Understanding and Rethinking Shared Access

How People Collaborate and Share Knowledge and Technologies in Ghanaian Cybercafés

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ABSTRACT

In many low-income countries, where computer ownership and home and business internet access is rare, public access venues, especially in the form of business-operated cybercafés, are how most people access computers and the internet. This form of public access is often viewed as having been born of economic necessity and considered to be a second-best alternative when compared to private, individualized access. In this study, we interrogate this assumption, finding that public access can support forms of collaboration and knowledge sharing that enhance learning and productivity and offer rich opportunities for interaction and co-work. In this way, public shared access is not necessarily second-best to private, individualized connection, but may, in some contexts, be a preferred access method. In order to better understand the forms of collaborative co-present sharing in cybercafés, as well as the advantages and disadvantages associated with this sharing, we conducted a survey of users in two cybercafés in Accra, Ghana. Survey results reveal that public access enables forms of sharing and collaboration among patrons that range from the most simplistic (such as asking a café employee a quick question), to the more formalized (such as meeting business partners and working together around a single computer), to the fleeting and voyeuristic (such as glancing at a stranger's computer screen and noticing an interesting website). Contrary to the belief that resource constraints drive public shared access, the participants surveyed who do share computers highlighted the learning benefits of working together much more frequently than the economic grounds for sharing. Following these surveys, we designed a system to promote opportunities for co-located sharing and collaboration between users at an internet café.

KEYWORDS

public access, information and communication technologies, ICT, ICTD, ICT4D, cybercafés, internet cafes, Ghana, knowledge sharing, collaboration

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EXECUTIVE SUMMARY

In many African countries, where computer ownership and home and business internet access is rare, public access venues, especially in the form of business-operated cybercafés, are how most people access computers and the internet. Thus, public shared internet facilities are particularly important in low-income settings, such as those found in Africa. This form of public access, especially in these low-income settings, is often viewed as having been born of economic necessity and considered to be a second-best alternative when compared to private, individualized access. In this study, we interrogate this assumption, finding that public access can support forms of collaboration and knowledge sharing that enhance learning and productivity and offer rich opportunities for interaction and co-work. In this way, public shared access is not necessarily second-best to private, individualized connection, but may, in some contexts, be a preferred access method.

This study is comprised of two interrelated research activities.

First, in order to better understand the forms of collaborative co-present sharing in cybercafés, as well as the advantages and disadvantages associated with this sharing, we conducted a survey of users in two cybercafés in Accra, Ghana. The basic research method was a structured survey administered to 150 café customers, and our findings are the result of summary and multivariate statistical analysis.

Following these surveys, we designed a system to promote opportunities for co-located sharing and collaboration between users at an internet café. Called BusyBoard, the system was created to support online content sharing between peers located in the same physical space—with the hope that such a system could spur connections and reveal opportunities for café customers to interact and work together. BusyBoard allowed users of the café's workstations to share text, images, and web pages with others who were also present at the venue. Two large television monitors mounted in the café displayed, in real time, a rotating slideshow of the posts shared by users. Moreover, all of the posts were accessible to users connected to the café network for viewing via a web browser. The system offered no guidelines or restrictions on what users could post, aside from some simple controls for café staff to remove inappropriate material.

In addition, we explored the feasibility of using video recordings to assist us in understanding user behavior in these venues. We created a prototype system that automatically analyzed a video stream to identify instances of collaboration. The video was recorded from an overhead camera mounted in the same Ghanaian cybercafé where BusyBoard was installed, and stored on a local computer. Our application then performed an analysis on these recordings and presented the user with an annotated video of the events. The annotated video might track individual users within the frame or highlight motion occurring in the scene. Beyond analysis of the video already collected from an overhead camera, we do not plan for further work in this area.

We find that public access enables forms of sharing and collaboration among patrons that range from the most simplistic (such as asking a café employee a quick question), to the more formalized (such as meeting business partners and working together around a single computer), to the fleeting and voyeuristic (such as glancing at a stranger's computer screen and noticing an interesting website). Contrary to the belief that resource constraints drive public shared access, the participants surveyed who do share computers highlighted the learning benefits of working together much more frequently

than the economic grounds for sharing. After a three-month deployment of the BusyBoard system at a cybercafé in Accra, Ghana, we observed that users predominantly posted commercial advertising. The system's design may influence this use, but nonetheless, the use exposes a desire for advertising opportunities to reach the café's clientele.

Based on the results of this study, we strongly believe that there is a need to develop information and communication technologies and applications that support collaboration and group work in shared internet access venues, as the existing technology in the cybercafés we studied is designed primarily for single-user scenarios. Our survey results suggest that café visitors would be interested in using the computers in new ways that support collaboration among them. The great majority of the respondents indicated that they would like to participate in collaborative group work at the café. Thus, beyond the BusyBoard system we have already developed, we see much potential for other collaborative applications and workspace architectures to be designed and deployed in these settings.

INTRODUCTION

In many African countries, where computer ownership and home and business internet access is rare, public access venues, especially in the form of business-operated cybercafés, are how most people access computers and the internet. Thus, public shared internet facilities are particularly important in low-income settings, such as those found in Africa. This public access, especially in these low-income settings, is often viewed as having been born of economic necessity and considered to be a second-best alternative when compared to private, individualized access.

In this study, we interrogated the above assumption by asking: Does public access support forms of collaboration and knowledge sharing that enhance learning and productivity? And in this way, is public shared access not merely a second-best alternative to private, individualized connection, but a preferred access method in some contexts?

We hypothesized that both explicit and implicit collaboration occurs among co-present internet users—at times intentional and purposeful, while in other cases accidental, fleeting, or voyeuristic. Furthermore, we hypothesized that the desire for working in groups is common at these venues, and that such opportunities greatly support learning.

Additionally, we conducted design experiments to better understand how technologies could support co-present collaboration between users. In this report, we describe the initial observations of a system we developed, BusyBoard, which allows users in a cybercafé to share online content with each other, and which was deployed in one of the cybercafés where our surveys were conducted. Key questions underlying the BusyBoard experiment included the following: 1) Can we motivate people to talk to each other, taking advantage of the fact that they're co-located while using computers? 2) Would people use BusyBoard to communicate with other cybercafé patrons, including people they did not know? 3) Would people look at the BusyBoard display, tapping into the voyeuristic value of cybercafés that featured prominently in our initial survey results?

We also explored the feasibility of using video recordings to assist our aim of understanding user behavior in these venues. We created a system using video recordings to automatically analyze a video stream to identify instances of collaboration.

LITERATURE REVIEW

A few prior studies have examined how information and communication technologies, knowledge, and equipment can be shared among collocated individuals in schools and public venues. See Best (2008) for a larger review.

Device Sharing

The telephone is a widely shared communication technology in many parts of the world, and a number of researchers have examined the dynamics of phone sharing. Very recent work has focused particularly on non-commercial sharing of individually owned mobile phones, where friends, family, or co-workers share handsets or phone credit (Best, 2010; Mwesige, 2004). Additional studies have examined commercial forms of phone sharing, such as at public call offices, where entrepreneurs sell time on a publicly accessible telephone (Best, 2008). A famous example of this form of commercial phone sharing is the Village Phone Operator model made particularly notable in Bangladesh through the Grameen Phone network (Bayes, Braun, & Akhter, 1999; Burrell, 2010).

An ethnographic study of intermediated technology use in Bangalore, India, also explored device sharing. It cited fear of technology, lack of literacy or technical skills, habits of dependency, cost, and access constraints as some factors motivating intermediated interactions (Sambasivan, Cutrell, Toyama, & Nardi, 2010). While technology use in cybercafés is not always intermediated, we note that some of these motivations are echoed in our observations in the cybercafé setting.

Computer Sharing in Schools

Sharing of computer equipment among students is ubiquitous, especially in low-income settings. For instance, a survey on classroom computer use within four different states in India noted that, “during 28 field observations, we found no cases where only one child was at a single computer terminal. At times, as many as 10 children grouped around one computer” (Pal, Pawar, Brewer, & Toyama, 2006). This computer sharing is not just an outcome of resource constraints; it also stems from social and pedagogical motivations. Indeed, as we will see, even outside of classroom settings, such sharing can enhance communication, collaboration, and learning.

Technical innovations have been developed to enhance the educational outcomes that arise from collocated computer sharing in schools. In 1998, computer scientists studied how students “collaborate via a shared computer with a single shared display and simultaneous use of multiple input devices” (Stewart, Bederson, & Druin, 1999). The computer setup, which enabled co-present users to collaborate, was called Single Display Groupware (SDG). In a four-week controlled experiment, elementary school students were randomly asked to do similar tasks in either a single-input device condition, or an SDG setting with two mice. The majority of the students (85%) found the shared-use setup easier, and at the same time, all but one student found the shared use more fun.

Similarly, Microsoft Research developed a system in which multiple mice are connected to a single computer (Pawar, Pal, & Toyama, 2006). Each mouse controls an individual’s uniquely colored cursor on a single shared screen. In one experiment, Microsoft compared learning levels in an English language-retention task between students individually operating a standard computer and groups of students using a single-display, multiple-mouse system. It was found that students using the “multimouse” configurations performed equally well as those using single-user systems for this retention task. Moreover, in some cases, the multimouse systems resulted in enhanced learning outcomes, for instance

amongst boys when they were required to collaborate on the learning activity (Pawar, Pal, Gupta, & Toyama, 2007).

Computers and the Cybercafé

A few studies have helped to identify the importance of public shared computer facilities, especially in low-income settings. For instance, a survey of 280 small and medium enterprises (SMEs) conducted across 14 African nations found that more than half the respondents reported the internet as either important or very important to their business, but that only 18.7% of responding enterprises had direct access to the internet (Stork & Esselaar, 2006). This dramatic access gap among SMEs is closed in most cases through the use of cybercafés and other shared access facilities. Of those respondents who did not have direct access to the internet, 72% were able to use cybercafés for some access.

Adding to our understanding of the importance of cybercafés in these African settings, studies have also examined the general flow of activities and patterns of use in African cybercafés, as well as the general rise of a cybercafé culture (Foster, Goodman, Osiakwan, & Bernstein, 2004; Furuholt & Kristiansen, 2007). For instance, one series of papers has focused specifically on a set of Nigerian cybercafé case studies (Adomi, 2007; Adomi, Omodeko, & Otolo, 2004; Ajuwon, 2003).

A limited number of studies have examined the forms of collaboration and learning that occurs in cybercafés. For example, Sairosse and Mutula (2003) noted that people often chose internet cafés because they offer some form of IT training. Similarly, Haseloff examined Indian cybercafés, which "can function as a center for support, education and learning about new tools and therefore could help people overcome skill deficits which would normally exclude them from access to new technologies" (2005, p. 55). Researchers studying cybercafés in both Asia and Africa noted that many people gained IT knowledge there. In a cybercafé in Yogyakarta, Indonesia, 66% percent of the respondents stated that they learned IT skills from friends, while 23% learned from the café's staff. In a Tanzanian study, respondents tended to ask for help from the staff. Altogether, 44% learned IT skills from the staff, while 29% asked for help from their friend (Burrell, 2009).

Burrell has conducted a multi-year ethnographic study of Ghanaian cybercafés (including research at one of our field locations, Busy Internet). She has noted ways in which cybercafés became shared spaces for creating face-to-face relationships. "For youth in groups, visits to the internet café served as a way to build social cohesion within peer groups, as well as to establish individual status and roles" (ibid., p. 164). In a book-length examination of her ethnographic studies, Burrell prefigures many of our findings, as well as underlines the importance of group social dynamics beyond the individual alone:

> In shared and public access settings, such as the internet café, where two people are often seated together before the screen speaking with one another in person while they travel online, where a user may peek at other adjacent screens, and where a nosy or helpful internet café operator might direct use, the narrow focus on the isolated user contending with the machine interface alone is more apparently unsuitable. (2012, p. 19)

Designing Workspaces for Collaboration

Many prior studies have addressed the problem of designing workspaces that use technology to facilitate collaboration. These studies considered the issues present in the status quo, such as observations about how students collaborated with their classmates based on their position relative to the computer (Pal, Pawar, Brewer, & Toyama, 2006), and designed technologies to address them. Many workspaces in which collaboration occurs are already designed with expected interactions in mind

(Fruchter, 2004). Similarly, as work by Voida et al. (2008) suggests, it is important to look beyond individuals' behaviors and consider how we can use our observations about the space in which collaboration is occurring to further improve our understanding of collaboration and how we can support it.

