Investigating Different Map Views for Exploring Neighbourhoods

by

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To

I dedicate this thesis to:

My father sheik, Salem Edrah

Your strong and loving support motivated me to succeed academically and inspired me to utilize my full potential. We miss you and even though you are not with us physically, your spirit and legacy will stay with us forever. May Allah grant you rest in the peace of eternal paradise.

My mother, Fatom

Your great support, prayers, and unconditional love have guided me throughout my life and have made me the person I am today.

My husband, Mohammed

Your tremendous patience and unwavering support have encouraged me through my studies, which have been so challenging at times.

All my Siblings

Your immense love and support mean the world to me.

Ms. Gwendolyn MacNairn, Ms. Jessica Chubb, Ms. Allison Nicolle and Dr. Linda MacDonald,

Your help in nurturing and developing my skills is truly appreciated.

THANK YOU ALL!

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ABSTRACT

Mobile wayfinding and guide applications have become indispensable tools for navigating unfamiliar urban spaces. Such applications address locations targeted, "just-in-time" queries, however, and are not specifically designed to support neighborhood discovery expeditions, or planned excursions intended to quickly build route and survey-level familiarity with a neighborhood. This thesis reports on research examining mobile tool requirements and support for neighborhood discovery in the context of purchasing a home. In the first phase of the research a preliminary study examining how existing online tools were used for neighborhood exploration was conducted in an urban Toronto neighborhood. Results were combined with prototyping work and interviews with real estate agents, homebuyers, and an online real estate service provider, to propose a set of desired features for neighborhood discovery support, including rapid transitions between synchronized spatial views, and transitioning between planning, wayfinding and exploration modes of use. We conducted a second study, considering a home buying scenario in two different Halifax neighborhoods, to assess specific limitations of a popular existing mobile based navigation and Google Maps application for neighborhood discovery. We found that the application's design impacted the choice of Map View used by our participants, by promoting a specific wayfinding task flow, while individual preference and task also played a role. There were issues with switching between spatial views: access to location details, search, or Street View required the user to switch from their current screen to Map View, leading to confusion and loss of state as users sometimes restarted the app in frustration. Participants also tried to use Street View to locate destinations when lost, but were usually unsuccessful in doing so. From these and other results we derive a set of design requirements for mobile tools for neighborhood discovery and present a prototype application called Block Party that addresses a number of these requirements. Block Party supports itineraries with numbered waypoints, single click transitions between synchronized spatial views, and single click transitions between planning and view/wayfind modes. Future work will evaluate Block Party's design in another study.

LIST OF ABBREVIATIONS USED

POIs Point of Interests

app Application

SBSOD Santa Barbara Sense of Direction Questionnaire

P Participant

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CHAPTER 1 INTRODUCTION

The use of Smartphone applications has shown huge growth over the last ten years. Smartphone applications have the ability to make people's lives and tasks easier. Smartphones are used in different situations including navigation, when people search for destinations while on foot, by car, etc. Real estate clients need to identify specific locations especially when they are in unfamiliar environments and smartphone applications can help to complete their tasks more effectively and easily. Many of these activities involve using mobile maps to help identify and then navigate to nearby services. Using mobile devices in real estate applications has been shown to be more effective than general web sites for new homebuyers or renters for finding locations of interest since they are designed and implemented for that specific purpose.

Now technology is available for professional real estate agents to improve homebuyer services. Real estate applications illustrate how a range of techniques and tools such digital maps (e.g., Google maps) are needed to purchase a home and to locate points of interest (POIs). A tailored mobile app could support a range of different information that homebuyers are asking for. Given the pervasive use of smartphones today, tailored mobile applications are something the real estate market place is ready for.

This project was a collaboration with HomeZilla Inc. (http://www.homezilla.ca/). HomeZilla offers potential homebuyers online support tools (e.g., learning about neighbourhoods, maps, etc). We have been working together to design, implement, and evaluate mobile map applications for homebuyers. HomeZilla offers a prototype for building leads in real estate via a suite of online services for potential homebuyers. HomeZilla supported ca field (preliminary study) with our mobile prototype using a Google map application evaluation and existing services, with participants in neighborhoods located in the Halifax and Toronto area. The field evaluation was conducted using the Google map application, with a focus on navigation and neighborhood familiarization for potential homebuyers. The HomeZilla company sponsored this project until the preliminary study was completed in April 2013.

After the formal relationship with HomeZilla ended, we continued our research as an applied scenario of a more abstract question about navigation. That question examined whether or not a tool that supported switching between synchronized spatial views would provide better support for wayfinding.

The subsequent study was funded as part of the Boeing Company Mobile Graphics project where they were interested in looking at the utility of a landmark-focused approach to support navigation through an area where there were many common, repeated features. This study considers navigation and wayfinding, with an emphasis on supporting multi-step itineraries and exploration via multiple views. Improvements based on prior studies have been incorporated into an application called Block Party. The current iteration of the Block Party application offers a variety of potentially interesting information to the homebuyer when that homebuyer is searching for specific services in a neighborhood, including parks, restaurants, schools and shopping.

During development of the Block Party app we conducted a field study first using Google map so we could gather more information on how people use the existing way finding tool to explore a neighborhood. We recruited 10 participants who navigated two different neighborhoods, in the downtown area of Dartmouth and the downtown area of Halifax. We wanted their feedback on when, where, and why users use different views. This feedback was used to improve Block Party, which will be tested in a subsequent field study evaluation.

1.1 RESEARCH PROBLEM

The key problem for exploring neighborhoods is determining which views are most helpful for certain uses, and how much variation there is between individuals. Often homebuyers use paper maps, maps on mobile devices and other mobile applications to help them navigate and get to know a neighborhood. Paper maps can be cumbersome to carry and awkward to use. Using multiple mobile applications to learn about places (e.g., using maps for route information and other applications to find nearby schools) requires a lot of switching between tasks and mental effort to coordinate the different views. Finding the right mix of information and presentation formats is a crucial challenge in

mobile application development. Mobile users want targeted information, accessed in short bursts in contrast to typical browsing behavior at home.

What we propose is a smartphone application for the real estate industry that offers locating services to homebuyers who are looking to explore a prospective neighborhood. The users can use a map to identify a route to arrive at specific points of interest. In particular, this new mobile phone application has been designed so that homebuyers can quickly identify particular services they are looking for in the neighborhood (e.g., schools, daycare restaurants and stores). Such an application should also support multiple spatial and data views, reflecting the diversity of ways homebuyers may want to explore neighborhood information.

1.2 RESEARCH OBJECTIVES AND RESEARCH QUESTIONS

Information and Communications Technology (ICT) support for homebuyers who are using mobile devices is a largely unexplored area. However, it has great growth potential, because a significant proportion of house hunting occurs in neighborhoods. A successful mobile service for homebuyers could also provide insights into mobile application design for other neighborhood-centric activities.

The current experimental simulation of a home buying scenario evaluates how mobile map applications can help homebuyers (or renters) find specific points of interests in a neighborhood. In this work, we asked study participants navigate and walk around a neighborhood, they were asked to locate points of interest, including schools, daycares, playgrounds, restaurants, gas stations and parks. Participants were permitted to use any of the different Google Map Views: From this, we hoped to discern:

1. Which map view participants preferred and which was the most helpful for doing the three different tasks?
2. What are the limitations to using Google Maps for discovering a neighborhood, and how might a specialized application be designed to address these limitations?
3. Whether or not the use of different map views encourages more exploration and learning about neighborhoods?

4. Whether or not the participants' spatial abilities have an impact on wayfinding and ability to use the different map views?

1.3 THE NEW PROTOTYPE "BLOCK PARTY"

Block Party was designed to help homebuyers become familiar with neighborhoods. It was designed for a specific purpose rather than as a general web service such as Google map. In particular, the Block Party application has been designed so that homebuyers can quickly identify particular nearby points of interest (POIs) and particular services. It was designed to allow for easy switches between three views (map view, list view and immersive view). The bottom of the application provides a navigation panel with a button for each view. Isers can always see this panel no matter which view is currently being used. These three different views were selected to give the participant some variety with which to view the data.

The Block Party application supports synchronized multiple views, which can reflect the diversity of ways homebuyers explore neighborhood information. The users can use maps to identify a route to arrive at specific points of interest (POIs). Also can sequence the points with numbers that can be added to the route on the map and the numbers are assigned based on that order or priority. The List View can displaye the POIs as a list with assigned numbers or as a small box displayed key information (e.g., name, address) on top of the Map View. The prototype also has two modes: planning and viewing (See Chapter 6). The planning mode shows locations from categories and the viewing mode shows locations users have chosen. This tool will be targeted to users who are also interested in learning additional tools/views to help them in urban neighborhoods.

1.4 OVERVIEW OF NEW PROTOTYPE PROCESS

This study had two parts: 1) an observational study, with a short design exercise using existing Google map and other online tools and 2) and evaluation of the new tools designed based on what was learned in Part 1, using the same observational approach. The second part of this study will evaluate how our mobile map application "Block Party app" can assist potential homebuyers or renters identify specific services in a neighborhood. As shown in Figure 1.1 the overview of the Block Party prototype process.

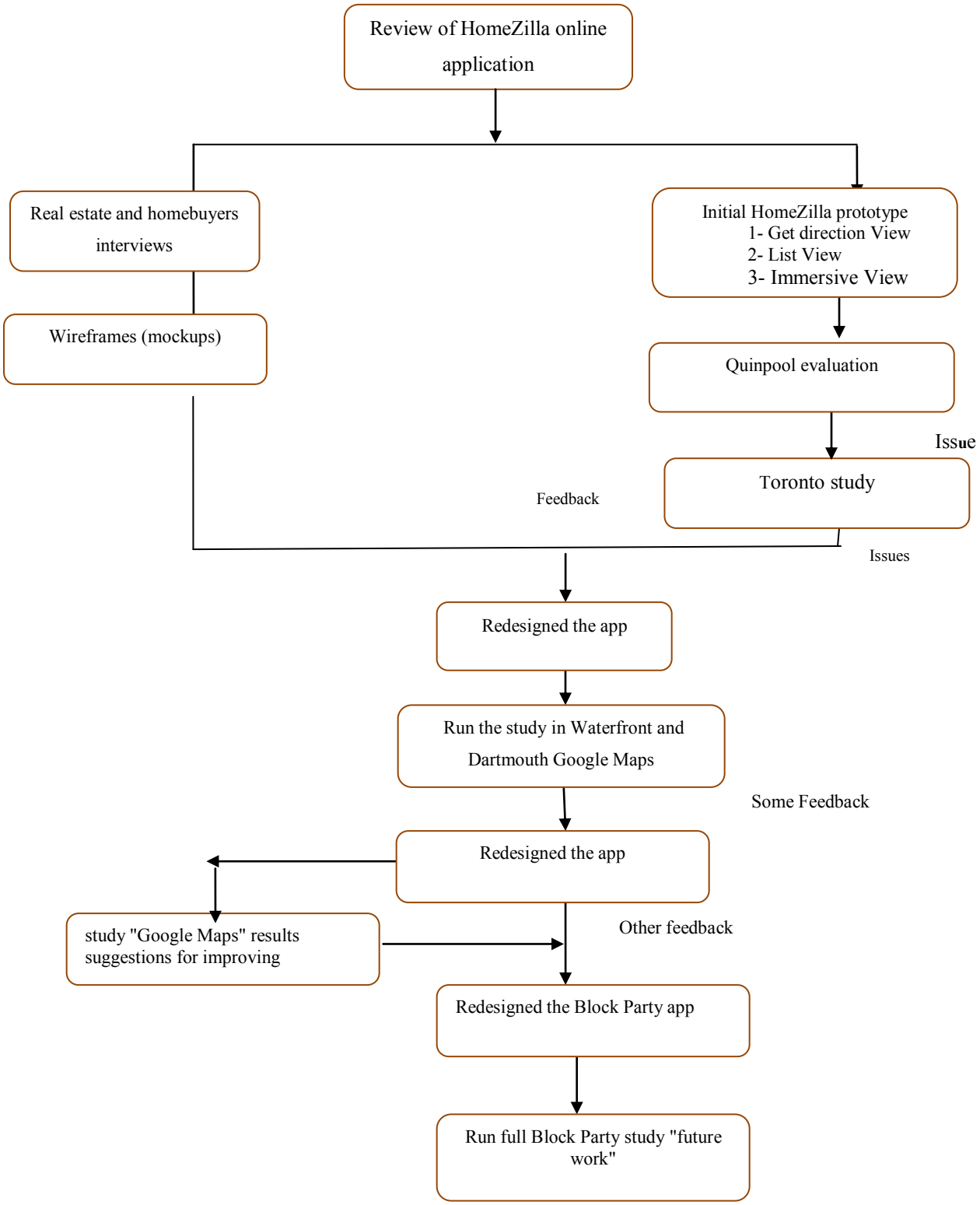


Figure 1.1 overview of the Block Party prototype process

1.5 CONTRIBUTION

We tested the initial interface using the tasks and materials for the Quinpool are prior to running the first study in Toronto. We had some issues related to the prototype; some aspects of the interface were not fully ready or understood. As a result, the implementation did not meet the design specifications. We modified the Quinpool study before running the study in Toronto. We decided to choose a Toronto neighborhood called "the Riverdale" because it is a unique area and it was very friendly with a wide variety of services. Since Quinpool and Riverdale have a large concentration of businesses and other POIs on a single street, we then replaced Quinpool with downtown Dartmouth as a target neighbourhood. Our other location remained the Waterfront area of Halifax.

While in Toronto, we ran a modified version of the study with the same tasks and with similar goals as outlined in the study design. Our revised goals were to get a sense of how people used existing tools (Google map and other online tools including Yelp and Google search) available on a Smartphone to answer research questions. Then we made the decision to modify the study to use Google map and other online tools to understand how these tools could help homebuyers explore the neighborhood.

When we went to Toronto, it was the first time we evaluated the application. We were not able fully to test the app because we encountered a number of issues related to the prototype. These issues made it difficult to evaluate the prototype. As a result, the application did not meet the design specifications. After completing the itinerary, we showed our prototype to get some feedback. The Quinpool and Riverdale evaluations plus the interviews with the real estate agent and the homebuyer couple experiences contributed to the formal study design.Then we made some changes to be tested for the next study. We derived design requirements for neighborhood expedition support from the outcomes of the previous study and from our preliminary research into the domain of digital tools for real estate. We ran the formal study in Halifax, with some modifications in light of our experience in Riverdale. We have replaced Quinpool with downtown Dartmouth as a target neighborhood, since Quinpool has a large concentration of

businesses and other POIs on a single street. Our other location remains the Waterfront area of Halifax.

We duplicated the study ran in Riverdale in order to understand how people used the existing tool "Google Maps" to explore an unfamiliar environment. In the meantime we updated the Android prototype (Block Party) to reflect the wireframe design and the results from the preliminarily study. The study was conducted using Google map and other online tools with 10 participants using different scenarios with the same research questions. At the end of the study we showed participants the redesigned app to get feedback for improving the prototype. We also used the results of this study (Google map) to redesign the current version of the Block Party application (app). A new study will be run in the future using the same scenario with small changes.

1.6 THESIS OVERVIEW

The thesis organization is as follows. Chapter 2 introduces the background and literature review in the areas of navigation using mobile devices, models of spatial awareness, route map design (layout), mobility and attention and augmented reality. Chapter 3 describes the preliminarily study conducted in Quinpool area (Halifax) and the Riverdale neighborhood (Toronto) to provide contextualizing information about the full study. It was also used to give feedback design, and to explore how other tools might be used (participants were not restricted to just Google map) Chapter 4 presents the formal study design for the existing tool "Google map". Chapter 5 presents the results and analysis of data collected from the field study in the Halifax waterfront and Dartmouth downtown neighbourhoods as well as the feedback. Chapter 6 includes discussion and limitations of this research, and the next phase as future work. Finally, Chapter 7 includes the conclusion of the thesis.

CHAPTER 2 LITERATURE REVIEW

This chapter covers research literature relevant to the topic of using mobile devices for neighborhood navigation and discovery. The research discussed in this chapter reviews models of spatial awareness, route map design (layout), mobility and attention, example Applications and services, navigation cues-landmarks and Augmented Reality (AR). Additional aspects that impact discovering peoples' behavior include time, location and social aspects such as conversion. These topics inform our research and provide theoretical grounding for our prototype design decisions.

2.1 SPATIAL AWARENESS

Draper (1995) defined spatial awareness as how people build awareness or knowledge of the location of points of interest (POIs) correlated with people's current location in the environment. It can be measured by the ability of people to locate and remember locations (Draper, 1995). There is variability in spatial awareness between people. Some people's brains are more focused on spatial knowledge or awareness than other people. Accommodating spatial awareness abilities, such as awareness of compass bearings or knowledge of landmark locations, is a key component to designing mobile applications for navigating in unfamiliar surroundings.

2.2 TWO MODELS OF SPATIAL AWARENESS

Tversky (1993) presents models of how people build awareness about location. The two models that capture the complexity of maps are cognitive collages and spatial mental models.

