City Explorer: The Design and Evaluation of a Location-Based Community Information System

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ABSTRACT

Many working professionals commute via public transit, yet they have limited tools for learning about their urban neighborhoods and fellow commuters. We designed a location-based game called City Explorer to investigate how transit commuters capture, share, and view community information that is specifically tied to locations. Through a four-week field study, we found that participants valued the increased awareness of their personal travel routines that they gained through City Explorer. When viewing community information, they preferred information that was factual rather than opinion-based and was presented at the start and end of their commutes. Participants found less value in connecting with other transit riders because transit rides were often seen as opportunities to disengage from others. We discuss how location-based technologies can be designed to display factual community information before, during, and at the end of transit commutes.

CCS CONCEPTS

• Human-centered computing → **Collaborative and social computing;** • Human-centered computing → **Field studies**

KEYWORDS

Community; urban informatics; location-based games; mobile computing

ACM Reference format:
Carolyn Pang, Rui Pan, Carman Neustaedter, Kate Hennessy. 2019. City Explorer: The Design and Evaluation of a Community Information System. In *2019 CHI Conference on Human Factors in Computing Systems Proceedings (CHI 2019), May 4–9, 2019, Glasgow, Scotland, UK.* ACM, New York, NY, USA. 15 pages. https://doi.org/10.1145/3290605.3300571

CHI 2019, May 4-9, 2019, Glasgow, Scotland, UK. CHI 2019, May 4-9, 2019, Glasgow, Scotland, UK.
 ACM ISBN 978-1-4503-5970-2/19/05…$15.00.

1 INTRODUCTION

People are often interested in knowing about the happenings and activities within their community and environment [34]. For example, they may want information about local festivals they could attend, leisure activities and programs for themselves or their children, or about development proposals affecting their neighborhood. This community information is valuable to people as it can help them manage and organize everyday life, as well as learn about the activities going on around them [14,23,26]. Yet studies have shown that people still find it challenging to gain such information [16,34]. The amount of information available to them through digital tools such as social media, has increased drastically and it can be hard to know what is most relevant [2,30,53]. People may also feel disconnected from those physically around them in their community, despite seeing 'familiar strangers' on a regular basis [35,36].

Our research explores this design space to more deeply understand when and how people want to learn about community information and connect with community members around them. We decided to focus on transit commuters and their commute time as prior research has shown that it provides people with opportunities to engage with one's community and community members (e.g., familiar strangers) [2,10,11,12,24,36]. We wanted to explore how we might be able to encourage transit commuters to more actively learn about their community and connect with others; as such, we turned to location-based games. Location-based games (LBGs) are games played on mobile devices where content is tied to specific locations and accessed by players when they are there [31,37,42,44]. They can provide motivation to players to achieve goals through in-game incentives. While existing location-based technologies, such as Google Maps and Foursquare, enable people to access information, connect with friends, and explore places [25,38,46,52], little work has been done to explore how location-based games might be able to support transit commuters with learning more about the happenings within their community.

In this paper, we present the design and evaluation of a LBG, City Explorer, for working professionals who rely on public transit for their daily commute. City Explorer is a mobile game that provides people with a means to share locally relevant information about one's community and to explore areas within the city. We hoped that by connecting people with others in their community, the game could act as a catalyst to increase awareness of community happenings, including sharing real-time information and cultivating a sense of community participation. We conducted a four-week field evaluation of City Explorer with a focus on working professionals who regularly rode transit. Our research was exploratory and focused on exploring when and how people would use a transit-based LBG; what types of community information transit riders would want to know about; and, whether such a game would encourage community awareness and city exploration.

Our results found that players valued gaining additional knowledge about their transit commutes through City Explorer, including knowing how much they rode transit. Yet they were much less interested in seeing location-based community information throughout their commute. This information was seen as transient and less relevant to them. On the other hand, they valued information about the start and end of their routes given its geographic importance to them (e.g., at home or work). They also valued information that was factual rather than opinion-based. Lastly, while other research has pointed to the value of engaging with familiar strangers [36], we saw a desire for reduced in-person social interactions as people tended to want to use their commute times to disengage from face-to-face interactions. These results illustrate that careful design considerations are required to balance people's needs for personal space, existing social ties, and community information acquisition.

2 RELATED WORK

2.1 Community Information & Social Media

Community is a broad term for a variety of social arrangements, including community of practice, community of interest, social communities (e.g., Facebook, Twitter, etc.), and neighborhood communities [13,15]. Community information encompasses a variety of things from information about community or municipal activities to traffic information to leisure activities [34]. The common thread is that all of this information helps manage one's everyday activities and learn about what is going on around them [14,23,47]. Mobile technologies have provided new ways for people to view and share community information [2,22,34]. For example, people share real-time information to inform others of transit status and delays, as well as to notify drivers of traffic conditions, such as accidents and congestion [16,47]. In turn, commuters and drivers can choose to take alternate routes, avoiding lengthy traffic situations.

Research has shown that social interactions amongst people have shifted from just one's local community to also include geographically-dispersed family and friends [19,49]. Social media tools have played a strong role in letting people share community information as well as in fostering social capital within communities [1]. Social capital is defined as a set of properties of a social entity within communities that enables joint activities and cooperation for mutual benefit [1]. Tools such as Facebook, Twitter, and Reddit offer ways to communicate and connect within groups, where social exchanges build social capital and establish credibility within the group [2,9,30,53]. However, as the number of information sources (and technology platforms) grow, so does the opportunity for misleading, false, or opinion-driven information [53]. People are challenged with parsing and filtering the abundance of information publicly available, especially as we see that many social media platforms have become tools for which users can initiate and propagate information [2,9,53]. Amidst a perceived proliferation of online negativity, many users have decreased their consumption of news via social media, turning towards more credible journalistic organizations that have invested significant efforts to high-quality fact-checking of online content [2,9,53]. As such, the challenge becomes how to curate content, manage it, and add a degree of trust when sharing community information.