Burrell, however makes clear how many shared internet venues are actually architected in ways that discourage and inhibit sharing, noting that:

> The typical arrangement of machines in the internet café lined up side by side along the walls usually left users antisocially positioned with their back to the center of the room. Furthermore, the minimalism of these small internet cafés featuring only machines and chairs in a 1:1 ratio and no additional table or seating space offered limited support for extraneous social engagement and interaction. (2012, p. 33)

Video-based Analysis

While we know of no prior work using video-based analysis to study collaboration in public internet venues, a number of researchers have developed technologies that are appropriate to this problem and setting. Romero, Summet, Stasko, and Abowd (2008) presented a method of visualizing video streams collected from overhead cameras by using low-level computer vision to generate a short summary of a video, in the forms of sequences of stationary images called "keyframes," or of moving images called "video skims." This summarization, known as "video abstraction" (Truong & Venkatesh, 2007), allows analysts to quickly look through an entire video stream and then choose specific frames for further study without needing to do a frame-by-frame search for changes in the video. Beyond summarizing and visualizing video using computer vision techniques, Counsell and Puybaraud (2006) showed that it is possible to monitor, record, and store contextual knowledge in order to automatically provide a working environment adapted to the needs of each user or group of users.

METHODOLOGY

This study is comprised of two interrelated research activities, along with a third mini-study: User surveys conducted at Busy Internet and First Page Internet Café and the design and deployment of an online content sharing system at Busy Internet comprised the main research, while the development and piloting of a computer application designed to analyze video recordings of user behavior at Busy Internet was our mini-study. The results from the user survey shaped the design of the BusyBoard and video tools. A description of the two study sites and three activities follows.

Busy Internet
Busy Internet was founded in 2001 with the mission to help transform the local economy to meet the opportunities of the digital age. Busy (as it is commonly called) is situated on a 14,000 square-foot plot in one of Accra's busiest commercial areas. It currently has 68 computers available for use, as well as a 27-seat, Wi-Fi-enabled lounge for clients who visit with their own laptops. Busy Internet also offers secretarial services, digital copying and printing, scanning, binding, and laminating. In addition, the company provides for rent, in its business incubator, ready-to-use office space that is equipped with broadband internet, fixed telephone lines, air conditioning, and furniture.

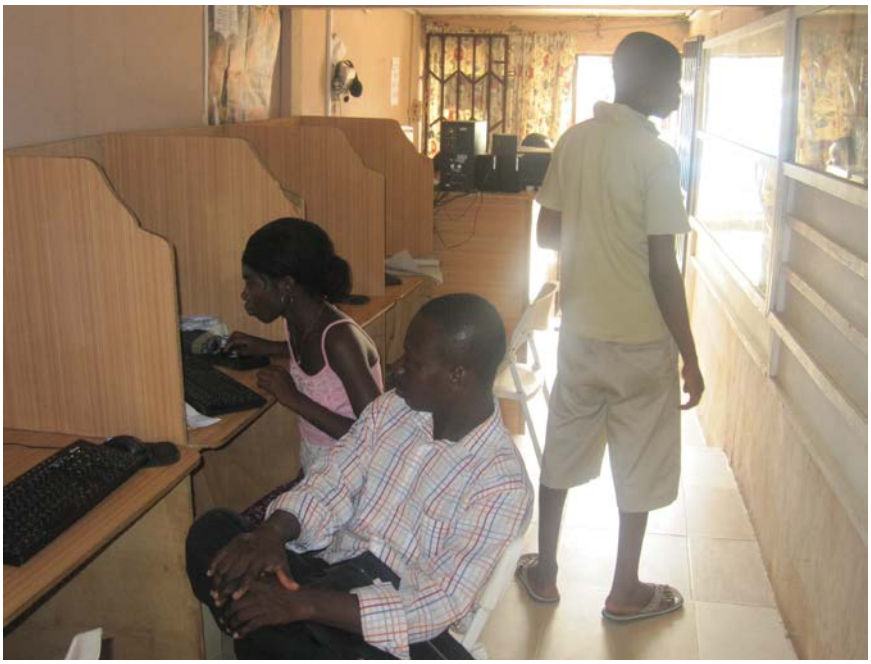
In many ways, Busy Internet is not a typical Ghanaian cybercafé. It is the largest and has the highest profile in the country, and it is known for a high quality of service and fast internet connections. While typically African cybercafé users are more educated and better off than the general population (Mwesige, 2004), this is especially true at Busy, due to its higher prices and enhanced service.

Figure 1: The main computer work area at Busy Internet

First Page Internet Café

In order to gain comparative leverage and control for the unusual properties of Busy Internet, we selected another cybercafé to survey. First Page Internet Café is a small, family-owned café in the peri-urban outskirts of Accra. First Page differs from Busy Internet in many ways. This café is much smaller, offers a lower cost of access, and is less centrally located, situated in the Ga West District about 10 km outside of central Accra. First (as we shall sometimes call it in this report) has nine relatively obsolete computers, a printer, a server, and a scanner. It is family-owned and -operated, and it caters almost exclusively to local community members. In addition to basic computer and internet access, First offers video rentals and some mobile phone services.

Figure 2: The First Page Internet Café



Survey Design and Implementation

The basic research method was a structured survey administered to café customers, and our findings are the results of summary and multivariate statistical analysis (preliminary survey results are described in Best, 2010; Best, Kollanyi & Garg, 2012).

Seventy-five participants were interviewed in each of the two venues, for a total sample size of 150. Participant recruitment and interviews commenced at Busy Internet on October 5, 2009, and were completed on November 19, 2009. Work began at First Page on December 15, 2009, and ended on February 5, 2010. All activities were conducted on weekdays, Monday to Friday, between the hours of 10:00 am and 7:00 pm. Although Busy Internet is open 24 hours a day, due to this research design, we have no data regarding nighttime users and weekend visitors. The participant sample was established through a simple recruitment protocol: A research assistant was positioned at the entrance of the café. If he (our research assistants were male) was not already engaged with a potential participant, he stopped and asked every entering or exiting customer who appeared to be of majority age if they would be willing to participate in a survey regarding their experiences in the café. If the person agreed, they

were brought to a space reserved for the interview and led through an informed consent procedure. The study interview usually took between 45 minutes and one hour to conduct. The respondents received 1.5 (at Busy) or 2 (at First Page) hours of free internet access as compensation for participating in the study, and they could stop the interview at any time.

Our questionnaire consisted of 72 questions. We asked almost no open-ended questions. Nearly half of the questions focused on respondents' visiting habits and their computer and internet use in the café. We asked respondents to rank and group the most important activities they engaged in when visiting the café. We also asked questions about computer sharing and various forms of collaboration in the café. We ended the questionnaire with a block of questions regarding digital literacy and a brief demographic section.

BusyBoard Design

Following on the findings from these two surveys, we designed a system that we hoped would promote opportunities for co-located collaboration between users at an internet café. Called BusyBoard, it allows for online content sharing with peers located in the same physical space. The Busy Internet café, described above, offers internet access via approximately 70 fixed workstations arranged in rows within a single room. Our system allows users on these workstations to share text, images, and web pages with other users in the café. In real time, two large television monitors mounted on walls at each end of the room display a rotating slideshow of the posts shared by users. These monitors are visible to users of the workstations, as well as to other visitors in the café's lobby. Additionally, the system is accessible to users connected to the café network for viewing via a web browser.

As is further detailed later in this report, our surveys yielded a number of interesting results. Given the basic impetus from these results that café visitors would be interested in using new technologies that support collaboration, BusyBoard is specifically inspired by both the finding that users would like to participate in collaborative group work in the café, and that they reported glancing at strangers' screens in a form of voyeuristic sharing. This led us to conceptualize a system in which users could explicitly choose to share online content with others, and make it easy for others to view the shared content from their individual workstations in the cybercafé. We hypothesized that such a system would improve the cybercafé experience by providing an online venue for knowledge sharing. Our initial concept envisioned a system that would encourage the best forms of collaboration and sharing by allowing strangers in the café to learn about shared interests among the users, and to find ways to connect in person and in real time.

Note, however, that BusyBoard does not aim to address all of our survey results; for example, this system is not designed with facilitating learning as a primary goal, nor does it aim to motivate the physical sharing of a single computer. We believe that these other issues can be separately addressed in future projects.

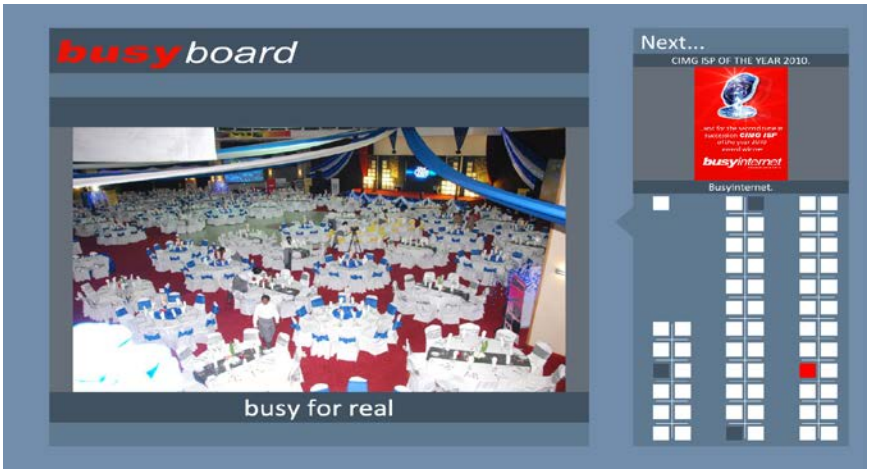
With this initial concept, BusyBoard was designed with three primary considerations in mind. First, in order to take advantage of the fact that users are co-located within the same room, location is strongly emphasized in the user interface. Any time a post is displayed, the workstation it was submitted from is highlighted on a map of the café. We hypothesized that this physical context might motivate users to seek out and talk to or collaborate with other café patrons who post content they find interesting, which our survey results suggest may lead to a more productive or engaging experience than working alone. Second, to motivate use of the system, we aimed to reduce any barriers to participation. Users are not required to register or personally identify their posts, though their workstation is automatically

identified upon posting. The system offers no guidelines or restrictions on what users can post, though we did provide some simple controls for café staff to remove inappropriate material. Third, to provide for a real-time experience, posts automatically expire and are removed from rotation on the television monitors after a pre-set time interval. Similarly, only the most recent post from each workstation is used in the rotation, ensuring that a single user cannot flood the system with posts. If they would like to view older content, users are able to browse all posts via the web interface.

We formulated these specific design aspects through an iterative design process involving heuristic methods in Atlanta and the input and feedback of management staff at Busy Internet. Beginning in January of 2011, and guided by our overall design goals, we brainstormed a number of ideas and interfaces for this content-sharing application. This led to many low-fidelity mockups, which were further refined into three design options (Figure 3). Incorporating heuristic review and feedback from the café's management at this stage, we implemented the final design pictured below in Figure 4. Unlike some of the other options, which devoted the entire screen to posts, the prominent workstation map in our final design provided a clear emphasis on the co-location of the system's users. The hope is that this might lead customers to locate other café users based upon shared interest, which then might develop into discussion or collaboration opportunities. Our survey work had clearly underlined customers' interest in group work and collaboration.

