transactions people would very secure systems.

8.2 Technology Evaluation

Conduct long-term evaluation phases: When evaluating information technologies in rural communities, sufficient time must be given in the evaluation process to allow users to learn and appropriate the technology. The evaluation trial implemented for CKS was too short, and thus could only scratch the surface of villagers' opinions. The question underlying most research in the technology and development field is whether technologies can improve the social, economic and cultural environments of rural areas. Such impact analysis can only be done through long term, rigorous study.

9 Conclusion

This thesis has presented Community Knowledge Sharing, an asynchronous discussion system designed for use in the developing world. Recognizing that large segments of the population in rural communities have low levels of literacy, CKS implements a multi-literate design in which the system can be customized based on the abilities and preferences of the user. The four main functions implemented in the system are logging in, navigating the bulletin board, posting content and reviewing content.

Evaluation of CKS was conducted in Bohechio, a rural agricultural community in the Dominican Republic. Three research areas were explored. The first research area investigated whether the multi-literate interface design increases accessibility of the technology. Reactions to the system were overwhelmingly positive across the evaluation participants. The study found that low literate users prefer iconic interfaces, speech synthesis is not effective, and literate users are willing to create both text and audio content. The second research area was to explore perceptions villagers have around the security and trust. The study found that in the context of messaging environments rural people have different security requirements, and need to trust both the communications channel and content of the system. The third research area was to identify information patterns in the community. Health, news, commercial and family information were the most used and most demanded types of information.

Policy recommendations are drawn to inform future technology design and evaluation efforts. Developers of information technologies for use in the developing world should design iconic interfaces for low literate users, not rely on speech synthesis technologies without significant user acceptance testing, collaborate with communities, and balance cost, security and accessibility in their technology design. Evaluation of these technologies should take a longer-term approach in order to ensure that participants understand the application being tested.

CKS provides one of the first examples of an appropriate messaging system for the developing world. It is hoped that continued research in this field will one day expand the benefits of networked communications widely in the world.

9.1 Future Directions

Future work in appropriate multi-literate discussion boards should address how to equalize visual and text representations of information, and reduce bias towards users with education and literacy skills. Returning to the research on interfaces to social information spaces, we are reminded that the key challenge in interface design is to identify the salient data and represent it accurately and intuitively (Donath, Karahalios & Viegas, 1999). One approach that should be further investigated is geography, where discussions are visually associated with the geography of the community. For example, in the TARAhaat.com interface introduced in Section 2.4.1, information and services are accessed through a map of the village. Health information is found by selecting a picture of the hospital. In a community like Bohechio, where they own a digital camera, this can be taken one step further. The system can be customized with pictures of different community locations that will have equal meaning to all users of the system. Another approach is to organize discussions as the bulletin boards grow by visually representing relationships between messages. The CommunityBoard provides a good starting point, where similar messages are grouped visually on the screen (Matsubara, Ohguro & Hattori, 1998). Extending such this approach may not be feasible, however, until speech-to-text software that can run with high accuracy on shared systems is available.

Consideration must be given to the infrastructure as well as to the interface of messaging environments. CKS implements its own communications protocol to exchange information between client and server. To develop the system into something more open and interoperable, it is important to continue research into extending the USENET infrastructure to support rich multimedia content. Having several disconnected multimedia messaging environments scattered throughout the world will not go far towards increasing connections and communications. The knowledge horizons in Bohechio will open more when they can interact with communities in El Salvador, Peru and Argentina across an open multimedia platform.

Lastly, beyond considerations of software it is important to recognize that technologies like CKS are being developed to aid communities like Bohechio. For this to happen the communities must themselves participate in designing and building technologies. Little work has been done on formal software design methodologies for rural communities. Extending the methods of software

design and participatory development to this end will accelerate the quality of research in the field, and the benefits to the underserved communities of the world.