2.2 Urban Informatics

Urban informatics explores the impacts of technology, systems and infrastructure on people in urban environments [8,23,51]. Studies in this field are far-reaching, with research spanning the study of social behaviors (communication studies, cultural studies, etc.), urban communities (urban planning, architecture, etc.), and technical systems (computer science, human-computer interaction, etc.) [40,50,51]. Community participation has often been studied within the field of urban informatics. Several mobile systems have been designed to encourage playful civic engagement and communication with government organizations [23,27,39]. For example, *Fix-o-Gram* enabled residents to submit photos of issues to be fixed to the city [23,24]. *CityFlocks* offered residents the ability to stay informed and to learn about their

city by accessing residents' comments about different places within the city [6]. These systems offered various interaction methods for people to use when socially navigating urban environments. Our research builds on this work to explore how to design location-based technologies to support transit riders in gaining community awareness and exploring the communities in which they live and commute through.

2.3 Location-Based Technologies & Games

Cities have become hybrid spaces with physical buildings, people, and social structures where location-based applications have become increasingly pervasive [18,37]. Location-based technologies are those where information is tied to and accessed via specific geographic locations [46,48]. They allow people to stay up-to-date on community information, enrich urban participation, connect with one's social network, and explore places [23,27,39,46,52]. Some applications are location-centric, where location is the core of the entire product (e.g. Google Maps), while others offer information based on a user's current location (e.g. Yelp, Foursquare) [23,26]. Sharing one's location has been seen to enhance peripheral awareness, foster a sense of connectedness, and build trust within social groups [1,15,42].

Much work has studied the motivations behind location-sharing behaviors, where many uses of location-based tools are purpose-driven or social-driven [41]. We also see tools that offer incentivized location-sharing services, where users receive incentives for disclosing their location [29]. Here, researchers found that people valued incentives over privacy and that people's motivations for sharing their location altered as well [29]. While the use of mobile devices has grown to become a part of everyday life, there exists several major concerns with location-sharing services, such as privacy, self-representation, and safety [32,35]. People hesitate to share personal data, are concerned with how they are portrayed on their social media profiles, and worry about whether allowing location-sharing can allow for others to trace their route [6,15,28].

A form of location-based technology gaining popularity is location-based games (LBGs). LBGs use players' physical locations to elicit a sense of discovery through exploration, sharing, and collaboration [17,20,37]. Over the years, researchers have explored how location-based games can be used to influence community participation and awareness [31,42,43,44]. For example, *ZWERM* was designed to augment neighborhood participation by encouraging teamwork, applying time pressures as a form of challenge, and enabling players to express themselves [31]. In *Feeding Yoshi*, players searched for open Wi-Fi hot spots in their communities, with a portion of play occurring during commutes as players were able to weave game play into everyday life [4]. In *Anywhere*, an actor following players on a city tour was found to enhance people's awareness of the community [3]. More recently, *Pokémon GO* players led to a significant increase in physical activities, as the augmented reality environment of catching Pokémon in the real world was enjoyable and incorporated social aspects with outdoor group activities [2]. Together, this work shows that game mechanics and incentives can enhance people's participation and experience with their community. Transit rides offer an interesting opportunity within which social behaviors can be explored, including personal routines, interactions with others, and awareness of events within a community [5]. This work offers an exploration of how people moving within a community via public transit experiences the world around them, and how such experiences strengthen awareness and engagement via information sharing and discussion.

3 CITY EXPLORER: A LOCATION-BASED TRANSIT GAME

City Explorer is a city exploration transit game where players collect points as they ride public transit. The more they ride, the more points they earn, where the overarching goal is to collect the most points and earn a spot on the leaderboard. Players can complete route-specific challenges and collaborate with other riders to multiply their points by riding the same route. Players can also create geo-tagged posts to describe and share community-related information. City Explorer encourages the sharing of user-generated content related to players' transit trips. It consists of five main features, described in the remainder of this section.

3.1 Map

City Explorer's map is the home screen for the game (Figure 1). Once signed in, a player's location and nearby transit stops are detected within a 100-meter radius. Each transit stop offers potential points that can be earned by passing by the transit stop. Once the player passes the stop, the flag disappears and the player earns the marked points. A player can only earn points for a stop every 30 min. This parameter was set to restrict players from earning duplicate points for the same stop while waiting for transit to arrive. We determined the expected maximum wait time for transit to be 30 min. As the player moves, their route is tracked with a series of blue dots on the map.

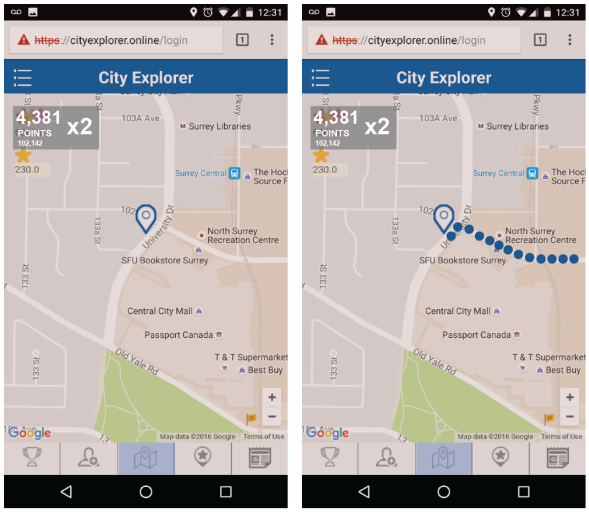

Figure 1: Map feature, including individual location and route in City Explorer

3.2 Friends

The *Friends* feature was designed to support awareness of other players within a 150-meter range. We wanted to explore whether such a feature would strengthen existing ties or create new relationships with other transit riders. If a player turns their game visibility to "ON", all players within a 150-meter range can see them in the *All Players* list shown in Figure 2 (left). To connect with them, one needs to click on the 'Add' player button. Thus, players can connect with other players who are strangers to them. If they want to connect with a player that is further away than 150 meters, they can choose to type in their email address and *Add Friend* (Figure 2, right).

