Long-term Sustainability of Tele-Centers: Comparing Model Cases

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1. Introduction

The socio-economic benefits of information and communication technologies (ICT) have been well established by numerous studies (for reviews see Hudson 1995, 2006). Yet despite the exponential growth in computer networking and information technology that bring these benefits through adoption and use, there are still large segments of the population in developing countries and in the economic periphery of industrialized countries that are restrained in obtaining these benefits by low computer literacy and lack of internet access.

Universal access to internet-based resources is an important goal of government telecommunication policy. Achieving this goal is difficult. One way governments have attempted this is through the establishment of Internet technology centers or telecenters. Alternatively, government or other agencies can support the acquisition of computer technology and network access through existing organizations, such as schools and social services organizations. There are two main models for the establishment of telecenters: a 'stand alone' versus 'embedded' model. In the stand-alone model, the sole activity and *raison d'etre* of an organization is the provision of access to (and training on) computers with access. In this paper we argue that it is oftentimes more difficult for organizations in this condition to become self-sustaining than when computing technology and network access are 'embedded' or integrated into the ongoing activities and operations of an existing organization.

When computer network technologies and skills transfer (i.e., training). are housed (i.e., embedded) in existing organizations there is a greater likelihood of long term sustainability for the computing infrastructure. This is due to the fact that the hosting organization has a *raison d'etre* beyond providing computer equipment and services to its users. Thus, in the embedded model, an existing organization, such as a school or a library, decides to seek outside funds to purchase computers and Internet access that they make available to users who are already frequenting the facilities or utilizing and benefitting form the services of that organization. Finally, existing organizations have a set of social network ties –friends, family members or acquaintances – who commonly experience and assess the services of organizations which provides a social context within which they subsequently can talk about computer services.

This paper compares the sustainability of these two models for providing universal access through telecenters, highlighting findings from other studies, and drawing on case studies of both models in Iran and Appalachia in the US, where the researcher has been studying diverse telecenter initiatives. The two model cases in Iran are the Zahedan Information Technology Center or ZITC (stand-alone) and SchoolNet (embedded), as

exemplified by the Neyshabur "Math House". In Appalachia, in southeastern US, the model case is drawn from the local chapters (New River Valley in southwest Virginia) of a national network of Community Action Agencies.

2. Importance of Social Networks in Innovation Adoption

Social networks are essential to innovation diffusion, particularly for interactive technologies, such as computer networking (Markus, 1987; Rice, 1900; Rogers, 1995; Valente, 1995). A person's social network is comprised of the friends, family and acquaintances with whom that person stays in contact and exchanges resources of friendship and aid (Fischer, 1977; Wellman, 1982). Our social networks expose us to innovations, new experiences and resources, and exert influence over our actions (Kraut, et al, 1998; Rice, et al, 1990).

Many of the people who use tele-centers are there because they can not afford to own a computer or pay for Internet access at home. People in poverty are less likely than others to have strong social ties with Internet users (NTIA, 1999, 2001; Pew, 2003; Gartner Group, 2001). For example, while the lower middle class in the United States has been adopting IT at greater rates than before, households below the poverty line do not show similar trends. In some cases, low socioeconomic status (SES) households do not have basic infrastructure (electricity, telephone) that makes personal computing or network connectivity even possible. People below the poverty line nonetheless may have affordable Internet access and support through community organizations serving their needs. As such, they have *weak* social ties with Internet users, including organization staff, volunteers, and other clientele (community action agencies, technology centers, public health clinics, charitable groups).

Low SES populations rely on trusted community organizations to help them access the wealth of network-based resources in the areas of education, health information and job training, as well as to access IT directly through public terminals and IT training opportunities at these sites. The staff and volunteers of these organizations also have weak ties to people in other community organizations (government, community college, university) with which they exchange resources and garner IT skills and knowledge. In essence, weak social ties bridge diverse groups and their members or clientele, linking people below the poverty line to information technology (IT) skills and knowledge throughout the much wider community. As people gain greater competencies in important domains (education, employment) and feel a stronger sense of control over their lives, their sense of self-efficacy rises. They learn hopefulness just as they learn helplessness, that is, through the outcomes of their efforts.