2.2.1 Cognitive Collages

In this model the brain puts many pieces of information together but this image does not always represent the image in reality. People using computers can remember information for a whole location even if the computer does not present the whole map as a big data structure. Instead of having a large map people put small pieces of information together to form mental representations of locations. This model is more suitable for representing spatial knowledge of the environment on a small screen. This implies that users of this

information only have to remember a place they were before and some text they have read, for their memories to help them make links between locations (Tversky, B. 1993).

2.2.2 Spatial Mental Models

According to Tversky (1993) making a spatial model of the relationships between elements is helpful when people are trying to identify locations. If the local area is known very well, people can remember spatial relationships of POIs. For familiar areas and simple environments, people can remember quite accurately representations of the relationships between POIs, but they may not be accurate in terms of distance. The comparison between this model and the previous one is that cognitive collages can represent small pieces of the spatial relationships more accurately. Tversky's study defined two ways to describe and remember the locations, *route* and *survey* descriptions. The "*Route"* describes landmarks using words like turn "left" or "right" while "*survey"* describes landmarks using "north", "south", "east" and "west". Spatial mental models do not care whether you are using route or survey view, people use both at the same time to remember the relationships between landmarks (Tversky, B. 1993).

In these models, people use reference signs, which assist them to identify locations. Landmarks are important for helping people find locations, to remember locations, and to revisit locations by remembering important landmarks. The author concludes that people do not like to know exact distances but instead prefer descriptions of location from one POI to another. People generally have an easy time understanding spatial relations between POIs. Terms that are used can be easily understood by people such as "turn left" or "right". Language expressions about location and orientation are used frequently and were easy to understand. The author points out that cognitive and spatial mental models are more consistent with errors that humans make in navigation.

Block Party helps users remember locations because it is focused on neighborhood POIs (i.e., landmarks), which are the focus of human navigators in remembering locations and already the points are marked by numbers with a small window showing the name and address.

The Block Party app uses both route perspectives which present an augmented reality (AR) view of the street and buildings (showing the north direction) and survey perspectives which present a Map View. Homebuyers can easily switch between them. The way people naturally navigate and figure out where they are is by things like landmarks, POIs and directions, all possibly aided by GPS. Hence, providing people with the relationships between POIs can be used to help those people with unfamiliar environments where they do not have the advantage of using their memories because they have no experience. We used those concepts that people naturally use when we designed the tool to make it easier or quicker for them.

2.3 LANDMARK-ROUTE-SURVEY (LRS)

According to Sas (2004) Landmark-Route-Survey (LRS) is one of the most common cognitive map models. This model describes spatial knowledge and how a person thinks about places in their brain. The LRS is composed of three parts: landmark knowledge, route knowledge and survey knowledge (Sas, C. 2004).

LANDMARK KNOWLEDGE IS THE MOST IMPORTANT TOOL FOR NAVIGATION BECAUSE THEY ARE EASY FOR PEOPLE TO REMEMBER. THIS DESCRIBES INFORMATION ABOUT UNIQUE FEATURES THAT ARE

AND TEMPORAL CONNECTIONS BETWEEN THESE LANDMARKS, THEY ESTABLISH THEIR ROUTE KNOWLEDGE.

Survey knowledge is understanding the area from above by seeing the pattern of blocks and streets. It is the highest level of spatial awareness (knowledge) because it combines both landmark knowledge and route knowledge.

Landmark-Route-Survey knowledge is applied to our real estate application by considering all three components. For example, a house, restaurant, gas station and daycare are landmarks. Route knowledge is connecting these landmarks to each other, having them in a spatial an order and some idea of the time it takes to go between them. The survey knowledge of the neighborhood highlights how to get from place to place or how to navigate within the area.

2.4 ROUTE DESIGN

Agrawala and Stolte (2000) state that there are four design goals in order to efficiently display the information on electronic route map. The goals are "readability, clarity, completeness, and convenience".

- *Readability*: the components of the route should be simply and visibly designed y for the navigator to easily identify the route.
- *Clarity*: it is very important to mark the route clearly and the map should have only the necessary information.
- *Completeness*: navigators should find all the necessary information.
- *Convenience*: designers should consider "how, when, and where the information is used". For example a route map can be used to identify POIs, while traveling and discovering neighborhoods. It should be easy to use and clearly displayed.

2.4.1 Information conveyed in route Maps

According to Agrawala and Stolte (2001) it is important to represent the entire route on the same screen since routes that are represented on parts of different maps and at different scales can be disorienting.However people are not concerned with the exact distances between navigation waypoints. They care that all the turns are clearly visible on the map. This is comparable to how people draw maps and spatial relations. This is a consideration for any mobile application because, for example, some POIs may have small separation distances , which would make it hard to see on the screen (i.e., overlap). As such, it becomes important to distort short paths by lengthening them, to make them more visible. The opposite is true for very large separation distances.

The authors also suggest that designers should distort the representation length to mark clear and useful information beside route names such as the name of the street or distance of the road, and landmarks around the road unless it interferes with the redrawing of the map. Additional information can help users with navigation. Providing landmarks is not necessary for creating the route but can help people to feel more confident that they are traveling along the right way during their navigation (Agrawala et al., 2001).

The Block Party application built a route that contained all the POIs that the homebuyers hadpreselected from the main menu. This enables them to navigate based on the order they already selected and the numbers could help them to remember the priority of the services that they want to visit first.

2.5 MOBILITY AND ATTENTION

Gong and Tarasewich (2004) conducted a study in which they looked at user's attention. The recommended designs of mobile applications require users to use their hands or eyes as little as possible during navigation. When a mobile interface requires more attention, it may distract users from their primary activities. Mobile applications should be designed as simply as possible. In order to reduce interaction, information overload and distraction, the best way to display information is to use a hierarchical structure, rather than representing all details at once. The users should have options to switch from general to specific. For example, instead of giving details about all streets, it might give main streets then the user can decide what specific area they want to look at in more detail. The author suggests that the best way to interact with a mobile application is to use sound or tactile output as feedback to display the information. It should be acknowledged that Block Party uses neither but these could be future enhancements. Good mobile interface design should not split the user's attention (Gong & Tarasewich, 2004).

According to Inbar, Lavie, and Meyer (2009) when users interact with mobile devices time is important. When using a mobile device, the average user wants to be able to get the information they need in four to eight seconds. For example, imagine GPS navigation: if a driver is looking at a mobile device for directions while there are other cars and lights, that driver cannot take his/her eyes off the road for very long. In general, mobile drivers should need to take only brief moments to examine their devices. Mobile devices are used when people are on the go and time matters; any mobile device interface really has to communicate quickly with the user (Inbar et al., 2009).

In terms of mobility and attention we try to make Block Party as simple as possible to ensure that the navigator could be aware of their surroundings to avoid focusing exclusively on the screen.

2.6 EXAMPLE APPLICATIONS AND SERVICES

Zipf and Jost (2012) conducted a study where they classified location-based services into a set of primary and secondary service categories based on their level of importance. The primary services given by the authors are Mobile Location- Based Search, Mobile pedestrian navigation and Regional and Local -Based Services. These services are similar to those required of a neighborhood exploration application focused on homebuyers and renters, as discussed below.

2.6.1 Mobile Location Based Search (LBS)

Mobile users currently search for location-based services using common search engines such as Google Maps, Yahoo or others to get the desired service or information. In the last ten years, the method of searching for these services has changed from traditional desktop computer based search to mobile searches. Applications have also been developed for mobile searching to offer location-based services such as directions, routes, maps and POIs. This sophisticated LBS assists people to find the specific locations they are looking for (Zipf et al., 2012).

Location is described as an important factor that provides additional information with regard to user queries. This would be useful whenever a service is both needed and located nearby. Users have different needs when navigating in unknown environments. If users have no awareness of which services are available in the current location, their search might not find any results. The authors state that people use mobile LBS to gain familiarity with new areas (Rao et al., 2003).

According to Arikawa, Konomi & Ohnishi (2007), no previous research has been done stating the challenges and effectiveness of spatial awareness when trying to navigate in a large and busy urban area (such as downtown Toronto).

We know that there are going to be challenges with spatial awareness when people are in a large urban environment. Whatever tool is developed, it has to accommodate large urban centers by assisting people to find their way around when they get surrounded by many things. Any tool we use has to simplify the environment so that the navigators can find their way around more easily and not become overloaded with too much information.

In our field studies, the user's current location was necessary for finding POIs and what homebuyers need to know about where their targets are located. By presenting a sequence, going to one at a time, the amount of directional information presented at one time was reduced.

2.6.2 Mobile pedestrian navigation

Zipf and Jost's second category is mobile pedestrian navigation (2012). Mobile navigation was first used in cars but has now evolved to smartphones being used by individual navigators traveling on foot. The number of people using these applications has increased, for example, "more than 27 million" devices were sold in 2007 (Zipf et al., 2012). Mobile navigation presents specific locations of POIs for pedestrians and then guides them towards their destination. Navigation behavior for pedestrians is different from navigation by car because it is not restricted to staying only on roads (Millonig & Schechtner 2007). The development of mobile applications should assist pedestrians to find POIs in specific neighborhoods. In comparison, pedestrians have free movement especially in urban areas but cars are restricted to navigating on roads. The largest benefits of mobile pedestrian navigation is to guide people on foot from their current position to the required destination (Popa et al.,2010) and it supports people by providing route information which leads them to the target especially in unfamiliar areas (Millonig & Schechtner 2007).

Landmarks play an important role to support pedestrian navigation (Popa 2010). They can be used as reference points or distinct objects which assist people as they navigate within the surrounding area (Popa et al. 2010). One might thing that GPS should eliminate the need for landmarks but it does not.

The Block Party application is focused on neighborhood navigation by pedestrians. We found that the participants could identify the Halifax landmarks more easily than the Dartmouth landmarks which might have been due to a familiarity factor since they were more familiar with Halifax than with Dartmouth.

2.6.3 Mobile Location-Based Services (MLBS)

According to Chen and Lin (2011) mobile devices assist pedestrians to find locations or nearby POIs they try to reach. Also, users will have different paths from their current location and then users choose the best one. Navigation support such as electronic maps or other mobile phone apps should provide location, orientation and related geographic information that matches the real world (Chen and Lin, 2011). Sequentially the authors classify the MLBS into four categories: information, navigation, commerce and security tracking. Each category contains its own services. For the category "information" the service is the nearby location. “Navigation” has three services: traffic information, navigation and map. Their results that showed that user's preference for finding nearby POIs and navigation to or between those locations was a primary consideration for susers. There was a need for an application to satisfy these service’s needs.

Block Party is an application designed to satisfy users' services needs such as finding a navigating to or nearby locations.

2.6.4 Regional and Local -Based Services (RLBS)

The scales or levels of the data must be appropriate for the task to be accomplished through mobile applications. The data to create a route from has to be large detailed enough to accomplish the task. The data must match with the task in order for the application to be successful. For example when a user searches for a cafe the result they get should include the address and street name. Levels of data needed will depend on matching the data with the task (user’s need), for example regional or local data may be provided, whichever is most appropriate for the task. For example when homebuyers are looking for a house, the data should allow street name and number to be matched. (Zipf et al., 2012).

Black Party views were designed to display more information about the POIs using a small window to list the address and the name of the point.

2.7 NAVIGATION VIEWS

Beeharee and Steed (2006) conducted a study to assist users finding locations using photographs. By using simple mode and augmented mode photographs. The prototype was designed to display location photographs to assist users who were unfamiliar with their environment. The authors evaluated the system by comparing 2modes of navigation. In simple mode ("tabs map and route") users navigated using a map and the text routing. In the augmented mode, there was a photograph that users could use via a "viewer tab".

The results show that the users required less time to navigate when using augmented mode than users who used the map with text. The most cited reason that users did not follow the correct route was because the road was without a name on the map. However, some of those in the augmented mode used a photo, in conjunction with the map, to get back on track. One issue they encountered with augmented mode was that some participants went off the route because the photo was out of date. The authors concluded that photographs helped people stay on the right path and made them feel more secure in making the right decision, but the issue was keeping the photographs up to date (cf., Google Street View).

Unlike Beeharee and Steed (2006), who use one photo, Block Party offers an immersive view which supports an up-to-date image. However, Immersive view always displays POI details (i.e., GPS) and then uses a live camera to present the POI. Nonetheless, the information about the POIs could become out of date. It can displays POIs up to 80 kilometers away. The Block Party app is an improvement over Beeharee and Steed because, while in Map , List , or Immersive View, Block Party provides users with better maps and more up–to- date images.

Partala and Salminen (2012) evaluated three different mobile maps used by pedestrians in urban environments. The three interfaces compared were a graphical map, a

photorealistic satellite interface and photorealistic street-level map views. Their study considered location, direction and current position. They were interested to know how well users were able to identify landmarks in the real world during navigation tasks. Participants were required to select the view they most preferred. The authors found that Street View was effective for displaying landmarks but users needed more time to look at the street view than the other two views. Also, users found photorealistic street view and photorealistic satellite maps to be more interesting but less pragmatic because users needed more time to compare their location with the view on the phone. The graphical map view was more likely to be used than a traditional map. The graphical map view was effective for displaying landmarks.

With the Block Party application we considered these issues and we built the application so that the potential homebuyers could freely and easily switch between different views. We used a list view instead of a satellite view so users could see POIs as a list with the names and address.
The Block Party offers an augmented reality view that can be used to identify landmarks referred to by a white circle in the camera image. This action displays locations and landmarks physically. As well, the map is supported with information such as street names.

2.7.1 Navigation cues-landmarks

May et al. (2003) aimed to understand what information pedestrians are looking for while they are navigating and to determine the "implication on design for navigation in mobile devices" in urban environments. The study required participants with local knowledge to identify the information pedestrians would need to navigate different routes. They found that the most prevalent navigation cues were landmarks rather than “street name, numbers and distance information”. Pedestrians can easily navigate by landmark information, but it is costly to add, update, and maintain current views of landmarks. The authors recommend that landmarks should be assigned to specific name rather than a generic name.

Kallioniemi and Turnuen (2012) compared different types of landmarks selected by pedestrians and landmarks presented on mobile maps. Their model overlaid landmark images and street maps, and asked participants to choose landmarks they thought were unique, close to the route (within a distance of 200 meters), and obvious. This prototype highlights the notion that preferable landmarks are unique on some property such as shape, distance to route, structure, height, or age. The authors believe that this model is very appropriate for taking into account landmark saliency for pedestrian navigation.

Obviously landmarks are an important way for people to navigate. In the studies presented in this thesis, we asked participants to identify landmarks and spatial features (intersections, vistas or buildings) they passed by during the study. This was intended to demonstrate how our prototype design could be helpful in remembering preselected POIs.

The views in our prototype included relevant landmarks such as building. Homebuyers who are unfamiliar with Neighborhoods particularly appreciate the ability to use landmarks to help them navigate. Our application displays landmarks with specific names rather than general names (such as Bank of Montreal rather than bank) and includes more information for POIs.

2.7.2 Time, location and social aspects

Teevan et al. (2011) performed a survey to provide a picture of how people behave when using local mobile search. The goal was to understand how time, location and social aspects can affect local mobile navigation. Users are often interested in searching for information in relation to their current location ("their current location, routes and finding nearby services or near the route to their destination"). Time is important because users want to use the information immediately. For example, they may search for a coffee shop, and then immediately go to that coffee shop. Also, the social aspects of navigation are important since most searches take place in groups where social triggers are an important factor. A desire for conversation may lead a group to search for restaurants. The

application should be able to provide sufficient detail to allow a group to choose a destination.

Potential homebuyers need to identify services (schools, gas stations, etc.) and how close certain services are to potential new homes (recent position). Our new application provides these locations as POIs locally to the users and allows the user to select which they are interested in. As well, users can save those POIs that they are interested in while on route to other locations. This implies that designers must also consider the social context when designing the interface. If two or more people search for a home, then the application must provide options to satisfy the needs of all users.

Our application allows users to quickly identify a particular nearby service with one of three views: Map View, Immersive view, or List view. List view also allows users to look at all targets in a defined order and a small window that includes the name and the address of the POIs. This enables users to retain their current actions, and minimizes the time spent searching. Moreover, users can also quickly re-find the POIs because the application design provides saved POIs in categories for locations. Hence, users need not resort to a search.

Church and Smyth (2009) attempted to understand users' informational needs when users are “on the go”. They focused on the importance of location, time, and the type of information. The authors also considered how changing locations, time and social interaction can affect the type of information needed by users, specifically when navigating an unfamiliar place. They found three subclasses of navigational guidance:
1- Local implicit is the more general navigational need, such as “Where can I get coffee?” That is, the user is looking for a physical location that meets a particular need, but there is no specific criteria.
2- Local explicit is the more explicit requirement such as “Where is the nearest Tim Horton?” , or “Where is [a particular street number]”. In this case, there is a single specific location that meets the criteria.

3- *Directions* is the category used when looking for a route between two points (e.g., looking for the best way from school to daycare).
Their results showed that the most common mobile topic was identifying local services. The authors found that when users were traveling away from their locations they requested a tool to help them navigate to a new area. The highest number of requests was about getting directions and route information. Finally, they found that a mobile application is different from general web browser because mobile users are freely moving when locating different types of services.