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Appendix A. Participant Information Instrument

Informacion Basica

A. IDENTIFICACION

A1. Sexo _____

A2. Edad _____

A3. Cual es su principal ocupacion actualmente? _____

B. EDUCACION

B1. Asiste a la escuela actualmente?
1. *si*
2. *no*

B2. Hasta que grado curso?
1. *primario incompleto*
2. *primario completo*
3. *secundario incompleto*
4. *secundario completo*
5. *comercial y/o tecnica*
6. *universtario*
7. *otro*

C. ALFABETISACION

C1. Sabe leer correctamente?
1. *correctamente*
2. *con dificultad*
3. *apenas lee su nombre*
4. *no sabe leer*

C2. Tiene habito de lectura?
1. *si*
2. *no*

C3. Si lee, que tipo de literatura?
1. *periodico/revistas*
2. *novelas/historietas*
3. *biblia/materiales religiosos*

C4. Otros _____

C5. Sabe escribir correctamente?
1. correctamente
2. con dificultad
3. apenas escribe
4. no sabe escribir

C6. Se comunica por carta?
1. si
2. no

C7. Si escribe carta, a quien la escribe mas a menudo?
1. familiares
2. amigos
3. jefe
4. profesor
5. otro _____

D. LINCOS Y USO DE COMPUTADORAS

D1. Conoce la unidad LINCOS?
1. si
2. no

D2. Si la conoce, cuantas veces la ha visitado? _____

D3. Cuales servicios ha utilizado?
1. telefono
2. radio
3. unidad de telemedicina
4. pruebas de suelo y agua
5. computadoras
6. otros _____

D4. Cuando lo ha visitado se siento a gusto o en confianza?
1. si
2. no

D5. Si no se siente a gusto, diga porque? _____

D6. Ha utilizado alguna vez una computadora en LINCOS o en otra parte?
1. si
2. no

D7. Si la ha usado diga cuantas veces?
1. una
2. varias
3. muchas

D8. Con que proposito la ha usado?
1. internete
2. correo electronico
3. mecanografia
4. otros _____

D9. Ha tomado clase de computadoras en LINCOS o en otra parte?
1. si
2. no

D10. Si ha tomado clases, diga por cuantas horas? _____

D11. Que tipo de clase o curso?
1. internet
2. correo electronico
3. mecanografia
4. otros _____

Appendix B. Literacy Test

PROYECTO LINCOS Y SU IMPACTO EN EL DESARROLLO COMUNITARIO

PRUEBA DE HABILIDAD DE LECTURA Y ESCRITURA

LECTURA:

1)Puede usted identificar y describir las siguientes imágenes:

				
Garza blanca:	Caballo grande:	Casa bonita:	Emisora Lincos:	Grupo:
Esta garza blanca se come las plagas que dañan la cosecha.	Mi caballo es de gran utilidad porque se come la yerba mala y me ayuda a hacer los surcos.	La casa de mi abuela María, pintada se ve bonita.	**Toda la comunidad** escucha los programas de la emisora del Proyecto LINCOS	Hanni, Marcos, Juan y Santiago pertenecen al Instituto Tecnológico de Massachuset y al Proyecto LINCOS respectivamente. Todos formaron un grupo para aplicar una encuesta sobre las actitudes de los residentes en esta comunidad acerca del uso, importancia, ventajas y/o desventajas de la tecnología.

Por favor escriba brevemente lo que más recuerde de lo que acaba de leer.

Prueba de Habilidad de Lectura y Escritura

A. EJERCICIO 1

A1. Leyo con claridad?
1. si
2. no

A2. Leyo con fluidez?
1. si
2. no

A3. Comprendio la lectura?
1. si
2. no

A4. Aprobo la seccion?
1. si
2. no

Comentario

_____

_____

B. EJERCICIO 2

B1. Leyo con claridad?
1. si
2. no

B2. Leyo con fluidez?
1. si
2. no

B3. Comprendio la lectura?
1. si
2. no

B4. Aprobo la seccion?
1. si
2. no

Comentario

_____

_____

C. EJERCICIO 3

C1. Leyo con claridad?
1. si
2. no

C2. Leyo con fluidez?
1. si
2. no

C3. Comprendio la lectura?
1. si
2. no

C4. Aprobo la seccion?
1. si
2. no

Comentario

_____

_____

D. EJERCICIO 4

D1. Leyo con claridad?
1. si
2. no

D2. Leyo con fluidez?
1. si
2. no

D3. Comprendio la lectura?
1. si
2. no

D4. Aprobo la seccion?
1. si
2. no

Comentario

_____

_____

E. EJERCICIO 5

E1. Leyo con claridad?
1. si
2. no

E2. Leyo con fluidez?
1. si
2. no

E3. Comprendio la lectura?
1. si
2. no

E4. Aprobo la seccion?
1. si
2. no

Comentario

_____

_____

F. EVALUACIÓN FINAL DE LECTURA

F1. La habilidad de lectura fue:
1. pesimo (iletrado total)
2. regular (iletrado parcial, nivel primario incompleto)
3. bueno (letrado parcial, nivel medio primaria completa)
4. muy Bueno (nivel secundario completo o incompleto)
5. excelente (letrado total, secundario completo y/o superior)

