

# Understanding Local Community Attachment, Engagement and Social Support Networks Mediated by Mobile Technology

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**Understanding the impacts and consequences of information and communications technology in local communities through theoretical and practical approaches has long been studied. Among different types of technologies, mobile technology suggests new opportunities for community informatics because a growing number of people across different age groups have adopted smartphones, which have become an indispensable part of people's daily lives. Because mobile technology transcends the limitations of time and place, it expands the ways of accessing and interacting with local community information and lowers the barrier to participation. In this paper, we present our ongoing initiatives in community informatics including digital cultural heritage and local volunteer efforts mediated by mobile technology. We highlight how mobile technology, together with increased mobility, immediacy and social presence, shows a significant influence on local communities with respect to community identity, awareness and participation and also social support networks.**

## RESEARCH HIGHLIGHTS

- Present the relationship between affordances of mobile technology and a conceptual model of local communities.
- Describe two mobile civic projects and discuss the findings from empirical user studies.
- Articulate the impacts and consequences of and present a comprehensive analysis on mobile technology to local communities.

*Keywords: human-computer interaction (HCI); ubiquitous and mobile computing; information systems and applications; mobile applications; user studies; information and communication technology; community informatics*

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## 1. INTRODUCTION

Nowadays people live in their mobile, electronic, individualistic age, yet a geographical local community is still significant for people, because a local community is the place where they are physically located, spend their everyday life and interact with other people. The goals of geographical communities are to strengthen community identity, enhance awareness, promote participation in a variety of community activities and

increase social diversity and connection among people. Community informatics is a research field focusing primarily on the interaction between local communities and information technologies and a more particular focus within social informatics such as assessing the impacts and potential consequences of computing resources from information and communications technologies (ICTs) as applied to those geographic community goals (Schuler, 1996; Williams and Durrance, 2010).

Among the different types of ICTs, mobile technology has gained a lot of attention from researchers and practitioners in community informatics, especially after the smartphone was introduced, mainly due to the two following reasons. First is the continuing increase in smartphone adoption. According to the recent report from the Pew Internet & American Life, 56% of American adults are now smartphone users and the number of smartphone adoptions has steadily increased across different age groups since 2011 (Smith, 2013). A growing number of people also utilize their smartphones as portable computers, spending a lot of time using them for certain tasks (Jara *et al.*, 2014). The especially high percentage of smartphone adoption and usage by young people is an indicator of future trends in people's usage patterns, which would also affect community networks. Secondly, mobile technology not only incorporates benefits and complements challenges from other technologies, but it also creates distinctive affordances and opportunities. More specifically, it increases both mobility and accessibility, allowing people to access a great amount of locally relevant information anytime and anywhere (Geser, 2004; Green, 2002), significantly increasing people's reliance on and expectation for such technologies to keep them up to date and in touch with their community.

In addition, Web 2.0 technologies have the potential of providing new community-oriented approaches in creating and disseminating locally relevant content within geographical communities (Mason and Rennie, 2007), because they allow people to create and share personal experiences with others in the form of user-generated content, shifting perspectives from top-down to bottom-up (O'Connor, 2008; Paulussen and Ugille, 2008). Rather than accessing or consuming information provided by officially designated institutions, people start to create rich and more diverse stream of community information by taking advantage of technologies (Gillmor, 2004). More recent expansion and prevalence of using social media platforms, such as Facebook, Twitter, Instagram, Pinterest, and much more, garners opportunities and options for people to engage in such activities. Those social media platforms contribute to lowering the barriers to participation by providing easy-to-use and straightforward web and mobile interfaces that support the creation and sharing of various types of information including text-based messages, digital photos and video clips (Bollen *et al.*, 2009). These all lead to fulfilling the notion of *hyperlocality* (Farhi, 1991), allowing information and interaction to be placed within a geographic context and to be locally shared and accessed.

These standpoints motivate and even necessitate the investigation of the influences and outcomes of mobile technology utilized in a context of local communities. We describe two mobile community projects in community informatics that have been continuing over a year. We have designed and implemented the smartphone applications and conducted the user studies for each project, aiming at understanding the following research question.

*RQ: How does mobile technology influence local geographical communities with respect to community identity, community awareness and participation, and social support networks?*

In this paper we first describe a conceptual model of community, affordances of mobile technology and the previous theoretical and practical research efforts in community informatics. Then we introduce our two research projects along with the designated mobile application and describe the goals and the procedures of the user studies. Then we present the findings and discuss how mobile technology facilitates community information creation and sharing as well as strengthening community identity and constructing or reinforcing social interaction among local people and with their community. Finally, we discuss future research directions in the space of hyperlocal community mediated by mobile technology.

## 2. CONCEPTUAL MODEL OF COMMUNITY

Community is a widely used term that has been theorized extensively. It is commonplace to call a social group a community if a group of people has similar interests (Wenger, 1998) regardless of offline or online environments. The premise is that all that is required to become a 'community' is a non-specific social warmth within that group. This is aligned with the notion of sense of community which refers to 'a feeling members have of belonging, a feeling that members matter to one another and the group, and a shared faith that member's needs will be met through their commitment to be together' (McMillan and Chavis, 1996).

Among a number of different definitions of community, our focus lies in the geographical local community. We are particularly interested in the local communities mediated by mobile technology in which people access various types of community news or event information, express their personal opinions or thoughts on certain topics and form or maintain social relationship with others in online and offline environments through technologies. Since the late 1990s, the deployment of community networks has more continuously increased and widely been investigated by many researchers, because of the development of the Internet as well as the growing number of its use and the installation of broadband wireless network in many communities.

To better understand the connection between technologies and communities, we employ a conceptual model of community consisted of the three facets, namely community identity, local participation and awareness and also support networks (Table 1; Carroll, 2012).

*Community identity (CI)*: it indicates a sense of attachment and belonging to people, local places and past events. When people think they are part of the community that they live and want to be more aware of and get involved in their community activity, they form and maintain community identity. Having a community identity is a fundamental requirement for people to become

**Table 1.** A conceptual model of community (Carroll, 2012).

Facet	Description
Community identity (attachment)	Members experience ideal of community by sharing values, episodes, traditions and experiences of local and world events; feel belonging and shared emotional connection; regard for local places and past events; experience community membership as part of who they are; are committed to and believe in the community's capacity to thrive and develop.
Participation and awareness (engagement)	At least some members enact shared identity through collective activity, including leadership and innovation in community practices. Through this activity, members become known; their conduct and contributions are visible; all members see that one can have an impact on community decisions and initiatives, and come to regard the community as sustainable and effective. A less active form of participation is maintaining awareness of community activity.
Social supported networks	Community members typically play a variety of roles, and provide and reciprocate social and material support through a multitude of different tie types. The community is a relatively densely interconnected sub-network of the societal social network.

interested in their local community and influence their civic awareness and participation.

*Participation and awareness (PA)*: it refers to more visible actions or activities developed from community identity. People become more aware of local community news, events or activities, and depending on individual preference and motivation, some local residents are actively involved in different types of community activities to voice their opinions to the public or their community whereas some less active and motivated people prefer to maintain their awareness of local topics. It is important to note that participation and awareness, and community identity are mutually related because increased participation and awareness also strengthens community identity.

*(Multiplexed) social support network (SN)*: it refers to different types of actions and roles that each individual community member can take while participating in different activities. Each community member will have his/her own perception or knowledge of local community information that affects the degree of his/her participation. For example, one member is a father of a family, a local high school teacher and a member of a local volunteer group. This member will be motivated to express his/her opinions to some local topics or issues such as high school renovation projects or other local volunteer activities. In this sense, because the community is an interconnected sub-network of the societal social network, a variety of information will be generated and shared by community members who have different motivations and expectations. In Coleman's analysis, the *multiplexity* of ties in a modern community is critical to developing and facilitating flows of social capital (Coleman, 1998).