The basic premise of our research is that universal participation can be achieved for socio-economically disadvantaged individuals through weak social ties between them and Internet users in embedded and trusted local organizations serving their needs. At the same time, these organizations need Internet tools that allow them to become information producers as well as consumers, with greater capability for authoring and collaboration, in order to better serve their clientele.

3. Methodology: Participatory and Value-Sensitive Design

Our research uses value sensitive and participatory design to investigate sustainable models of universal participation (Carroll et al., 2001; Muller and Kuhn, 1993; Schuler and Namioka, 1993). We are investigating two primary questions, pertaining to the two populations of interest, that is, the user population and the staff and administrators of the tele-centers examined in the

case studies: 1) What factors affect Internet technology adoption and usage among tele-center users and 2) What factors affect long term sustainability of different types of telecenters (stand-along versus embedded in host organizations)? This paper presents findings from a larger study of Internet access, use and impact in periphery regions, whether in developed or developing countries.

Participatory design attempts to avert problems and find opportunities by involving users as early as possible in the design process. Value-sensitive design deepens and complements this concern by drawing our attention to the larger social structure around the technology. The essence of value-sensitive design (Friedman, 1997; Freidman, Kahn and Borning, 2003; Friedman, 1999) is to ensure that (1) *all* the stakeholders, direct and indirect, affected by the design are represented in the thinking about the design and (2) the range of potentially differing values held by these different stakeholders are uncovered explicitly as part of the design process. Direct stakeholders are users. There may be different kinds of direct stakeholders. In the current example, direct stakeholders may include both people currently without access to technology, and service-providers for those people. Indirect stakeholders include a larger group, such as the families of the people who gain access to the Internet, and the organizations that support or oversee the tele-center. Different kinds of direct and indirect stakeholders may have different ideas about how and whether the technology should fit life.

In an early examination of inner-city access to information technology in the US, Clark (1996) found that participants were most motivated by having access to information that would facilitate day-to-day problem solving, such as job banks and day care, yet this information was not readily available through the Internet. Because of the lack of useful content, inner-city users did not view Internet technology as useful, and thus had no desire to adopt it. A more recent study by Ervin and Gilmore (1999) found that African American students were more likely to report suspicions that the Internet and WWW were used to gain private information that could be used against them. Anderson et al., (1995) and Harmon (1998) found that low usage and negative attitudes even occurs among African-Americans with the means to own a computer. A basic human factors principle that could explain these data is that people will not use something that does not fit into their cultural view, does not meet their needs and expectations, or that is perceived as another means to maintain inequitable power structures. Harvey (1996), in an examination of Internet characteristics and content, emphasized the importance of using design models that account for gender, class, age, and geography in order to produce usable and meaningful information technology.

Although some research is functionally relevant, most approaches in traditional human-centered research are not ethnographic, and therefore are out of touch with the real day-to-day needs of the user. Bowman (1991) not only advises the use of community input into project planning and process, but also supports the use of indigenous interviewers and community consultants. Therefore, in each of the case studies described here, the researchers have worked closely with community stakeholders who are known and respected in the community and who are empathetic to the needs and capabilities of non-users. The individuals representing community stakeholders have provided advisory assistance during project planning and project implementation. The involvement of indigenous technology champions enhances participant involvement and facilitate data collection and interpretation of results.

Ethnography is a qualitative approach that has challenged researchers in human-computer interaction for at least a decade. Ethnographic research is not only qualitative, but is

experientially and contextually-based. The methodology is implemented in the context of real users in real environments and does not assign priority to quantitative features of data, but places value on all data reflecting user preferences, problems, needs, and skills. The major challenge to human-computer interface researchers has been in selecting and/or modifying existing qualitative approaches to incorporate into an ethnographic research design and in developing tasks and protocols that elicit useful human-centered concepts.