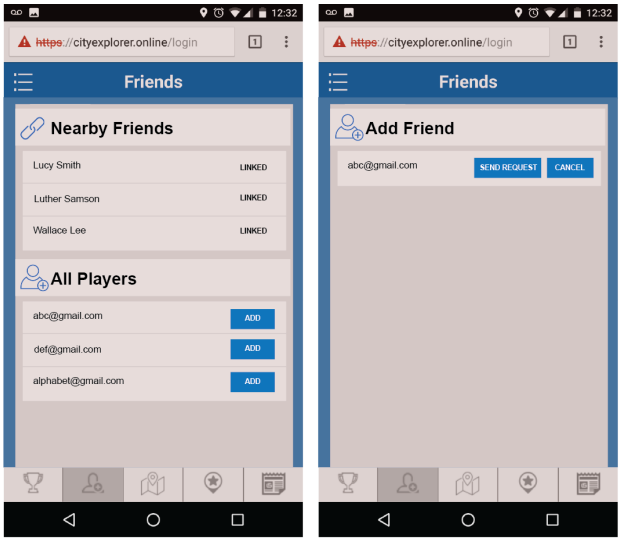

Figure 2: Friends feature, including nearby friends and adding friends in City Explorer

We determined this range through an estimation of the average length of transit buses, trains, and/or terminals. Once both conditions are met, players are *Linked*. Accepted friends within a 150-meter range become game "multipliers" for their shared trip in Daily Mode. Multipliers award players for skillful play [6]. In City Explorer, this translates to collaborative play. This means that travelling with one friend along the same route will yield both players double the route points (travelling with two friends = triple the points, three friends = quadruple the points, etc. to a maximum of eight friends). Thus, even though the game is competitive, there is an advantage to periodically collaborating with others.

The Friends feature enables players to build and access an All Players list for game players who have set their public visibility to "ON". This setting was included as we recognized that some players may have concerns with having their location be known to others. When players set their visibility to "OFF", their locations were hidden from other players, rendering them invisible in the game.

3.3 Challenges

It was our aim to challenge players to explore nearby areas, atypical of their daily routine. City Explorer offers destination challenges to players based on their geographic location (Figure 3, left). A destination challenge is a pre-determined route to a community center, building or park that a player needs to take to score additional points. Details of all possible challenges for the player will display on this screen. Challenges included routes with multiple stops and were predetermined in the game's design by us where we created challenges around community centers, libraries, and public parks located in each of the suburbs within the city.

3.3.1 Difficulty City Explorer automatically determines the difficulty of challenges based on a player's current location and a calculation of the number of vehicles (buses, trains) required for the player to arrive at the destination (Figure 3, left). An "Easy" challenge requires a player to use one transit vehicle (e.g., one bus) within a single trip. An "Intermediate" challenge requires more transit vehicles (e.g., one bus and one train) to complete the challenge. Finally, a "Difficult" challenge contains more transfers and changes of vehicles (e.g., two buses and two trains). For example, a large park in the city's downtown core may be "Easy" for a player currently located downtown as it is within 10 km away, but it may be "Difficult" for a player located in a suburb 40 km away as the routes may involve the use of multiple vehicles.

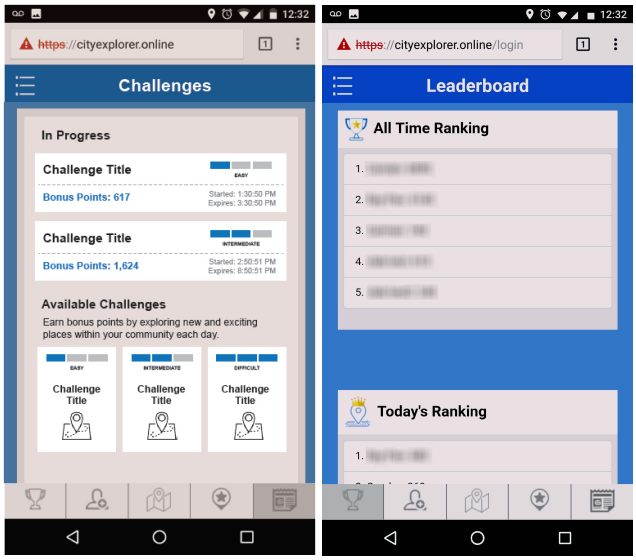

Figure 3: Challenges and Leaderboard features in City Explorer

3.3.2 Time Limits Many games employ a time limit to indicate how much time the player has to complete a level. We decided to set an expiry period based on the difficulty of the challenge: 2 hours (Easy), 6 hours (Intermediate), or 12 hours (Difficult). As it is unlikely people will commute for more than 12 hours to arrive at their destination, we set this as the time limit for the most difficult challenge.

3.4 Leaderboard

City Explorer's *Leaderboard* allows players to see how they rank amongst other players in terms of game points (Figure 3, right). The Leaderboard displays the *All Time Ranking* for the lifetime of the game for the top 10 players. It also shows *Today's Ranking* for the past 24 hours for the top 10 players. This offers players a sense of in-time competition to increase their engagement with the game.