### 3. AFFORDANCES OF MOBILE TECHNOLOGY

#### 3.1. Mobility

The principal advantage of mobile technology is increased *mobility*. It allows people to access services wherever they go and transcends limitations of geography and distance when digitally communicating with others. As such, there have been a number of research studies aiming at understanding its aspect and influence in different contexts ranging from mobile health (i.e. allowing individuals to receive needed medical attention and advice) (Istenpanian *et al.*, 2004), mobile-payment system (i.e. flexibly managing their account or money transactions) (Kim *et al.*, 2010) to mobile workers (i.e. providing remote communication and collaboration among field workers) (Yuan *et al.*, 2010).

When it is applied to a local community context, one could easily imagine that mobility will facilitate access and interaction with various types of community information (e.g. reading local news or events and adding comments) as well as having social communications and interactions with others (by exchanging text messages or using social media) anytime and anywhere. This could possibly lead to evaluating mobility primarily based on a technological perspective or merely as an alternative to a static or fixed activity. However, it is also important to understand mobility within a lens of social and cultural aspects, because it can be interpreted differently depending on how it is socially, culturally and contextually situated (Dourish *et al.*, 2007). In this sense, we aim at articulating the applications and consequences of mobility in local community contexts by taking social standpoints.

### 3.2. Immediacy

*Immediacy* refers to the quality of bringing one into direct and instant involvement with something (e.g. entities, events, actions, etc.) in somewhat more time-critical situations or conditions (Anckar and D'Incau, 2002). When it is linked to mobile technology, immediacy usually pertains to how fast one could meet his/her expectations in terms of obtaining or accessing information in a particular situation or context. For example, Kynäslähti (2003) highlighted that immediacy of mobile technology allows the people to make memos and take photos while they are attending or observing lessons as well as sharing them with others instantaneously. By conducting a study with high school students, Rau *et al.* (2006) found that increased immediacy from mobile communication technology contributes to social presence and motivates students to participate more actively in classrooms, because it facilitates communications between students and instructors as well as making students feel more connected to the instructors and classroom activities.

Similar to these findings, when it comes to a local community context, we can imagine usage scenarios where a local member consumes information pertinent to a local community and interacts with any local content through their mobile device whenever he or she wants. More and more people are carrying their mobile devices at all time and wireless connectivity and capacity continue to increase with the expanded availability of WiFi access points or 3G/4G networks, various types of local community information (e.g. news, events, meetings, etc.) will be accessed through mobile applications or a web-browser when requested, and people can also create new content by themselves and share it with their friends or the public through emails or other social media channels.

### 3.3. Social presence

*Social presence*, which refers to the 'degree of salience of the other person in a mediated communication and the consequent salience of their interpersonal interactions' (Short *et al.*, 1976, p. 65), is considered to be a critical factor in creating and maintaining social interaction, as it stresses togetherness, psychological involvement and behavior engagement among people (Biocca *et al.*, 2001). Social interaction often takes the form of digitally mediated communication; therefore, technology also shows a great impact on social presence. Social presence can be broken down into more dimensions such as immediacy and intimacy (Short *et al.*, 1976), but our focus lies in immediacy. As increased mobility is closely related to increased immediacy, the combined influence of mobility and immediacy broadens and increases social presence.

As such, there has been much research highlighting the positive correlation between mobile technology and social presence. For example, Hampton *et al.* (2009) present that Internet connectivity in public spaces contributes to the generation of social interaction and participation, increasing

social presence in public space. They show that the use of ICTs leads to larger and more diverse social networks with people based on the analysis on a number of data collected from people's cellphone and Internet usage. Humpherys (2010) describes how people create and maintain their social relationship with others through use of *Dodgeball*, a mobile application that enables users to meet up by distributing location-based information of user whereabouts. *Dodgeball* users found that the mobile social network facilitated social connection and also transformed the traditional notion of public space into a socially interpreted space. In her book, Chayko (2008) describes the phenomena where groups of people connect via online and mobile technology with their friends, family members and even people whom they have not met before, and develop a shared identity and culture as well as a sense of belonging and togetherness from making themselves more socially visible.

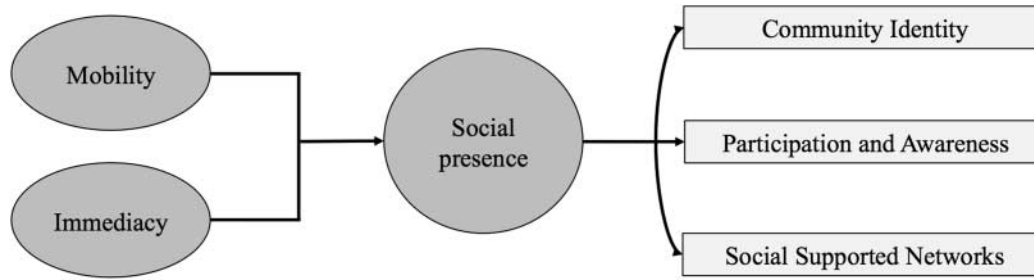
## 4. PROPOSED MODEL OF MOBILE-MEDIATED COMMUNITY

These three affordances are found to be core elements of mobile and ubiquitous computing. Although each has unique characteristics and implies different impacts and consequences, they are not mutually exclusive but rather influence each other and develop together. Our literature review highlights that mobility is a more location-oriented and immediacy is a more time-oriented element of mobile technology. Social presence is the one that is greatly influenced by the combination of mobility and immediacy. In other words, mobile technology significantly increases mobility and immediacy in terms of information access, share, and dissemination, and these two factors increase social presence.

Therefore, in this paper, we aim at understanding the relationship between affordances of mobile technology and the three facets of a conceptual model of community based on the two mobile projects we have conducted (Fig. 1). We believe that investigating the roles and impacts through social perspectives, namely community identity, awareness, participation and social support networks, will provide insights on understanding the application of ubiquitous computing in another context in which it spatializes, temporalizes and embodies everyday life (Galloway, 2010).

## 5. RESEARCH IN COMMUNITY NETWORKS

Community networks conceptualize technologies as important agents for community transformation (Williams *et al.* 2005); in this sense, much research has been conducted to investigate how technologies contribute to the strengthening of community identity, enhancement of awareness and promotion of participation. As network infrastructure has become more accessible to the general public, motivated individuals and



**Figure 1.** Proposed model of mobile-mediated local community. Mobility and immediacy create and facilitate social presence of people co-located in the same area, which also leads to the positive influence on community identity, participation and awareness and social support networks. We investigate this relationship based on our two mobile community projects.

groups in place-based communities began to explore the potential for ICTs to be deployed to support the creation, provision and sharing of local community information. With this increased connectivity among citizens, groups, local organizations and more, the community has found new ways to reinvent itself to fit into the different technological, social or economic conditions over time (Wellman, 1999), and people in the community also expect up-to-date information and value-added interactions through technology (Carroll *et al.*, 2011). Carroll and Rosson (2008) investigate the benefits on infrastructure, service supports, education and culture, and recreation from ubiquitous computing in community context.

Along with the theoretical insights, much research has been done on the development of systems that harness the benefits of supplementing community activities with technologies. Millen and Patterson (2002) describe the design idea of community software and discuss how to stimulate social engagement among members. Having a channeling mechanism and explicit notification message to make community activities more noticeable is necessary to facilitate discussion between community members. For example, *What's happening* was designed to easily convey community information and interact with other members with minimal efforts by integrating simple interfaces such as a communication bar and a screen saver (Zhao and Stasko, 2002). *AwareNews* employs the notion of context awareness to present organizational community news information to people and to promote knowledge sharing among them (Decurtins *et al.*, 2008).