Ethnographic approaches are used in this research because they lend themselves to easily coincide with participatory design, and also with traditional human factors approaches to interface design, which involve the application of theories and models of cognition and perception and performance-based assessment. Since, in some cases, the target user groups consist of disadvantaged users or organizations addressing the needs of disadvantaged users, ethnographic approaches provide a means to communicate benefits of the research to participants as the project is implemented. Because researchers are involved and immersed in the users' environments, ethnographic research empowers participants to become agents of change.

4.1 Case Studies of Tele-Center Models

The evaluation design for all of the model cases is a basic case study, using mixed methods of quantitative and qualitative (ethnographic) techniques. The qualitative data includes interviews and review of records and reports. In addition to basic counts of participation and course offerings from office records, quantitative data include participants' questionnaires and registration data. The respondents are the individuals who came to the centers and took courses or other training sessions.

4.1 Stand Alone Model: Zahedan, Iran

We summarize here findings from an evaluation of the use and sustainability of the Zahedan Community Technology Center in Zahedan, Iran from data collected between July 2002-June 2004. The focus of the research is on the set up, management, center activities and clientele. Data for this study were collected by the author in collaboration with project directors, managers, and staff, using various methods, including, unstructured interviews, completed registration forms, self-report anonymous exit questionnaires by clientele of Internet training and use, site visits, project records and observation.

Zahedan (population one-half million) is the provincial capital of Sistan and Baluchestan (SB) Province located in southeastern Iran, on the border with Pakistan and Afghanistan, with substantial ethnic and religious minorities. The ZITC is a community organization unto itself with its own building in which the technology, related facilities and services (training, networking usage) take place.

The Zahedan Information Technology Center (ZITC) was established by the Science and Arts Foundation (SAF) with support from a two-year grant from the InfoDev program (July 1, 2002-June 30, 2004). The Zahedan ICT Center was established to serve as a demonstration project for taking ICT to remote and underdeveloped areas of Iran, by implementing a project designed to promote the use of ICT technology in the most deprived province of Iran. The Center sought to provide intensive ICT training, especially targeting youth and women, but also NGOs; teachers; government officials; city council members; and the business sector. The Center also sought to develop electronic learning materials (online tutorials and computer-disk based training

programs). These were meant to supplement or provide alternatives to face-to-face training opportunities (for businesses, government staff, university and high school students and teachers, possibly even the general public). The project further sought to promote ICT focused micro-enterprise and employment generating activities among women and youth, by establishing an e-shop to sell local women's handicrafts internationally—a demonstration project designed to address the high rates of unemployment among Iranian youth, who make up over 50% of the Iranian population of 60 million.

Zahedan (population roughly one-half million) is the provincial capital of Sistan and Baluchestan (SB) Province located in the southeast of Iran, on the border with Pakistan. Sistan and Baluchestan is the third-largest province of Iran (covering an area of 187,502 kilometers) and home to 11.4 percent of the country's population. It shares 1,700 kilometers of common border with Pakistan and Afghanistan, and stretches 300 kilometers along the Gulf of Oman. As a result of these borders there are ethnic minority and religious minority populations in the provincial population of 1.772 million. Sistan and Baluchestan Province has seven large towns – Zahedan, Chabahar, Khash, Zabol, Saravan, Iranshahr and Nikshahr.

4.2. Embedded Model

4.2.1. SchoolNet/The Math House, Iran

By contrast, SchoolNet in Iran is nation-wide network of public schools (grades 6-12 typically) providing internet access and teacher support through the leadership of the Science and Arts Foundation (SAF) and Sharif Univeristy in Teheran, Iran. In this paper, we focus on one case study within the larger network of schools in the SchoolNet network of schools, administrators and teachers.