_____

_____

G. EVALUACIÓN FINAL DE ESCRITURA

G1. Numero de errores ortograficos:

1. *insuficiente (8 o mas errores)*
2. *regular (6-7 errores)*
3. *bueno (4-5 errores)*
4. *muy bueno (2-3 errores)*
5. *excelente (0-1 error)*

_____

_____

Appendix C. Information Use Instrument

Informacion Enviada y Recibida

A. INFORMACION ACTUALMENTE RECIBIDA

	A1	A2	A3	A4
Tipo	**Descripcion de la informacion recibida (sino recibe ninguna informacion ignore las opciones siguientes).**	**Que tan importante es para usted esta informacion?** **1 = MUY IMPORTANTE** **2 = MEDIANAMENTE IMPORTANTE** **3 = POCO IMPORTANTE** **4 = NO TIENE IMPORTANCIA**	**Con que frecuencia recibe la informacion?** **1 = DIARIAMENTE** **2 = INTERDIARIO** **3 = SEMANAL** **4 = MENSUAL** **5 = RARA VEZ** **6 = NUNCA**	**Por que medio recibe la informacion?** **1 = DE OTRA PERSONA** **2 = RADIO** **3 = TELEVISION** **4 = TELEFONO** **5 = CARTA** **6 = OTHER (ESPECIFIQUE)**
	Descripcion	**Codigo**	**Codigo**	**Codigo**
a) Educacion				
b) Salud				
c) Gobierno				
d) Negocio o comercial				
e) Noticias				
f) Deportes				
g) Social				
h) Entretenimiento				
i) Emergencia				
j) Ninguna Informacion				
k) Otro				

B. INFORMACION QUE DESEA RECIBIR

	B1	B2
Tipo	**Descripcion de la informacion.**	**Que tan importante es para usted esta informacion?** **1 = MUY IMPORTANTE** **2 = MEDIANAMENTE IMPORTANTE** **3 = POCO IMPORTANTE** **4 = NO TIENE IMPORTANCIA**
	DESCRIPCION	**CODIGO**
a) Educacion		
b) Cuidado de salud		
c) Como mejorar mis productos/servicios		
d) Precios de productos y servicios		
e) Lugares de compra de productos y servicios		
f) Oportunidades de mercado para sus productos y servicios		
g) Ofertas de trabajo		
h) Actividades socioculturales		
i) Condiciones del tiempo		
j) Servicios publicos		
k) Noticias/deportes		
l) Cultura		
m) Religion		
n) Turismo		
o) Otro		

C. INFORMACION QUE ENVIA ACTUALMENTE

	C1	C2	C3	C4
Tipo	**Descripcion de la informacion enviada.**	**Que tan importante es para usted esta informacion? 1 = MUY IMPORTANTE 2 = MEDIANAMENTE IMPORTANTE 3 = POCO IMPORTANTE 4 = NO TIENE IMPORTANCIA**	**Con que frecuencia recibe la informacion? 1 = DIARIAMENTE 2 = INTERDIARIO 3 = SEMANAL 4 = MENSUAL 5 = RARA VEZ 6 = NUNCA**	**Por que medio envia la informacion? 1 = OTRA PERSONA 1 = CARTA 2 = TELEFONO 3 = FAX 4 = RADIO 5 = INTERNET 6 = OTRA (ESPECIFIQUE)**
	DESCRIPCION	**CODIGO**	**CODIGO**	**CODIGO**
a) Educacion				
b) Salud				
c) Gobierno				
d) Negocio o comercial				
e) Noticias				
f) Deportes				
g) Social				
h) Entretenimiento				
i) Emergencia				
j) Ninguna Informacion				
k) Otro				