Figure 3: Early mockups of the BusyBoard slideshow design

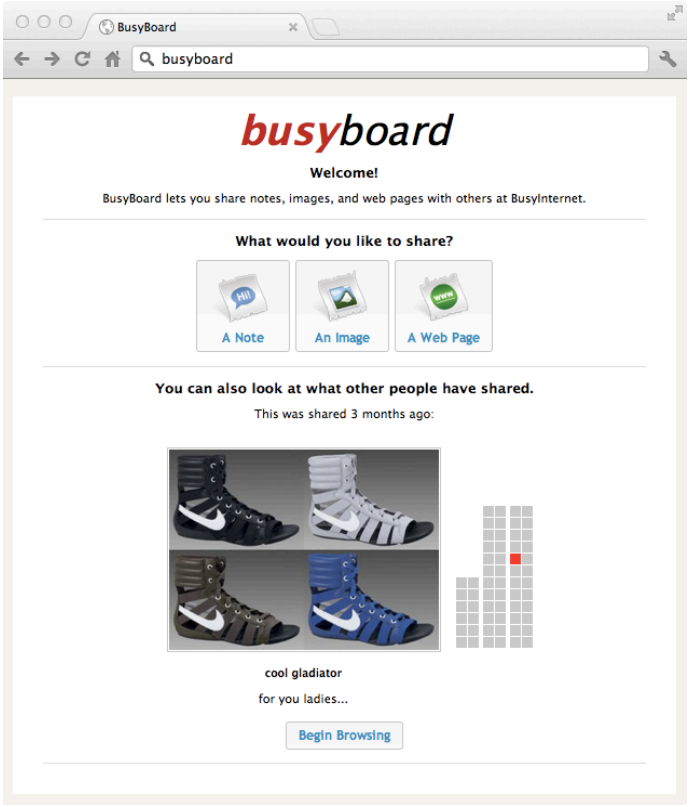
Figure 4: A screenshot of the final BusyBoard slideshow design featuring an image and caption shared by a user. The workstation where the user sat is highlighted on the right



Users are able to post to the system through its web interface, which is accessible from any workstation connected to Busy Internet's café network. The website briefly explains the system and prompts users

to create a post using a simple web form (Figure 5). In addition, users can browse existing posts in reverse chronological order, allowing for interaction at a more personalized speed than the slideshow display. This interface was designed to reflect the slideshow's layout, and it features extremely similar design elements, such as the café map to the right of each post.

Figure 5: The BusyBoard web interface



The system was implemented with two software components. A Ruby on Rails web application manages the backend and web interface, and it also saves posts and other metadata to a local database. The slideshow display used on the television monitors was developed with Adobe Flash, and it interfaces with the web-based backend to access content in real time. Both components run on a single PC we connected to Busy's café network, and neither are visible from the public internet outside of the café.

We installed BusyBoard at the Busy Internet café in May 2011, including deployment of the web interface on a standalone server and installation of two 46" LCD BusyBoard screens with clear sight lines to most cybercafé users. Because our implementation relied on specific characteristics of the café's network in order to automatically identify which workstation a post originated from, we worked closely with the café's network operations managers to install the system and configure the café's internal domain name server accordingly.

We designed the BusyBoard system to permanently save a history of all posts and user activity for analysis. We reviewed the resulting data to understand the content users shared and how usage rates changed over time. Additionally, we collected supplemental qualitative data through interviews with three stakeholders: a manager at Busy Internet, a staff person at Busy Internet, and a developer

involved with the design and installation of BusyBoard.

Video-Based Analysis of Collaboration Design and Implementation

Additionally, we explored the use of video analysis to assist us in understanding user behavior in these venues. As our primary findings are the result of qualitative surveys, we hypothesize that video analysis can be used in a complementary manner to generate quantitative data about user behavior. To this end, we used our own lab at the Georgia Tech campus in Atlanta as a test-bed to gain an understanding of the appropriate technology, as well as such deployment specifics as camera placement, network characteristics, etc. We then developed some basic tools to perform automated analysis of recorded videos.

We created a prototype system using staged videos recorded in our lab—which we expect to be similar to what we would capture in the field—that analyzes a video stream to identify possible instances of collaboration. The video is first recorded from a networked surveillance camera and stored on a local computer. Our application then performs analysis on these recordings and presents the user with an annotated video. Depending on the user's specified settings, the annotated video may track individual users within the frame or highlight motion occurring in the scene.

PUBLIC ACCESS ICT CONTEXT FOR THIS STUDY

The demographic findings of our survey work from Busy Internet and First Café provide a snapshot of the ICT users in the region. We did not perform a study of the broader ICT context in Ghana.

Of the 150 survey participants, most were males (79%), and 96% of respondents were Ghanaian, with the rest coming from neighboring West African states. The plurality identified as Akan (47%), while other significant ethno-linguistic groups included Ewe (18%) and Ga (14%). As for religion, 74% identified as Christian, 22% as Muslim, and six respondents reported "other" or no religious affiliation. The ethno-linguistic and religious affiliations broadly echo, though not preciously, Accra averages.

The age of most respondents was below 35; 51% were ages 26–35, while 29% were ages 18–25. Only four respondents were over 45.

Subjects reported high levels of educational attainment, with 60% indicating some form of post-secondary school education and 31% stating that they had passed through secondary school. This is higher than Ghanaian national averages. In terms of their current employment status, the largest group (27%) reported being unemployed, while 25% indicated having fulltime employment and 18% were self-employed. Students made up 18% of the sample, and 11% were in national service, which is a one-year national program targeting, in particular, new university graduates (www.nssghana.org).

Outside of employment information, we asked the respondents to identify a set of consumer goods and services that they have at their home, such as electricity, a TV, a motorcycle, or a car. We used these responses as an economic surrogate measure, as opposed to the more difficult approach of directly asking for income figures. By summing the numbers of "yes" responses to the 12 items we asked about, we arrived at a relative measure of family economic status. This measure will be used in subsequent analysis.

We also asked questions as to the computer and internet experience and expertise of the subjects. Overall, the respondents report a fairly high level of technological expertise. Of our sample, 65% reported more than five years of computer experience, and 50% reported the same for the internet. Only 3% reported just one to two years of computer experience, and that figure was 6% for the internet. Nobody reported less than one year of experience with either system. Finally, in order to get a stronger indication as to the technical expertise of the respondents we asked them to rate their experience on a five-point scale, ranging from "none" to "some" to "full," for a number of internet-related terms, such as "MP3," "preference setting," "PDF," and "downloads". Here, we find a much more nuanced set of responses, with, for example, 44% indicating no experience with PDFs, while 84% reported "good" or "full" experience with "advanced search." Based on metrics designed by Hargittai (2005), we computed a single aggregate experience score from the seven internet-related questions. This variable will also be used in our subsequent analysis.

In summary, respondents were mostly male, well-educated, and financially well-off, and they also had considerable experience with computing and the internet.

Respondents were asked which features and services of the internet café they most valued. When asked to rank 14 features of the café that they thought were most important, visitors most often selected

high-quality computers and relatively good internet connections as their top choice. A safe location, knowledgeable staff offering high-quality assistance, and the appealing layout and design of the venue were important in both cafés. Respondents were also asked what they considered to be the most important activities they performed in the café. For both cafés, the clear number one activity was reading and sending emails. At First, other important activities included general browsing of the internet and social networking activities, while at Busy, commerce, business activities, and searching for schools or jobs abroad were the next most important.

First customers were almost entirely local, and many probably visited that particular café due to its geographic convenience, while many Busy customers traveled a good distance to get there, but still made the effort because they favored that venue over others. Of the Busy respondents, 25% had travelled farther than 5 km to reach the venue, compared with just 1% at First. Conversely, while just 12% of Busy subjects had traveled less than 1 km, that was the case for 39% of First respondents. A full 90% of Busy respondents stated that it was their preferred internet café, compared with just 49% of First participants. While 87% of First respondents stated that they visited the cybercafé at least once a week or more, this was true for only 60% of Busy participants.

RESULTS

This section presents findings from the user survey, findings from the BusyBoard experiment, and a brief overview of the design of a video analysis prototype.

User Survey

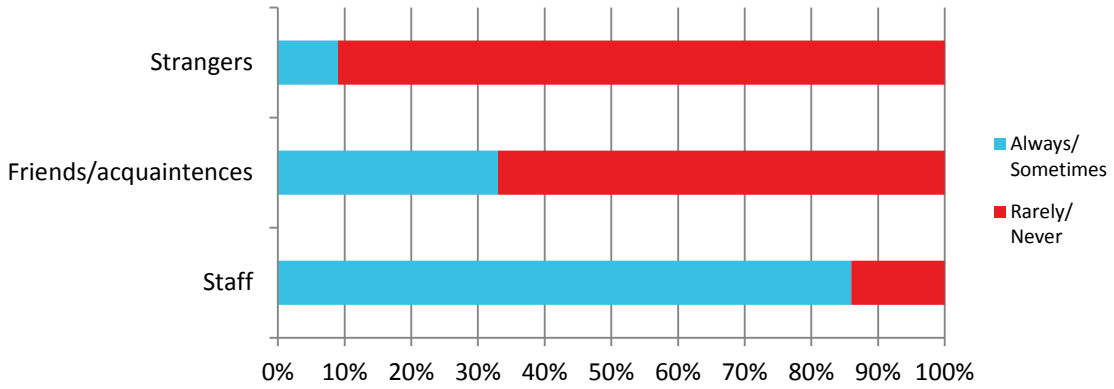
Results from our survey of collaboration and sharing in two internet cafés underline the importance of shared public internet access. We find that public access enables several forms of sharing and collaboration among patrons, from the most simplistic (such as asking a café employee a quick question) to the more formalized (such as meeting business partners and working together around a single computer), to the fleeting and voyeuristic (such as glancing at a stranger's computer screen and noticing an interesting website). In this section, we will detail some of these top-level results.

Helping Others in the Café

Perhaps the most obvious form of collaboration and learning among collocated individuals at cybercafés occurs simply when customers ask or answer basic computer-related questions. Indeed, when café visitors run into a problem they cannot solve alone, they often ask for help from the staff of the café or other users.

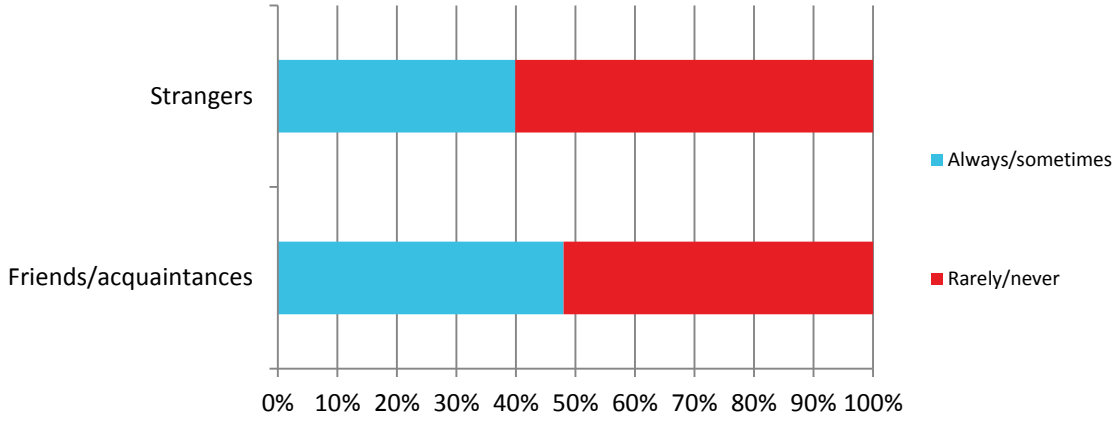
Of our respondents, 86% stated that they ask the café staff for technical assistance if they have a problem with the computer systems. Asking friends or acquaintances for help at the café was less common, with 63% claiming that they never do this on a four-point Likert scale (always, sometimes, rarely, never). Moreover, asking help from strangers is even less common, with 85% reporting to have never done so (see Figure 6). Respondents from First were more likely to ask strangers for help than those from Busy (16% versus 13%; χ^2 =10, p = .007, n = 150).