With some guidance from SchoolNet and outside support from alumni, the public high school in Neyshabur, a large city in northeastern Iran, has established 'The Math House' where interested students can interact after school with teachers and other students who enjoy mathematics. The Math House is an after school program housed in a separate building supported collectively by the local public schools. It began with a small set of activities and infrastructure. Teachers and staff of the Math House take care of the computing equipment as part of their duties and responsibilities in helping to plan learning activities for participating students. As such, the equipment is an integral part of the larger organization.

With financial support from several alumni, the Math House equipped one of its rooms with computers and connected them to the Internet, for use by students and teachers as part of the after school math program. They used the computers to connect to math websites and tutors around the world (e.g., the "Math Forum" website with tutors that was initiated by Swarthmore College in Philadelphia, Pennsylvania, in the US, with support from the National Science Foundation).

4.2.2. Appalachia, United States

The New River Valley area of Virginia in the Appalachian region of the US followed an embedded model of technology integration in 1998-2000 with funding from the Public Telecommunications Facilities Program (PTFP) of the US Department of Commerce

(#510399231). Appalachia is one of the poorest regions of the US, with many residents below the national average in income and education. In many ways, it is a periphery economic region of the US, and is historically so. The locality within Appalachia of the US tele-center case studies investigated in this paper, is known as the New River Valley, named after its New River, which is known as the second oldest river in the world after the Nile. The New River Valley area (NRV) comprises four rural counties, one city and two towns, and a population of about 175,000. It is also the home of the land grant university, Virginia Tech in the town of Blacksburg as well as the community computer network known as the Blacksburg Electronic Village (BEV) which serves not only Blacksburg with Internet based information and related resources, but the surrounding Montgomery County, and to a lesser extent the NRV area.

The author, in collaboration with other researchers and network experts at Virginia Tech, spent a full year of planning prior to purchasing and installing equipment at various localities in the NRV in order to identify and cultivate relations with community organizations that are trusted and frequented by the target population (i.e., underrepresented or disadvantaged, lower SES residents of NRV). Ultimately, we collaborated with the local area offices of the Community Action Agency (New River Community Action Agency or NRCA) and the Appalachian Women's Alliance (AWA), and the public schools districts of Floyd County (in NRV) and neighboring Smyth County. We also collaborated with the New River Public Health District (NRPHD); however, we do not discuss NRPHD in this paper since NRPHD doctors and nurses, including those in rural clinics, rather than residents were the primary users of the computer networking equipment purchased and installed under the Commerce Department grant. Our focus here is on citizens' use of information technology. Nonetheless, there is a link between the public health districts and the public school districts, since many of the nurses in rural public health districts serve as school nurses in area public schools (as is the case in the NRV).

Almost one-fifth (17.8%) of the population of the NRV (over 29,000 individuals) was living in poverty according to the US Census data published in 2000. This is well above the state average (9.6%) and the national average (12.4%). Over half (56.1%) of female-headed households with children under the age of 5 years live in poverty. This is also well above Virginia rate of 40.7% and the US rate of 46.4%. The actual *number* of female-headed households with children under the age of 5 years in poverty has increased 70.5% since 1990. Almost a third (30%) of students are approved for free or reduced lunch in the 4 rural NRV counties. More than a fifth (21.7) of the total NRV population has less than a high school education. Over a half (51.7%) of the total population has a high school education or less. The vast majority (91.7%) of the population is white; only 4.1% is Black, 1.3% Hispanic, 1.2% two races. The National Institute for Literacy (1998) estimates that there are about 20,000 people in the New River Valley area who are functionally illiterate. In Montgomery County, home of land grant university Virginia Tech, an estimated 19% of the population is functionally illiterate. Adjacent Floyd County, an estimated 14% of the population is estimated to be functionally illiterate.