D. INFORMACION QUE DESEA ENVIAR

	D1	D2
Tipo	**Descripcion de la informacion.**	**Que tan importante es para usted esta informacion?** **1 = MUY IMPORTANTE** **2 = MEDIANAMENTE IMPORTANTE** **3 = POCO IMPORTANTE** **4 = NO TIENE IMPORTANCIA**
	DESCRIPCION	**CODIGO**
a) Identificacion personal y ocupacion		
b) Productos que oferta		
c) Servicios que oferta		
d) Productos que desea adquirir		
e) Servicios que desea contratar		
f) Informacion sociocultural		
g) Ninguna		
h) Otro		

Appendix D. Multi-Literacy Experiment

Prueba de Ejercicios Practicos

A. DEMOSTRACIÓN: PRESENTACIÓN DE LAS FORMAS DE APLICACION

A1. De las formas que ha visto cual prefiere utilizar?
1. *grafica*
2. *grafica y texto*
3. *texto*

A2. Por que? _____

B. EJERCICIO: ENCONTRAR UNA DISCUSIÓN CON LA FORMA ELEGIDA

B1. Que tan dificil fue encontrar la discusion?
1. *muy facil*
2. *facil*
3. *dificil*
4. *muy dificil*

Comentario _____

B2. Que tan facil o dificil resulto movilizarse entre los mensajes?
1. *muy facil*
2. *facil*
3. *dificil*
4. *muy dificil*

B3. Que tan facil o dificil resulto moverse en la discusion?
1. *muy facil*
2. *facil*
3. *dificil*
4. *muy dificil*

B4. Entendio el significado de las graficas en la discusion?
1. *muy bien*
2. *bien*
3. *con dificultad*
4. *no entendio*

B5. Entendio el significado de las graficas para moverse en la discusion, agregar mensajes?
1. *muy bien*
2. *bien*
3. *con dificultad*
4. *no entendio*

B6. Que tan facil resulto leer los mensajes?
1. *muy facil*
2. *facil*
3. *dificil*
4. *muy dificil*

B7. Durante el ejercicio, sabia en cual discusion estaba colocado?
1. *muy consciente*
2. *consciente*
3. *un poco confuso*
4. *no sabia*

C. DEMOSTRACIÓN: MODO DE CAPTAR EL MENSAJE

C1. Como prefiere captar los mensajes de la discusion?
1. *como se transmitio originalmente*
2. *totalmente en audio (solo voz)*

C2. Por que? _____

D. EJERCICIO: CAPTAR UN MENSAJE EN EL MODO PREFERIDO

D1. Que tan dificil fue captar el mensaje?
1. *muy facil*
2. *facil*
3. *dificil*
4. *muy dificil*

Comentario _____

D2. Si fue de audio, que tan dificil le resulto escucharlo?
1. *muy facil*
2. *facil*
3. *dificil*
4. *muy dificil*

D3. Si fue de texto, que tan dificil le resulto leerlo?
1. *muy facil*
2. *facil*
3. *dificil*
4. *muy dificil*

D4. Si fue de audio, que tan dificil le resulto utilizar los botones para captar los mensajes?
1. *muy facil*
2. *facil*
3. *dificil*
4. *muy dificil*

E. DEMOSTRACIÓN: APORTAR UN MESAJE LA DISCUSION

E1. Como prefiere aportar un mensaje a la discusion?
1. *audio*
2. *audio y texto*
3. *text*

E2. Por que? _____

F. EJERCICIO: APORTAR UN MENSAJE A LA DISCUSIÓN EN EL MODO PREFERIDO

F1. Que tan dificil fue captar el mensaje?
1. *muy facil*
2. *facil*
3. *dificil*
4. *muy dificil*

Comentario _____

F2. Si fue texto, que tan dificil le resulto escribirlo?
1. *muy facil*
2. *facil*
3. *dificil*
4. *muy dificil*

F3. Si fue audio, que tan dificil le resulto grabarlo?
1. *muy facil*
2. *facil*
3. *dificil*
4. *muy dificil*

Comentario _____

F4. Si fue audio, que tan dificil le resulto usar el microfono?