Figure 6: "Do you ever seek technical assistance from [strangers, friends, staff]?"



However, participants were more likely to say that they provided technical assistance to friends, acquaintances, and strangers. As shown in Figure 7, 48% stated that they had provided assistance to friends and acquaintances, and 40% had assisted strangers—four times as many as reportedly received help from strangers.

Figure 7: “Have you ever provided technical assistance to [friends, strangers] you met here?”

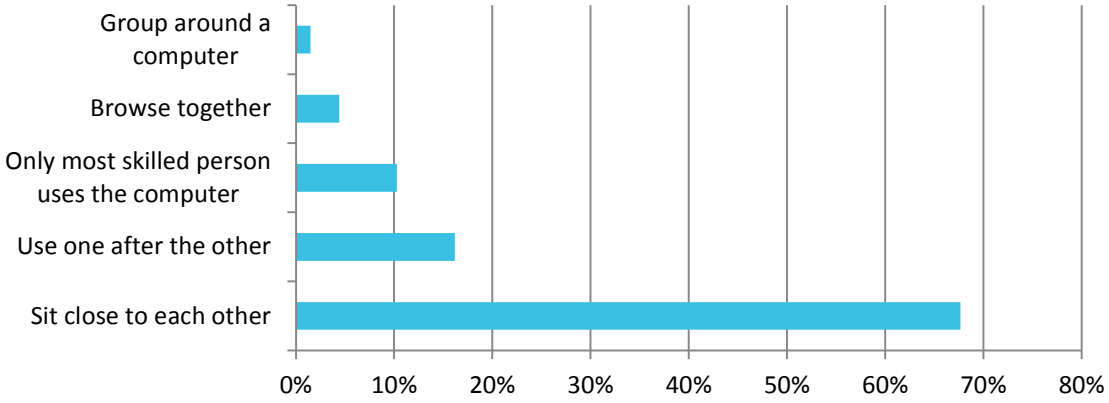


Overall, four-fifths of participants had received technical assistance from internet café staff, and almost half had provided assistance to other customers.

Computer Sharing in the Café

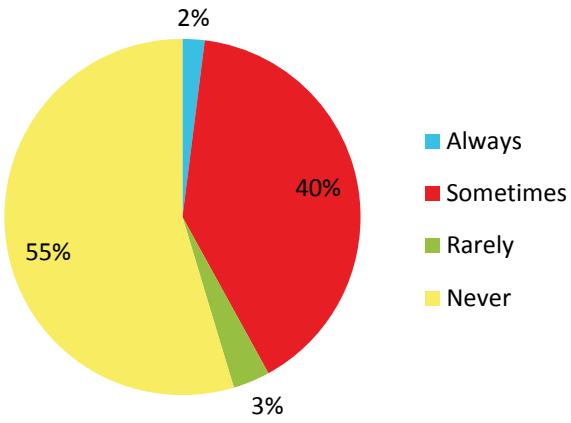
The material sharing of a computer among users is certainly one of the simplest and easiest forms of collaboration to study. Two-thirds of respondents characterized sharing as users sitting close to each other at a computer. To a lesser extent, computer sharing is seen as taking turns to use a computer, having only a person with more skills use it, or people browsing together (Figure 8).

Figure 8: “How do you share the use of a computer with other person(s) in the internet café?”



Nearly half of all study participants reported at least some physical computer sharing at the cybercafé in the past, as shown in Figure 9. On our four-point Likert scale, we found that respondents generally did not report “always” or “rarely” sharing a computer, and instead claimed to share “sometimes” or “never,” with a slight preponderance of the latter answer.

Figure 9: "Do you ever share the computer use with a friend or any other person(s) in this internet café?"



In much of our analysis, we will examine and compare users who reported engaging in these types of physical sharing of a single computer with those who did not. Those who reported sharing did not represent a distinct demographic group compared with those who did not. Performing a statistical test with the main demographic variables, we found no statistically significant relationship (at the .05 level) between sharing and age, sex, ethno-linguistic groups, etc. (but see Burrell [2009], who found young users more likely to visit Ghanaian cybercafés socially and work together in groups sharing computers).

We will use this basic form of physical computer sharing as a "collaboration surrogate" and categorize our respondents into currently active or non-active sharers; below, we study if this categorization can help to explain variation among other variables. We have created a dummy variable which is assigned a "1" for those cases when the respondents always or sometimes shared a computer, but is otherwise assigned a "0." The former group we will call "sharers," and the latter group will be referred to as "non-sharers." There was no significant difference in the proportion of participants categorized as sharers between the two venues. Overall, we found 45% of participants reporting as sharers under this surrogate measure. A lot of variation does exist, however, between the sharing and non-sharing participants when studied against other variables of interest. For example, when asked if they ever requested help from strangers while at the café (results reported in the previous section and in Figure 7), we found that non-sharers were less likely to have done so, with 93% of them never asking strangers for help, compared to 76% for sharers across the two venues ($\chi^2 = 9.4$, $p = .009$, N = 150).

Economic Motivations for Computer Sharing

Given the economic realities of many within our respondent pool, even allowing for their relative wealth, one might hypothesize that the main reason for them to share a computer would be cost-related, with sharing prompted by limited financial resources. If this were, indeed, a primary motivation, we would expect to find a correlation between measures of economic prosperity among the participants and their propensity toward computer sharing as measured by our dummy variable categorization.

Since economic status is difficult to measure through self-reports, we captured this through a set of surrogate questions including questions about ownership of high-value items. Participants were asked if

they owned twelve different items, such as a motorcycle, car, or television, as well as whether they had home electricity service (see Figure 10 for the list of consumer items). For these twelve items, we found a statistical relationship with sharing (at the .05 level or better) with just three—cassette players, radios, and personal computers—a suspicious list, insofar as these particular commodities do not suggest to us a propensity toward sharing as compared to the others. In addition, when we asked participants a direct question regarding their employment status (were they working, in school, unemployed, etc.), we found no significant relationship ($\chi^2 = .47$, $p = .49$, n = 75) between it and their propensity toward sharing.

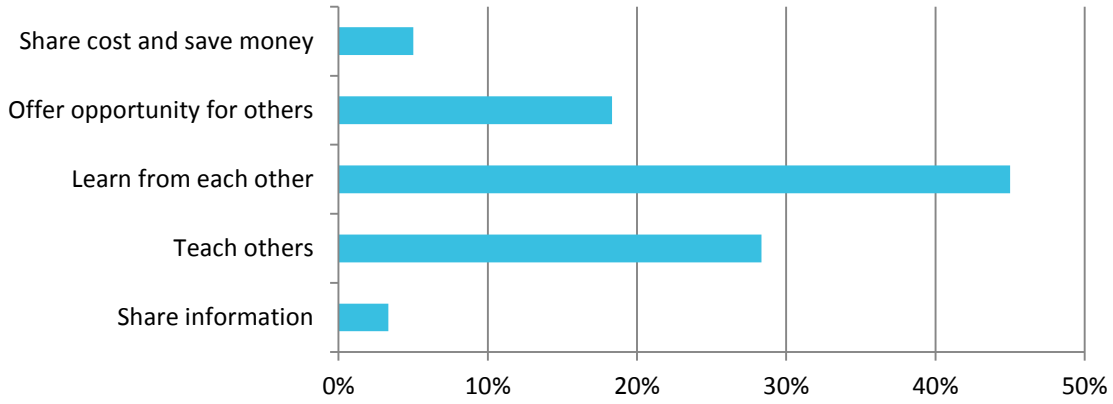
Figure 10: "Do you own any of the following at home?"

Electricity services	Radio	Cell phone
Telephone service	Cassette player	Desktop computer
TV set	DVD player	Laptop computer
Internet access	Motorcycle	Car

In order to have a single summary economic surrogate measure across all 12 consumer items, we summed up these responses, creating a single 12-point economic indicator. When we compared this economic surrogate with sharing, we did not find a relationship at Busy, but we did find a statistically significant relationship at First ($\chi^2 = 11.8$, $p = .0006$, n = 75), with less well-off people more prone toward sharing. But while the effect is statistically significant, the difference is modest, with non-sharers having only a single point elevation on average in our 12-point scale (mean of 6.3 for non-sharers versus 5.3 for sharers). This shows that economic dimensions may have a mild influence on sharing habits in at least one of the venues we visited.

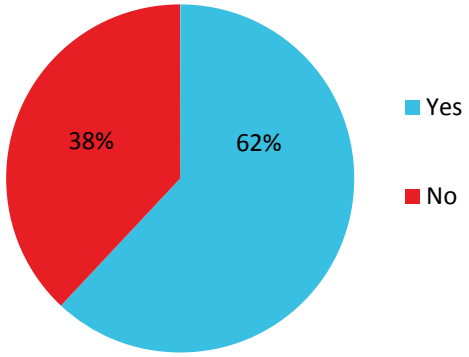
We also asked participants what they saw as the most important reason for sharing a single computer. Of participants who answered the question, only 4.7% indicated sharing the cost of access as the most important reason. Instead, nearly 75% responded that the most important reasons were educational—to learn from each other (45%) or teach others (28 %).

Figure 11: "What is the most important reason for sharing the use of a single computer?"



Furthermore, when asked, most respondents claimed that they would continue to share even if the price of the service went down. If users could pay less for the internet service, 61.8% of the people who reported sharing would still like to share (see Figure 12).

Figure 12: “If the internet services here were cheaper, would you ever share its use with a friend?”



We also asked those who share a computer about the mechanics of their sharing and how they manage the cybercafé access costs. Almost half of the respondents (45.6%) said that he or she pays the costs entirely, approximately one-third (32.4%) of the respondents said he or she lets the other person pay the entire amount, and another 2.9% pay alternately. According to these results, only 19.1%, less than one in five, share the access costs with their partner. There were no significant differences between the two venues on this line of questions.

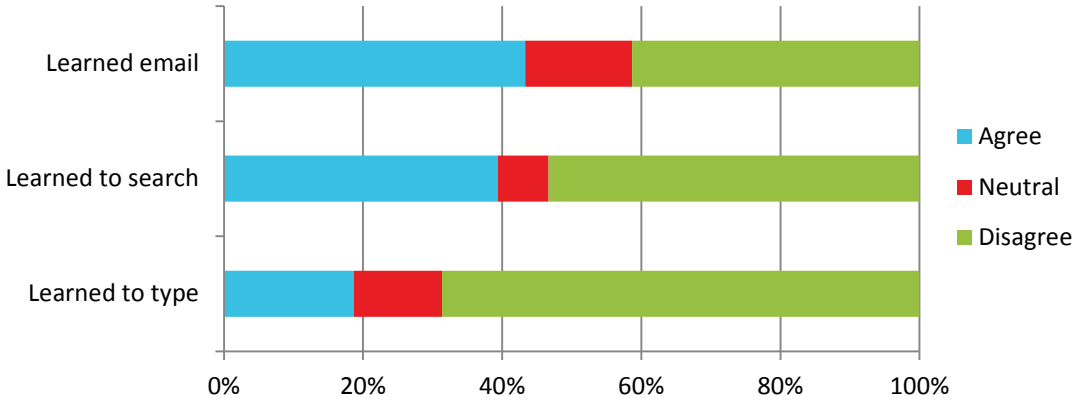
Given these results, we submit that there is no significant relationship between whether a subject reports computer sharing and measures of their wealth and work status at Busy, and only a very modest relationship at First. Instead, we find that learning and collaboration are the prime motivations for public computer sharing.

Learning Through Sharing

Given that educational, rather than economic, interests were reported as paramount to sharing among most of our respondents (see Figure 11), we asked further questions to try to understand what and how these cybercafé users were learning.

Utilizing a five-point Likert scale, we asked respondents to rate how closely they affiliated with statements that they learned to type, search, or send email by watching others in a public internet café. Overall, while only 18% stated that they learned to type by watching others at a café, 39% and 43% respectively claim to have learned to search and email by watching others (see Figure 13). In other words, more than one-third of respondents learned these two critical computer skills by being in a public internet facility where they were able to watch other patrons.