Floyd County covers 383 square miles of rural rolling hills. There is only one stoplight in the entire county. Transportation issues remain one of the strongest barriers for people to overcome in seeking out services or opportunities. In this bedroom community, the Floyd County school system is the largest employer. The last remaining

textile plant closed in 2000. Almost half (46%) of the population does not have a high school diploma or Graduate Equivalency Degree (GED). In 2000, unemployment was estimated at close to 4%. Almost half (45%) of the population was working 'out of county.' Overall population was about 13,000 – with roughly 300 of the 13,000 being members of the Hispanic community working at tree nurseries and other farms.

The Appalachian Women's Alliance (AWA) with a main office in Floyd County and a satellite office in distant Dickenson County, is a grassroots coalition of low-income and working women from six states who organized in 1993 to achieve a greater impact for Appalachian women on local, regional and national levels. The AWA includes black, white and Cherokee, wage earners and welfare mothers, rural and urban, with and without traditional education. AWA programs serve to empower and encourage self-determination for women in low-income and disenfranchised Appalachian communities in Virginia, West Virginia, Kentucky, Tennessee, Ohio and North Carolina. Priority issues are violence against women, economic justice for women and children, and dismantling racism in Appalachian communities. Dickenson County has approximately 16,000 people and is the most depressed county in VA.

With support from the US Department of Commerce in 1998-2000, as part of a larger project, we assisted the public school districts in Floyd county (in the NRV area) and Smyth counties, the Smyth county Community Action Agency (called Mountain Community Action Agency) and New River Community Action Agency (NRCA) and the Appalachian Women's Alliance (AWA) in planning for, purchasing and setting up public access computers, printers, and overhead projectors. For the two community action agencies, which encompassed five counties, we set up their public access networked computer and printer in their "family resource rooms" at each of the five county sites. We chose the family resource rooms as the locations for the networked computer set ups because these rooms were already being used by parents of Head Start students in the building, and disadvantaged members of the community who came to the community action agency in the community for social service support (food bank, clothes bank, meetings, emergency loans, etc.). We also worked with each locality to integrate and upgrade their local area network (used for ongoing office operations) and the computer network connection in the family resource room to a broadband connection that they had agreed to support financially in the coming years.

While we do not have Internet adoption and use rates for the NRV area beyond Blacksburg and surrounding Montgomery County, we believe it compares closely to the larger US population. That is, despite increased adoption rates among lower SES populations in recent years (Cooper, 2000; NITIA, 2000; Pew, 2003) according to Pew studies of low SES population and internet use in 2003, almost a quarter (24%) of Americans had never tried the Internet and often did not know many people who had ever tried it (Pew, 2003). A minority of non-users had chosen not to use the Net, or had tried it and quit, or who used it intermittently; but the majority (69%) of non-users, are what Pew calls the "truly unconnected." As a group, the truly unconnected have low incomes: 43% live in households that earn less than $30,000 a year, and 29% live in households earning less than $20,000 per year. The majority (74%) have a high school education or less, and are white (75%). The truly unconnected tend to be older (62% are over 50) and more than half (59%) are female.

The truly unconnected are less likely than Internet users to have strong social ties (close friends or family members) with anyone who goes online (Pew, 2003). Among Internet users,

only 4% say they do not know anyone who goes online. Conversely, 56% of the unconnected say very few or none of the people they know go online; and 25% say none of their close friends or family is online.

5. Results

5.1. Stand Alone Model: Zahedan Internet Technology Center

The immediate main goals of the Center, as specified in the InfoDev grant award, were met, particularly in terms of setting up the center and conducting the training program. The Center was established and operated with at least 40 participants per month for the bulk of the grant period (2003-05). The project also developed a web-based tutorial (e-learning program) and produced compact discs (CDs) with eight technical content areas, as planned. The Center overcame changes in personnel without much difficulty as far as course offerings and general Center operations were concerned. Common problems, unrelated to changes in personnel, were fairly minor, such as getting training materials photocopied in a timely manner. The electronic commerce (e-shop) goals of the project were not achieved as originally planned, however, as it was not possible to secure a partner organization (such as a bank) for financial transactions.