More recent projects in community networks include *CiVicinity*, a community portal that builds upon the tools provided by web technology (Carroll *et al.*, 2011; Hoffman *et al.*, 2012). Local news or calendar feeds are dynamically generated from various community sources, and *CiVicinity* aggregates and displays the community information, bringing it into one easily accessible and central location. It also leverages the location information as a main context and visualizes both one's physical and the news or events location on the map. *Virtual Town Square (VTS)* has a similar design rationale of what *CiVicinity* takes into account with respect to aggregating

local news and information to increase community awareness and participation (Kavanaugh *et al.*, 2013). *Local News Chatter* is the smartphone application that provides an algorithm to filter and associate local tweets that are relevant to local news topics, where the aggregated news and tweets are then presented in a tag cloud (Han *et al.*, 2014c). *ACTion Alexandria* is the online tool to create the coordination of problem solving and local volunteerism (Hanson *et al.*, 2014). It provides a channel to facilitate online interactions activities in sharing experiences and stories, disseminating tasks and challenges to others, as well as fosters offline collective actions by helping members in their community.

Another popular research study in community networks points to the utilization of large screens to display community information and allow people to contribute their own inputs (Struppek, 2006). For example, Koch (2005) presents the idea of large displays to make community activities and members more visible and emphasizes the importance of facilitating community communications to enhance community awareness. *Twitterspace* collects tweets and displays them on large screens at the university to deliver events and member activities to a broad audience (Ryan *et al.*, 2008). *Discussion in Space (DIS)* is a feedback platform utilizing large screens to advertise community relevant questions and issues to the public and mobile devices to allow local people to add corresponding responses (Schroeter, 2012).

All of these projects contribute to understanding the application of technologies in the context of local community. However, most of them focus primarily on describing technological benefits of their system and less on articulating social outcomes to and providing comprehensive analysis and insights on people and their community. Apparently, our research is consistent with the goals of those civic projects in terms of their motivations and expectations; however, our unique contribution is that we take a socio-technical approach. We aim at not only designing and implementing mobile applications that create new or additional ways of accessing and interacting with local information and people, but also understanding their impacts on people and their communities

(i.e. how mobile technology makes community information more visible, positively affects community participation, and creates and reinforces social connection and interaction based on the conceptual model of community). Moreover, we present a more comprehensive analysis based on the result drawn from the two independent community projects with different objectives.

## 6. OVERVIEW OF ONGOING COMMUNITY PROJECTS

We have been working on two research projects in order to investigate mobile-based community services and applications. Because each project depicts different aspects of local communities, we detail the motivation and intention of each project and introduce the designated smartphone application.

### 6.1. Lost State College

Digital storytelling is synergetic with the continuous evolution of mobile devices and the introduction of Web 2.0 applications, enabling people to easily add digital photos and leave personal experience narration (Jokela *et al.*, 2008). When situated in local community contexts, digital storytelling encourages people's interests in their community and is effective in engaging community members (Klaebe *et al.*, 2007) and shared stories of community history strengthen the sense of community (Freidus and Hlubinka, 2002). Especially, for local residents, history of a community is part of feeling a sense of belonging or an emotional connection, which is regarded as community identity. The history of a community is a part of its identity and is the essence of the communal roots that local residents inherit or share by cohabiting or visiting a physical region (Carroll and Rosson, 2008).

In fact, there exist a number of mobile tour applications that used in museums or historical landmarks and much research has been made to understand how mobile technology transforms the traditional ways of social connection. For example, Aoki *et al.* (2002) developed a mobile tour application called *Sotto Voce* that incorporated an audio sharing mechanism. By using the application, participants were able to share audio clips through an 'eavesdropping' mechanism, which created a strong interaction between companions. *Explore!* (Ardito *et al.*, 2008) is a mobile game application that is used in archaeological parks. Groups of people perform a game to explore and enjoy heritage by interacting with each other and using mobile devices. However, little research has been placed on detailing the relationship between user interactions with the application and the notion of storytelling, and how people perceive that aspect as linkage to their community.

In this sense, Lost State College was designed to make local heritage more visible and available to community members, aiming to capture and share the collective memories of a town's history (Han *et al.*, 2014a). Its name implies preservation efforts

of local history; otherwise it will be 'lost' in the future. It utilizes 14 official historic downtown landmarks provided by a Borough of State College, Pennsylvania. For each location, it provides a set of information including a name, an address, a set of official historical and current photos, a text description and a pre-recorded audio description. It also provides a walking route from one landmark to another, allowing users to easily take a walking tour of the historical places.

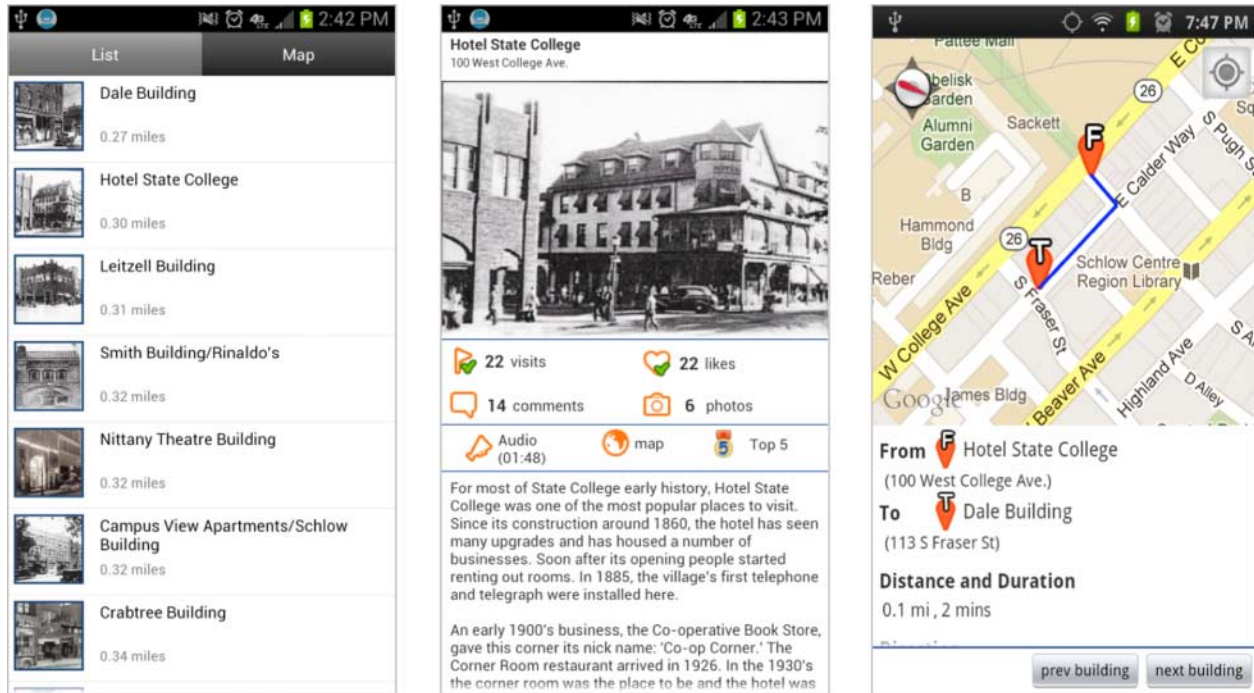
Along with these official content, Lost State College also provides four additional interfaces called *Social features* in which local residents can provide their personal reflections and stories to the landmarks through visits, likes, comments or photos on the mobile device (Fig. 2). Our design rationale of having Social features is to investigate how people utilize them to reconstruct landmarks into more dynamic and socially meaningful places both to people and community.