Figure 13: “I learned [email, to search, to type] from watching others in a public internet café.”



While learning motivates sharing, there was nonetheless only a weak relationship between whether a respondent was categorized as a sharer and if he or she responded positively to the statements related to learning from others in the café. The only statistically significant case was in learning to search on the internet, where 48% of sharing respondents agreed or strongly agreed to have learned to search by watching others in a café, compared with 32% of non-sharers ($\chi^2 = 14$, $p = 0.007$, n = 150). Thus, sharers are a bit more likely to claim to have learned to browse the internet thanks to a collaborative public internet educational experience, but even one-third of non-sharers also claimed to have such an experience.

While our sharing surrogate did not explain very much variation in a respondent’s affiliation with the learning statements, there was considerable difference in responses to these statements between the two cafés (all at $p < .0001$ significance). For instance, at First, 39% of respondents agreed or strongly agreed to have learned to search the web by watching others in a café, compared with 28% at Busy ($\chi^2 = 24.3$, $p < .0001$, n = 150).

Below, we describe “voyeuristic learning” as a special type of collaboration where someone, for example, glances at a stranger’s computer screen. The learning described in this section may or may not be a form of voyeuristic learning; our study shows no relationship between these two lines of questioning. For example, if a respondent agrees or strongly agrees that they sometimes look over the shoulder of another patron at the café, they are no more likely to agree that they have learned to email from others at the café ($\chi^2 = 3.7$, $p = 0.45$, n = 150).

We conclude from the results presented in this section that economic aspects are not the most important consideration involved in deciding whether to share a computer with others in these public internet venues, and that educational benefits are, instead, the most salient. We also find that more than one-third of respondents learned some critical element of computer use, such as email or internet browsing, by watching other people in cybercafés. Additionally, this level of in-café learning is measurably higher at First, a more informal and interactive space, than it is at Busy.

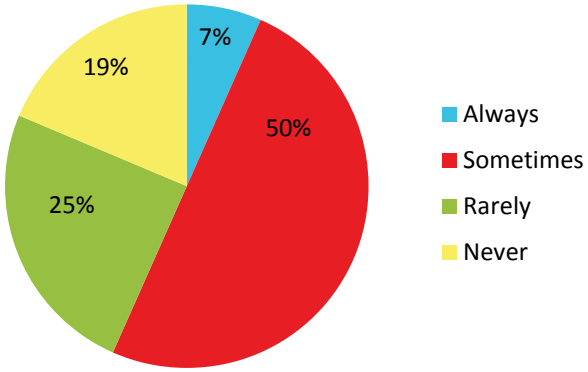
Group Work in the Café

While the physical sharing of a computer may be one of the most basic forms of co-present collaboration, in many ways, we are interested in more complex forms of group work and collaboration—perhaps over multiple appliances and within a richer environment.

Currently, there is no formal organized way for multiple people to work together at either of the cybercafés. Instead, both cafés allow some forms of group work by crowding around individual computer stations. In addition, at Busy, a "laptop lane" allows users to bring their own laptop computer and connect wirelessly to the internet. While much of this area is carrelled for individual use, two large tables are present with a layout and architecture that is clearly more convivial to group collaboration.

We asked survey respondents if they would be interested in using the computers within a collaborative group setting if given this option. As shown in Figure 14, only 19% responded that they would never want to participate in collaborative group work at the café, with the largest groups responding sometimes (50%) or rarely (25%). Clearly, most users would like to, at times, participate in collaborative group work. However, there was a significant difference in the interest in group work between First and Busy, with patrons at Busy being more likely to have an interest in this collaboration rarely (33% versus 16%), while First respondents were more likely to respond with sometimes (63% versus 37%; $\chi^2 = 11.3$, $p = .01$, n = 150).

Figure 14: "If you had the option, how often would you be interested in this group use of the internet?"



What other factors might best explain the variation in respondents' interest in formal collaborative group work in the café? First, we compared the attitudes of current computer sharers and non-sharers (using the dummy variable from above) toward group work. Visitors who have previous sharing experience with computers are significantly more open to collaborative group work, with sharers responding that they would always or sometimes like to engage in collaborative group work 78% of the time, compared to 39% for non-sharers ($\chi^2 = 3.3$, $p < .0001$, n = 150).

Thus, we reason that respondents who had previously shared their computer experience were either predisposed (perhaps in their psychological or social makeup) to collaboration at the café and thus excited about additional collaboration opportunities or had positive experience with sharing, which increased their propensities toward engaging in collaborative group work in the future. That notwithstanding, the group of non-sharing respondents still did include a reasonable percentage of

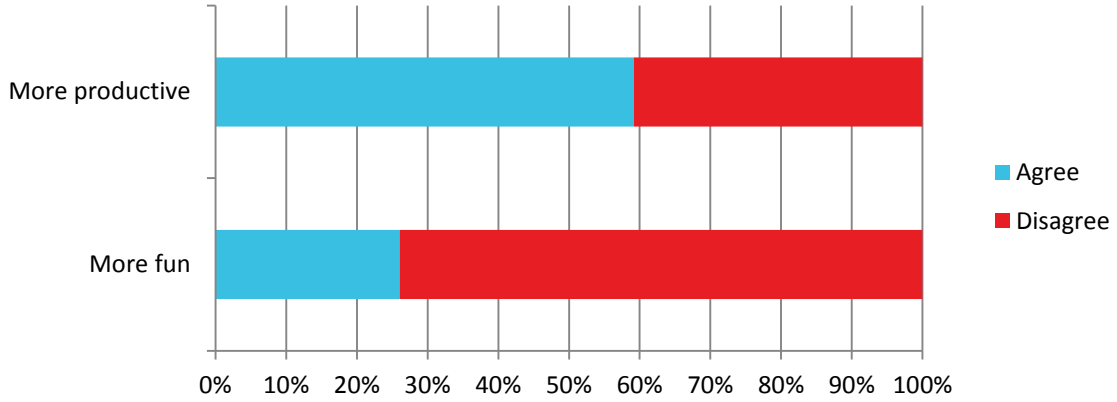
people willing to consider collaborative group work sometime in the future. And this was particularly the case in the smaller and more family-oriented First Page Café.

Sharing for Productivity or Fun

We asked the respondents to evaluate different statements about sharing in internet cafés with the help of a five-point Likert scale, ranging from strongly disagree to strongly agree. In particular, we asked the café visitors if they thought that sharing made visits to the internet café more productive, or if it was more about having fun.

Respondents agreed more with the statement "sharing makes coming to the internet café more productive" than with the statement "sharing makes coming to the internet café more fun" (see Figure 15). There were 58% of our respondents who agreed or strongly agreed that sharing made visiting the cybercafé more productive, while just 25% agreed or strongly agreed that sharing was more fun.

Figure 15: "Sharing makes coming to the internet café more [fun, productive]."



Our sharing dummy variable explains a good bit of variation as to the responses to these two questions. Non-sharers are less likely to strongly agree or agree that sharing makes a visit more productive than sharers are (46.8% versus 73.5%; $\chi^2 = 19.9$, $p = 0.0005$, n = 147). Similarly, sharers are more likely to agree that collaboration makes visits more fun, with 38.2% agreeing (nobody selected strongly agree), compared with just 14.1% for non-sharers ($\chi^2 = 13.4$, $p = .0038$, n = 146).

In the demographics section above, we mentioned that, by far, the most popular activity at the cafés was to send and receive email. When we compare how respondents rated activities against their categorization as a sharer or non-sharer, we find that non-sharers listed general browsing as their second most important activity, while sharers cited social networking. The third most important activity for non-sharers was reported to be searching for schools or jobs abroad, while the third most important for sharers was commerce and business activity. While productivity and instrumental activities were cited as a powerful incentive to collaborate in public internet venues, the often non-instrumental social networks were flagged as critical applications among the sharers, but not among the non-sharing respondents, though commercial and business activities come up as a very close third.

Our casual observations conform to this response; people working together are, indeed, often using social networking tools together, but similarly, close collaboration is often witnessed among business

associates working together on a shared project. Clearly, cybercafé collaboration spans from strongly instrumental and commercial activities to primarily social uses.

Coming Together and Meeting People

Cybercafés in Ghana are not only internet access points, but for many customers, they are meeting points and centers of social life and activity among friends and family. Indeed, many respondents reported traveling together or meeting friends, family members, and business associates at the café. In our survey, 50% of respondents reported usually coming to the café with other people. Those people were mostly friends (37% of those same respondents), though some came with family members (18%) or business associates (6%; see Figures 16 and 17). And whether or not they arrive with other people, 67% reported usually meeting people they know at the café. When respondents do come to the café with others, 60% responded that they sit next to each other, though only 30% reported that they follow along with what the other person is doing on his or her computer.

Figure 16: "Do you usually come to the center along with other people? Meet people you know?"

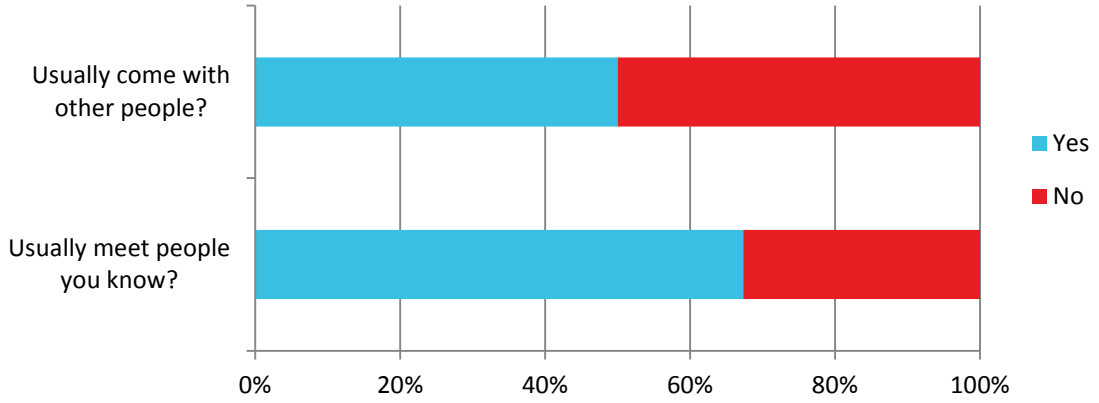
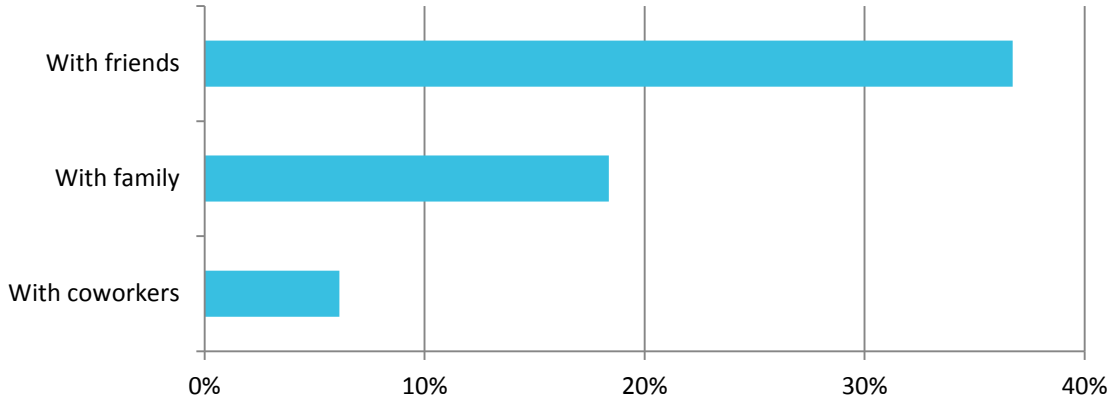


Figure 17: "If you usually come here with other people, whom do you come with?"