The Block Party is specialized for geographical informational needs; it assists homebuyers to determine the locations they need and is supported with route description. The Map View mode allows users to create several routes between different preselected POIs. The list view mode assists users to set the preference of navigation points labeled by numbers based on their first destination. It makes it easier to discover nearby geographic POIs from the current location and helps users to explore new neighborhoods. The Block Party is designed for a specific purpose rather than as more general web browser. As such, it is tailored to that need

Sohn et al. (2008) reported in their research that pedestrians have different information needs while on foot but satisfying these needs was challenging for users who are unfamiliar with an environment. They sequentially classified the user's needs based on diary entries into three aspects: location, time and conversation. Their results indicate that location was the first category. Location is used to get directions to POIs, for example, nearby stores, banks and restaurants. The authors also found that users made use of a variety of methods to satisfy their needs quickly.

The Block Party application reflects the Sohn et al (2008) study in that users can mark their POIs quickly by selecting these services from location categories instead of searching. Also, the needs of users were met by providing different views to identify POIs: For example if the user is interested in the actual view of a building, they can use Immersive View. Users can use List View to see their POIs with associated information.

Also, Sohn et al. point out that the information generally available on the web is insufficient for finding services our new app is designed for this particular purpose so that users can find the relevant information efficiently. Soln et al. recommend that locations, time and social desires should be considered by designers to assist users in identifying their needs efficiently. The application should also offer different strategies to assist users to address their needs.

2.8 AUGMENTED REALITY

Augmented Reality (AR) is a set of context-sensitive features added to enhance the users' display of the physical environment (Reitmayr, G., & Schmalstieg, D. 2004). AR applications are developed in diverse fields such as navigation or gaming (Nilsson S, Arvoa M, Szczepanski, A and Bång, M 2012). In mobile AR applications, users hold a mobile device and the POIs are highlighted on the phone's camera image with meaningful information (Gotow, J. B., Zienkiewicz, K., White, J., & Schmidt, D. C. 2010). AR provides useful real time feedback to the user through the camera regarding the current location and the relative distance and visual identification of POIs. The user's view of the camera is augmented with the target based on the current location (Reitmayr, G., & Schmalstieg, D. 2004).

Dunser et al. (2012) compare navigation by using information displayed using an AR interface, versus maps, versus a combination of the two. The study was conducted by examining a user's navigation behavior and satisfaction as they were guided to POIs by a 2D map or an AR interface. The system was designed to display POIs within 10 meters of the starting position. It also showed the user the route by displaying the second target after the first had been reached. The authors found AR was less useful when users were not in the direct line of sight of the target (i.e., context sensitive features are not useful if they cannot be seen). Their results show that AR systems allow users to trace a direct path between two POIs. In addition, the researchers found that, relative to the simple map view, users with the AR + Map View spent more time focused on the screen and took longer to reach the target. w. In comparison, when users had the AR interface (without the Map View), they spend less time looking at the screen. If users lacked experience

with maps, they preferred navigation using AR interface. In their summary, the authors concluded that there is no best navigation tool that can work for all types of users or environments. AR was only appropriate when the user had a clear line of sight to the target and the success of the AR system depended on personal preferences.

We applied a map and an AR (immersive view) interface to our real estate application which displays all the targets that homebuyers previously selected within 80 kilometers. The prototype presents the physical environment with AR and walking distances to search for POIs. This view uses the Smartphone's GPS and camera. The images are always up to date but the POIs might be out of date.

All of these previous presented concepts are very important to consider when designing mobile applications for humans because people are different and their preferences are also different. We considered all of these issues when we were designing our Block Party application. However, we were dealing with a population that had specific needs. The next chapter will outline preliminary work undertaken in order to understand the context and design the Block Party application.

CHAPTER 3 PRELIMINARY INVESTIGATION

The purpose of the ongoing research project, which is a main part of this thesis, it is to design and evaluate a mobile application that will assist potential homebuyers in identifying services in a neighborhood, and to assist them in building other kinds of familiarity tasks including likely itineraries and walking routes. We proposed an initial smartphone application for the real estate industry that offers nearby location services to homebuyers who are looking to discover their new neighborhood including schools, day cares, parks and restaurants.

In this brief chapter, we outline preliminary work done with HomeZilla: field tests of an initial prototype in the Quinpool area of Halifax, a pilot study in Riverdale, Toronto, as well as interviews with homebuyers and a real estate agent, and finally the designed application mock ups for HomeZilla, which in turn influenced the design of Block Party. We built the basic prototype with HomeZilla as a step to get started. The prototype was developed for Android devices, using the phone's GPS, camera and orientation sensors, the Google Maps API and a third party augmented reality API to display the different services close by. Three Map Views were supported: Get Directions (a map-based route display that is linked to a perspective turn-by-turn route), List (actually a Map View where POIs were displayed and could be selected to present more information), and Immersive (see Figure 3.1). The prototype was implemented by Gourav Sharma, with support from Sudheer Rajana.

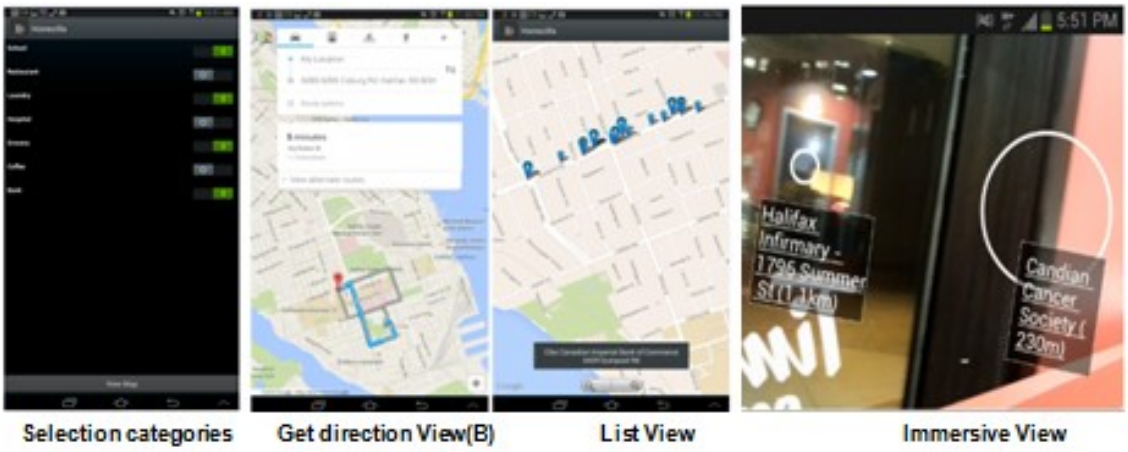


Figure 3.1 The initial design of the prototype with the three views for Exploring Neighbourhoods

3.1 Pilot test on Quinpool

The researchers conducted a pilot test of the Android HomeZilla prototype in order to validate its features against the requirements of the research. We conducted an initial route building exercise based on the scenario for Quinpool we had created in an initial study design, then followed the route to visit locations of interest in the neighbourhood. We tested the interface using the tasks and materials for Quinpool and uncovered a number of technical flaws and functional defects. As a result, the implementation did not fully meet the design specifications, although it gave us technical insights regarding how to build a mobile application to support neighbourhood discovery.

3.2 Riverdale pilot study

We ran a pilot study using 4 participants. Our study design involved building an itinerary of points of interest relevant to homebuyers in a prospective neighbourhood, and then following that itinerary. Due to the technical issues with the prototype, we decided to run a modified version of the study using the same tasks and scenarios and with similar goals as outlined in the original study design. Our revised goals were used to get a sense of how people use existing tools (Google Maps and other online tools including Yelp and Google search) that are available on smartphones for discovering a neighborhood.

3.3 Interviews

A real estate agent and a homebuyer couple were interviewed to get a sense of how a range of techniques and tools are used when purchasing a home. The use of a mobile device to explore neighborhoods was one tool used by homebuyers and it was clear that any related apps should support a range of different kinds of spatial and information queries.

3.4 Mockups

Wireframe designs were created, based on the aesthetic of the existing HomeZilla web services, while being reflective of the need to support a range of spatial and informational queries during the home buying process. The wireframes also attempt to achieve a high level of simplicity, and to reduce the effort required to switch between spatial views. Designs were created by Sarah Orford. We intended these wireframes to inform the interface of the prototype to be evaluated in our formal studies. . Using search screen the

user identifies categories of interest and the location to search in. The search result could be viewed in any one of the three views- Map View, List View and Immersive View

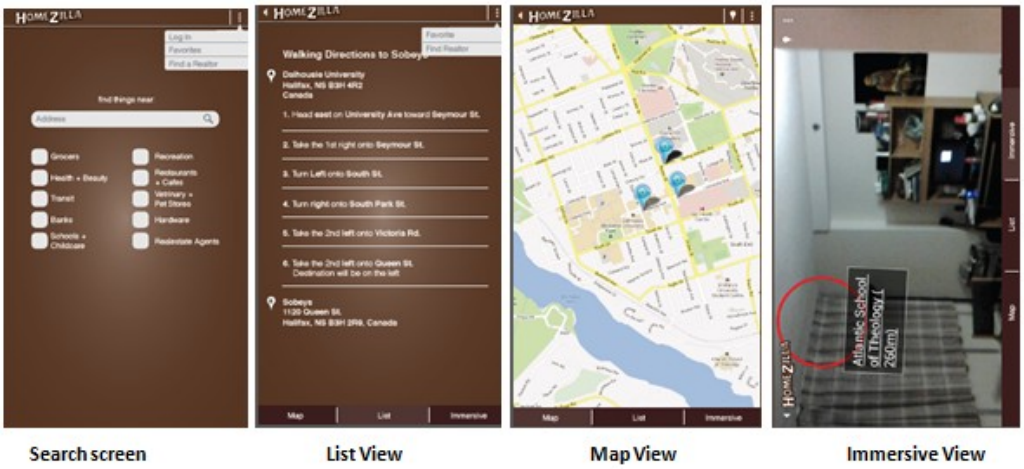


Figure 3.2 User identifies categories of interest and the three Mockups for the prototype

We considered results of the preliminary evaluation as well as the issues we had with the initial prototype and the HomeZilla mockups and the outcome of the interviews. All of these experiences contributed as input to the formal design for the Block Party app.

The experiences were also used to create a revised study design, intended to give us further insight into the unique requirements of tools that support neighbourhood exploration. The following chapter will describe the new study design.

CHAPTER 4 STUDY DESIGN

The Quinpool and Riverdale evaluations and the other activities discussed in Chapter 3 contributed to the study design presented here. We ran the formal study in Halifax in two neighborhoods: in downtown Halifax centered around the waterfront, and in downtown Dartmouth. In light of our experience in Riverdale we used a similar task structure, but modified the overall scenario slightly, and adjusted our research questions as described below. As stated previously, we replaced Quinpool with downtown Dartmouth as a target neighborhood, since Quinpool and Riverdale have a large concentration of businesses and other POIs on a single street, and we found that reduced the need to use the mobile application in the Riverdale pilot. We therefore tried to choose neighborhoods with more complex layouts.

We chose to continue exploring how Google Maps supported neighborhood discovery, and record where it fell short in doing so. Google Maps is a common tool to navigate and to find points of interest (POIs), and studying its use for neighborhood exploration would yield insight into the needs that are particular to that activity. After using Google Maps, participants would be given a chance to reflect on the design of Block Party. This is our custom built tool that emphasizes multiple synchronized spatial views. The outcome of this study was used as design feedback for Block Party.

In this chapter I will first introduce the Google Maps application, then itemize the research questions and finally describe the study design.

4.1 Google Maps

Google Maps is a web-based map application provided by Google. It offers variety of map-based services, such as local search and navigation support. Recently, the Google Maps for mobile app has become a popular tool for smartphones. Google Maps for Android devices helps find where you are, where you are going and how to get there. Google Maps offers different options and features. “Voice-guided turn-by-turn navigation, whether driving, walking or taking public transit. See estimated time to your

destination" (www.google.ca/mobile/maps/). In our research we had participants use Google Maps as pedestrians to find nearby services.

4.1.1 Google Maps application flow activity

This section illustrates the process or the flow of how participants used Google Maps to find nearby services. This is the typical process if you were using this tool as a pedestrian. Google Maps has a number of views and screens that users are led through when they are navigating on foot.

As shown in Figure 4.1 (A) when user clicked on Google Maps icon then it would pop up the map. Then you will see in the above field called search, this space allows you to type locations/addresses that you want to search for. Also, it shows the current location option which told the user where user is located (see 4.1 B). As shown in figure 4.1 (C) user clicked on the search field, it allowed to type the query or where you want to go (Sushi restaurant) then the system provided the results including several sushi restaurants as shown in Figure 4.1 (D) then the user chose the relevant service, he chose the closest sushi to the house as shown in Figure 4.1 (E). Then when the user clicked on the red marker on the map you will see options such as estimated time to get to the destination, save, share and street view. When you flip the screen up, user will see other information such as website, reviews as shown in Figure 4.1 (F). Clicking on the "little walking man" showed the user different routes to get to the destination from your current location with the expected time as shown in figure 4.1 (A). Also, they can use this view to peruse points on the map they had saved and/or search results, selecting each point in turn by tapping its marker, see figure 4.1 (F).

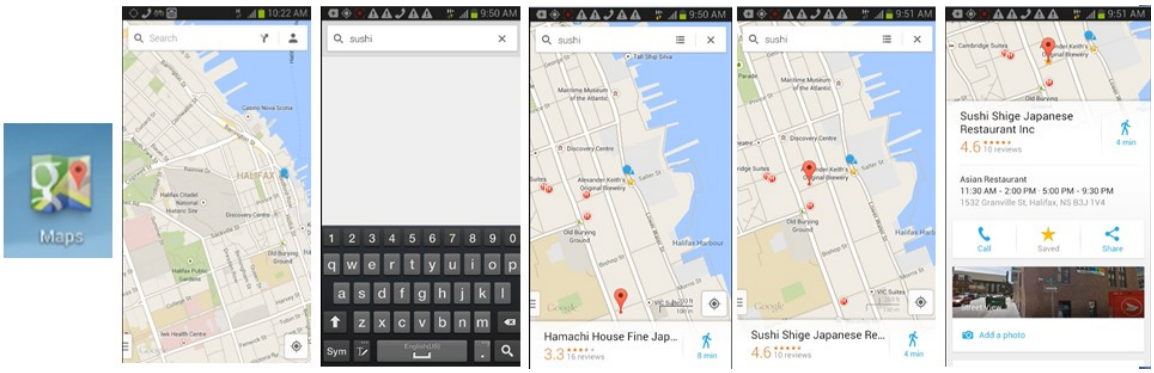


Figure 4.1 Illustrated the process when user started using Google Maps. (A) is Google Map icon.(B) is top down regular Map View. (C) displayed a set of choices (Sushi). (D) when user select one of the choices. (F) is information regarding to the selected point.

As we can see in Figure 4.2 (A) users can select direction button option; driving, public transportation, bicycling or walking. When user selected walking option and chose the route, and then he followed the route (Route view, as shown in Figure 4.2 (B). As soon as the user clicked on the "Start" button on the right, it transitions from route to Navigation (Satellite View, Traffic View and step by step views), it gave to pedestrian instructions to get to the destination supported by the voice guidance. When user clicked on hide Satellite View then the system pop up the Navigation with (Traffic View). If pedestrian clicks on the button on the right bottom as shown in Figure 4.2 (C), then it pop ups options (Route preview (Traffic View), step by step, voice guidance as shown in figure 4.2 (D). Users selected Step by Step as shown in Figure 4.2 (F).

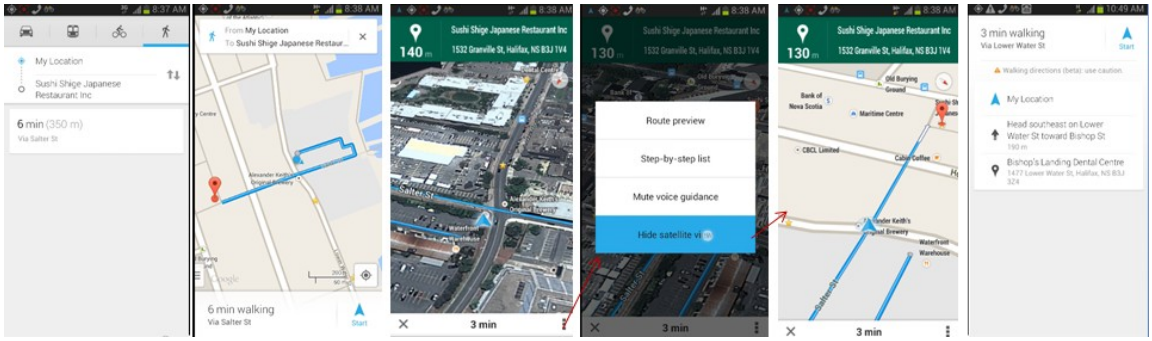


Figure 4.2 (A) is walking option with different routes. (B) is Rout View is a route between pedestrian current location and the destination. You can start to navigate by clicking on Start button it will give you instruction to get to the destination supported by the voice guidance as shown in (C, E and F), it is Satellite view which gives a top down picture of the location and then if you click on a little man walking direction then it gives options to which directions you want to .