### 6.2. Mobile TimeBanking

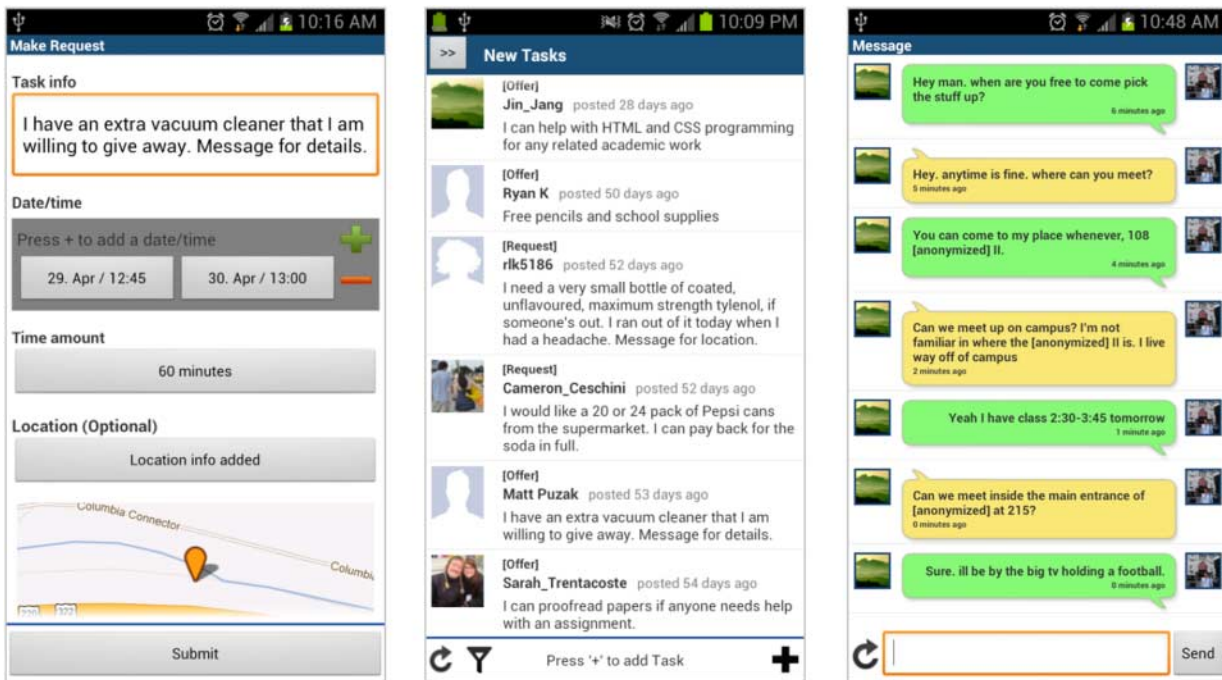
Volunteering has long existed in local communities and been one of the critical elements that sustain local communities (Putnam, 2000). It is not difficult to see that many local people are willing to donate their time and money to help other people, schools, churches, hospitals and local nonprofits in an effort to improve their communities.

Timebanks use time as a form of currency and aim at expanding community-based volunteering through the exchange of time and skills among community members, creating an environment in which people receive and provide a service in exchange for time credits (Cahn, 2000). For example, one neighbor who has a vehicle can give a senior citizen a ride to and pick them up from the hospital. Then, the earned time can be used to ask another member to fix their computer. At its core, timebanking emphasizes its members using their own unique and valuable skills to help others. It also emphasizes the notion of co-production in which the provider and recipient create and enact a timebanking service together, which leads to positive social outcomes for people and the community (Cahn, 2010; Carroll, 2013). This helps timebank members develop a sense of self-efficacy and achievement regardless of their professional or income level (Bellotti *et al.*, 2014; Collom *et al.*, 2012; Seyfang, 2004). In this sense, timebanking emphasizes beneficial social outcomes derived from social interactions and connections with others not necessarily a value of time credits.

As timebank is community-oriented movement and initiative, there are several timebank organizations in the USA. Many of them have already leveraged technologies; for example, developing web platforms to simplify what was traditionally paper-based work by coordinators, such as setting up timebank member accounts, recording time credit balances, providing a list of requests from others, and so on. TimeBanks USA (<http://timebanks.org/>) is one of the largest timebank organizations that has about 250 timebanks with over 25,000 members in North America and 13 other countries and



**Figure 2.** Screenshots of the Lost State College application. A list of historical landmarks in downtown, State College (left); a detailed page of the landmark integrating official and social content (mid); a walking route page from one landmark to another (right).



**Figure 3.** Screenshots of the Mobile TimeBanking application. Add a task page (left); a list of tasks added by participants (mid); a task detail page (right).

created a web-based platform called *Community Weaver*. hOurworld (<http://www.hourworld.org/>), another national non-profit timebank organization, which has about 120 timebanks with more than 15,000 members in the USA, provides a web-based platform called *Time and Talents* (as of February 2014).

Mobile timebanking is an extension to traditional timebanking. It aims at not only supporting conventional timebanking activities but also providing new opportunities by leveraging features of mobile computing such as high mobility and accessibility. We have been collaborating with the hOurworld timebank, and after having a series of design sessions with hOurworld administrators, web developers and coordinators, we have designed the timebanking smartphone application. The application supports most web timebanking operations such as posting and accessing tasks or services, reporting completed tasks, giving time credits and accessing task history and user's profile details (Fig. 3). To take advantage of smartphone capabilities, the application has been also designed to support more functionalities that are suited well in mobile computing such as having a map view that shows both user's location and task locations as well as providing a notification feature which allows users to receive a notification for any incoming text messages from other users or status updates of the tasks in near-real time.

In summary, both Lost State College and Mobile TimeBanking all account for the utilization and application of mobile technology in the context of local communities. Each project focuses on a specific local context (i.e. local history and volunteer efforts and actions), but the overall design goals for both projects are to increase the visibility of local information and participation, create and strengthen community identity and support social interaction.

## 7. USER STUDIES AND RESULTS

To articulate the application of mobile technology in a local community, we have designed and conducted the user study for each project. In the following sub-sections, we describe the design and the methodology of the studies as well as the results.

### 7.1. Study methodology

Both studies were conducted based on the similar rationale. We recruited participants via mailing lists, a research website and word-of-mouth. All participants for both studies were first asked to complete a brief pre-survey that asked for demographic information and to use the mobile application. As the last step of the study, participants were asked to have an interview with us that asked for sharing their experiences and perceptions about the application. Thus, our analysis was based on all application usage logs, survey responses and quotes. We employed both quantitative and qualitative as well as thematic analyses to those collected data to understand and evaluate all the constructs presented in our proposed model.

### 7.2. Lost State College

We conducted a user study with a total of 34 community members; 21 were males and 13 were females, with ages between 20 and 50 (mean = 30.2, SD = 9.6). Participants had differing familiarity with the town and downtown location of the tour, ranging from having resided in the community for <1 year (11 participants), 1–2 years (4), 2–4 years (7) and more than 4 years (12). Ninety percent of the participants were not aware of the history of the downtown area, but expressed high interest in learning more through the study.