Whether respondents self-reported as computer sharers or not (as defined by our dummy variable) explains a lot of variation in whether they come in a group or meet people they know at the café. While there was no significant difference between sharers and non-sharers as to whether they met people they know at the café, sharers were more likely to travel to the café with people as a group (56% versus 42%; $\chi^2 = 6.9$, $p = .0084$, n = 150). Furthermore, sharers were much more likely to come with friends

(63% versus 14%; $\chi^2 = 40.1$, $p < .0001$, n = 147) or with family (32% versus 6%; $\chi^2 = 17.3$, $p < .0001$, n = 147), as opposed to coming with business associates. Finally, self-identified sharers were more likely to share a single computer when they did come with someone to the café (51% versus 1%; $\chi^2 = 57.2$, $p < .0001$, n = 146), and also much more likely to sit next to the person they came with if they used two computers (92% versus 33%; $\chi^2 = 50.7$, $p < .0001$, n = 145). They also were much more likely to follow what was being done by their companion (56% versus 8%; $\chi^2 = 42.8$, $p < .0001$, n = 144). Overall, sharers were more social than non-sharers, which is as expected.

Unlike the differing behaviors between sharers and non-sharers described above, there is little difference between the two cafés as to whether and how people came to the café in a group or met people they know. The only significant difference between the cafés is that, at Busy, respondents were more likely to meet people at the café for business purposes (28%) compared to First (7%; $\chi^2 = 12.7$, $p = .0004$, n = 150). This too is not surprising, given the stronger business profile of Busy.

Voyeuristic Learning and Privacy

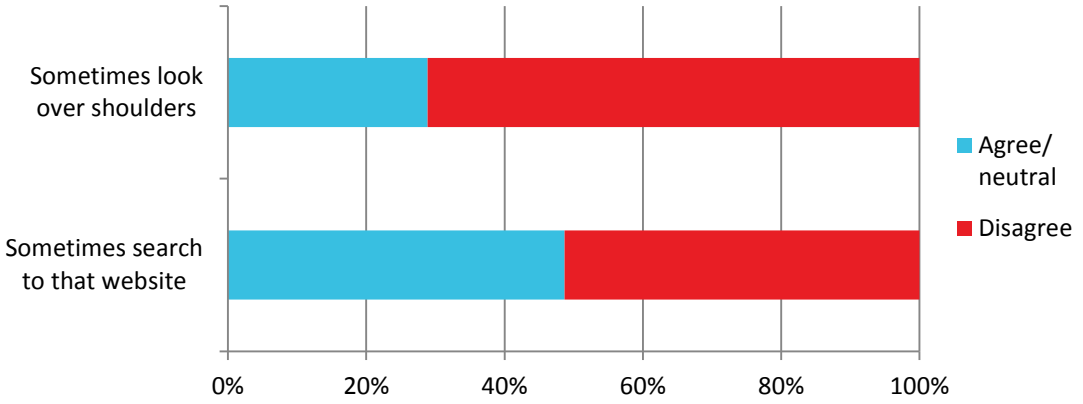
So far, we have examined how people knowingly seek help, interact, and work together in public internet venues. But another form of learning and interaction includes voyeuristic and fleeting forms of collaboration, for instance, when one glances at a stranger's screen. Some respondents reported engaging in voyeuristic and even uninvited sharing, which is clearly in tension with the fact that many respondents reported significant privacy concerns.

When asked to rate the statement, "I sometimes look over the shoulder of people while they use a computer here" according to our five-point Likert scale, we found that 71% disagreed or strongly disagreed, meaning that nearly one-third of respondents were neutral or positive to it (see Figure 18). This result was similar across sharing and non-sharing respondents ($\chi^2 = 5.4$, $p = .25$, n = 149).

We also asked directly about a specific form of voyeuristic learning: glancing at a website that a neighbor has browsed to. As shown in Figure 18, respondents rated the statement "If I see someone next to me looking at an interesting website I sometimes search to that same site myself," with 51% of respondents overall disagreeing or strongly disagreeing with this statement. Thus, a full half of the subjects seemed to be neutral or engaged in some instances of this form of voyeuristic learning.

There were differences in responses to this question between the two cafés ($\chi^2 = 22.8$, $p = .0001$, N = 150), and between those categorized as sharers versus non-sharers ($\chi^2 = 11.2$, $p = .02$, n = 150). Between the two cafés, a strong majority of respondents from First (90%) reported as neutral or disagreeing with the statement about glancing at a neighbor's computer, compared with just 58% from Busy ($\chi^2 = 32.1$, $p = .0001$, n = 149). Perhaps counter-intuitively, while First is generally a more convivial space with a physical layout that ensures patrons are in much closer physical proximity to each other, the respondents from First do not report glancing at their neighbors screen as commonly as those at Busy do.

Figure 18: "Sometimes I look over the shoulder of people while they use a computer here. If I see someone next to me looking at an interesting website, I sometimes search to that same site."



It would seem, as well, that a respondent's comfort with and tendency to engage in voyeuristic and fleeting collaborations would be impacted by his or her own level of privacy concerns. Overall, respondents reported very high levels of privacy concern while working at the cybercafés. On a four-point Likert scale (ranging from very important to very unimportant), we found that nearly every respondent (93%) described computer privacy as either important or very important.

However, the two cafés were statistically different in the level of their privacy concerns. For instance, at Busy, 68% of respondents identified privacy as being very important, compared to just 32% at First ($\chi 2 = 20.9$, $p < .0001$, n = 150). Also, First continued to demonstrate less of a business focus, with just 7% of respondents reporting privacy of commerce and business affairs to be important or very important, compared with 79% at Busy ($\chi 2 = 85.5$, $p < .0001$, n = 150). As mentioned above, the First café positions patrons very close to each other, with little privacy for their screens compared to Busy, which has a bit more space between patrons.

Aligning with expectations, we found that our sharing respondents were less concerned with privacy than those who we identified as non-sharing. Of participants who did not share, 60% identified privacy as very important, compared with 38% who did share ($\chi 2 = 10.7$, $p = .005$, n = 150).

BusyBoard

Results from our BusyBoard experiment indicate that, despite initial interest in the system, BusyBoard did not influence computer sharing, interpersonal interactions, or collaborative activities at Busy Internet, because it did not sustain user interest. However, the experiment did reveal challenges and limitations of collaborative technology in an internet café setting, as well as the continued importance of designing a system that fits the needs of users in shared public internet access settings.

Additionally, the data exposes a desire for advertising opportunities to reach the café's clientele. In the words of a manager at Busy Internet who we interviewed for this report:

> *From a design, display, and concept point of view I think it was just super. I don't have anything to add here. It was more to come from the response. It didn't happen as expected.*

Results on how the system was used, the sort of material shared, reasons behind its low usage, benefits accrued to the venue, technical limitations, and suggestions for system improvements are discussed below.

General Usage

The BusyBoard system saved a history of all posts and user activity. Between May 12, 2011, and September 20, 2011, users posted to the system 2,806 times. After high usage in the first couple months of the deployment, the frequency of posts decreased over time, with 248 posts in May (partial month), 1,009 in June, 930 in July, 486 in August, and 133 in September (partial month).

Users could share images, notes, or screenshots with BusyBoard. Our data shows that posts were overwhelmingly image uploads, comprising 87% of the total, followed by text and websites at 8% and 5%, respectively.

To understand the content users shared, we manually coded all BusyBoard posts into five categories: advertising, humor, personal messages, words of wisdom, and other. Advertising posts featured commercial products, events, or services. Humor posts generally consisted of written jokes or humorous images. Personal messages, such as "happy birthday" posts, would address specific other people. Words of wisdom were typically proverbs or quotations providing food for thought. Finally, the "other" category included posts that did not cleanly fit into the buckets already listed; in general, these other posts consisted of random images, such as scenery, animals, or sports-related images. Some representative samples for each of these categories are presented in Appendix A.

Based on the four months of data we collected from the BusyBoard system, we observe that users predominantly posted commercial advertising (56%), followed by other (32%), wisdom (7%), humor (4%), and personal messages (1%; see Appendix A for sample posts). Inappropriate content was extremely minimal, and café staff removed only 11 posts. Interview participants agreed that advertising posts were common, however, other types of shared images and text were initially popular. According to a staff person:

> *You had every kind of picture running on it—be it funny images, pictures of Accra, a person's photo, a flyer. We had notes, just a sentence like: "Today is a bad day," "Tomorrow is a public holiday," "Where can I find stuff?" or "I'm new to BusyBoard, hi." The screenshots didn't really get a lot of usage. There were just a few developers or designers who used it to show off the websites they built. But after a long time, the people who used BusyBoard most were people who wanted to show off their stuff, to advertise.*

Results from the Busy Internet user survey (as discussed above) indicate that computer sharing at the venue is popular, is oriented toward learning, and can be voyeuristic, yet BusyBoard was not used for these purposes. BusyBoard usage data and the interview participants concur that the system did not seem to directly facilitate collaboration or spur interpersonal interactions. Rather, as one participant noted, "I think people saw it as a broadcast system, a system for advertising—not for [interpersonal] communication." The system's design may influence this use, as it offers high visibility in this public space.

Reasons for Low Usage

As we learned through interviews with internet café staff, decreased usage of BusyBoard over the four-month study period can be attributed to a few key factors.

First, many users didn't see posting to BusyBoard as a valuable use of their time. Interview participants told us that visitors were willing to post an item once or twice to see how the system worked, but did not continue to do so if they saw no benefit in sharing. As a staff person said:

> *At a certain time, everyone posted a comment or read a comment. But by the end, people mostly used it to get their voice heard, like with advertising, showing things they wanted people to know. It would be better used when people knew they could get something.*

Additionally, many visitors were too limited by time to use the system. Some rush in to the café to complete a specific task, such as checking email. Others face time constraints imposed by the price of using a computer terminal. For example: *"If [I] have just 30 minutes to spend in Busy, and I get my coupon, I wouldn't really want to share my time because 30 minutes might not be enough for me to use. I wouldn't want any distraction."*

Second, some visitors were reluctant to share with strangers in a public setting on an open platform. Interview participants described how most café visitors preferred to work privately or sit next to collaborators, rather than broadcast material over BusyBoard. From the perspective of one manager:

> *From a concept point of view, I feel the system was useful. People could share their pictures of their feelings. But it's a very conservative environment. It's not like the US or UK where they are very liberal and open to these kind of ideas. Here it is kind of difficult. Probably that was one of the reason that we didn't see the usage we were expecting to see. I think it comes down to the point that people thought, why should I share my stuff? People who came were doing stuff privately on their machines and they didn't want to put this on the BusyBoard. That is what we found from our investigation and questioning of the customers.*

Results from the user survey (discussed above) indicate that café visitors are very concerned about privacy while using public access computers. In the context of BusyBoard, interview participants also expressed the opinion that privacy concerns remained paramount. In the words of a staff person:

> *Busy Internet is a public place. We have every kind of people coming in here. Some people are so careful. Because of the internet, they are careful and don't want to talk to many people. They wanted to keep their private stuff private. A few other people spoke to each other, though, yeah.*

Concerns about privacy were downplayed in BusyBoard's development, however. A designer stated*: "I think we imagined it more that people would want to share what they were doing. The [user interface] was built around that. It's also entirely possible that people didn't want to share a message with the whole room."*

Third, visitors lost interest in viewing BusyBoard posts. As the number of shared items declined, people got bored with the system. A manager stated:

> *You see, the whole thing would have been interesting if there were quite a few pictures in the queue. But if you see only one or two people posting their pictures, and those pictures keep repeating, you might see them for a second or two, but then ignore it. If there are more people posting pictures, you are inquisitive, you want to see what is next. But we never had a situation*

where we had 10 or 12 pictures in the queue at a time. Or if we did, that was the best case scenario. Most of the time it was one or two.