Three out of ten participants used Satellite/Map view. They had to click on the button on the left bottom of the phone then a pop up a menu appeared as shown in Figure 4.3 (A). Then they had to click on the Satellite option as displayed on Satellite/Map View as shown in figure 4.3 (B). When some participants extended Satellite/Map and zoomed it out then Route View was displayed as shown in Figure 4.3 (C). Also, most participants tended to use Street View to see how the destination looks, so they had first to switch to Map View and click on the star to see the point's name then it showed the Street View icon as shown in (D). Then they clicked on the icon then Street View pop up as shown in Figure 4.3 (E).

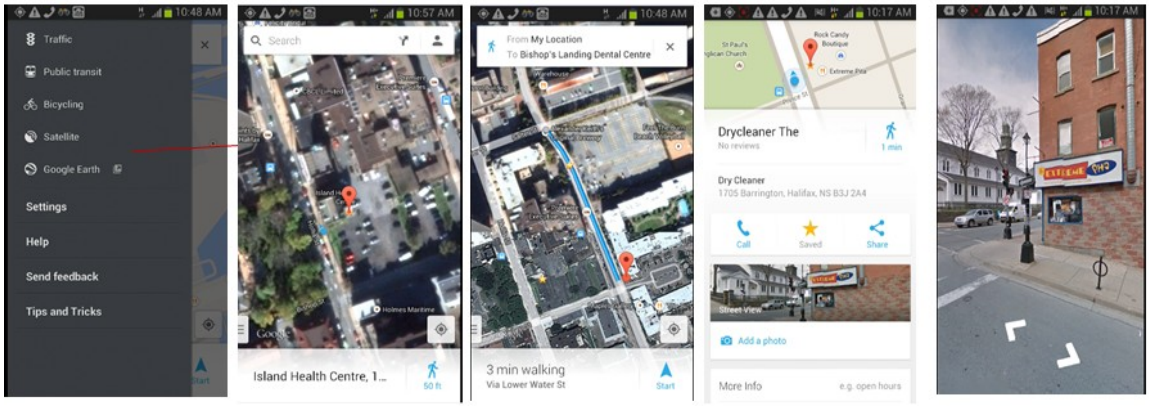


Figure 4.3 Participants selected the Satellite option from the menu (A) which is then displayed (B) and only when zoomed will it feature the Route View (C). (D) is when participants saved the star and participants can use it to search for points later. Also when participants clicked on the Street View icon then it pop up to Street View (E).

4.2 STUDY TASKS AND SCENARIOS

We asked each participant to do the same tasks (although we tried to personalize the tasks when we could e.g., to use their real pets' names, which we got from a pre-session questionnaire). There were four types of tasks that we asked participants to perform.

1. Locate points of interest within walking distance: we provided the participants with a set of services that they needed to find within each neighborhood.
2. Create a route to investigate these chosen services: the participants walked to each of the services and pointed these out to us. We let them decide the order and the route to get to each POI. We made sure that all services were easy to walk to and would be at most 5 minutes between each location.
3. Navigate to each POI in the itinerary in order.

4. Reorient according to a fixed landmark: we stopped the current task that the participant was doing and asked them to point in the direction of fixed landmark that they would be familiar with (e.g., the house they want to buy).

The smartphone had the Google Maps app installed. Note there could be just one of one type of service available (e.g., a hospital) or there could be several, forcing the participant to select one to investigate (e.g., coffee shops). Once the participant had selected the points then told which services they have chosen to investigate, they told us the route they wished to take (e.g., the order that they will walk to each). Experimenters followed them while they performed their tasks. At 3-4 different points we asked them to stop their current task and to point in the direction of a specified landmark.

We ensured that the itineraries selected by each participant had similar distances to walk, and included mostly the same service types (although not always the same selected services).. For more detail regarding the scenarios for participants who started from Waterfront see Appendix A1 and for participants who started from Dartmouth please see Appendix A2.

4.3 Research Study

In this chapter we discussed the methodology for the study design based on preliminarily results we received from Riverdale and Qunipool. The motivation for this study is to identify the need for a specialized application for neighborhood exploration, to validate design decisions and discover refinements that we could add to Block Party app. We had asked 10 participants to use an existing tool "Google Maps, to assess the limitations of this popular mobile navigation system "Google Maps" and search application for discovering a neighborhood. We ran the study in the Waterfront area of Halifax and the downtown core of Dartmouth using Google Maps. The preliminary pilot study was used as input and gave us a lot of useful information to redesign the final version of our prototype.

4.3.1 Revised research questions

The original research questions were modified based on our prior work and the decision to use Google Maps in the study.

1. Which map view do the participants prefer and find the most helpful for doing the three different types of task?
2. What are the limitations to using Google Maps for discovering a neighborhood and how might a specialized app be designed to address these limitations?
3. Does using different map views encourage more exploration and learn more about the investigated neighborhoods?
4. Do the participants' spatial abilities have an impact on wayfinding and using the different map views?

4.4 STUDY PARTICIPANTS

We recruited a total of 10 participants (6 male, 4 female) from the Dalhousie University community that were assigned participant numbers 100, 101, 102, 106, 108, 113, 115, 116, 117, 118. Nine were between 18- 35 years old and one participant was over 50. Participants had average self-reported sense of direction, scoring 61.5 (SD=8.2, Max = 77, Min=53) on the Santa Barbara Sense of Direction Questionnaire (SBSOD) with the possible score range from 15-105. (The higher the value, the more confident the participants feel about their directional ability). All the participants currently live in Halifax and rent their current home/apartment. Half of the participants (5/10) stated they were familiar with the Waterfront area of Halifax and most (8/10) were unfamiliar with the downtown area of Dartmouth. Participants indicated that the most important features and services they would like to be nearby their homes were: transportation (10/10), parks and green spaces (9/10), grocery stores (8/10) and banks (8/10). When finding their current residences, 9/10 participants used online sources and 2 used mobile maps. Five participants started from Waterfront to Dartmouth and the other five started from Dartmouth to Waterfront. All participants had used a smartphone or a small-screen device before. The participants were screened to be comfortable walking around a neighborhood with stops for about 25 minutes.

Participants were recruited by email announcements through Dalhousie University Notice Digest (notice.digest@dal.ca), Facebook account and through the Computer Science mailing list (cs.all@dal.ca), and by posting posters around campus. For more details for recruitment email (Appendix B). The Facebook post of the Face book gave a brief description of the study and directed any person interested to send a private message to the Facebook account. When we received requests, we emailed out the recruitment notice. If a participant was still interested, then they would email the contact in the recruitment notice again to set up a time to meet. In the recruitment notice, participants were asked to email their interest to the listed researcher who would then send out the pre-session questionnaire and the link to the consent form (Appendix C) that will direct them to two online surveys: Demographic online questionnaire (Appendix D) and Santa Barbara Sense of Direction Questionnaire (Appendix E). The participant and researcher were communicated to find an appropriate time to meet to do the study.

4.4.1 Informed consent and compensation

All participants involved in the study signed an informed consent form. First, they filled out the consent online and then we also administered it again by a researcher at the initial meeting of the study. The informed consent outlined the risks and benefits associated with the study, a description of the study, the participant's right to withdraw without consequence, and assurances of confidentiality and anonymity of personal data. As well, the informed consent made it clear to participants that they could withdraw from the study without loss of compensation. All participants in the study received a $30 gift card from Amazon (Appendix F) for participating in the study (whether they were able to finish or not). We also reimbursed participants for the bus ticket to be used to get the ferry to go to Dartmouth or coming to Waterfront (Appendix G).

4.5 Study Locations

4.5.1 Halifax Location

In Halifax, we used the neighborhood down by the waterfront for our participants. This location has several newer condo and apartment sites that are intermixed with popular restaurants, trendy cafés, shops and it is close to the downtown core (see Figure 4.4).

Figure 4.4 The Waterfront Downtown Neighbourhood in Halifax

4.5.2 Dartmouth Location

In Dartmouth, we used the downtown neighborhood. This up and coming location has several family style homes and has several intermixed with restaurants, cafés, schools, parks and green spaces, and it was close to the ferry that goes to Halifax (see Figure 4.5).

Figure 4.5 Downtown Dartmouth Neighbourhood

Then we designed new application called Block Party. Ben Swinden is chiefly responsible for the Block Party implementation. The first version of the redesigned app is described as follows:

4.6 Revised Study

When we came back from Toronto neighborhood we decided to replace Quinpool to downtown Dartmouth as a target neighborhood, since Quinpool has a large concentration of businesses and other POIs on a single street, and we felt that in Riverdale this had a large impact on the way the mobile tools were used. Our other location remained the Waterfront area of Halifax. We also decided that it would be easy for us to recruit across the board and to ask individual demographic questions to personalize for participants in our current study, rather than have scenarios that targeted particular demographics. It had been difficult recruiting people with young families for the Riverdale pilot. So, rather than a between-subjects design with 3 distinct scenarios in three different neighborhoods, we decided instead to have a general home buying scenario considering two potential neighborhoods, but with tasks that were personalized to people's preferences. Each participant would experience both settings (a within-subjects design).

In the meantime we revised the Android prototype to reflect the wireframe design and the results from our study (the Block Party app, as described above). The following chapter will describe the new study design.

4.7 Study Details

The study was designed to take about 2.5 hours. The time required for each section is described below (see Table 4.1):

Table 4:1 Study detail

Task	Time required
▪ Explain the study, answer questions and get informed consent (Appendix C):	~5 minutes
• Provide a training session with the mobile device (and potential apps):	~5 minutes
• Perform the perform the scenario with the mobile device with location 1 (Waterfront) (Appendix A1)	~25-30 minutes

• Take the ferry across the harbor: o During this crossing participants will: oFill in the neighborhood familiarity survey Waterfront (Appendix H)	~5 minutes
• Perform the scenario with the mobile device with location 2 (Dartmouth) (Appendix A2)	~25-30 minutes
• Fill in the neighborhood familiarity survey Dartmouth (Appendix I):	~ 5 minutes
o Participate in the semi-structured interview (Appendix K)	~ 10-15 minutes
• Demonstration of the Block Party application, feedback elicited from participant about specific features	~5 minutes
• Answer any questions, final comments, payment (Appendix F and G)	~3 minutes

4.8 Study Methodology Details

Before we met with any participants, they had filled out the online pre-session questionnaire (Appendix D) using the Dalhousie University Opinio survey service to confirm that the participants meet our requirements (e.g., to assess their knowledge of the two neighborhoods). They also used copy of Opinio to complete the SBSOD questionnaire and the consent form,

Two researchers met the participant at a specified location (Tim Horton's near the ferry terminal in Halifax, or in the ferry terminal in Dartmouth). Then we asked the participants again to sign the consent form in case they had questions and since there could be a few days elapsed between filling in the surveys online and when we met with them. They were given a copy of the consent form. We reviewed the study scenario with

the participant and provided them with a Samsung Galaxy Note smartphone with Google Maps loaded.

We demonstrated the features and the views of Google Maps to the participant, and then conducted a training session on how to use the Google Maps that involved walking from the meeting point to the location of their potential home: an apartment (condo) in Halifax and house in Dartmouth that was a rental or purchase possibility.

During the training session we asked participants to use specific views at different stages while walking to the home or the condo. We were careful to emphasize that the task was designed to build familiarity with the features, not to suggest a "best" way to use the application. Participants visited nine POIs pointed to three landmarks (World Peace Pavilion, Curling club and park) and pointed to three previously visited locations in Dartmouth. In Halifax, there were ten POIs visited, they pointed to three landmarks (Clock tower, supermarket and park), and were asked to point to two previously visited. We videotaped the participants, and used smartphone screen capture and voice recording software (SCR Pro), that captured all interactions made with the application (e.g., scroll, zoom, switch views). Visual trails indicating touch screen interactions were superimposed on the captured screens by the software. The researchers also took informal hand written notes from the training session onward. Once we arrived at the home or the condo, participants entered a planning phase. Each participant was given a list of generic destinations/services to search for using Google Maps. When possible, generic destinations were personalized, so for example "find a restaurant" became "find a Greek restaurant" if the participant indicated that they liked Greek food in the demographic questionnaire. Once they determined the destination POIs then the participants starred/saved their different locations/points on the map. When participants were asked to create route to visit each of these saved locations. At this point, they began the neighborhood expedition. Each wayfinding task involved going to the next destination in the itinerary.

Once at the destination the participant needed to show the facilitators that they were aware of its location. When participants searched for matching POIs nearby to the house then sometimes the system returned no matches; in such cases the participant could choose to not include that category in their itinerary. One specific destination was also mandated, to ensure that all participants would reach the same location at some point (for both Halifax and Dartmouth). At that destination a diversion (interruption) was introduced which consisted of three side tasks, each with specific routes, so that all participants would share some of the same wayfinding experiences.

When the interruption began, participants were asked to search for and go to three specific destinations in turn. For example, in Halifax the premise was that friends wanted to meet at Grand Parade, and then change the meet up location, and ask the participant to check out a third location on the way. While they were navigating we did not constrain which application features that they prefer to use for any of the tasks; rather we were interested in seeing when features were selected, and whether or not they would be of help with the tasks. At three different points we asked them to stop their current task and to point in the direction of a pre-visited landmark (e.g., the house or the ferry terminal). We also asked participants to be on the lookout for other places of interest to them and to star these locations.

Two researchers were present during the study. One researcher videotaped the participant and was ensuring that the participant performs the tasks safely, and the other one took notes and manage the scenario. Researchers occasionally asked questions while observing the participants (e.g., "Why are you going that way?") to clarify what the participant was doing. When participants finished exploring the first neighborhood they were asked to complete a neighborhood familiarity test, containing questions meant to assess their level of landmark, route and survey knowledge of the neighborhood. Then participants visited the second neighborhood, following the same procedure as the first neighborhood. At the end of exploring the second neighborhood they fill out the second neighborhood familiarity questionnaire. At this time we conducted a short semi-structured interview

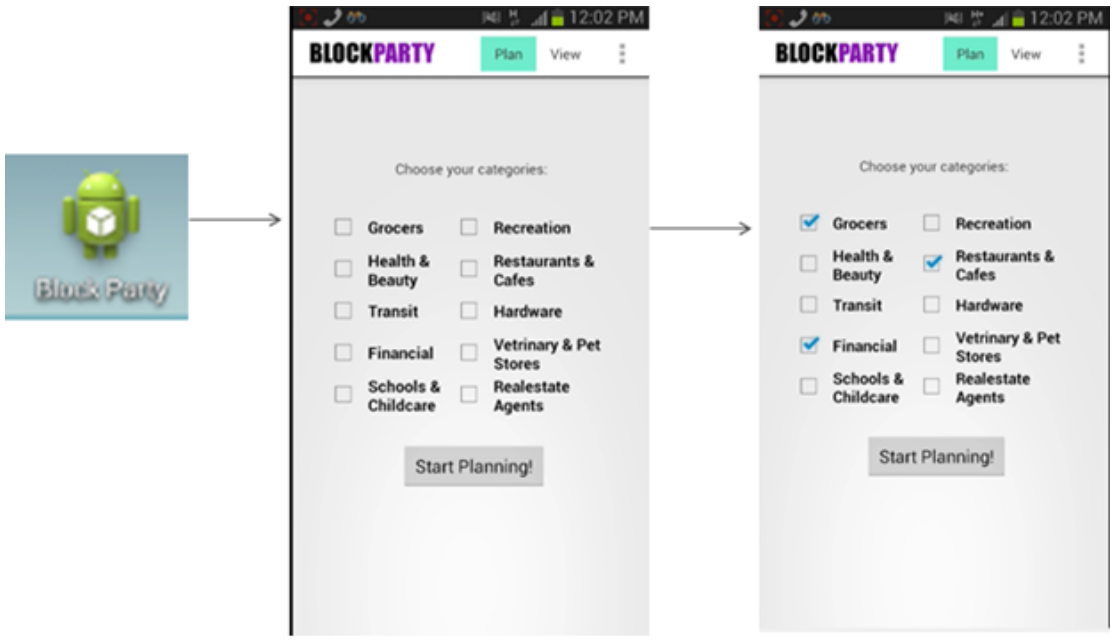
that was also recorded. At the end we showed them how our new Block Party prototype could be used to explore the neighborhood and to get their feedback.

4.9 The First version of the Block Party prototype

Block Party was designed to use three different types of navigation views. These views are; Map View, Immersive View, and List View. These views will be described in next section. It has been designed for users to switch very easily between the three views. At the bottom of the application there is a navigation panel with a button for each view, users can always see this panel no matter which view they are using during the navigation. These three different views were chosen in order to give the user a variety of different options to view the data.

The Map and List views have two modes: planning and viewing modes. The planning mode shows all locations from selected categories and the viewing mode shows only specific locations users have marked from within planning mode.

As can be seen in Figure 4.6 (A) as soon as the user clicks on the Block Party icon the first screen of the Block Party prototype shows the main menu which has all the categories of locations in neighborhoods. Participants can select the categories' locations that they are looking for as shown in Figure 4.6. (B). Once the participant has selected the specific categories, the checkbox becomes selected. After participants have selected the categories that they are looking for, then they press start the “planning navigation” button see Figure 4.6 (C).