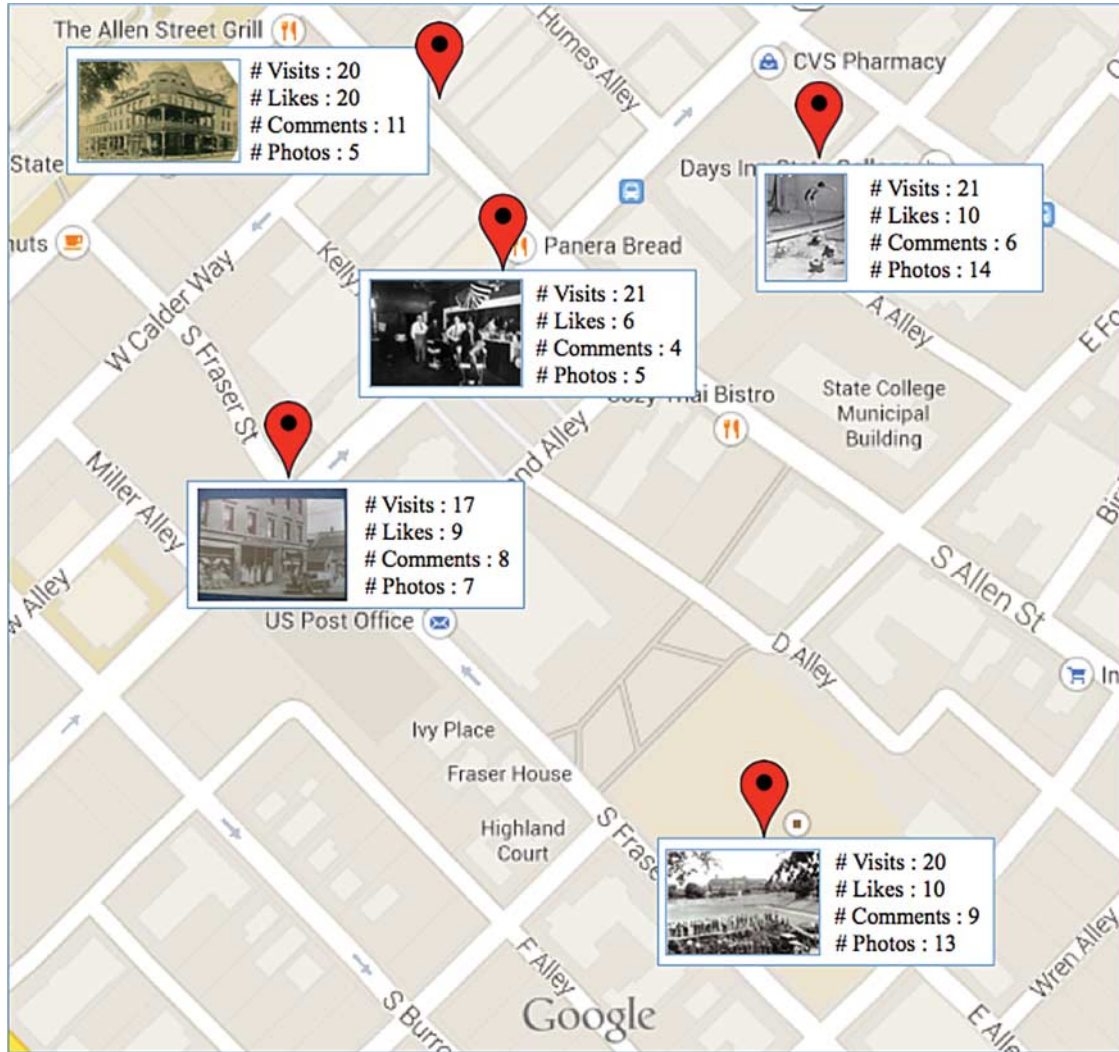
Participants were asked to visit all 14 landmarks by taking a tour. They started at the given location, and using a smartphone, as they moved through the tour at their own pace (we also followed them, answering any questions that they had and observing how they use the application). The tour took about 56 min on average. During the tour, participants were asked to stop at the marked locations to investigate and to contribute their own reactions or other content when relevant through the interfaces of Social features (Han *et al.*, 2014a).

As illustrated in Fig. 4, participants' Social features usage on each landmark was quite well distributed across the landmarks. Our observations indicate that participants interacted with LNC when they arrived at those landmarks. They checked the official and user generated (social) photos as well as reading text description and comments. They also added Likes expressing their personal preferences to the landmarks. It seemed that many participants enjoyed using LNC and especially liked Social features, because each individual feature provides a unique way to interact with other participants and the landmarks. Some participants specifically mentioned interactive aspects of the application, because they were able to check and interact with both official and socially generated local history contents right from their mobile device while they were physically located at the landmarks or in front of the historical buildings. These findings are closely related to *mobility* and *immediacy* of mobile technology, also echoed by some participants' comments.

This app gives you online social interaction. Much more convenient to use with a map feature displaying my location and the walking route to the next landmark. (Mobility and Immediacy)

An interesting observation was that the usage of Social features generally increased as more tours took place. In other words, participants in later groups tended to spend more time on adding and accessing contents from Social features whereas those in the earlier groups tended to spend more time on reading official descriptions and photos of the landmarks. The usage results indicate that as more participants began to use the Social features to contribute new content to the landmark pages, the overall use of Social features gradually increased. This might be an example of increased *social presence* about local history mediated through the application, where participants could see other local people's actions and engagement.





**Figure 4.** Example of user engagement during the study. Participants checked and augmented a number of contents while they were physically located at the landmarks.

I can see many people are sharing valuable contents through the app.  
(Social presence)

Participants' interactions with all four Social features (Visits, Likes, Comments, and Photos) show different motivations and expectations. More specifically, participants added Visits to mark their presence and Likes to express their personal preference to the landmarks in a simple manner. They also took and shared a variety of photos for landmarks. Interestingly, we found that participants tended not to take photos that looked similar to existing ones that already had taken by other participants. Instead, they added ones that captured different angles, interesting architectural or decorative features, close-ups, insides, surroundings and so on (Fig. 5), creating a full picture of the landmarks. Similar to adding photos, participants augmented text-based information to the

landmarks. Participants added different types of comments including one's appreciation toward a landmark in a few words (e.g., 'nice hotel', 'classic structure'), physical observations about the landmarks (e.g. 'The nittany quill is here and a closed store dragon chaser'), additional information or stories to the landmarks (e.g. 'There's an orthodontist office up there and it has an awesome fish tank in the waiting room'). The activities of utilizing different types of social features showed participants' great interests on the landmark while having the tour. Interacting with the landmarks and other users through Lost State College seems to increase participants' civic awareness and engagement.

Participants also showed different degrees of participation and engagement. Those who have lived in a town longer (i.e. more than 4 years) tended to add more photos and comments and more informative content than those who are relatively newcomers (i.e. <1 year). For example, they shared personal

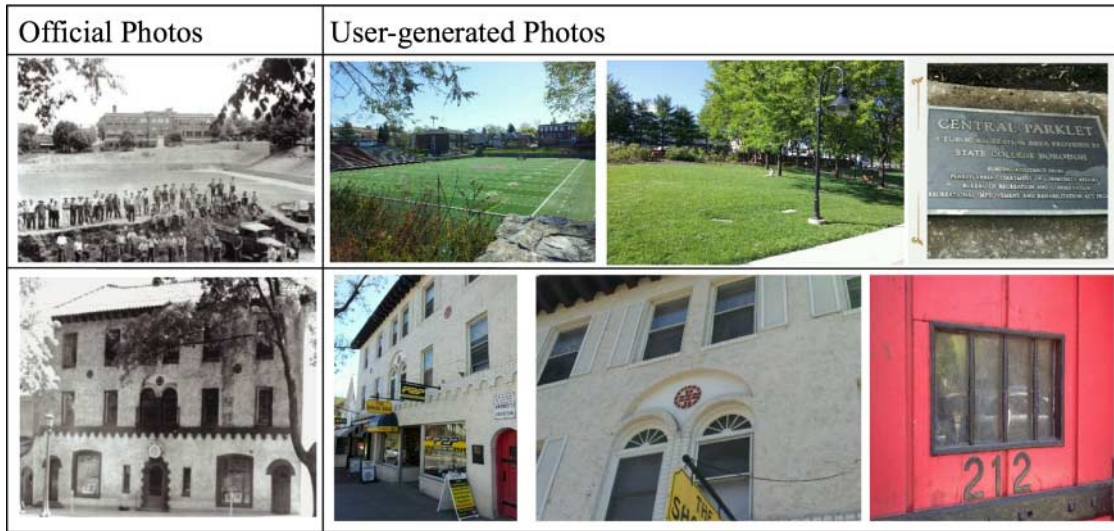


Figure 5. Examples of official photos and user-generated photos. Participants took various types of photos related to the landmarks.

experiences and stories or provided additional information about the landmarks while those in the low-residence group tended to add more personal appreciation to the landmarks. This result in part indicates that people who have lived in the community longer might be more aware of local history or more motivated to participate in this activity, which clearly shows different actions and motivations toward digital storytelling among local residents.

Regarding one’s connection to the community, it seems that Lost State College provides an opportunity to make participants believe that the place where they live has its own long and rich history as well as giving them heartfelt appreciation for the people and families who built up the town over many generations. They also mentioned that they felt more identity and belonging to a community after completing the tour.