3.5 Posts

To support community awareness and discussions, we included a *Posts* feature in our game. Players can add content (text, links, photos, videos) to a location within a 150-meter radius of their physical location. Information is surfaced to all players in the game when they are within 150-meters from it and it is, hopefully, geographically relevant.

We were interested in the types of information people chose to share with others during their transit commute. Because posts are geo-tagged and related to the players' locations (e.g. traffic condition, road detours, or construction, etc.), we set a default expiry period of one hour for all posts. Content was not moderated, though, players were able to "boost" a post to keep it active for another hour. This allows any players to determine the value of community information and whether it needs to remain available for others to view past the hour. For example, a traffic incident may only be needed for the hour whereas a petition for enhanced park security may need to remain active for several days. Boosting can only be done once every 12 hours by a player for a specific post (this prevents players from continuously boosting the same post).

3.6 Implementation

City Explorer was designed as a web application that could run on any platform of mobile device to support users of both Apple and Android devices. It was implemented using a combination of HTML5 and JavaScript, with the back-end comprised of Spring MVC, AJAX, and Tomcat. It also integrated data from the transit authority's existing Open API to provide transit data, including bus stops, train stations, routes, and schedules.

4 FIELD EVALUATION

We conducted a field evaluation to explore how routine transit riders would play City Explorer; what types of community information transit riders wanted to know about; and, whether such a game would encourage community awareness and city exploration. Ethical approval for this study was obtained from the university's Office of Research Ethics (2014s0314). Written informed consent was obtained from all participants before the study.

4.1 Participants

We advertised our study through snowball sampling (word-of-mouth), social media, and community forums. We also placed advertisements on public boards and bus shelters located at major transit exchanges calling for participants who took transit at least four days/week. Fifty participants applied for the study and through a set of screening questions, we chose 12 participants who were working professionals between the ages of 23-35 years of age, and lived within Metro Vancouver in BC, Canada. We wanted a fair distribution of gender (5 male) within our age group (23-35); we selected commuters who took transit 5 days a week to get to and from work, and we chose those who had played LBGs in the past. We also selected 7 people who had children as we wanted to explore if and how their transit routines affected family activities.

All participants owned a mobile device with adequate data coverage to play and commuted a minimum of five times a week via public transit. The median age was 27 (min. 23, max. 35) and we had 7 female participants. Five participants lived in the city for less than 4 years (five for 4-9 years, and two for more than 10 years). Seven participants had children between the ages of 1-6. All participants had played LBGs (e.g., Pokémon GO, Geocaching) in the past, with 5 participants playing somewhat often (several times each month). We purposely only chose 12 participants because we wanted to carefully monitor the play of all participants while also gathering detailed data from each. Participants were compensated with $50 for taking part in the study.

Participants selected were not meant to represent all commuters within the city; rather, our 12 participants were representative of commuter times and distances (shorter and lengthier travel across Metro Vancouver) as they lived in varying regions within the larger metropolitan area. We also felt that 12 participants would likely saturate our data, and indeed, this was found to be true in our analysis where data saturation occurred after about 8 participants.

4.2 Four-Week Usage

Our study took place in March and April 2018. During this time, participants had staggered start dates based on availability for in-person interviews; everyone had started playing City Explorer within a week's timeframe of each other. We started the study by conducting in-person interviews individually with participants to understand their prior gaming experiences. While all participants had prior experiences playing LBGs, seven participants noted they did not play as frequently now as in the past, given their work and family schedules. During the interviews, we also wanted to understand how they defined 'community', what types of community information they currently sought, and what challenges they faced in acquiring this information. We wanted to understand if and how City Explorer might affect these practices. Questions also focused on exploring participants' weekly schedules and routines, understanding what their existing transit experience was like, including what types of activities they currently do on their commutes. For example, we asked, *"Tell me more about what your transit experience is like – do you take the same buses/routes"*; *"What kinds of things do you like to do while on your transit commute?;* and, *"When do you use location-based services on your phone?"*.

We asked our participants to play City Explorer on their own personal mobile devices to ensure they were comfortable and adjusted to using the device. During this time, participants would sign in to the game at the start of their commute and City Explorer would detect their location while they travelled on public transit within the city. Participants played for four weeks during which time we asked them to play during at least five of their transit trips. Following the first week, we encouraged participants to play as frequently as they desired, and this was monitored by us through system logs.

4.3 Seeding Content

City Explorer was designed as a location-based game to be played within a large, urban city with an expansive transit network where one might expect hundreds or thousands of players and a large amount of existing in-game informational content about one's community. Given our research goals and the practicality of conducting our 4-week exploratory study with 12 participants, we came up with a systematic way of seeding content within the game to provide a realistic environment of gameplay. The method of seeding content needed to be done in such a way that would be automatic and limit our interference with the participants as they played.

We chose to use Twitter (and its API) due its capability of being integrated with current, concise, community-based content. We searched for Twitter accounts that mentioned the city, tourism groups, or police Twitter handles. We found 31 accounts that contained factual and opinion-based content that prior work has shown people are interested in knowing about in their community, e.g. recreational information, traffic data, municipal government information [34], and selected these accounts for our study. Content was automatically pulled from these accounts once daily and added into City Explorer.

Using Twitter accounts to seed content offers several advantages. First, content is current, sometimes even real-time, and offers players with information that is locally-relevant. Second, Twitter is already a popular platform that people use to share thoughts and links to other items [2,12]. Its format of a maximum 280-character limit mapped well to our post-size in City Explorer. Lastly, Twitter allows us to easily bootstrap the system as it provides a source of content at a time when there are not sufficient users. This supports exploratory research at an early design stage.