Block Party icon (A) Block Party main menu (B) Block Party selection categories (C)

Figure 4.6 The Block Party icon, the main menu of the category of locations and the chosen categories of the Block Party prototype

4.9.1 Map View

The Map View is top down map display points in the neighborhood and shown as markers. It shows the location of the requested POIs (e.g., cafe) in relation to where the user is located in street layout (current location with small blue point). It shows all chosen POIs on the map.

As shown in Figure 4.7 (A) the users selected POIs based on the categories they chosen and they got marked with red color. Then when the user selected what he interested in, the markers changed to green color as shown in Figure 4.7 (B).

In Viewing mode as shown in figure 4.7 (C) once user clicks on viewing mode, it shows only the chosen points in blue color and when the points chosen are added to a user's route and changed to green color in Figure 4.7 (D). Then user can generate the route including all the chosen points as shown in Figure 4.7 (E).

Figure 4.7 Map View in planning and viewing modes for Exploring Neighbourhoods

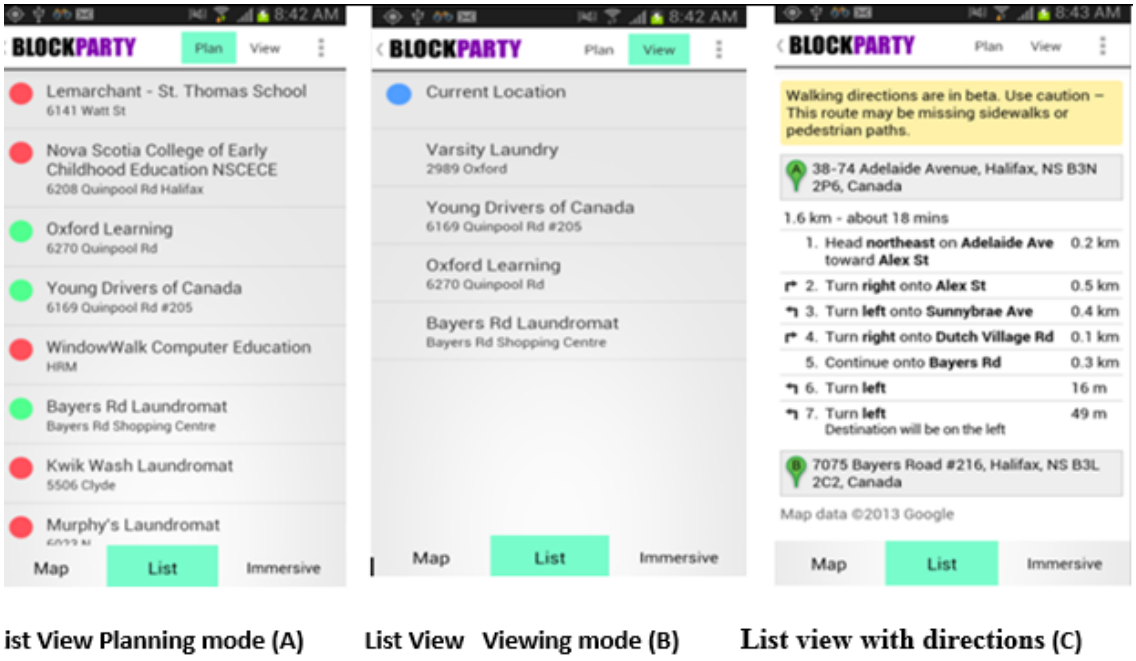
4.9.2 List view

The participants can also use the list view to find POIs. The List view displays locations information as list.

In planning mode**,** it shows all locations from the categories that the user selected with a red dot on the list. The user can select locations to add to the route, then it will be marked with a green dot as shown in Figure 3.8 (A). While we can see in Figure 3.8 (B) in viewing mode, it shows the current location and presents only the chosen location from the list of planning mode. User can select two location from the list and then it present to

the user directions from the first location marked with letter A to the second marked with letter B (from current location to the location they want to go, from one location to the second one or from the location they want to go to the current location).

List view with directions: this view was generated from viewing mode. The user can select two locations on the list to get a list of text directions to walk between these two locations. The direction appears over the viewing mode. This view shows the directions between the two chosen locations from the previous screen. As shown in the figure it shows the direction between two points a (current location) to B (the location we want to go). It presents the walking directions supported with instructions to get point B (see figure 4.8 C).



ist View Planning mode (A) List View Viewing mode (B) List view with directions (C)

Figure 4.8 List view in planning and viewing modes for Exploring Neighbourhoods

4.9.3 Immersive View

This view uses a live camera. As shown in Figure 4.9 this view gives the user and augmented reality view that uses the camera and displays information about POIs in the direction where these points are located (e.g., coffee shops). The phone uses the camera view and overlays all the requested POIs with a box includes the name and address of the

points as well as with their distance. This view was without planning and viewing modes see Figure 4.9

Figure 4.9 Immersive View

Also the Block Party app has function on the top right of the both modes (planning and viewing modes in Map and List view only as shown in 4.10)

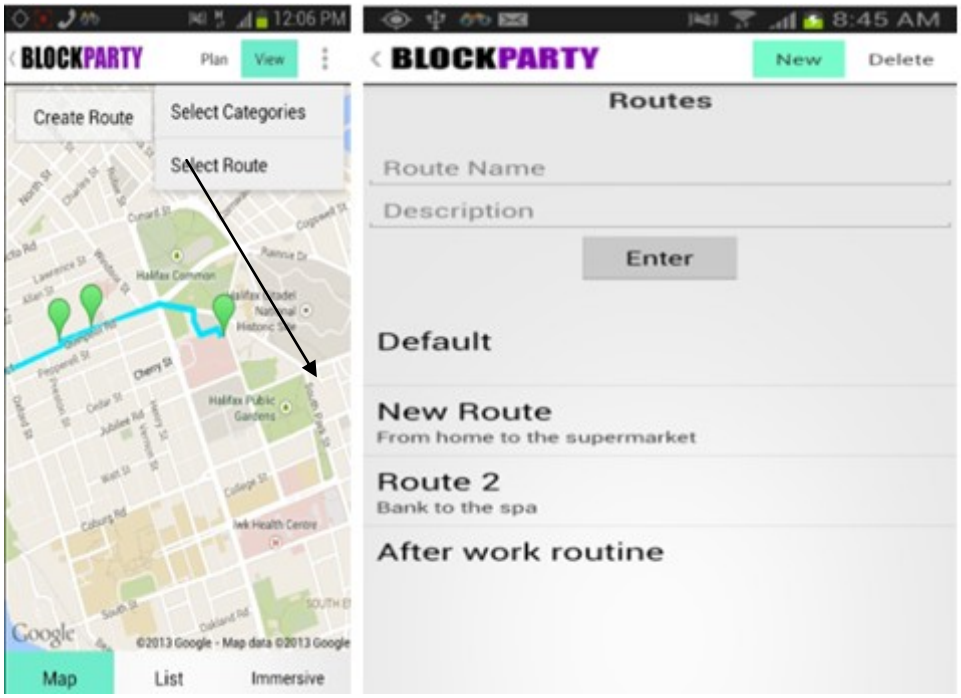
Figure 4.10 Planning and Viewing modes

Two choices, select categories and select route.

In select categories option, user can add more categories of locations to the current route so when the user clicks on it, it will move to the main menu and then he can choose the categories they want as shown in Figure 4.11 (A).

Select route option has already default route which is the first route that was created when the user started the application for the first time. This choice has two buttons: new which allow user to make more than one route and the second one is delete which means user can delete the previously created routes. User can save the created routes and make description about the route they created as shown in Figure 4.11 (B). For example, route from bank, spa to home. The user can easily create more than one route between all

chosen locations. The Map View allows users to make more than one route and save the routes with description. See the Figure 4.11 (B)



A B

Figure 4.11 Selected Categories and Selected Route

4.10 DATA COLLECTION TOOLS

We used diverse methods for collecting the data before, during and after the study (see Table 4.2).

4.10.1 Data Collection

As shown in Table 4.2 diverse methods were used data collection within three distinct phases: Pre Field Study (before the Field Study), Field Study, and Post Field Study (after the Field Study).

Table 4:2 Data Collection Tools

Phase	Instruments/Tools	Comments
Pre Field Study	Background Questionnaire	Demographics
	Direction Questionnaire	Self-Rating of sense of direction
Field Study	Observational Notes	a written log of the actions of the participants
	Phone Screen Capture	a record of all actions performed by the participant on the smart phone
	Video	a video recording of the participants actions during the navigation task
Post Field Study	Semi-Structured Interview	preferences for navigation views by type of task general feedback about navigation task
	Neighborhood familiarity survey	participants memory for locations visited
	Prototype Assessment	feedback for a new navigation application (version of Block Party app)

4.10.2 Data Coding

The responses from the demographics questionnaire were tabulated. The responses from the Santa Barbara Sense of Direction Questionnaire were coded as per instructions. The main data coding concerned the merging of the data from the SCR Pro capture data, the video and the Observational notes of the Field study.

For these three streams the goal was to create one single stream of behavioral data that would code all the navigation relevant actions of each participant. Adobe Premiere software was used code the data from the SCR Pro capture data and from the participants' video synchronized side by side. The Observer notes were used to aid in this synchronization.

First, the screen capture data was coded first into a spreadsheet (i.e., Excel file). The coding was a sequential representation of the image displayed on the phone. The coding captured the type of view and the time (the frame number) of the change in image. The coding specifically noted the type of navigation view (i.e., map view, satellite view, navigation view, direction view, searches, and combinations of views). The coding also captured zooming, scrolling, orientation changes, and application errors. A final code was used for "off task" activities (i.e., other actions).

To create the entire itinerary for each participant, the SCR Pro capture data had to be merged with the video data. Therefore data from the video was added to the spreadsheet. To synchronize the two videos, Adobe Premiere was used to present both simultaneously side by side. Then, the actions at common points were noted. This had to be accomplished manually because the two video streams used different frame rates (60 frames/sec for the video; 5 frames/sec for the SCR Pro screen capture data). The Observational data was also used to aid the synchronization.

Table 4:3 The combined spreadsheet data code for the following actions

Current Navigation View (or other) in SCR Pro Screen capture data		
Stopped or	Walking	Looking at the phone (not changing views)
Stopped or	Walking	Fiddle with phone
Stopped or	Walking	Using the phone as a phone (i.e. conversation
Stopped or	Walking	No apparent reason

Stopped or	Walking	Looking around -- not within a specific category
Stopped or	Walking	Looking at destination name on phone
Stopped or	Walking	Looking at street signs
Stopped or	Walking	Looking at house
Stopped or	Walking	Looking at landmarks (e.g., building names)
Stopped or	Walking	Appears lost
Stopped or	Walking	Saw another navigation location while on route
Stopped or	Walking	Pointing out directions
Stopped or	Walking	Comparing app information to the neighborhood
	Walking	Passed the Target
Turned to a particular direction – purposive		
Turned aimlessly in multiple directions-- Does not seem to know where to go		
Linking the phone and environmental information: Duration		
Pointing or estimation task that is not about the next destination		
Revamped map		
Used the current location option of application		
Using voice guidance		
Phone carried at waist		
Phone carried at eye-level		
Reoriented the phone		
Zoom In (closeup)		

Zoom Out (overview)
Using left hand
Using right hand
Appears Lost
Appears Confused
Identified a target without resorting to the phone
Knew the target location when asked
Pointing to a target when requested
Pointing to a target without using app when requested
Locating a target using direction terms like North, South, East, West
Required help to get back on the path
Explained the information from the phone when asked
Closed Application
Reopened Application
Closed Phone
Reopen Phone
GPS Lost
Time required to download a satellite view
Time required to download street view
Conversation relevant to navigation
Conversation not relevant to task
Interruption not relevant to task
Duration of off-task interruption
Distracted by non-task
Content of conversation

- The annotation codes used were selected by consensus with all the members of the research team. In addition, it was necessary to examine the data several times so the codes were refined as the project continued. The actual coding required several hours per participant.

- Participants' summary: we used the Adobe Premiere tool to synchronize the screen capture software tool with the video camera to describe the entire itinerary for each participant at each location in both neighborhoods. In this aspect we considered all their actions and the interaction they did with the views like switching views and their behavior like getting lost while navigating.
- For the familiarity quiz scores were tabulated based on question category. The interview data and Block Party feedback was transcribed, and summaries generated, to be used in a subsequent affinity diagramming exercise to derive key themes.
- The researchers held meetings to look at the raw and summarized data and try to identify interesting events and comments. Each researcher captured interesting details from the video annotations, characterizations and interview transcriptions into individual notes. We also included the coding data derived from the SPPS tool.
- The affinity diagramming exercise was then conducted. We separated the video annotations and interview transcription into individual notes. Placing and rearranging notes and all previous descriptions and SPSS and excel data on a large wall until major themes emerged. This gave us an overview of the common points we interpreted from the attitudes and behaviors of our participants.
- We calculated the proportions of time spent using each view and number of view switches across each participant and across each start/end point. We further split each start/end point into a planning phase and an on-path phase. The planning phase started when participants were instructed to go to the next destination to visit or explore, and ended when they were ready to leave. The on-path phase started when they began to walk and ended when they successfully identified the destination or they gave up.

4.11 Data Analysis

As noted above, the primary data concerned the Field Study for each participant. That data consisted of a large spreadsheet that coded for the sequential actions of each participant. Before further analyses, that spreadsheet was split into two separate data files.

The first concerned the "On Task" activities while the second concerned the "Off Task" activities. The On Task activities concern the navigation between specified locations (planning the route between destinations, executing the plan).

The Off Task activities concerned the various secondary tasks the participants completed throughout the field study (e.g., pointing and estimating distances to previously visited locations, pointing and estimating distances to locations not visited). The time required for the Off Task activities was *not* included in the On Task analysis.

For the On Task data, the primary interest was the type of navigation view (i.e., map view, satellite view, step by step navigation) used. However, there was one other main consideration. Activities at a location were considered separate from activities while on route between locations. In some sense, one would expect participants to *plan the route* while at one location (indeed, the instructions encouraged this), and then one would expect participants to *execute (implement) the plan* between locations. This delineation allows one to separate planning from execution. For each participant, the raw data was a sequential map of activities. From this, the time per activities (e.g., the time per navigation view) and the transitions between views were computed. From this, the proportion of time in each view could be computed. In addition, we noted the times and numbers of other associated activities (e.g., zooming, reorienting the phone). Finally, one could note whether or not a participant seemed lost. This was computed and compared for the Planning and Execution phases separately. All participants completed navigation tasks in two separate cities, and between various locations. Hence, analyses considered "view type and time" as a function of Planning/Execution, city and location.

For the Off Task data, the primary interest was the type of view used (i.e., map view, satellite view, step by step navigation, none) when trying to estimate the location of, or distance to, another location.

Google Maps View categories

We divide the Google Maps views into main categories: Map, Route, Navigation and Street Views. Map View category includes regular map and Satellite/map as shown in

Figure 4.12 (A). Route View category includes Route view and satellite /Route, as shown in Figure 4.12 (B). Navigation category View includes (Traffic View, Satellite/Route and

Step by Step View) as shown in Figure 4.13 (C). Street View (A), Search Mode (B) and Search: location information(C) are shown in Figure 4.14.

Figure 4.12 Map, and Route views in Google Maps. The interface allows destination search and selection from Map view. Selecting a transportation icon (e.g. walking) transitions to Route view. Clicking "Start" transitions from Route to Navigation view.