I really didn’t know buildings have some stories and history. Giving more different perspectives to my community. (Identity and awareness)

I love to know about the story of each building. Knowing a little bit more makes me feel even more like ‘townie’. (Identity and awareness)

In summary, our study results show a few insights that are all related to three facets of community model. By using Lost State College, participants became aware of local history through official and user-generated content (*Awareness*). Being at the historical landmarks and accessing content through the application evoked some participants’ personal memories and stories, and some motivated participants started to augment additional information (*Participation*). Such unique personal stories and additional information of the landmarks were not available in the official content. They were indeed served as additional layers of local history, which were read and consumed

as meaningful information by other local people (*Social support networks*). A series of interactions and activities reconstructs, preserves and develops local cultural heritage and connects local people and landmarks, forming and strengthening *community identity*. Lost State College facilitates these flows because it placed participants at the landmarks and enabled them to access, create and share content through a mobile device.

7.3. Mobile TimeBanking

Along with investigating usability and feasibility of mobile timebanking to local community members, the purpose of the Mobile TimeBanking study was to analyze overall mobile timebanking usage and investigate social interactions among participants that were influenced by their increase awareness and participation (Han et al., 2014b). Of 32 participants that we recruited, 21 were males and 11 were females. Seven participants were under 20 years old, and the rest were in their low 20s. All participants have their own smartphone and are familiar with using the smartphone for different activities such as using social media, web-surfing, emailing, gaming and so on. We asked them freely used the timebanking smartphone application for 5 weeks.

The study results first demonstrate that mobile timebanking extends the functionalities of traditional paper- and web-based timebanking, as well as creating additional affordances by harnessing capabilities of mobile technology. We observed that participants created tasks that were found in existing practices of timebanking (e.g. exchanging goods, giving away items, looking for advices, asking for a ride etc.; Collom et al., 2012), and the ones that seem to be highly pertinent to participants’ school life, which are not found to be highly

popular in conventional timebanks (e.g. proofreading reports or assignments, tutoring, etc.).

We also observed some interesting examples of more time- or location-sensitive timebanking activities that were highly influenced by enhanced mobility and immediacy. For example, there was a task involving buying items named, 'Need a pack of A4 paper if someone is near a store. I can meet on campus or give directions to my apartment if needed'. One participant took this task because he was at the location specified in the task description.

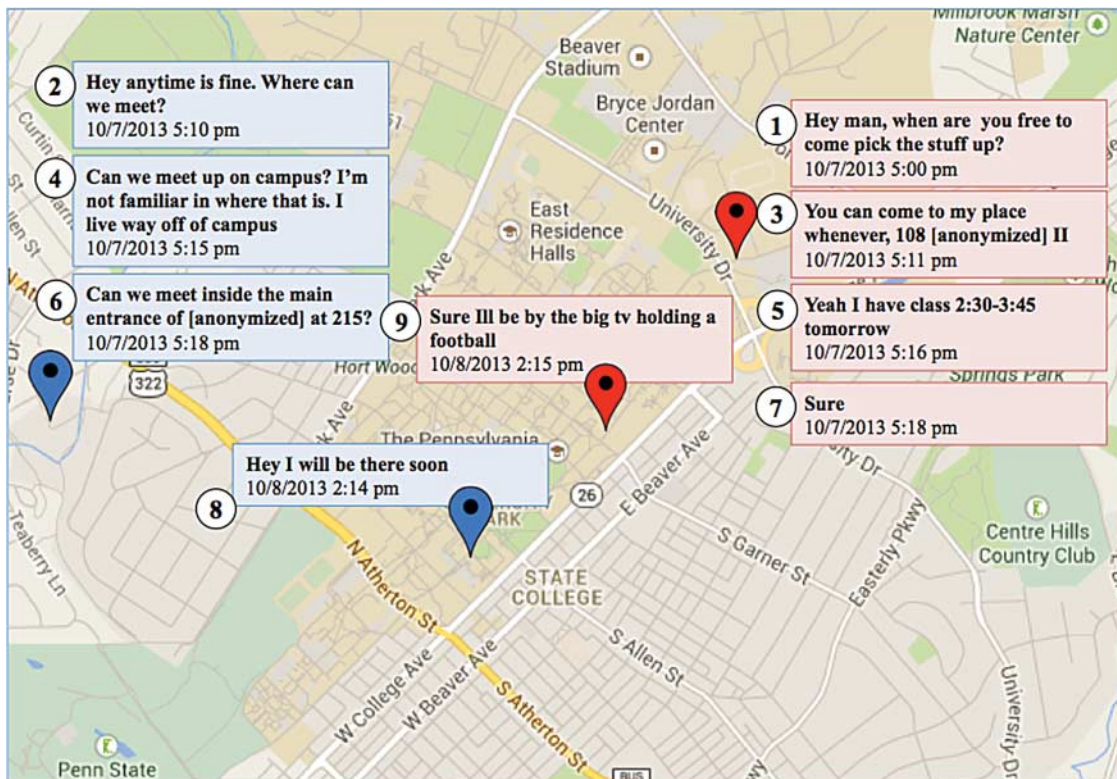
*I took this task because I saw it while I was at BestBuy looking for something else. I was able to pick up A4 paper and give them to him on campus later that day. He paid me back. (Mobility and Immediacy)*

This task taker did not go to the store just for the purpose of timebanking, and it is worth noting that completing this type of task requires a number of pre-conditions: (i) the taker was at the right place to start it and getting to the right place to complete it was not inconvenient, (ii) he found the task from the timebanking mobile application, (iii) he had enough money for this and (iv) he was willing to take the task. Of course these are not always required for initiating or completing a timebanking task, but its activity or transaction at least needs some conditions to be processed. Consequently, we found that both participants

felt great about this task completion because it was easy for the task taker, and valuable to the recipient.

Participants also utilized the messaging feature to set up or negotiate schedules and ask for more information about the tasks and others' profile (e.g. phone number, home address, etc.). As shown in Fig. 6, for example, there was one usage case in which two participants exchanged messages for task management while they were at random places such as café or in transit. This allowed them to set up the date and time and the location to complete the task as quickly as possible. In fact, a similar practice could also occur within web-based transactions; however, mobile timebanking facilitates social interactions among participants by allowing them to check and exchange messages in real time because a lot of people nowadays have their mobile device with or nearby them. This makes the whole timebanking process fast. Overall, these usage results suggest opportunities in finding, managing and completing timebanking activities and transactions leveraged by especially *mobile* and *immediate* aspects of mobile technology.

These sharing and interacting with timebanking through the mobile application is also likely to increase *social presence* of local volunteer efforts and activities among people. Some participants mentioned that they were surprised because there were a lot of tasks posted and completed by others. Some of them also mentioned that they were pleased to discover that there were many people willing to help each other in this community.



**Figure 6.** Examples of message exchanges between two participants (blue and red pins) for coordinating time to meet (Task category: Free stuff).

This app helped me see what other people need and who is there for them. (Social presence)

We observed the evidence of the formation and reinforcement of social connection among participants. For example, there were some participants who had not known each other before participating in the study, but they became to know more while completing multiple tasks. Some participants tended to interact with others whom they already knew, maintaining and reinforcing existing social relationship. There were also some cases where some participants who had not been well acquainted with each other became more familiar while exchanging a number of messages and completing the task. For example,

I barely knew him but now I feel more connected to this person after this study. We text and hang out now. (Social support networks)

Some participants also mentioned they felt more connected toward their community after the study. They were glad to have a chance to help and were pleased to discover that there were many people willing to help each other in this community. They said mobile timebanking made them feel that a lot of people were quite trustworthy for completing simple tasks and assisting others.

The app helped me see what other people need and who is there for them. It has definitely given me more confidence and trust in the community because now I feel like the community would be there to help me when i need any help. (Identity and Social support networks)

I found that factors such as how busy I was with other things and if I needed anything done at the time affected how willing I was to help other people. (Awareness and Participation)

Overall, our study results indicate that timebanking with a smartphone application showed a potential of increasing the diversity and visibility of service exchanges because it allowed people to share and check tasks and services easily and quickly from their mobile phone (*Awareness and Participation*). Young students are different populations compared with what most timebanks generally have (Collom *et al.*, 2012), and they shared additional types of timebanking tasks or services. Timebanking with a smartphone application will attract them to join their local timebank. Like what we found in this study, if existing members in timebanks use the timebanking smartphone application, we could expect a variety of tasks and services shared and created (*Social support networks*) which are not existed before in traditional paper- or web-based interactions. Such timebanking tasks include making small requests for services in-the-moment and elect to be 'on-call' to be notified of requests that apply to their current location. Previous research already found that timebank members develop a sense of community and belonging to their community while engaging in timebanking activities and interacting with others, and our study also showed a similar outcome (*Community identity*).