Influence of BusyBoard at Busy Internet

Nonetheless, our data exposes a desire for advertising opportunities to reach the café's clientele. In fact, some of the advertising posts featured services of the Busy Internet café itself. A manager confirmed this, stating:

> *But we, the Busy team, put up advertisements, some displays of products, this and that, on the screen, so that it interlaces with the display coming from [BusyBoard] users. For example, if one terminal was displaying a pictures or a photo, next could be the busy advert or a client advert, and then next would be a [BusyBoard] screen. We tried to interlace it with pictures of our own just to make it more interesting.*

Interview data suggests that café staff found the system to be an effective way to market to customers, and this use by staff may have motivated customers to, likewise, post advertisements of their own. Accordingly, an unintended benefit of the system may be that it bolsters opportunities for drawing revenue from advertising. A BusyBoard developer stated, "*I think it clearly outlined an opportunity for places like Busy to monetize their space by selling advertising. That's not something they do right now."*

Additionally, a staff person indicated that deploying BusyBoard created buzz throughout the community and attracted customers: *"The system got some people coming into Busy to check it out. It created conversation. People wanted to know about it, use it, try it out. It got a lot of audience."* The new flat-screen monitors also drew positive attention to the café. As a manger stated:

> *BusyBoard made a big impact on the whole environment of Busy, we can't deny that. You see, the flat screens show some pictures. But at times we showed videos to our staff to show what it was. The overall impact was good, I'm not denying that. But the purpose for what it was put, it was not achieved.*

In summary, most of the benefits derived from BusyBoard use accrued to the venue itself, or to customers looking to advertise products and services.

Technical Limitations

BusyBoard did not seem to spawn interactions between café visitors, and one contributing factor may have been the result of an engineering constraint: Posts remained on the slideshow for three hours, long after most visitors would have left the café. As such, there was no guarantee that the person shown to be sitting at a workstation had posted the image displayed. A developer described the design decision the following way:

> *Initially we only wanted a shared item to show while the user was still in the room. But we couldn't automatically take a post down because we had a technical limitation—we wouldn't know when someone left or signed out. This is because we wanted anyone who was sitting there to be able to easily use it, so there was no process that a user had to sign-up or submit their name. [We decided that posts would expire after one hour but] people weren't sharing often enough so we had to increase the time. We went from one hour to three hours. Three hours worked better, but probably people weren't there anymore.*

Additionally, interview participants suggested that the BusyBoard could have been improved or redesigned if developers had been allowed more time to test and adapt the system. The system was installed in ten days. Developers were unable to make design improvements after the initial installation, due to the challenges of working from a remote location (that is, from the United States). Specifically, training the trainers on system changes proved to be prohibitively difficult, and the developers were concerned that unexplained changes would impede end-users from using BusyBoard effectively. Moreover, the developers also faced the time constraints of a four-month study period that did not include time for user surveys or follow-up visits. A developer said:

> *It would have been useful for one of the developers to have been there for a longer period of time. We never got to see it in action. If I had been there for a month instead of ten days, I would have gotten past the installation phase. I would definitely change that about it.*

Suggestions

We asked interview participants if they had ideas on how to improve BusyBoard. The Busy Internet manager stated that he thought the system was well-designed and had no suggestions. The staff person we interviewed also liked the system, but recommended that the café incentivize visitors to share items on BusyBoard by offering free minutes for internet sessions, and also incentivize visitors to view items by integrating current information into the slideshow to draws customers' attention, such as sports updates or news headlines. Specifically:

> *If anything could be displayed on it. Sports updates, scores, teams, events about teams. People are exceptionally curious about sports. The other thing that would want to take you from your workplace, aside from family or pleasure, would be sports. It could be once in a minute, a slideshow goes up about sports updates.*

The developer recommended designing a narrower user-interface to encourage specific collaborative behaviors:

> *In terms of collaborative behavior, I can't say we got much out of BusyBoard. But it is definitely something, if the resources were there, I would want to dig into deeper and try another round. There is definitely potential in enabling that kind of collaboration. Maybe in something that's not as open-ended. Looking back, I think it was kind of naïve to make it such an open-ended system in terms of what people could post. It was an explicit design choice, not something we overlooked. So it makes sense that the usage we got is what we got. In the future, I might want to design a narrower user-interface. To encourage some behavior, limit it to that.*

On the other hand, the manager and staff person were satisfied with BusyBoard's open-ended design, in terms of what people could post, and did not recommend narrowing the purpose of the system. The staff person stated:

> *I would want to be able to use it for anything I want to use it for. If I have ten minutes, what would convince me to take two minutes out of that time I bought just to use the BusyBoard? I want something attractive, something I can do freely.*

Following the results of the user survey, we designed and implemented BusyBoard to see if the system would 1) motivate people to talk to one another, taking advantage of the fact that internet café customers are co-located while using computers; 2) motivate users to communicate using the tool itself,

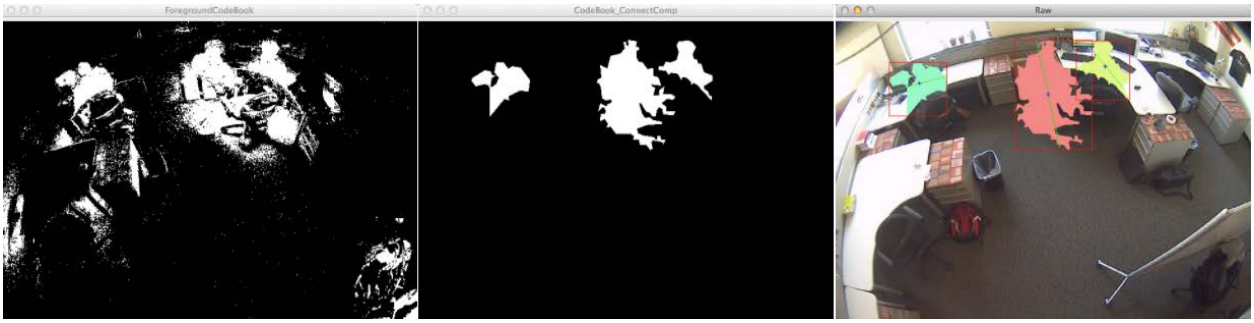
including people who don't know each other; and 3) motivate people to view the BusyBoard display, tapping into the voyeuristic value of cybercafés that featured prominently in the results of our initial survey. We find that, although the system initially provoked enough interest in users that they shared a few items and conversed about the tool, user behavior did not change much. Instead, most of the benefits of BusyBoard accrued to the venue in terms of generating new opportunities to advertise services and creating some buzz among customers.

Video-Based Analysis of Collaboration

We have explored the feasibility of developing video analysis tools to automatically identify instances of multiple users sharing a single computer. In order to accomplish this, a tool must determine where people are located within the video frame. We employed the background codebook method outlined by Kim, Chalidabhongse, Harwood, and Davis (2005) in order to build a model of the background, using reference frames that do not contain people. Rather than constructing a memory-intensive temporal model that predicts a background pixel's future values, such as the one described by Toyama, Krumm, Brumitt, and Meyers (1999), the background codebook method generates a threshold for each pixel, within which it would be considered to represent the background. In our implementation, we use 400 frames, or approximately 15–20 seconds of video, to construct the background codebook, which accounts for small variations in ambient lighting.

Once the codebook is constructed, we create a foreground mask for future frames that contains all of the pixels that do not match the codebook. Because this mask can be quite noisy, we create a secondary mask containing only the connected components. We then identify "blobs" present in the connected component mask, filter them based on size to include only those that are likely to represent people, and highlight them on the output video stream.

Figure 19: The three steps used to identify people within a video frame. First, all foreground elements are extracted from the image (left). Then, the connected components in the foreground are filtered by size to select objects that are likely people (center).

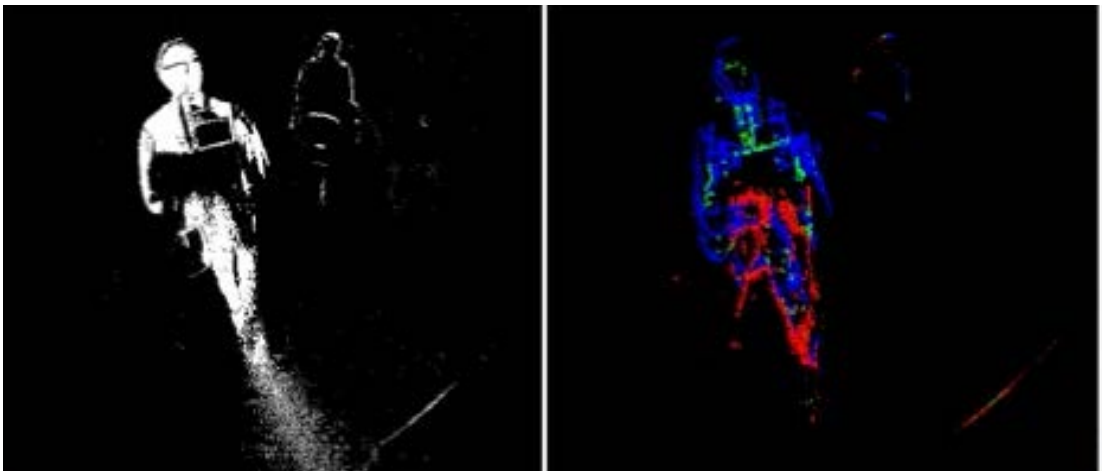


While filtering blobs based on size proved effective in identifying people while ignoring other foreground changes, our implementation was particularly susceptible to identifying people's shadows as false positives. Going forward, it will likely be important to mitigate this issue by applying other filtering techniques, and perhaps by relaxing the thresholds of the background codebook.

One concern in using video data for research purposes is that it must be adequately anonymized. Rather than utilizing facial recognition to specifically blur faces visible in the video, we accomplish this by painting over foreground elements entirely, effectively obscuring people's faces and bodies.

Prior to settling on the background codebook method described above, we implemented two other algorithms to extract foreground objects, but both proved to have issues that made them unsuitable for our task. First, we considered using motion to identify foreground objects. However, because people using a workstation are relatively stationary, they would appear in the foreground while approaching a workstation, and then they would fade into the background as they began to work, as depicted in Figure 20. We also considered using the histograms of oriented gradients algorithm proposed by Dalal and Triggs (2005) for person detection, which is frequently used for applications like pedestrian tracking. While the algorithm works well when observing people from profile view, it did not seem to recognize people from our overhead position, likely because the body features it attempts to track are not evident from above.

Figure 20: A screenshot of motion-based identification. On the left, we see all foreground elements of the frame. On the right, we see only those that have recently been in motion. Notice how the second person becomes nearly invisible by remaining stationary.



For convenience of camera placement on the ceiling in our lab, we chose to angle the lens slightly, rather than point it straight downward. However, while the camera's wide-angle lens still gave us broad coverage of the workspace and produced video that was suitable for analysis, the angled orientation introduced some issues. First, because objects changed in size based on their distance from the camera, our size thresholds for filtering blobs needed to be wider than would otherwise be necessary. Second, people and objects were able to occlude each other as they entered the scene. Positioning the lens in the downward direction would easily alleviate both of these issues. The fish-eye effect of the lens causes objects to change in size depending on their position, but that distortion can be easily corrected for in software.

In this phase of research, we used staged video footage from our own lab at Georgia Tech to formulate potential research questions and implement the algorithms for analysis described above. Our prototype shows that computer vision can be an effective tool for quantitative analysis in the cybercafé environment. Having access to video streams from the field would help us to identify the research questions that we would like to answer using computer vision, which in turn would allow us to develop tools to answer those questions, as the algorithms implemented are very specific to the particular source footage. For this purpose, we have collected hundreds of hours of footage from an overhead

camera mounted in the Busy Internet facility, and have begun analysis by extending the work described above, as well as by using Romero, Summet, Stasko, and Abowd's (2008) Viz-a-vis system for generating abstracted representations of video streams.