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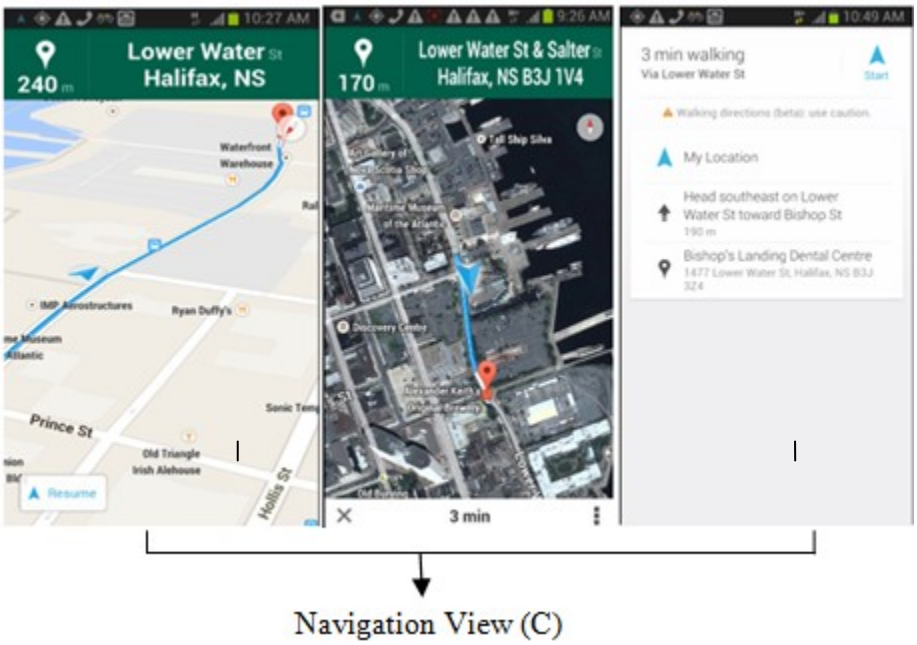


Figure 4.13 Navigation View (Traffic View, Satellite/Route and Step by Step)

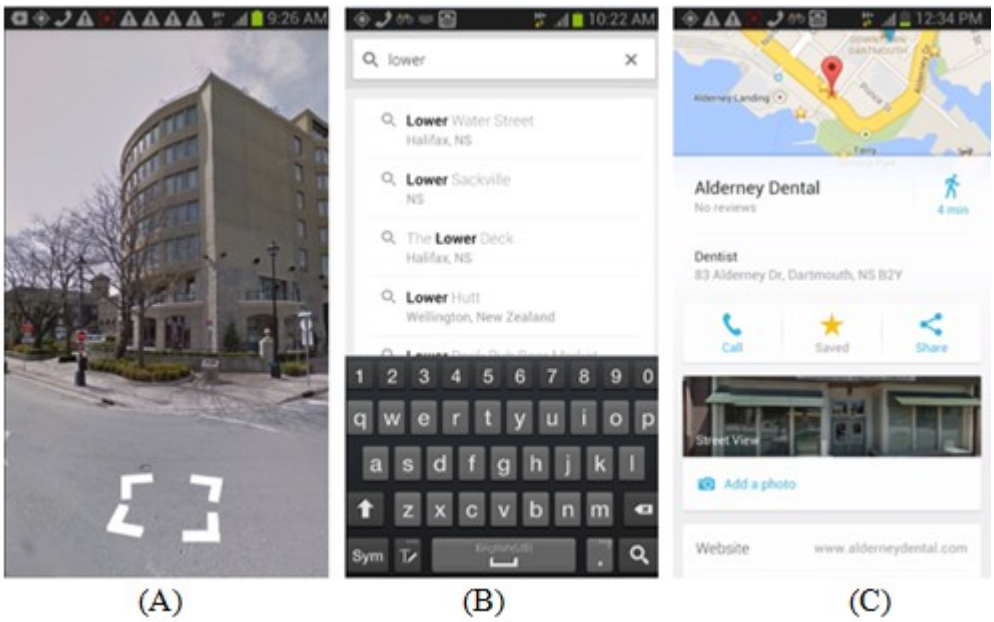


Figure 4.14 Showed Street View and Search Mode. Street View (A) shows a panoramic image of the street. Search Mode (B) brings up a list of possible results. Clicking on a result presents more information (C) including a small scale map and street view snapshot. Clicking the walking icon transitions to Route View; clicking the Street View snap opens Street View

Google Maps' interface allows destination search and selection from Map view. Selecting a transportation icon (e.g. walking) transitions to Route view. Clicking "Start" transitions from Route to Navigation view. When navigating, the user can choose to enable voice guidance. Step by step textual directions can also be selected from Navigation view. Street view provides a street level view with the buildings and other landmarks as you see them on the street, Figure 4.14 (A). The view can be controlled using swiping gestures or can be synchronized with the phone's orientation sensors. Selecting search results brings up a hybrid view containing information about the location, a smaller scale Map view and a clickable Street View snapshot.

Sequence analysis

We chose 6 common tasks (3 in each neighborhood) that most participants performed and we analyzed the view transition sequence data (i.e., the views used and durations coded for each participant in each task). Participants walked in each neighborhood to the same three locations. We considered the 6 common "diversion" tasks in Halifax (from Economy Shoe Shop to Grand Parade, then from Grande Parade to the corner then from the corner to Split Crow) and in Dartmouth (From Spa to Post Office, and from Post Office to the Happy Face Museum, then from the Museum to the corner). We analyzed the view transition sequence data (i.e., the views used and durations that were coded for each participant in each task) in R using the TraMineR module. The raw view duration data was normalized across all participants. We chose theses 6 locations because all participants had visited these locations.

All data analyses were conducted using in Excel, SPSS (Statistical Package for Social Sciences by IBM) and the TraMineR module of R (open-source software). For each task, a sequence diagram plotting the state distribution at each time point was created. Such plots show the distribution of views that were used by all participants across time. A transition point from when participants finished searching and planning to start walking towards destination was identified for each participant. The average time point was calculated and illustrated with a dashed line and a walking man on each diagram.

The results of this study will be described in the next chapter.

CHAPTER 5 RESULTS

In this chapter, the results of the study are discussed. First, we will talk about the proportional representation of time spent doing tasks for each category of the views in the three phases across Halifax and Dartmouth and the total proportion time across both. Second, a sequence analysis will illustrate the common transition pattern of views usage in the six tasks. Third, the main reasons for getting lost and strategies that participants used for reorienting to get back on track will be shown., Difficulties participants had with switching views will be discussed, as well as issues with searching. We then consider how the Google Maps' starring feature helped participants. We also listed the feedback given by our participants based on the first version of Block Party app. Finally we will present observations regarding route adjustment during navigation.

5.1 PROPORTIONAL TIME RESULTS

In this section, we can see the proportional time results for each category of the views "Map, View, Route View, Navigation View, Street View and No View" across Halifax and Dartmouth in the three phases (the planning phase started when participants were instructed to go to the next destination to visit or explore, and ended when they were ready to leave on path phase started when they began to walk and ended when they successfully identified the destination or they gave up; and pointing phase is when participants were asked to point and estimate distances to pre-visited locations during their navigation. View usage results for each phase are presented below.

5.1.1 Planning Phase

In the Figure 5.2 we can see that the percentage of time spent using the views was very similar in both neighborhoods. When the participants were planning for the next location they used Map View 37% of the time (for both Halifax and Dartmouth). The Map View was helpful for searching because the search box was only available through the Map View. Also Map View allowed participants to check the pre-saved star name when sometimes participants typed the address of a POI in the search field (an additional 14-15% of the time). The second most common approach was to use the Route View (26% in Halifax and 28% in Dartmouth). When participants switched to Route View from Map View, they just clicked on the little man icon then they could see the route. They zoomed

out and then they could see the start point and the end point. While they were walking they referred to the route frequently. Street View was used in a very few instances during planning (2% in Halifax, 4% in Dartmouth). In Halifax participant 102 switched to Street View when he was at the Grand Parade just to explore the park because grand parade is located at the park. He said "here is Street View with 6 photos". Also in the planning phase participant 117 switched to Street View when he arrived at the Economy Shoe Shop to explore the area around it. At the planning phase, when participants intended to use Street View they used only to explore the area around**.**

The proportion time spent in Navigation View was close in both areas (in Halifax 11% and in Dartmouth 8%). Participants switched to use Navigation View to see the Route to their destination.

No View was similar in both Neighbourhoods (in Halifax 9% and in Dartmouth 8%). Participants tended to use No View to plan to get to the next target when the next destination was close to the current target because the participants could easily see the next target. For example, in Dartmouth participant 113 could see the cafe from the spa and in Halifax participant 118 could see the clock tower from the Grand parade.

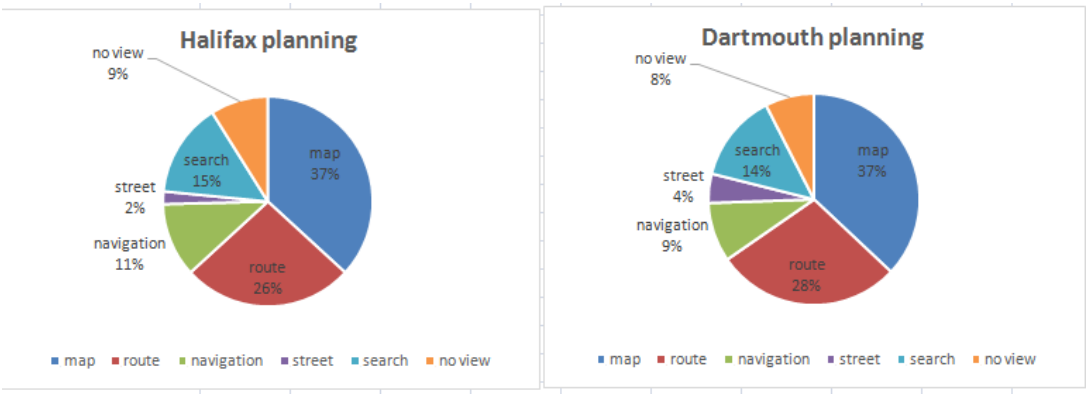


Figure 5.1 the proportion time in planning phase for Halifax and Dartmouth

5.1.2 On Path (while walking) Phase

We can see in Figure 5.2 when participants are "on path" in both areas. The Route View findings were similar in both areas (Halifax (32%) and in Dartmouth 35%). We can see also time proportion spent in Navigation View was higher to complete in Halifax (41%) than in Dartmouth (26%). This is because the number of tasks was higher in Halifax and took more time to complete on average than in Dartmouth. The number of tasks to complete in Halifax was 11 and the number in Dartmouth was 10. However, the locations in Halifax were (distributed) not close to each other than in Dartmouth. Task duration are normalized, duration varied significantly across participants; mean (165) and standard deviation was (73). The time proportion spent in Street View was lower in Halifax (1%) than in Dartmouth (6%). Participants intended to use Street View in Dartmouth more than Halifax because they used it to discover the area of Dartmouth. For example, participant 102 switched to Street View while he started walking from the Two If by Sea Cafe to the next target Spa. The streets in Dartmouth were wider and they could walk back and forth.

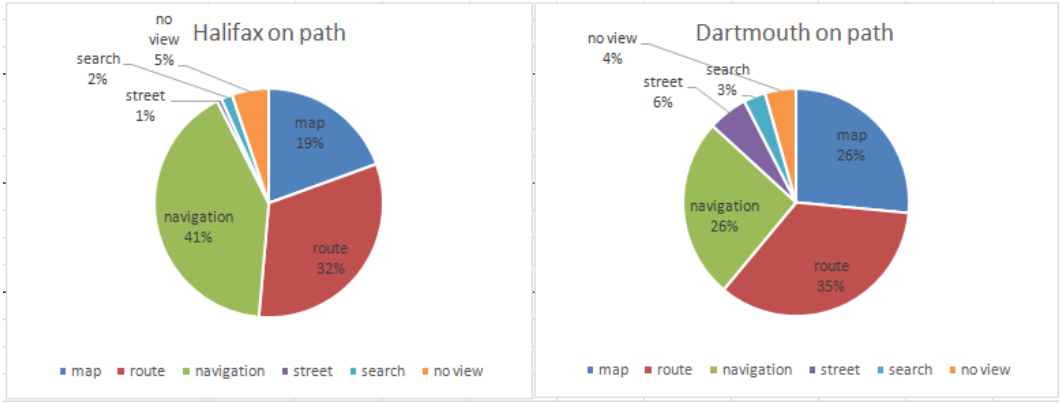


Figure 5.2 The proportion time in "on path" phase for Halifax and Dartmouth

5.1.3 On Pointing (answering questions) Phase

As we can see in Figure 5.3 the most common view used in both Halifax and in Dartmouth (48% in both locations) was the Map View. Participants intended to use Map View when pointing to places because they had to switch to Map View to retrieve the names of the starred locations or to use search, which helped them to point out the locations and to estimate the distances. The usage of No View was higher for the pointing phase than in the other phases in both cities, with slightly more in Halifax (22%) than in

Dartmouth (18%). We also see slightly more use of search (15%) in Dartmouth than in Halifax (11%). These differences correspond with the difference in familiarity with the two locations indicated by the participants. Street View was unused in both settings.

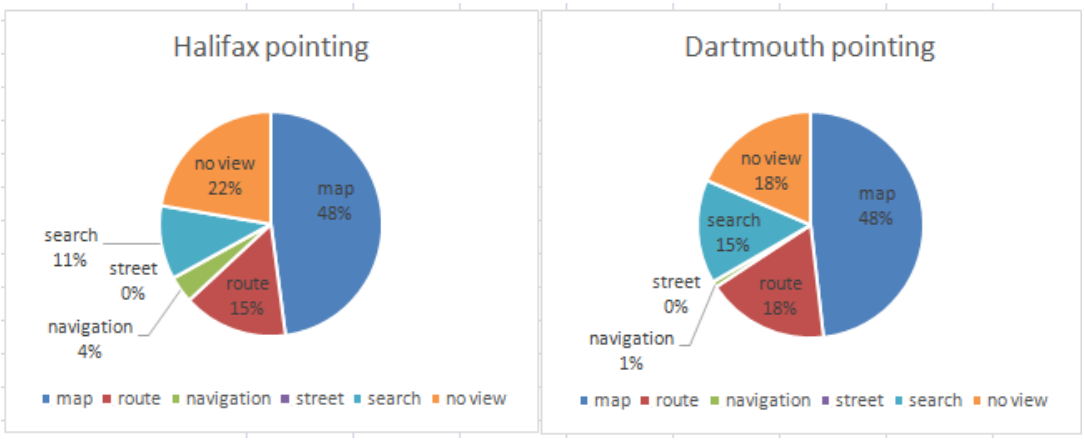


Figure 5.3 The proportion time in on pointing (answering questions) for Halifax and Dartmouth

Figure 5.4 shows the total proportion time usage of the views across both Halifax and Dartmouth On path. There is a relatively even use of navigation and Route View, with some sticking with the Map View. Planning sees less navigation and increased search for obvious reasons. Pointing sees more “No View” and more “map”.

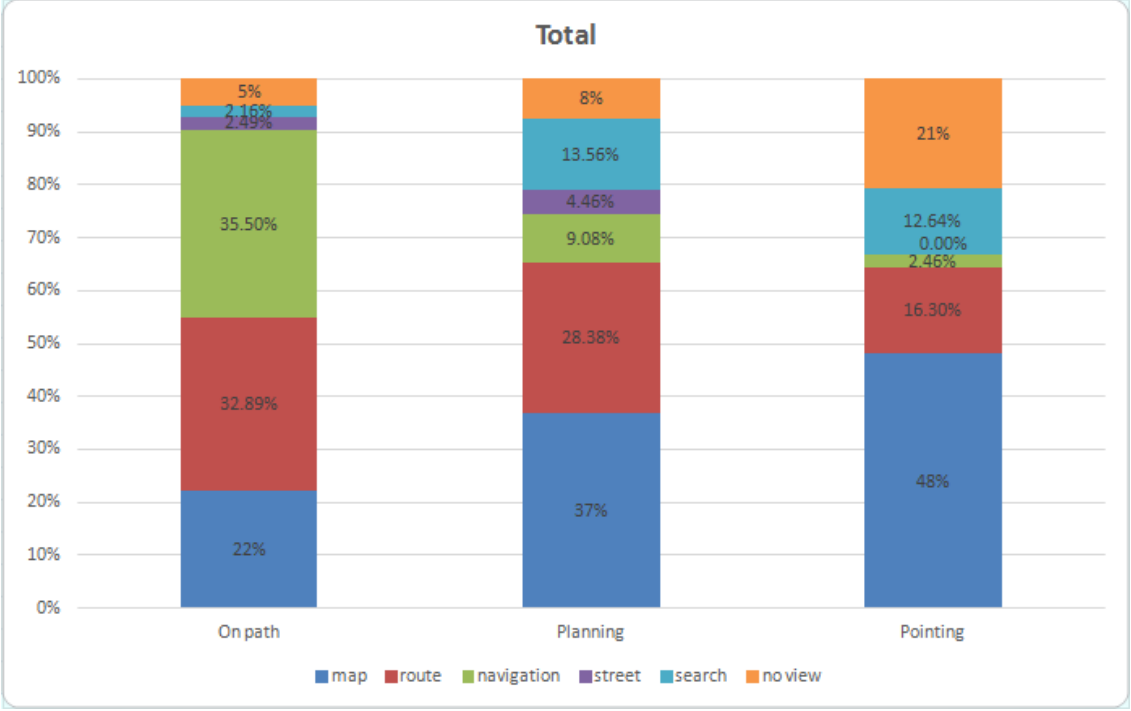


Figure 5.4 The total proportion time usage of the views across both Halifax and Dartmouth (At Planning, on Path and Pointing phases) during entire Itinerary.

5.2 Familiarity Test Score

In this test participants were asked to complete 4 parts, part 1 draw the route between 2 location route 1 and route 2, part 2 mark 7 locations with associated letter on the map, part3 draw 3 Arrows on the map pointing to a direction and part4 label 10 Photos on the map. In part 1, 3/10 participants drew the 2 routes correctly in Halifax while in Dartmouth was 4/10. In part2 there were 2 participants marked the 7 locations correctly while only one in Dartmouth.

In part 3 there were 5/10 participants draw the arrows on the map correctly while in Dartmouth was 3/10. In part 4 there were 4/10 participants labeled only 4 out of 10 photos correctly while in Dartmouth only one participant marked 3/10 photo correctly. Also, there were 2/10 participants in Halifax and 3/10 in Dartmouth did not mark any photo correctly on the map.