1. muy facil
2. facil
3. dificil
4. muy dificil

Comentario _____

F5. Si fue audio, que tan dificil le resulto utilizar los botones?

1. muy facil
2. facil
3. dificil
4. muy dificil

Comentario _____

Appendix E. Security and System Access Experiment

Acceso al Sistema

A. DEMOSTRACION: FORMAS DE ACCESO

A1. De las formas que ha visto cual prefiere utilizar?
1. por tacto
2. por rostro o cara
3. por clave (texto)

A2. Por que? _____

B. EJERCICIO: ACCESO CON EL TACTO

B1. Que tan dificil le resulto accesar con el tacto?
1. muy facil
2. facil
3. dificil
4. muy dificil
Comentario _____

B2. Que tan dificil le resulto usar el acceso con tacto?
1. muy facil
2. facil
3. dificil
4. muy dificil

B3. Que tan comodo le resulto usar el acceso con el tacto?
_____

B4. Cree que otra persona pudiera accesar a su informacion personal mediante el uso del tacto?
1. si
2. no

B5. Siente temor de que otra persona pudiera accesar a su informacion personal usando este modo de acceso?
1. si
2. no

B6. Cree que necesita asistencia o ayuda para usar este modo de acceso?
1. si
2. no

C. EJERCICIO: ACCESO CON ROSTRO O CARA

C1. Que tan dificil le resulto accesar con el rostro?
1. muy facil
2. facil
3. dificil
4. muy dificil
Comentario _____

C2. Que tan dificil le resulto usar el acceso con el rostro?
1. muy facil
2. facil
3. dificil
4. muy dificil

C3. Que tan comodo le resulto usar el acceso con el tacto?
_____

C4. Cree que otra persona pudiera accesar a su informacion personal mediante el uso del acceso con rostro?
1. si
2. no

C5. Siente temor de que otra persona pudiera accesar a su informacion personal usando este modo de acceso?
1. si
2. no

C6. Cree que necesita asistencia o ayuda para usar este modo de acceso?
1. si
2. no

D. EJERCICIO: ACCESO CON CLAVE (TEXTO)

D1. Que tan dificil le resulto accesar con clave?
1. muy facil
2. facil
3. dificil
4. muy dificil
Comentario _____

D2. Que tan dificil le resulto usar el acceso con clave?
1. muy facil
2. facil
3. dificil
4. muy dificil

D3. Que tan comodo le resulto usar el acceso con clave?
_____

D4. Cree que otra persona pudiera accesar a su informacion personal mediante el uso del acceso con clave?
1. si
2. no

D5. Siente temor de que otra persona pudiera accesar a su informacion personal usando este modo de acceso?
1. si
2. no

D6. Cree que necesita asistencia o ayuda para usar este modo de acceso?
1. si
2. no

D7. Luego de haber utilizado los 3 modos cual es el de su preferencia?
1. por tacto
2. por rostro o cara
3. por clave (texto)

D8. Por que? _____

E. PREGUNTAS SOBRE LINCOS Y EL SISTEMA

E1. Si este sistema se instalara en LINCOS, lo usaria?
1. si
2. no
Por que? _____

E2. Se sentiria comodo escribiendo su mensaje en el contenedor LINCOS?
1. si
2. no
Por que? _____

E3. Se sentiria comodo grabando su mensaje en el contenedor LINCOS?
1. si
2. no
Por que? _____

E4. Se sentiria comodo leyendo su mensaje en el contenedor LINCOS?
1. si
2. no
Por que? _____

E5. Se sentiria comodo escuchando su mensaje en el contenedor LINCOS?
1. si
2. no
Por que? _____

F. SEGURIDAD DE LA INFORMACION

F1. Que idea tiene sobre las formas de guardar los mensajes?

_____

_____

F2. Donde cree que esta guardada su informacion personal?

_____

_____

F3. Cree poder utilizar este sistema para obtener informacion que desea?
1. si
2. no
Por que? _____

F4. Tiene alguna informacion que no desea que fuera conocida a traves del uso general del sistema?

_____

_____

F5. Esta de acuerdo que todos los mensajes que envie a traves del sistema sean del conocimiento de todo usuario?

_____

_____

F6. Le gustaria enviar mensajes que solo lleguen a aquellas personas que usted desee?

_____

_____