The participants in the Center training program were for the most part 'early adopters' of computer networking. As such, they came to the Center largely by word of mouth through their social networks of family, friends and acquaintances, including teachers. However, to continue to recruit new participants over time, it is worrisome that the questionnaire responses suggest that advertising has not been reaching very many people who then register for classes. This is an area of activity that will need to be strong in the future to sustain the Center.

From the completed questionnaires, we know that participants were most interested in using the Internet for general information and email, not unlike most Internet users throughout the world. Also of high interest was online information needed for employment opportunities, and to a lesser extent, education. Since most educational institutions (notably, high school or university) do not require or even expect students to use computers or the Internet, it is possible that this is why 'educational requirements' was not a strong motivating factor for attending training classes, even among students. Nonetheless, more than a third of respondents report that demands of their job (or a potential job) are motivating factors for taking training courses at the Center.

The lowest categories for interest in using Internet include relations with family, playing online games, and online commerce. Presumably family relations are generally maintained face to face, and are already fairly strong (being a developing country this is generally the case). Interest in using the Internet for games may be low due to the typically slow speed of Internet connections. It is difficult to play online games with slow connections. Online commerce is generally not well developed for actual purchasing transactions, due to the lack of a credit system in Iran.

The ZITC project demonstrated some replicability through the establishment of satellite centers throughout the rest of the Sistan and Baluchestan Province. The original goal of the project was to address the need to expand beyond the capital city of Zahedan into the more remote and underserved areas. Chabahar, a free trade zone, was identified by government officials as a high priority location for setting up a similar program. In

response to this priority, youth and resource persons from Chabahar were specifically targeted for training activities at the ZICT Center. At the end of year one of the program, when devising a detailed sustainability plan, SAF, in collaboration with key stakeholders at the local level, the Zahedan ICT Center Board of Trustees, and the Municipality of Chabahar developed a plan for implementing a satellite training center in Chabahar. Chabahar municipality has since met this goal, primarily due to the heavy business orientation of the area as a free trade zone. Attempts to establish several other stand alone tele-enters throughout the province have not fared as well.

In 2005, the long-term sustainability of the stand alone Zahedan center looked reasonable, as there were investments forthcoming or already contracted with several government ministries for short term computer and Internet training. However, by 2008, the training center was struggling. The additional opportunities for growth included the possibility of the Center serving as an Internet Service Provider (ISP) in the city of Zahedan, but that has not materialized. Another potential revenue stream was to serve as a point for outsourcing programming and database management tasks from the Science and Arts Foundation and Sharif University. The Center applied to the Ministry of Telecommunications for an ISP license, and was prepared to comply with all necessary requirements, such as firewall and other filtering recently imposed by law. However, this option has also not materialized. While the City Council of Zahedan was a committed stakeholder in the Center through early financial contributions, this support has been primarily short-term.

The key areas of extra effort toward sustainability originally were to secure not only government contracts for training, but also contracts for training in the private sector (i.e., local businesses) through aggressive advertising and other promotional opportunities, such as trade fairs and business marketing conferences. In addition to supporting its ongoing operations as a training center for courses conducted over several weeks with a commitment from participants, it was originally conceived that the Center might be able to act as a kind of Internet Café for casual users willing to pay for Internet access. These activities, together with the outsourcing of programming and knowledge management tasks from stakeholders, are reasonable initiatives for longer-term sustainability. However, none of these have materialized as of 2008.