However, using Twitter in this manner comes with its limitations. Because City Explorer is pulling content from Twitter accounts, the type of content in City Explorer will be like the content that is already found on Twitter. As a result, in terms of content and format, this can influence how users behave as they may model (in terms of creating and sharing information) what they encounter in City Explorer. We also did not extensively vet the content, including the frequency of posts, on these Twitter accounts. This means that all content posted would be displayed in the game, even if it was not relevant to the community. That said, we reviewed the content provided by the Twitter accounts weekly and holistically at the end of the study, and, indeed, we felt it was generally representative of community information that people might find value in.

4.4 Weekly Surveys

At the end of the first and second weeks of the study, we sent participants an email with a set of ten questions to answer. Questions included understanding the features played in City Explorer during their transit rides, what they thought worked well (and did not work well) within the game, and how often they were able to play the game that week. For example, we asked why they added or linked with players that week (or why not); how frequently they read posts in the game; and to describe the types of community information they read in City Explorer.

4.5 Semi-Structured Interviews

Following the third week of the study, we interviewed participants over the phone to ask more probing questions about their experiences playing City Explorer. Upon completion of the four-week gameplay period, we conducted one-on-one interviews with each participant. Half of the interviews (six) were conducted in person or via Skype and lasted approximately 60-90 minutes each. The remaining six were conducted as contextual interviews on transit buses, while riding alongside the participants during one of their commutes. These commutes ranged between 30-45 minutes each and offered rich observations of activities of interest, including insights into the routines leading up to their transit ride, and observations of events and encounters during their commutes.

The interview protocol included questions about transit commuters' game experiences, their views on content quality and ownership, their community information needs and search behaviors; their motivations for playing the game (aside from being in a study); feedback on the features of the game, including privacy and location-sharing; and, how they shared the information they found in City Explorer. For example, we asked, "*How did you use the friends feature, if at all?"; "What prompted you to boost certain news posts?"; and, "How did City Explorer affect your interactions with people you recognized on your commutes, if at all?"*.

5 DATA COLLECTION AND ANALYSIS

Usage data, such as number and duration of game sessions, along with dates and times of gameplay, was collected through system logs, weekly surveys, and interviews. All interviews were audio recorded, transcribed, and analyzed to obtain a detailed qualitative description of needs and behaviors surrounding community information preferences, as well as an in-depth understanding of participants' experiences playing the game. We performed open, axial, and selective coding on all interview data collected. Open codes described the specific benefits and challenges of City Explorer, along with the various activities being performed. For example, codes included "track their commutes" and "check their player ranking" as activities transit commuters engaged in. Axial codes grouped open codes into categories, such as "tools", "information", "reasons", etc. During our selective coding stage, we saw main themes emerge around technology use (providing contextual information of their commutes), personal community information needs, challenges with learning about community events, and concerns with acquiring and consuming quality information. We reviewed this data alongside the system logs to create quantitative metrics illustrating how frequently participants played and for how long.

Our results first explore general play patterns through quantitative data. Then we report on the types of community information people were interested in, along with when and where they found it useful. Lastly, we outline interesting themes around the social behaviors that emerged.

6 GENERAL GAMEPLAY

The duration of our participants' commutes ranged between 35-55 mins, with 8-10 people playing simultaneously. Amongst our 12 participants, a total of 563 game sessions (instances when people logged in to City Explorer and played the game) were logged in the system, with a median number of 44.5 sessions per player (min. 5, max. 90). The average session duration was 8 minutes (min. 3 and max. 20). Our top player (as ranked on our leaderboard with the most points) had an average session

duration of 20 min and 3 sec, whereas the player who played City Explorer the least had an average session duration of 4 min and 4 sec. This supports data obtained during the interviews that suggested participants did not often play City Explorer throughout their entire commute. Instead, they played for short time periods, intermittently, during their commute. Review of the system logs that tracked the number of posts and boosts (to posts) showed minimal interactions with this game feature. Four players only posted 23 items (median 4; min. 3 and max. 6) and three players boosted 75 posts (median 2; min. 17 and max. 31).

6.1 Gamification and Challenges

Our interviews revealed that participants valued seeing their points accumulate during their trips, as well as seeing how they ranked amongst other players, based on points collected throughout the duration of the entire gameplay history and over the course of each day. Players earned points by passing bus stops and by completing challenges while playing the game.

In general, we saw patterns of gameplay that fluctuated week by week. Only three participants showed a steady increase of points, suggesting they played City Explorer more over time as they became more comfortable with the game and began to incorporate it into their transit routines. Other players showed varied interest in the game over time with likely an initial period of novelty for players who had high point values in Week 1 and low point values following it (e.g., P6, P8-P12). Subsequent weeks with larger amounts of play were likely a result of us conducting phone calls and interviews with participants, which may have acted as a reminder to play (e.g., P8-P10).

Players did not engage frequently with the challenges incorporated in the game. Instead, our analysis revealed interesting patterns in the unanticipated use of our game as a means of tracking routine commutes.

6.2 Increased Awareness of Commuter Data

First, we learned that participants appreciated the game mechanics of earning points with minimal interaction during their commute. They also valued seeing their routes on the map as a way for them to learn more about their personal commutes, rather than trying to gain more points than others. 11 of 12 participants described the points as helping them become more aware of their transit habits, often described in a way that was similar to journaling. This allowed them to understand how frequently they traveled and where. One participant described playing the game in a way that was like personal goal trackers, such as a FitBit, step and/or calorie counters. The idea of being able to track transit routines, keep records, and have a higher-level view on one's day-to-day was valued.