## 8. DISCUSSION

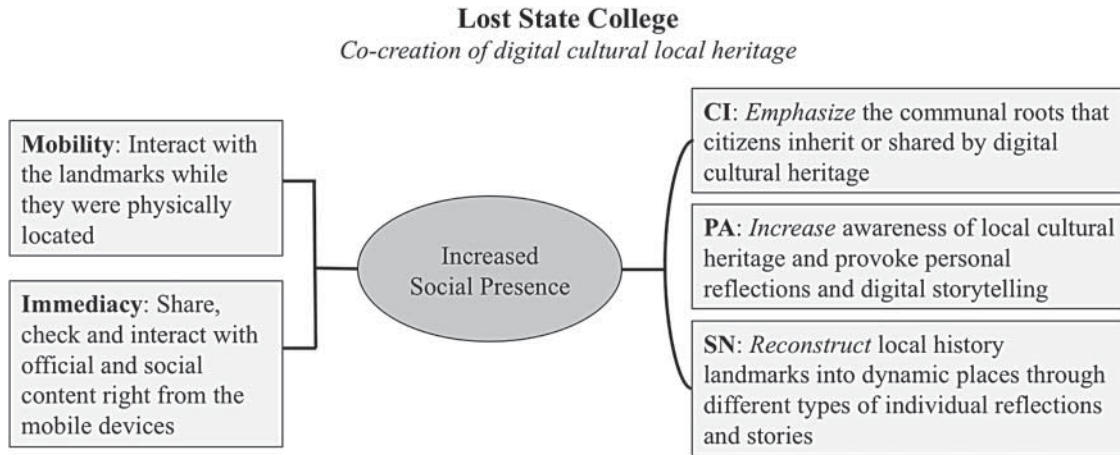
Researchers in community informatics have explored ways to increase citizen awareness and deliberation by creating new processes, and a tool integrated with technology is one way of supporting new kinds of participation. Because more people are adopting technology and become accustomed to use it in their daily lives, it is significant to consider how to leverage potential benefits and opportunities from technology into local community contexts. In other words, having the right tool that reflects local people's needs, expectations, motivations and more will greatly influence maintaining and increasing civic awareness and participation (Kavanaugh *et al.*, 2005).

Community networks take advantage of technologies to create and maintain the social network of interaction, trust, and reciprocity among different entities (e.g. people, groups, institutions, etc.) in the community, and its infrastructures have attempted to support and enhance community information generation and interaction (Carroll *et al.*, 2011). As technology evolves and changes over time, having different lenses to understand and apply design rationales in new technology is vital to fully harness the advantages of it. Although mobile technology has been introduced more than 10 years ago, applying its opportunities in a local community context has become popular more recently. This is in part because of the fact that a growing number of people are adopting mobile technology, and newer mobile technology itself creates a number of potential opportunities that local communities can leverage. From these perspectives, mobile technology evolves together with pre-existing infrastructures of wireless community and desktop-based interactions.

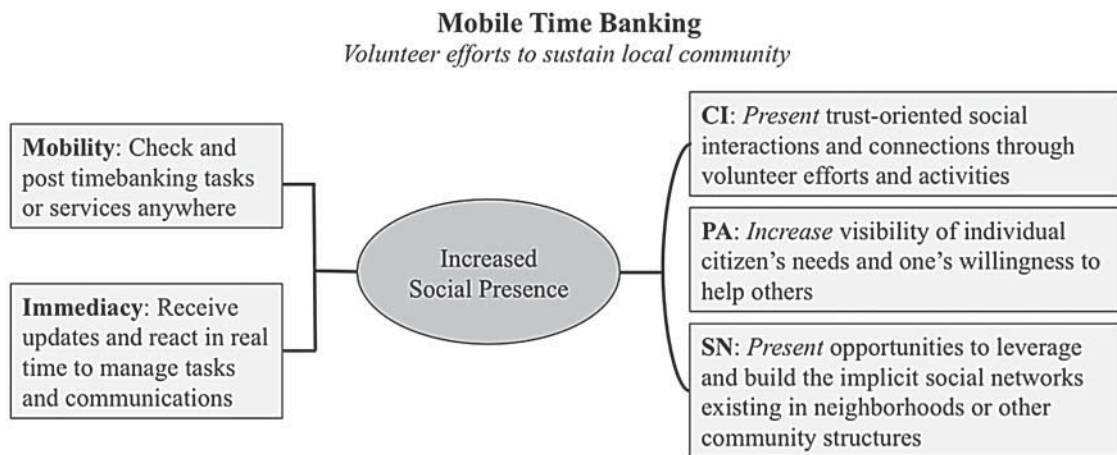
In this paper, we have described the application and utilization of mobile technology in a local community context from the two projects. Each project is not the one that was initiated and designed exclusively by ourselves but has been carefully planned and implemented by collaborating with other local community groups and stakeholders to accomplish the goals of mobile-supported community informatics. Both projects have the same design rationale with respect to allowing local residents to easily access a variety of local information anytime and anywhere, promoting their participation in community activities and supporting and reinforcing their social connections and interactions with other community members and their community all through their personal mobile device.

### 8.1. Community connection through mobile applications

We discuss our proposed model of mobile-mediated local community based on the user study results. We evaluate how Lost State College and Mobile TimeBanking leverage the affordances (i.e. increased mobility, immediacy and social presence) of mobile technology with respect to community identity, participation and awareness, and social support networks (see Figs. 7 and 8).



**Figure 7.** Evaluation of Lost State College.



**Figure 8.** Evaluation of Mobile TimeBanking.

### 8.1.1. Mobility, immediacy and social presence

First of all, our Lost State College and Mobile TimeBanking studies leverage mobility to a considerable extent in a way that each project not only has the designated smartphone application but it was also used by participants in the wild. In the Lost State College study, participants appreciated the landmarks and created and accessed official and social content while they were physically located at the landmarks, having more vivid and interactive cultural experiences. In the Mobile TimeBanking study, participants checked and posted timebanking tasks or services and communicated with others by utilizing the messaging feature while they were outside (or at a third place), facilitating management and transactions of timebanking activities easily and conveniently.

Immediacy is achieved when the participants are able to access information that they seek and share it with whom they want when they want to. In the Lost State College study,

participants were able to check or visit the nearest landmark by utilizing the map interface that displays the locations of both landmarks and participants. They were able to read and access historical information as well as creating and sharing content right from their mobile device. In the Mobile TimeBanking study, a list of timebanking tasks can be filtered and sorted based on one's time and location, allowing some participants to find a specific task that they could take, if the task satisfied their situational conditions. Participants also used the messaging feature to exchange task-related information, and the application notified them of incoming messages in real time to maintain conversations. This facilitates the management of timebanking exchanges quickly and easily. Immediacy will become more salient, not only because the increase of wireless network connectivity and capacity and its cost becomes more affordable, but also due to the fact that more people use mobile phone every day and place their device in close proximity.

Because immediacy is closely related to mobility, leveraging them together will create more time- and location-oriented opportunities such as proactively delivering community news, event or activity information to local people.

Finally, both projects showed increased social presence during the study. In the Mobile TimeBanking study, participants posted diverse timebanking tasks and services, increasing the visibility of not only themselves but also their needs and willingness to share. Many times, mobile timebanking requires face-to-face interactions between two people to complete the task even if the interaction is initiated online. From the study, we observed that some participants exchanged their phone numbers to facilitate timebanking task transactions or extended a possibility of maintaining social connection in the future. In this sense, mobile timebanking bridges social and physical presence and interaction. Although there was no physical or face-to-face interactions from the Lost State College study, accessing Social features, for example, checking who visited or liked the landmarks, reading comments and checking photos posted by others, was an essential part of their experiences as well as increasing the visibility of social presence. Participants indicated potential social outcomes if more local people including their friends or family members as well as visitors use the application. They expected to see more diverse and interesting historical content shared by more people and wanted to make local landmarks more meaningful and interactive places.