5.2. Embedded Models

5.2.1. The Math House

The data collection for The Math House has been limited to site visits, observations and interviews intermittently over a period between 2001 and 2008. The Math House programs for after school mathematics and network connectivity grew between 2001 and 2008 to multiple rooms and many students. Eventually, the Math House purchased adjacent land so that it could expand its after school program to a summer program for young students of mathematics (elementary school level). Approximately 100 elementary school students participated in the summer program of several weeks in 2007. Long after the alumni had made donations of computer equipment and network access, the Math House computer lab was thriving and bustling with users throughout the summer period as well as the school year (after school). The Math House had upgraded

its computers and connectivity to the Internet with its own funds, and funds contributed by participating schools through municipal government.

5.2.2. Appalachia, US

The New River Valley area of Virginia followed an embedded model of technology integration beginning with funding from the US Department of Commerce (with leadership by the author). The participating organizations included the public health district of the New River Valley (PHD NRV), the The New River Community Action Agency (NRCA) and the Appalachian Women's Alliance (AWA), Smyth and Floyd County public schools.

Mountain Community Action Agency (serving neighboring Smyth County) and New River Community Action (NRCA, serving the NRV region) integrated networked computers into their family resource rooms at five county sites. Clientele used the public access computers in the resource rooms to augment their regular meetings with online information, parent teacher conferences (for Head Start programs on site), casual drop-in access to the Internet, and continuing adult education. At the Floyd County Community Action Agency, a single computer in the family resource room grew by 2007 into a small computer lab with Internet connectivity where, since 2006, it has been holding computer classes for adults with low reading literacy.

The Appalachian Women's Alliance (AWA) installed a similar set up as NRCA family resource rooms at two sites that are separated by several counties across Appalachia: the AWA headquarters in Floyd county, and a satellite office in Dickinson County, Virginia. The networked computer/printer/projector system that was installed in 2000 led to a doubling of the number of women participating in training and workshops offered in face-to-face settings by AWA. AWA sites (Floyd and Dickenson Counties) also used the system for distance learning content available over the Internet (GED, computer courses, community college and university courses, etc.). In 1999, the Women's Alliance office in Dickinson County was offering computer classes with 8 computers, one (borrowed) printer, and no network connection for about 15 people (mostly low-income women on welfare). In conjunction with installing the upgraded and networked computer system in 2000, the AWA office in Dickinson County opened up their playground for kids from the nearby elementary and middle/high schools, and supervised their access to the computers. Since 2000, AWA has continued to offer diverse program opportunities through the networked computer, including informal distance learning (e.g., GED classes, healthcare information) that are very helpful to the community and attracted a growing number of women seeking computer-based job skills and related educational resources. The AWA sites have grown from a handful of women who were able to commit to a 10-week computer class at the center, to a full-time community center, with expanded services, open 5 days a week run by the Women's Alliance office.

Smyth and Floyd County public school districts leveraged the small number of computers and network infrastructure that the grant provided to grow their distance learning and adult education programs; outcomes as of 2006-07 included:

- Double the number of graduates from Smyth and Floyd County GED programs (from 150 to 300 per year in each county);

- Double the number of graduates from Smyth and Floyd County general continuing education program (from under 100 to over 200 per year);
- Double the number of curricular offerings in advanced vocational programs and information technology for at risk youth enrolled in 'Career and Technology Centers,' (formerly the vocational education school) of both Smyth and Floyd counties.

6. Conclusions and Directions for Sustainable Universal Access

The case studies here illustrate a pattern that is not unique to these cases. That is, stand alone tele-centers are more difficult to sustain over a long time frame, especially after grant funding ends. Such tele-centers often close or evolve into a different form of financial support and management than their original design. It is simply very difficult to build regular revenue streams as not-for profit Internet Technology centers. While the Zahedan Internet Technology Center illustrates this case very well, it is not atypical of other stand alone tele-centers throughout the developing world.