> "City Explorer fell into a camp of practice that I do a lot of, actually… using tools to track data about the self, about your day. Versus a game experience. It fell into more of a journaling thing for me, so like, for example; when I take walks, I use a walk tracker that tracks where I go. That logs my steps. That does all that stuff. I use calorie counters. Right? So I log if I eat half cup of rice and six carrot sticks. I enter all that information. And then usually, the end goal of a lot of quantified self-experiences are to go back over the data to review it." – P4, Female, 32 years

Another participant suggested that gamification and journaling were both routine and habitual, and that through playing City Explorer, she could see a pattern of her commutes. This was desirable.

In general, we learned that people were much less willing to deviate from their weekday routines to explore nearby areas for the sake of exploring. City exploration (i.e., challenges) was either considered or attempted on the weekends, when participants were walking or biking (and not while on transit to their destination). Participants were more willing to start a challenge when they had time to pass and if it was a short distance from where they were (or needed to be). For example, a participant described having just missed his bus and then having to wait for the next one, during which time he took the opportunity to see what was nearby in City Explorer and which challenges were easily attainable within this time.

> "Last Sunday, I missed my bus and saw I had 40 minutes until the next one. I checked City Explorer to see what was in the area and within walking range so I wouldn't miss the next bus. I kinda aimed for low hanging fruit… I wanted the bonus points." – P10, Male, 34 years

Four participants described having more awareness of community services through the challenges feature of City Explorer. One participant described using the challenges with neighborhood community centers as destinations to guide his regular evening run. As a result, he learned more about the nearby centers and various services offered.

> "When I was on my evening runs, sometimes I'd take a break and would walk around to complete challenges, but not too much. During my commute, I didn't because I wanted to be somewhere on time." – P7, Male, 33 years

6.3 Transient Community Information

We found that people consumed community information in City Explorer when they were relatively stationary prior to or after commuting. Information tied to the start and end points of their commutes was valuable, especially as it related to real-time impacts on their imminent route. Yet people tended to rely on the technologies that they used prior to the study because they were already familiar to them. For example, while walking to their first transit stop, 8 of our 12 participants used applications such as Transit and Google Maps to scan for any delays or accidents affecting their commute, allowing them to choose alternate routes if required. Upon arriving at their destinations, participants were interested in services (such as convenience stores, grocery stores, and coffee shops) nearby, describing it as convenient to fit into their routines.

Further analysis of the gameplay in City Explorer revealed trends around the types of community information transit riders were interested in before, during, and after their commutes. Community information that was transient (made available during travel) through City Explorer was less relevant for people. People often settled into routine activities during their commutes and were rarely interested in any community information that surfaced as they traversed different areas/cities during their commutes. Their interest was fleeting and information in transient locations that they moved through on their commute was of little importance or impact to them.

> "I know I see things when I'm on the bus or Skytrain but my thoughts are somewhat fleeting. I mean, I'll see an ad or something being built and I think to myself, that's interesting. But I don't really do more than that." – P9, Female, 34 years

In contrast to the location-specific information that City Explorer was providing them, participants said they valued information from communities of people with shared interests, such as hobbies, work, or culture, where participants could gain support, resources, or feel a sense of belonging. For example, participants described feeling like they belonged to communities with those who shared interests, such as scuba diving or photography, or groups with whom they shared a similar cultural background (e.g., country of origin, language, religion).

Participants also contrasted City Explorer's presentation of community information, which was location-based, to the way that they normally obtained such information. Participants said that they already had apps they would routinely use to obtain information and what they valued about these systems was the way that information was shown based on personal interest and not location. For example, news curators, such as Google News and Flipboard, were used to tailor current news for the person, displaying content that was deemed to be about relevant information. These were found to be more useful than City Explorer as the content (although general) was based on personal interests.

> "I also use Google News to stay up-to-date on current events on my phone. You know what, the information I consume there is more things I read in passing. Like, things that I'll read but not retain. It's just casual browsing. It's different from the information from Flipboard. That information sticks. I think it's so focused on my personal interests that I read it more often." – P10, Male, 34 years

For most participants, there was a desire to subscribe, search, and filter content based on personal interests and of immediate impact on their transit experiences. City Explorer had no way for users to filter content, unlike other apps people already used as part of their routines, including news curators (Flipboard, Google News). Such features were especially useful for them as they had set their personal preferences on topics to filter for them.

In City Explorer, people were often not interested in content that appeared to be based on personal, opinion-based information. Instead, they valued succinct informative information that had clear factual data. When discussing these findings with participants, eight said that they more generally avoided the news (outside of City Explorer), including those from local, national, and global broadcast stations and those that displayed on their social media feeds. They found news items to be frequently dismal and wanted to stay away from the negative aspects of it. For example, three participants described avoiding news surrounding current politics in the USA and their dislike for a particular administration. Another topic of avoidance that several participants noted was news related to the housing market and the challenges of finding affordable rental housing or the unlikeliness of

being able to buy into an expensive real estate market. Another participant described a conflict between having an awareness of crime and safety within his neighborhood and wanting to simply ignore/opt out of it.

> "Interesting… knowing about a break-in or crime around the corner from my house, vs. not knowing. I want to say I'd almost prefer not to know about it. It sounds silly, but it's more peace of mind for me if I didn't have to worry about it. Perhaps ignorance is bliss?" – P6, Female, 23 years

6.4 Time Spent During Transit Commutes

We learned that most participants did not want to use transit time to learn about community information and events nor post about them. Instead, transit time represented a period dedicated *"to zone out"* of everyday stresses. As such, participants' activities during their commutes were routinely passive in nature. That is, participants often chose to read a book, listen to music, or sleep while on transit. Similar results were found in prior work [10,11,12]. Thus, despite providing an additional avenue for connecting others—in the form of a transit-specific LBG—people still exhibited their existing habits. Participants enjoyed opportunities to have a mental break from stressful work or family times and have some alone time via music or online videos. This contrasted to the experience that City Explorer was meant to provide them. For example, one participant described the past two weeks as extremely stressful with multiple job commitments and many uncertainties.