### 8.1.2. Community identity, participation and awareness and social support networks

Increased social presence mediated by mobility and immediacy clearly shows a positive influence on the local community. On the one hand, Lost State College leverages mobile technology to emphasize and increase the visibility of the communal roots that local residents or shared by digital cultural heritage. It combines official historical landmark information and user-generated content through social features, allowing local residents to augment their different or sometimes distinctive personal and community memories and additional stories to the landmarks. This is a good example of how the participants utilized the mobile history application as a way of transforming static community historical locations into more dynamic and interactive places. This perspective aligns with the notion of *placemaking*, which refers to 'the active process of connecting and relating to locations that become meaningful in our lives' (Ciolfi, 2012).

On the other hand, Mobile TimeBanking presents trust-oriented social interactions and connections through volunteer efforts and activities. It combines volunteering and new opportunities of mobile technology, allowing people to check whether there is any community member who is in need or request a service if they want to get some help by others whenever and wherever they need directly from their mobile device. In this sense, timebanking with mobile technology

not only satisfies existing practices of traditional timebanking activities but it also shows a potential of increasing the visibility of local people's needs as well as providing a channel to build and strengthen social interactions and connections among community members. Because different community members would have different needs and motivations, Mobile TimeBanking presents opportunities to build the implicit social network existing in neighborhoods or other community structures.

Our studies also showed that participants had different levels of digital participation in augmenting and providing community information. In the Lost State College study, participants who have lived in this community longer tended to add more and informative historical content to the landmarks. Relatively newcomers added less photos and comments and were more likely to express personal appreciation toward the landmarks. In the Mobile TimeBanking study, different participants posted a different number of timebanking tasks or services and interacted with people at different levels of familiarity to complete the tasks. Also in both projects, we found that some participants preferred accessing and consuming information (maintaining awareness of community activities) to adding new content and interacting with others.

Regardless of the level of engagement, our studies demonstrated that mobile technology provides opportunities to some specific local community contexts (i.e. cultural heritage and volunteering). Given the fact that more people are adopting smartphones, delivering various types of local information through designated applications to their device would make them more aware of what is happening in their local community and encourage them to be involved in different types of community activities and interactions with others and their own community. These findings of mobile technology applied in a local community could be further developed into the notion of the Internet of Things (Atzori *et al.*, 2010; Jara *et al.*, 2014), which refers to the integration of identifiable objects of the physical world by making them accessible through the Internet. User generated content in Lost State College is all connected to the location of historical landmarks and timebanking tasks created and shared also contain location information. In this sense, both applications consider activities occurred in those locations to be the *Internet of Places*, which again would be greatly utilized by mobile technology. Our projects show the potential of reshaping the access of community information as well as the conservational methods of dealing with it in more interactive ways. They also give us an insight to better understand mobile technology application and management in contemporary geographical communities.

### 8.2. Limitations

The proposed model was evaluated based primarily on the application usage logs and the interview responses. There is a need for constructing a validated survey instrument for

the proposed community constructs so we can quantify their relationships more empirically. It would make the model more comprehensive and applicable to other scenarios (e.g., interacting with local news, participating in local events etc.) that utilize mobile technology in different local community contexts. Although we were able to validate our proposed model based on the data collected from the two user studies, the generalizability of our findings is limited by the relatively small number of participants. A long-term deployment study with more users is necessary to better understand the application of mobile technology to local communities. We are currently in the process of redesigning our systems based on our findings and conducting a long-term deployment.

This paper mostly presents the positive influences of locative mobile media applications on local communities, but fails to address potential concerns and negative implications. In her studies, *Silva (2010, 2013)* argues that a number of salient factors, such as privacy, security, power and sociability should be taken into account when designing mobile technologies. She emphasizes that understanding how social norms and influences could affect how people perceive knowing other people's locations and the subsequent privacy implications is particularly important. *Wilken (2013)* discusses social opportunities of leveraging mobile phones and technologies for not only strengthening existing social networks but also for opening up new social and interactive possibilities. For example, they propose that technologies could be designed to lower privacy concerns by allowing people to maintain a manageable and playful distance. In terms of how social inequality impacts ICT use and adoption in the community context, *Crang et al. (2006)* argue that many studies that introduce technology artifacts often fail to investigate social impacts and consequences of ICT-mediated social inequalities and urban digital divides of individuals and groups in place-based communities. In their case study of ICT practices of two groups (i.e. affluent and professional groups and marginalized groups), they found that professional group tend to utilize new media technologies as an individualized background infrastructure, whereas marginalized groups are more collective and collaborative and are affected by their existing social and neighborhood networks. In our future work, we hope to investigate how negative implications such as privacy concerns and social inequalities could be integrated into our proposed community model, and how researchers and designers could be more mindful of the negative implications ICTs on community identity, awareness, participation and social support networks.

### 8.3. Exploring more opportunities in mobile-mediated local communities

Lost State College shows technological implications of integrating social features to actions and recognition of digital cultural heritage. As we are collaborating with the Historic Resources Commission in State College, we plan

to add more local historical content to Lost State College and expand its application to the public to understand the notion of digital storytelling and placemaking of the local history through a longitudinal study, which will provide broader insights in co-creating local history mediated by mobile technology. Along with a mobile device, utilizing additional modalities (e.g. barcodes, RFID etc. (*Barthel et al., 2013*)) to capture more interesting and unique personal memories of community experiences is also a feasible future research direction. Moreover, as *Brown and Chalmers (2003)* found in an ethnographic study of tourist groups, participating in a group tour can be a very sociable activity. Thus, there is an opportunity to design a mobile application that allows the members who belong to the same tour group to share and reflect on their experiences during the tour, which will allow us to investigate experiences and connection to community heritage in different perspectives.

The current results of the Mobile TimeBanking study were based on the usage and experience of university students who had not known the notion of timebanking nor were timebank members. Having usage data from existing timebank members would reveal different user experiences and implications for mobile timebanking. We are closely collaborating with hOurworld and have more than 800 downloads from hOurworld members (as of February 2014). We expect to support more diverse types of timebanking activities, and this will allow us to investigate the effects of mobile timebanking in broader ways and compare the practices from mobile timebanking with traditional ones. We are also interested in expanding the application of mobile timebanking by integrating context-awareness features to support and facilitate more dynamic and efficient timebanking activities (*Bellotti et al., 2014*).

Along with these two projects, we are also investigating other possibilities of studying mobile intervention to local communities such as the aggregation of local news articles and locally relevant social content from social media, and the provision of the future plan of the local community in the form of photos and text descriptions. The main goals of these projects are also to make different types of local community information and interactions more visible and accessible, increase community participation and foster social interactions among local residents right through their mobile device. From all of these projects, we expect to gain a broader and more comprehensive picture of the application of mobile technology in local communities.

## 9. CONCLUSION

We introduce two community projects including digital cultural heritage and local volunteer efforts leveraged by mobile technology and discuss how each project shows the aspects of community identity, community awareness and participation, and social support networks. Based on the

theoretical understandings as well as our empirical user study results, we propose a model in which mobile technology increases social presence supported by enhanced mobility and immediacy and increased social presence leads to having community identity, awareness, participation and social support networks for local people and the community. We highlight that mobile technology is one salient part of new information infrastructures that raise new possibilities and affordances that can transform everyday citizen awareness and information and social interactions. As more local residents regardless of age will adopt smartphones and utilize them as a primary means to access and interact with community information, designing state-of-the-art and easy-to-use mobile interfaces as well as articulating user experiences and various social aspects of people and community is indeed required to better understand both theoretical and practical application of mobile technology to local communities.

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