Embedded Internet access, on the other hand, does not depend on completely new revenue streams to maintain equipment and connectivity. While outside funding may have offset the costs of initial equipment and connectivity, the ongoing activities of the organization in which they are hosted typically helps to support the cost of maintaining (even replacing and upgrading) the equipment and the costs of Internet connectivity. The cases presented here of SchoolNet and the Neyshabur Math House in Iran and of New River Community Action Agencies in Appalachia (and across the US) illustrate how and why long term sustainability of embedded Internet access is greater than stand alone center.

In addition to integrating equipment and Internet connectivity in existing community organizations such as schools, mobile telephone service offers potential for individuals to gain access to computing and Internet resources, especially in rural areas where electricity supply and telecommunications infrastructure are poor. Mobile communication infrastructure has been extending to previously underserved regions with voice, data and even Internet services. Further, mobile phone technology is often more affordable and a simpler technology to learn and use for people with low computer literacy and lack of Internet access. The mobile phone has the potential to act as a bridging (or scaffolding) technology in this learning process because people with low computer literacy, especially in developing countries, are more likely to own a mobile phone than a personal computer (Schement & Forbes, 2000; ITU, 1995-2004). There are currently more mobile than fixed phones in many developing countries, simply because fixed phone service and infrastructure has been under-funded by many governments for decades (ITU 1995-2004).

In a project to leverage existing technology use in Malawi, Africa, Glasson and Evans (2007) are investigating the facilitation of connections among community elders, primary school teachers, and science teacher educators using mobile phones (Tinker et al., 2007) and Web 2.0 technologies (Anderson, 2006) to learn about sustainable agriculture. In Malawi, the host country for the project, past research has shown that elders are a valuable source of knowledge for schools and villages (Glasson, 2006, 2007). However, this knowledge has not been systematically connected to the school science curriculum, due to social and technical barriers. An important goal of the primary school curriculum in Malawi is for children to learn from elders in the community; the researchers are

interested in how mobile phones and Web 2.0 technologies (blogs and wikis, instant and text messaging) could be used to establish and nurture social connections.

As most primary schools in Malawi have limited access to electricity and landline telecommunications, the potential for using mobile devices for educational purposes to access and create information is immense. For example, in the year 2000, Malawi had 49,000 cell phones in use and by 2004 the number increased to 222,100. Mobile phones are being explored as a platform for delivery of instructional multimedia (Evans, 2007, 2008) and for addressing the digital divide (Jones & Marsden, 2006) in developing countries. Thus, mobile smart phones are potentially a viable candidate to establish and maintain communications, access computer networks, and produce and deliver multimedia (Giulio et al., 2007).

In our testing of these and similar findings and claims for Appalachia we have been using primarily qualitative techniques, including appropriate protocols, observation, archival records and interviews with users (and tele-center managers and stakeholders). Our direction for future work is to investigate how low computer literacy groups use prior knowledge and experience to learn new tasks of computing. We are collecting data from a pilot study comparing populations with and without experience with mobile phones, how new users of desktop computers manage (and talk out loud about) basic computing tasks that we ask them to do. In addition to standard design and usability testing, such as timing a task, checking for accuracy and tracking clicks and drags on both mobile phones and laptops or desktop machines, we are looking for the mental models and metaphors that they might invoke as they work, either out loud or through recall in exit interviews.

Finally, we suggest various regulatory policy and private investment implications as well as technology design modifications that help to support mobile phone use among low literacy groups in periphery regions.

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

If the desktop computer had touch screen, for example, the differences in the mental models between the mobile phone and desktop computer would be less, making it easier for people with low literacy to use a desktop computer more effectively. The more accessible the desktop computer is to low literacy groups, the more people within their social network adopt it, and become available through desktop computing, thus, increasing the value of using such technology in order to communicate with members of their social network. A variant of this design direction toward a touch screen desktop computer (or public kiosk type) is that the networking capabilities of the mobile phone extend so far into the domain of the desktop computer (with electronic mail, web

browsing, etc.) that mobile phone users do not need to make hardly any mental or physical transition from mobile telephone to desktop computing.

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

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