> "So, in this like stress-time [at work], I usually wear my headphones when I'm on transit. I've been using them to watch an episode of a show. It lets me… I can pretty much shut everything … shut everyone out." – P12, Female, 35 years

Conversely, five of our participants engaged in more active activities while commuting, using their mobile phones to chat with friends, read social media feeds, catch up on personal emails, and plan weekend and social activities. Thus, they were much less interested in seeing information about the locations they traveled through on transit, and more interested in information that would be of value to themselves or their family's typical activities or planned events, such as events happening in their neighbourhood, skating lessons, or farmers' market hours. For example, a participant said that she used Facebook differently than City Explorer in that her Facebook feed would show events that her friends were attending; from this point of awareness, if she was interested in the event, she would then check her schedule to see if she and her son could participate.

> "Usually, it's by Facebook. I see events my friends are interested in and I decided if it's something Josh and I can do. Also, I always go to the library here… they post some fliers and some kinds of magazines, with programs for the year. This is important as I would like to know how this community spends its life, things…" – P5, Female, 35 years

6.5 Familiar Faces in Similar Places

Many of our participants described seeing the same people on their regular commutes. This would occur while waiting at the same bus stop or while riding on the same train. Regardless of how frequently they encountered these people, participants noted that they were not necessarily interested in connecting or chatting with them. This emerged as an interesting theme where co-located members of a geographic community were not necessarily interested in connecting with others while in transit. This suggests the game did not affect people's existing social practices of connecting with others (or a lack thereof) when commuting.

The Friends feature of City Explorer was used by all participants to connect with other participants in the study. Participants described this interaction as one with minimal risk, where they did not have to interact face-to-face with anyone, nor did they need to communicate further with them. Given that participants lived in a variety of suburbs within our city, the players did not cross paths during the 4-week deployment period, and did not end up invoking the game multiplier as a result. While there was some curiosity about other players, such as the top player on the leaderboard, connecting beyond that was not of particular interest to most of the participants, describing the game experience as one that was more solitary in nature.

Some participants described this behavior as being attributed to the culture in this urban Canadian city. This culture was seen as one that was considerate of others' personal spaces and boundaries. We learned that participants who recently arrived from another city or country appreciated people seemingly respecting other people's personal spaces. For example, one participant who recently moved from Brazil and had been living in her neighborhood for the past eight months described examples of these cultural differences while on transit.

> "It's interesting to see and to compare with my own culture in Brazil. Here, there's a sense of

> community and everybody cares about each other more than Brazil. They respect the silence or the privacy, and the space of each other. I think here… people are more polite overall. People helping you with a chair, those chairs that you have to put down the seat. Where I go with a load of bags and people are helping you to sit … In Brazil, there are people who help you but it's not that frequent." – P11, Female, 33 years

Others described this theme as being similar to information in passing (i.e., not important or applicable to them). Despite seven of our participants describing seeing familiar faces and even expressing curiosity about these fellow commuters (i.e., *Where do they work?; Why didn't they show up today?*), the extent of their curiosity ended there. They preferred to interact with existing social ties over reaching out to these familiar faces. For example, a participant described her use of her mobile phone during her commute to be focused on reviewing her social media feed and real-time chatting with friends in another country. For her, this was the most opportune time outside of her work commitments that allowed her to catch up with friends.

Similarly, participants who lived in a multi-housing complex (i.e., condos and townhouses) described how they would often see neighbors in passing and exchange pleasantries, but that was the extent of their communication. This experience with familiar faces (in a shared building complex) is different than what we saw with familiar faces on transit. Here we saw that geographic relevance was important, yet there was an opportunity to facilitate interactions to coordinate common activities. For example, one participant described his concern with a new housing development being built in front of his four-story apartment building. He wanted a way to connect with his neighbors to figure out a way to express their shared concerns to the city.

> "It's funny because I think it's like 10 houses per floor, you know we're an apartment building, but I know very few people. Only a handful I think. Well, yea there's lots of new development everywhere. So far, none of them messes with my view. But that's my possible worry. That they are going to build these high rises to block my river view. There just isn't an easy way to gather enough people to get momentum." – P1, Male, 26 years

7 DISCUSSION & CONCLUSIONS

We now summarize our findings and outline opportunities for the design of technologies to support transit commuters in connecting with their communities.

7.1 Routine Commutes and Patterns of Travel

First, we found that people appreciated learning more about their transit routines, including the routes, times, and frequency of their trips. Tracking routine commutes was similar to the idea of the quantified self, where the use of technologies provides people with self-awareness and self-knowledge through the collection of personal data [28]. Doing so created more awareness around patterns of travel and permitted our participants to learn about happenings that either negatively or positively affected their routines.

Previous work in the quantified self-movement has suggested how multi-modal sensors and rich features of mobile devices can capture information about users' life experiences and enhance the process of memory' retrieval [28,33,45]. Although the activity of walking to a bus stop can be seen as an unimportant aspect of one's life [45], our work shows that it would be valuable for people to collect information about their commute to support personal reflection. While participants in our study were less interested in community information throughout their commute, they were interested in their personal tracking data for this time period. They were interested in data from the moment they left their home until they arrived at work, including walking to a transit stop, traveling, and arriving at their final destination. Providing such data to transit commuters could offer opportunities for them to mentally link contextual details about their life, including knowledge of their frequency of travel, length of commutes, how much time they spend at home vs. away from it, and what activities they are able to do outside of work time. Transit-specific apps that we know of only offer the real-time status of transit vehicles, without offering context around delays, or alternate routes proposed based on personal travel routines. They also do not provide people with a broader understanding of the impact of commute time on their personal life.