We ran two-tailed Wilcoxon Signed Rank tests on the test score data. We compared the overall test scores for Dartmouth and Halifax and then scores on labelling tasks only. There was a difference for labelling scores at the p=0.1 level (Z=-1.845, p=0.065), with lower scores in Dartmouth. We found no difference in overall test scores, however (Z=-.971, p=.332). We concluded those participants' scores still slightly higher in Halifax than in Dartmouth (Appendix L).

5.3 Sequence analysis

Figure 5.6 bellow shows the sequence analysis result, the time of views used for the six wayfinding tasks. Task durations are normalized to illustrate common transition patterns. The dotted line shows the mean transition point between planning and walking to the destination. Traversing each leg of an itinerary should follow a common pattern of Map View access, as dictated by Google Maps' application design: target identification on Map View (using Search or by selecting a star), followed by the Route display, and followed sometimes by Navigation mode (if the user presses "Start" in the Route View.

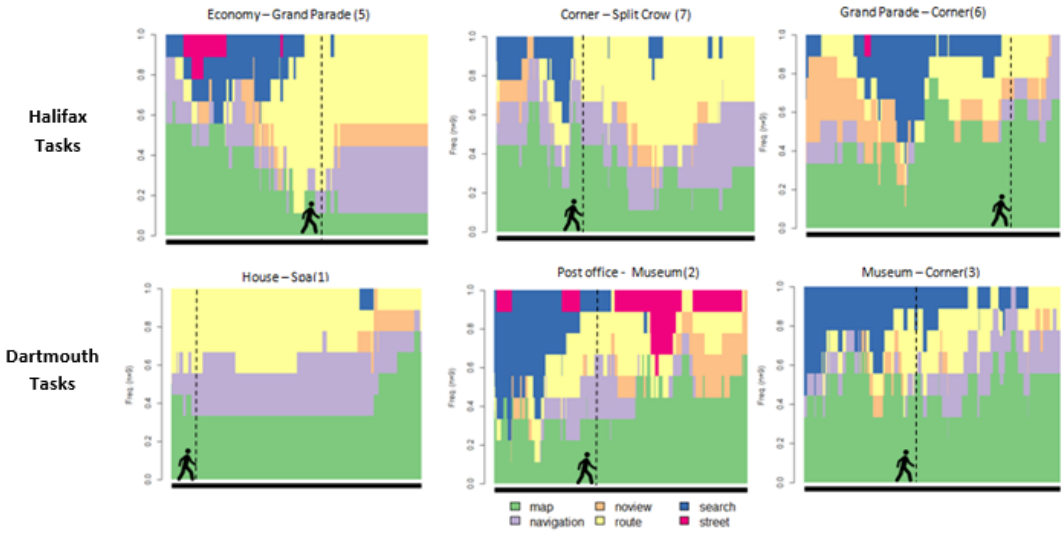


Figure 5.5 Proportion time of the views used for six wayfinding tasks to illustrate common transition patterns.

As shown in Figure 5.5 there is some consistency across tasks. As is to be expected, there is more searches during planning, and more use of route/Navigation Views while on path.

There are also some interesting differences based on task, however. The common transition patterns for each task are discussed below:

As we can see in Figure 5.5 in Halifax from Economy Shoe Shop- Grand Parade (Task 5), during the planning phase participants used map and search heavily as they were locating their next destination; this task required that a new POI be searched for. In the "on path" phase they tended to use mostly route and Navigation Views, while Map View use drops off considerably. This pattern contrasts with House-Spa (Task 1), where the planning phase was very short, and required no search: participants selected their destination from a saved starred item. Also most of the participants indicated that they arrived the Spa from some distance away, as it was quite visible.

In Halifax from the Corner to Split Crow (Task 7) we see a pattern similar to Task 5. In planning phase the most common pattern was Map View and Search (Split Crow was not a previously starred POI), while on path participants tended to use Navigation and Route Views. In Dartmouth from the Post Office to the Museum Task (2) the most common trend in planning Phase was search and Map Views so as result this task is required a new POI to be searched. Also we can see Street View was used by participant 102 and 115. They used just to explore post office when they arrived since they were unfamiliar with the area.

In Halifax from Grand Parade to the Corner Task (6) Figure 5.5 participants used Map and Search in planning phase. Also No View since the destination was very close and visible. On path phase mostly they stuck with the Map View. In Dartmouth from the Museum to the Corner Task (3) mostly they tended to use Map View and no Street View was used.
In comparison between the two tasks (6) and (3), as we can see in Task (6) and (3) participants were stick to Map View, since they could determine the corner simply by reading the street names.
Figure 5.6 shows going to the Corner in Halifax (point to the Clock Tower). The participant first searched for the corner and then using the Map View he navigated to the

corner. Once at the corner he was able to just point up to the Clock Tower. The destination was very visible and easily read the street name and stick to the Map View to get there.

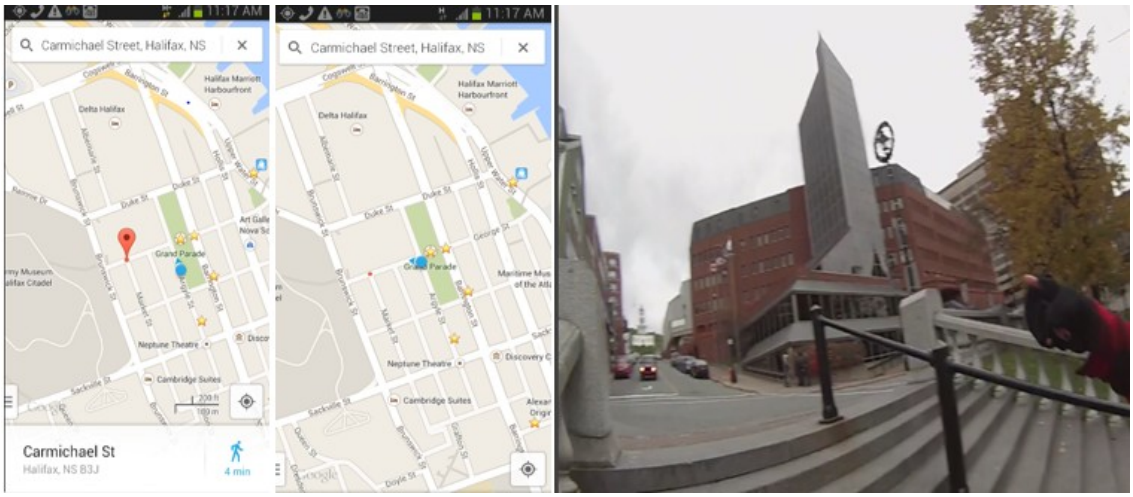


Figure 5.6 Going to the Corner in Halifax to Point to the Clock Tower

Figure 5.7 shows the Task going to the Corner in Dartmouth (point to the Curling Club). The participant first searched for the Corner and then used the Map View. She then zoomed the map out and started to walk to the corner stick with the Map View. At the Corner, she then searched for the curling club and then pointed it out.

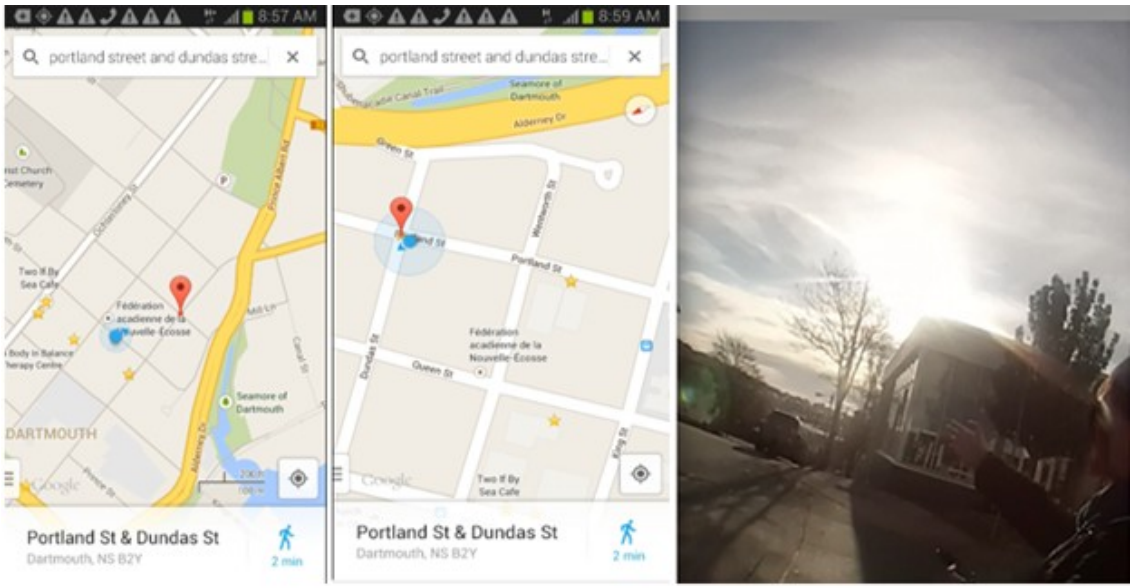


Figure 5.7 Going to Dartmouth Corner and pointing to the Curling Club

Table 5.1 presents the mean and standard deviation of the total time taken for each task. Duration varied significantly across participants and between tasks; mean and standard deviation for task duration are provided in the table below:

Table 5:1 There was wide variation in behavior across our partcipants

Total Time (sec)			
Task	**mean**	**Median**	**SD**
T1: House-spa	165	152	74
T2: Post Office-museum	242	228	137
T3: Museum-Dartmouth Corner	323	339	96
T5: Economy Shoe Shop-Grand Parade	239	245	73
T6: Grand Parade – Halifax Corner	169	177	87
T7: Halifax Corner- Split crow	323	287	93

5.3.1 View Usage in Planning Phase

As we see in Figure 5.8 in planning phase the usages of the views were significantly varied in behaviour across our participants in the entire scenario. For example, Map View was used between (24% - 78%), Route View was used (0% - 36%), Navigation View was used between (0% -15%), Street View was used (1% - 7%) and No View was used (6 % - 35 %) .

Participants 106, 108 1nd 113 tended mostly to use Map and Route View.

As we can see in Figure 5.8 and Table 5.7 that Participant 100, Participant 102 and Participant 108 were pretty close. They tended to use Map View and even they used the other views but P 102 and P 100 used No View more than P 108. While P 116 was stuck with Map View (78 %), No View (15) and Street View (7). P 118 and P 108 used Route View a fair bit during the planning with the combination of the other views as well, similar with P 115 but did not use Navigation View at all. Participant 116 used the map for most the times during the planning phase to reach 80%. What was interesting is that most the participants did not use the navigation and Street Views during the planning phase for long time and some participants (P113, 115, 116) did not use navigation at all. In general, all participants tended to use the maps and route views during the planning phase while they used navigation and street less often. However, they used navigation slightly more than Street Views. When the next target was close to the participants' current location, all participants used No View; they did not plan or use the app to search for the next target because they could see where it was already. Participants also used no view when they were engaged in conversation.

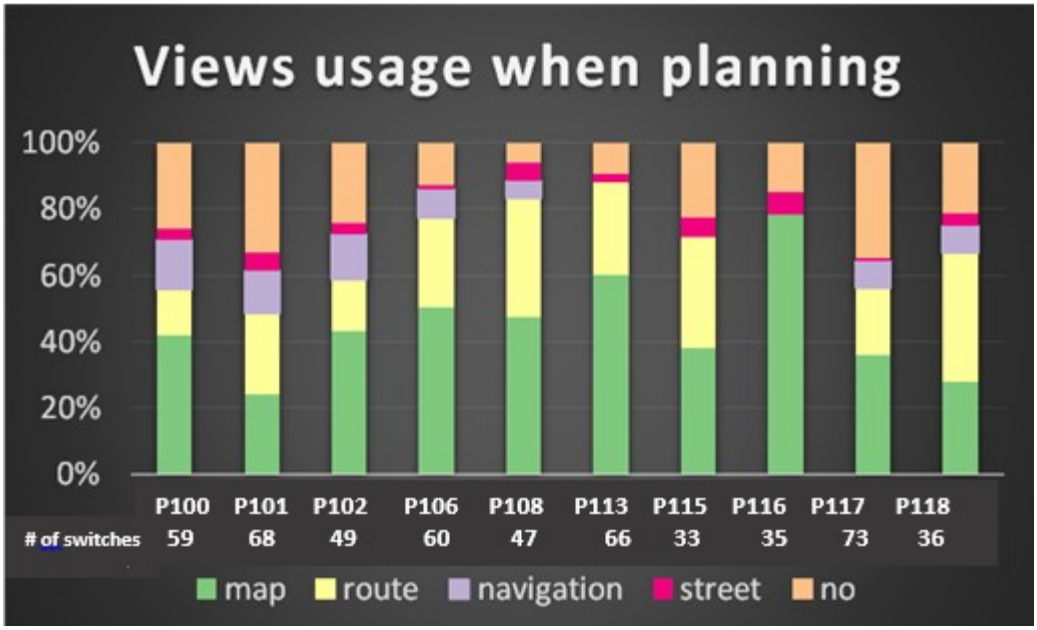


Figure 5.8 Proportion of views used while planning phase to the next destination across all tasks. The total number of view switches when walking is listed below each participant's bar.

5.3.2 View Usage on Path Phase

As we see in Figure 5.9 in walking phase there were wide variations in behaviour across our participants in the 6 tasks. Map View was used between (6% - 75%), Route View was used (1% - 79%), and Navigation View was used between (2% -71%) Street View (0%-5%) and No View(1% - 32 %).

As Figure 5.9 shows P113 and P115 tended to use Route View (79% and 63%) while P100 and P101 tended to use Navigation View (71% - 69%) even the other views were less. Participant 116 stuck with Map View (75%) or No View (21%) at all. The remainder of the other participants used some combination of Map, Route and Navigation Views.

No Views were used during the walking phase mostly by participant 118 (21%) and 116 (32%) while 101, 106, 113 were using other views most of the time. Participants 102, 115, 117, 106, 118 rarely used the Street Views while the rest of participants did not use it at all. On walking phase participants tended o use Navigation View or Route View most of the times but rarely using Street View.

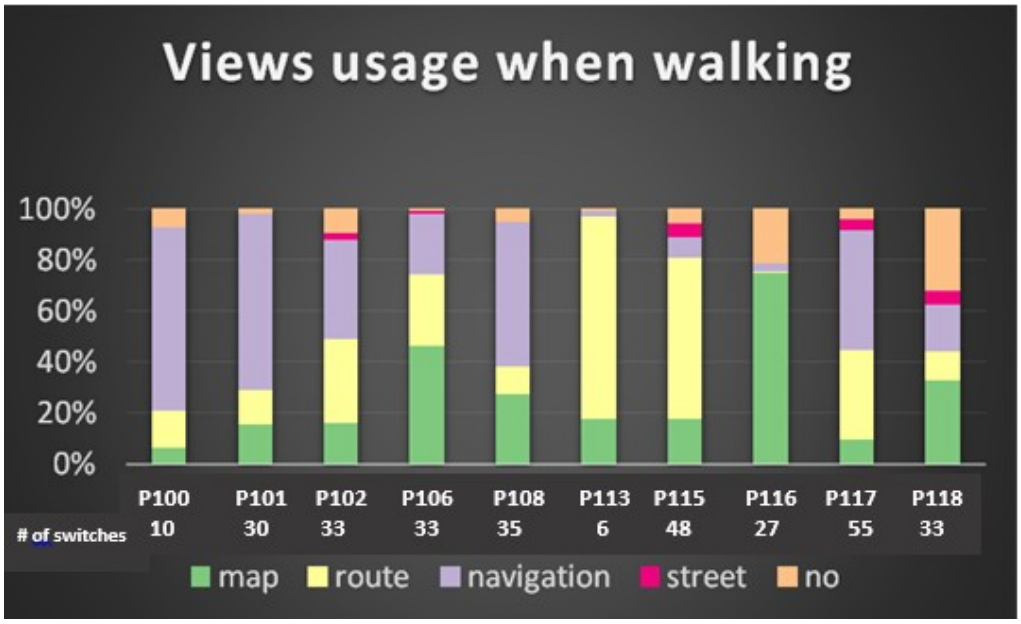


Figure 5.9 Proportion of views used while walking to the next destination, across all tasks. The total number of view switches when walking is listed below each participant's bar

We can also see the individual differences in how they switched views between planning and on path phases. As the Figure 5.8 and Figure 5.9 showed that P113 and P115 were stopped at Route View in planning (28%, 33%) and in walking (79%, 63%) , Also interesting is P116 who did not switch much at all, he stuck with Map View in planning (78%) and in walking (75%). P100, P101 ,P102 and P108 as they tended to use Navigation View during walking (71%, 69%, 39%, 57%) but less so while planning (15%,13%, 13% 5 %).

5.4 GETTING LOST

Despite having GPS, nine out of ten participants got lost at one or more points during the study. On average, each participant got lost 3 times (min=0, max=7). Even though all participants were more familiar with Halifax than Dartmouth, they got lost more often in Halifax. 8 out of 10 participants got lost in dry cleaners and in different doctor's office and dentist. In the Waterfront of Halifax neighborhood there were particular destinations which caused more people to get lost (dry cleaners, dentist and doctor office) while in the downtown area of Dartmouth the locations caused more people to get lost (museum, dentist and Tim Horton's). We identify three main reasons why participants got lost.