CONCLUSIONS AND RECOMMENDATIONS

Public shared access to computers and the internet in low-income countries is often painted both as second-class to individualized private access, and as the outcome of resource constraints. We have surveyed 150 patrons of two cybercafés in Accra, Ghana, about the ways in which they use computers in these venues and the benefits or drawbacks of public access and sharing. We find that public access often results in forms of sharing and collaboration among patrons that range from the most simplistic (such as asking a café employee a quick question) to the more formalized (such as meeting business partners and working together around a single computer), to the fleeting and voyeuristic (such as glancing at a stranger's computer screen and noticing an interesting website). Contrary to the belief that resource constraints drive public shared access, participants who were already sharing discounted the economic grounds for doing so, instead highlighting the learning benefits of working together. We surveyed patrons in two different cybercafés, one large, centrally located, and business-oriented, and the other small, family-owned, and located in the suburbs of Accra. We notice only limited differences in responses between these two cafés, suggesting some universal qualities of sharing.

Nearly half of survey respondents reported that they already physically share a single computer with others in the cybercafé, and three-quarters of respondents reported interest in environments that could support enhanced collaborative group work. Users also reported that sharing made their visits at the café more productive and fun.

We found that the main demographic variables, including wealth indicators, had little or no effect on sharing. In other words, people tend to share computers in Ghanaian cybercafés independent of their demographic or economic position. Moreover, we showed that the main motivation behind shared access to computers is not economic or related to sharing the cost. For example, it was uncommon for internet café customers to share the cost of common computer use with others, and respondents rarely reported sharing in order to save money. Instead, our data shows that users share a computer mostly because they want to learn from each other.

Self-reported learning outcomes from this public sharing were significant, with roughly 40% of respondents claiming to have learned to browse the web or use email by watching others in a public internet facility. Having fellow users and skillful staff present in the same physical space also reportedly helps to solve computer-related problems. When respondents faced difficulties with computer or internet use, they most commonly reported turning to the staff of the café. However, it was not uncommon that they reported asking for help from their friends, or even from fellow patrons whom they had not met before. Also, respondents reported that they sometimes themselves helped others, even strangers, in the café.

The collaborative nature of public internet access is also demonstrated through the social dimensions of a cybercafé visit. The majority of respondents to our survey reported that they came to the cafés to meet their friends, family members, or business associates. Ghanaian cybercafés are not only important social meeting places, but the physical setting and the social norms of the cafés also let visitors interact with each other, even while working on separate computers. For example, more than half of the respondents who join people they know at the café reported that they try to both sit next to each other and follow what the other one is doing on his or her individual computer.

Finally, we identified a special form of peer learning in the cafés that occurs when a visitor glances at a stranger's computer screen. We call this form of learning "voyeuristic or fleeting." Both the physical settings of the cafés, especially the arrangement of the computers, and the social norms of the venues seem to support this voyeuristic form of learning. Nevertheless, café users are highly concerned about their own privacy. Almost all of our respondents found privacy to be an important issue, though users who had experience with sharing were less privacy-conscious.

Following from these survey results, we designed BusyBoard, a system for sharing images, text, or webpages with other customers at an internet café. Our hope was that the system would help connect café patrons and thus open up opportunity for collaboration and sharing. We deployed this system at Busy Internet in Accra, Ghana, and accumulated experience and usage statistics. Our preliminary findings indicate that the system did not particularly motivate real-time collaborative behavior, and that it was, instead, used as a tool for broadcasting predominantly commercial messages to café visitors. Commercial messaging among cybercafé patrons in Accra is arguably a valuable service. For instance, it might help to develop economic opportunities for users of public internet venues. However, it is not entirely consistent with our initial design goals, which were to encourage group work and assist people in identifying opportunities to work together. This suggests, perhaps, that future systems aimed at motivating or augmenting specific behavior would benefit from a more focused design, as opposed to BusyBoard's flexible approach of allowing very open-ended content sharing. For instance, a system might only allow patrons to contribute specific requests for assistance or collaboration.

Next Steps

Based on the results of our survey, we strongly believe that there is a need to develop information and communication technologies and applications which support collaboration and group work in shared internet access points, as the existing technology and architectures in the cybercafés we studied is designed primarily for single-user scenarios. Our survey results suggest that café visitors would be interested in using the computers in new ways that support collaboration among their peers. The great majority of the respondents indicated that they would like to participate in collaborative group work at the café.

However, the applicability of such a group work application is not clear yet, especially to users themselves. It is not surprising that most of the people who are interested answered that they would only use this opportunity sometimes or rarely.

As we noted while discussing BusyBoard's design above, the system only aims to address a subset of the findings from our survey work; there is still much room for other design experiments in this space. In addition to improving the BusyBoard system that we have already developed and deployed, we are exploring other ideas for supporting collaboration. For example, a "shared clipboard" to support content sharing between individuals might enable users to collaborate on a single, shared task while using separate workstations. Additionally, we envision applications that could support educational use, such as by providing computerized training for basic computer literacy skills, or by making users aware of peers with similar interests or skills, so they could teach each other or work together. We hope that such prototypes will prove valuable in exploring how to best promote collaborative uses of technology, given the multi-user models we have discussed.

Our video analysis work demonstrated the promise and possibilities of these technologies' being applied to studying group and individual work behaviors in public internet venues. Our work there is only preliminary, and it mostly points to future research possibilities.

Our study is strictly limited to Ghanaian cybercafés, and we recognize that sharing in a public internet access point is influenced by the local cultural and social norms. We also believe that users' participation in the development process leads to better innovations, especially when developing technologies for users from a different culture.

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APPENDIX A: Supplementary tables, figures, pictures

Figure 21: A product advertisement posted to BusyBoard

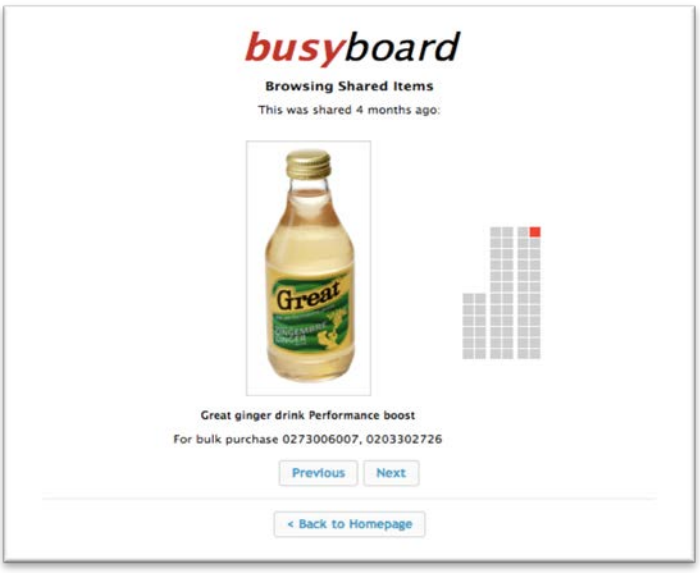

Figure 22: An event advertisement posted to BusyBoard

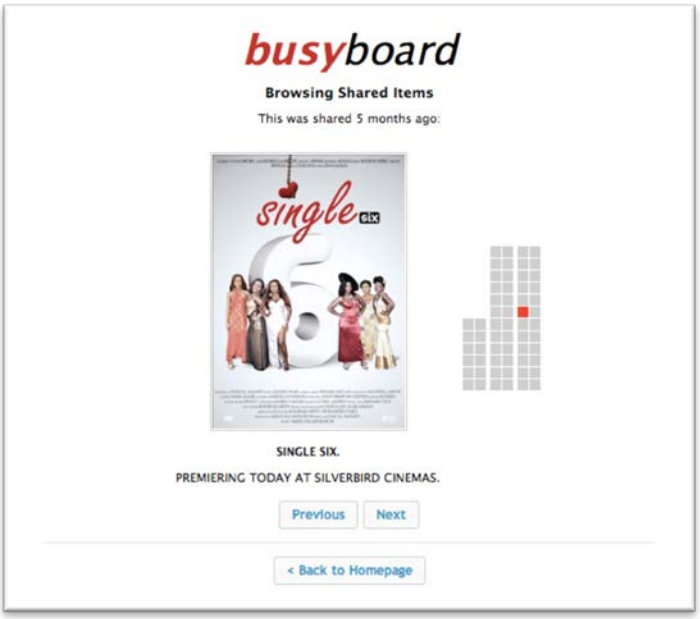

Figure 23: A humorous image posted to BusyBoard

Figure 24: A personal message posted to BusyBoard

Figure 25: Words of wisdom posted to BusyBoard

Figure 26: Another example containing words of wisdom posted to BusyBoard

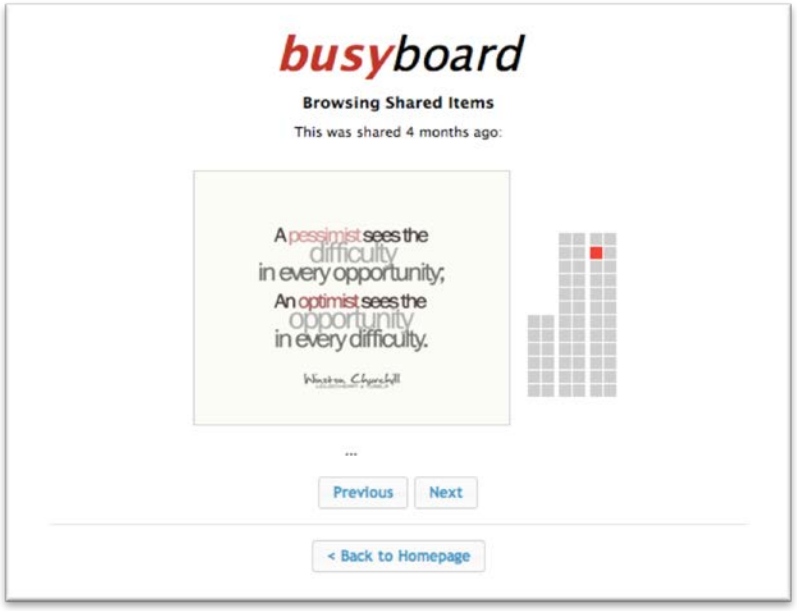

Figure 27: A random image posted to BusyBoard.

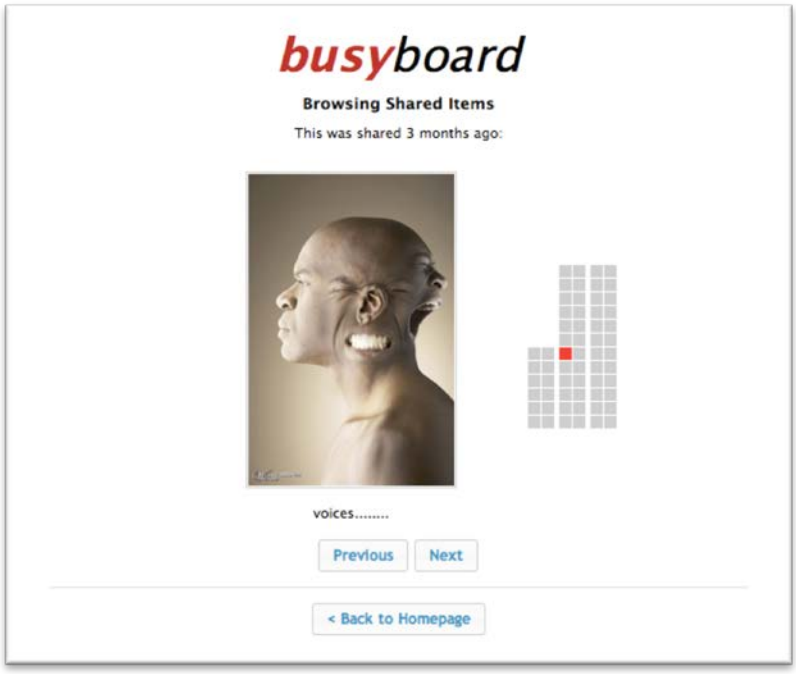

Figure 28: A sports-related image posted to BusyBoard