7.2 Timing of Factual Information

Our results revealed that people sought specific information related to their route prior to the start of their commute, including the real-time status of buses and any imminent delays. People were less interested in community information that was transient as they moved through the city. They were more interested in

information that affected their trip (e.g., start and/or travel during it) or that they could consume when they had more time (after their commute). Though prior work found that information presented at a pre-defined location worked well as reminders [1,7,26,39,41]. For example, when passing by a grocery store, one could be reminded of an item that they needed to buy there. In contrast, we saw the need for information to be shown *before* arriving at a specific location. This would enable people to consider any impacts transit delays would have and allow people to plan or modify their day in advance.

Our results showed a desire for limiting the amount of opinion-based information shared within communities. People valued information that displayed facts about an event or happening within their community. Similar to criticisms of existing social media platforms, the challenge lies in determining the validity and value of information [2,9,25,53]. Thus, there is a design opportunity to consider how to curate information to ensure that it is more factual in nature. This is similar to design work proposed by others already, but in different domains and not specifically focused on transit commuters [9,23,30].

We also found that people did not always want to use transit commuting time to learn about community information and events. Instead, transit time offered a much-needed relief from everyday stresses. This suggests an opportunity for systems to consider people's routines and when they prefer to see community information. For example, for those transit commuters who engage in more 'active' activities while commuting, such as catching up on emails and researching children's activities and events, information could be presented to them while they are commuting if it could help with managing family schedules. On the other hand, commuters who were more 'passive' with their activities could benefit from having such community information displayed at a later time, such as when at home. City Explorer treated all of our study participants as having similar needs, where community information was presented immediately (if the game was open) and tied to the location a person was presently at. It is clear that such a one-size-fits-all approach is too restrictive, and people would find value in seeing relevant information at different points in time. This means that being in a location to see information about it may not be the best design route. Instead, some people could value gaining location-based community information while in different locations.

7.3 Reduced In-Person Social Interactions

Lastly, our results revealed little interest by transit commuters to connect with fellow transit riders, suggesting that people want to improve their sense of belonging within their own defined social communities based on where they live, and less in terms of their transit community. This includes those they encountered on a regular basis (i.e., familiar strangers [36]). Despite seeing familiar faces on shared commutes, people were more comfortable keeping to themselves and partaking in solitary activities. Prior work has pointed to the potential for technologies to help individuals in public places gain an improved sense of belonging within their communities [21,33]. More specific to the context of public transit communities, research has suggested that social interaction between strangers offers a valuable opportunity for producing further engagement on transit journeys [2,10,11,12]. Our work found that people did not want to spend or invest the time in building this social connection. Thus, while there may be value in strengthening these connections, we found transit riders did not place much value on it. People wanted to use their commute time to connect with family members and friends already in their social network.

This points to design opportunities to strengthen existing social ties with less emphasis on creating new social interactions with familiar strangers. Given that we found some participants spent part of their transit time socializing with friends on existing social media platforms, such a feature would also address people's underlying preferences for coordinating social activities with their existing friends.

7.4 Limitations and Future Work

Our study focused on evaluating City Explorer with 12 individuals who took public transit every weekday. It is possible that those who do not take transit as often would have a different gaming experience, yielding different insights into what community information was valuable for them. Our demographic had a median age of 27, thus, those who are much younger or older than this median may offer additional perspectives as to what kinds of community information they would find valuable. Certainly, our findings do not generalize to those who take public transit in smaller, rural communities, nor to those who are part of lower or upper classes. Instead, our findings point to the likely routines of middle class people who live in urban North American cities that are highly multicultural. Our city is also perceived to have people with more liberal views in terms of politics; our results

may generalize to similar areas and people. We also expect our results to generalize to other cities whose transit networks span an extensive reach. In our city, this includes a geographic range of approximately 100 km for buses and 30 km for light rail transit.

Our study participants played one specific transit game, City Explorer, with a fixed set of game mechanics and structure. There is a chance that some of our results are tied in particular to the game and the way it was designed. For example, if different game mechanics were utilized, it could be the case that participants may have appreciated competing with other players for points more. Future work should consider such possibilities and explore a variety of different game mechanics. For example, given the benefit that participants found for using their transit data for personal reflection, one could consider game mechanics that reward users for such reflection (e.g., points for comparing transit usage over time, points for increasing transit usage compared to driving a car). One could also consider different incentives for game play where they move beyond leaderboards like the one we provided.

Overall, our results point to a variety of design opportunities to better support public transit users in a major metropolitan city. Future work can build on ours to support smart city governance, specifically where commuter data can solve problems through intelligent traffic planning and promotion of sustainable transport commutes. We began by trying to find ways to provide transit commuters with more information and more connections, yet, through our study, found that there is a limit and time period in which such information is actually desired. This illustrates that different kinds of community information needs to be presented at varying locations and times. For example, reminders can be presented at a time and place. However, real-time information that affects people's routes (and thus their days) needed to be done before one starts their day.

The importance of our study is the emerging idea of the quantified self and its tie to community information, which has not been reported elsewhere. The unanticipated use of our system suggests new ways of supporting people in finding timely opportunities for civic and community engagement.

ACKNOWLEDGMENTS

We thank TransLink for their collaboration on this project. This research was funded by the Natural Sciences and Engineering Research Council (NSERC) of Canada.

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