These reasons were missing or/ poor signs of the locations, vague or inaccurate location data, and a destination that did not match expectations. We will discuss these reasons in detail in the following section.

Table 5:2 Number of participants who got lost in both areas.

City	getting lost at location 1	getting lost at location 2	Getting lost at location 3.
Halifax	Dry cleaners 6 times (18%)	Dentist 9 times (28%)	Doctor office 5 times (15%)
Dartmouth	Tim Horton 4 times (12%)	Dentist 4 times (12%)	Happy Face Museum 5 times (15%)

5.4.1 Signs

The signs for the dentist in both Halifax and Dartmouth were small or not obvious or visible. In Halifax Bishop's Landing Dental and in Dartmouth Alderney Dental, signs were below participants' line of sight, on the other side of the building, or hidden by construction. For example see participant 115 in Figure x. Also some destinations were located inside large buildings without a visible sign on the outside (dentist "Tam Daniel Dr" in Halifax is located in a plaza and in Dartmouth Tim Horton's is located in the ferry terminal). The following examples illustrate these issues.

To Alderney Dental Dartmouth

We can see in Figure 5.10 Participant 115 first searched for the dentist and then used the Map View while on path. She passed right by the main door of the dentist, which was somewhat obstructed by the scaffolding. The participant then switched to Route View but could not identify the location. After this, she switched to Street View and walked from the front of the building to the other side of the building, continuing to use Street View. After this she noticed the small sign, hidden by construction and below of her line sight (Figure 5.11).

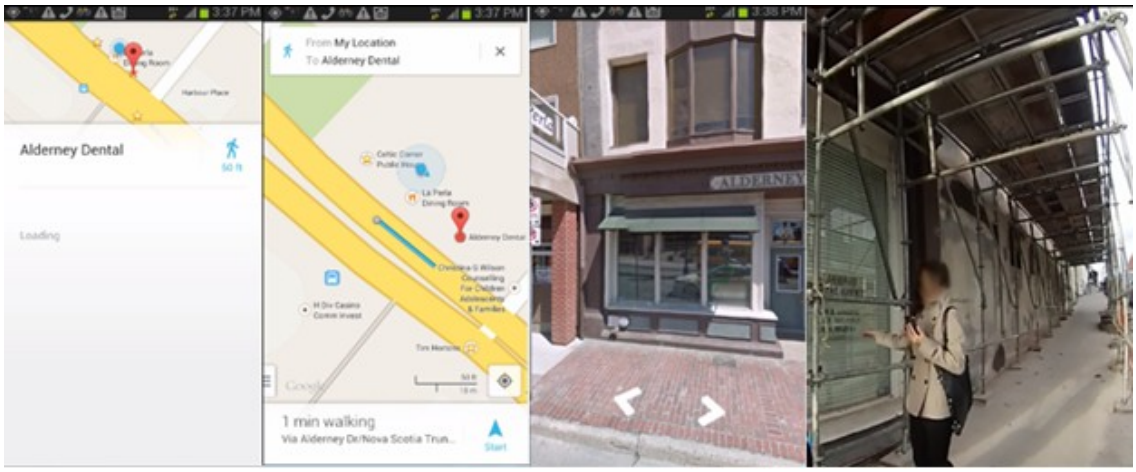


Figure 5.10 Going to Dartmouth dentist "Alderney Dental Dartmouth"

To Halifax Dentist –Dr. Tam Daniel

Participant 116 used Map View while navigating to the dentist. When she arrived she was looking on the map and then looking around trying to identify the sign. After a while she walked to the building to check the address. "Yes it says in this building, if I was actually looking for the dentist office I would go to check with the directory". See Figure 5.11.

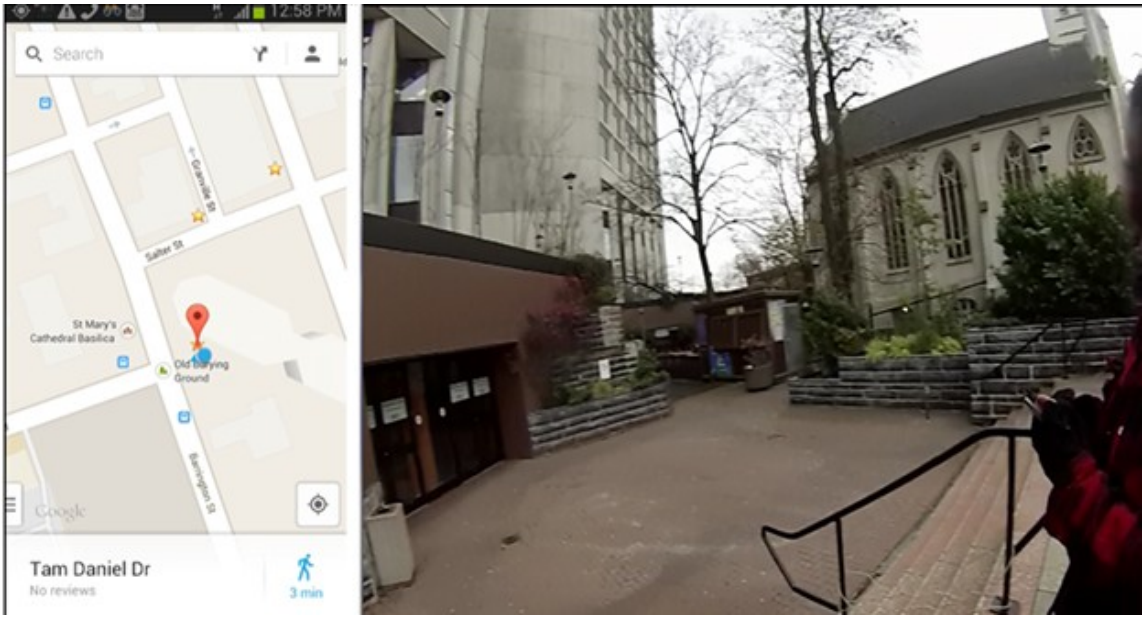


Figure 5.11 Going to Halifax dentist office "Tam Daniel Dr Dentist"

To the Dartmouth Tim Hortons

Participant 101 got lost finding Tim Horton's. Tim Horton's is located in the ferry terminal. In sequence of images in Figure 5.12 the participant walked in the opposite direction using Route View then looked at the phone and quickly realized that she was going in the wrong direction due to the direction of the pointer. The participant then zoomed the Route View out, walked back and switched to Map View At this point she was on Alderney Street on the other side of "Tim Hortons" building. (Figure 5.13). Then she walked further and then stopped and switched to Navigation View. "The map told me I already arrived but do not see the sign ". She was very confused.

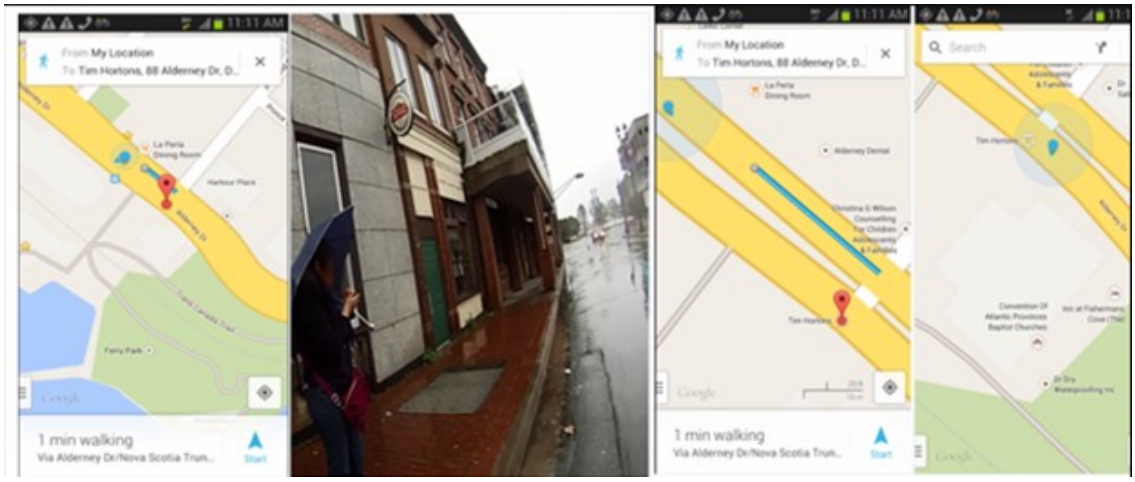


Figure 5.12 Participant got lost finding Tim Horton

Then she walked further and then stopped and switched to Navigation mode with voice as shown in Figure 5.13

Figure 5.13 Participant got lost finding Tim Horton

5.4.2 Vague or inaccurate location data

The search results for certain dry cleaners and medical centers in Halifax led to different businesses or to empty lots, confusing participants.

To the Dry cleaners

Figure 5.14 shows that Participant 106 used Navigation View without voice mode while en route to the dry cleaner . As soon as arrived she was looking around and said "I am interested do the Street View", switching to Map View than to Street View but could not identify the location. Then she walked to the other side of the dry cleaners building “a little confused", and then she checked the other side of the dry cleaners building trying to find a sign, saying "it seems the business has changed".

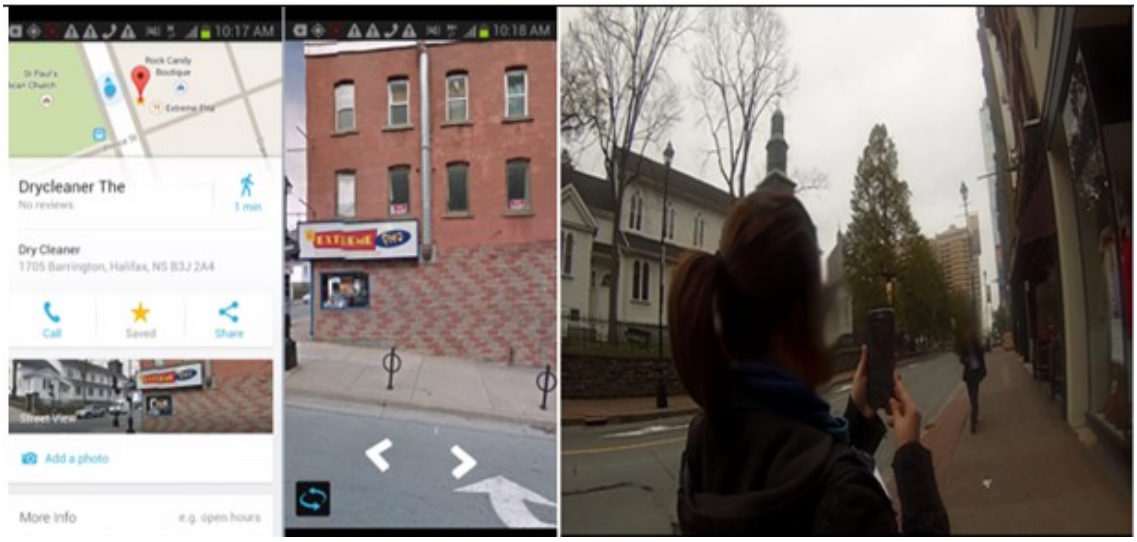


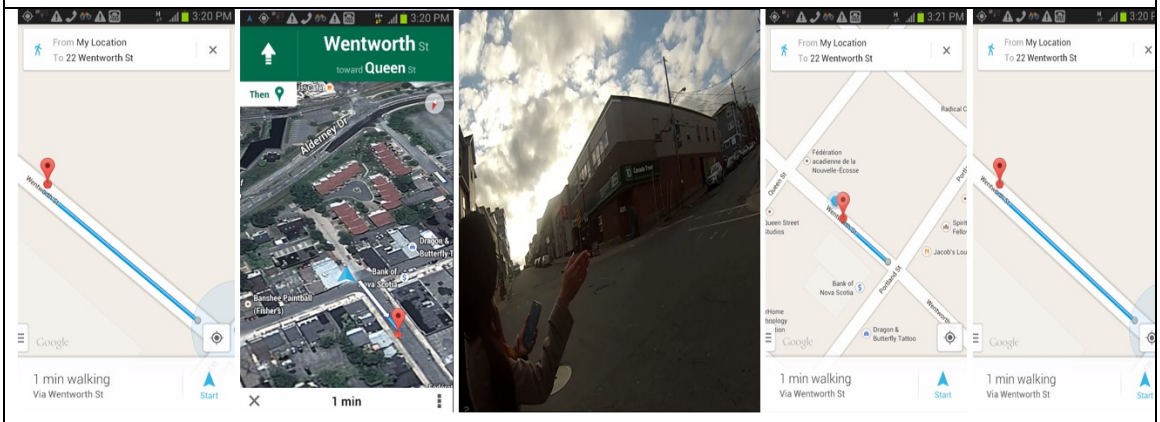
Figure 5.14 Going to dry cleaners

5.4.3 Inaccurate Presumptions of the Destinations

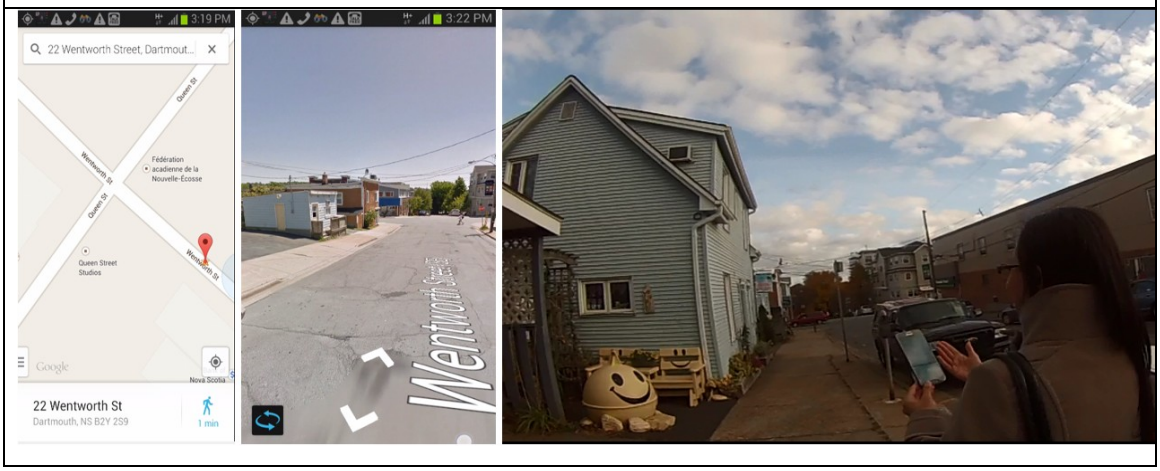
The study indicated that 5 out of 10 participants were confused when trying to find the Happy Face Museum. The museum in our study looked like a normal house with a small sign Participants got lost because there was no obvious sign on the house and some of them did not expect the museum to reside in a house. The other 5 participants could identify the museum because of the address and the happy faces decorating the house. Participant 102 remarked “I see happy faces, I do not think it’s called happy face museum anymore”. Participant 113 stated “it says 22 in the building…”

Participant 115 got lost finding the museum as shown in Figure 5.15 (A). The museum that the participant was asked to locate was in a home along a residential street. In the sequence of images in Figure 5.16 (B) you can see that the participant used a variety of Map Views to help her find the museum as shown in Figure 5.16 (c).

A- First, the participant went past the museum then switched to Street View. She walked further and continued using Street View.



B- Then she stopped and realized that she was in wrong direction, switched to Route View and continued to Navigation View. She turned back and pointed in the correct direction, then walked toward to the museum. While on her way she switched back to Route View and zoomed out.



C- Then she switched to Street View and tried to match the view on the phone with what she was seeing in reality. She also flipped back to Map View before switching again to Street View. Then she pointed to the museum “This is 22 Wentworth ". She said "I expected it was a big building ".

Figure 5.15 Going to the Museum

5.5 STRATEGIES FOR REORIENTING

5.5.1 Voice Guidance

Participants used different strategies to get back on track when they got lost. Nine out of ten participants used voice guidance, as it reminded them when they were on the route, close to their destination or when they passed their targets. Three out of the ten participants used the voice guidance during navigation; four used it one time, while the other two did not use it at all. Participant 115 said "the voice is helpful while you are walking and you do not look at the screen all the time and you want to watch around you"**.** Participant 117 indicated that **"** the voice [came on to] tell you turn right or turn left that really helped and when I reached my destination like it tells you you’ve reached the destination**".**

As Figure 5.16 shows, the problem when the participants reached or was very close to the destination, was that the system did not indicate that they had arrived. In Figure 5.16 it can be seen that Participant 102 previously searched for the corner of Argyle Street to point out the Clock Tower and Carmichael Street and then walked towards the corner. The Clock Tower was on his left hand side but he walked further, then he looked at the map and stopped, realizing that he had already passed the location. He expected the device to remind him of his location, and tell him that he had already passed. However, he was using Route View and the system does not have the capability to do this. He was frustrated when there was no voice (or any other) notifications to inform him that he had arrived. The participant passed the corner and he expected the system could help him. . "This is why it is sometimes frustrating when you figured you are there but it does not tell you are there".

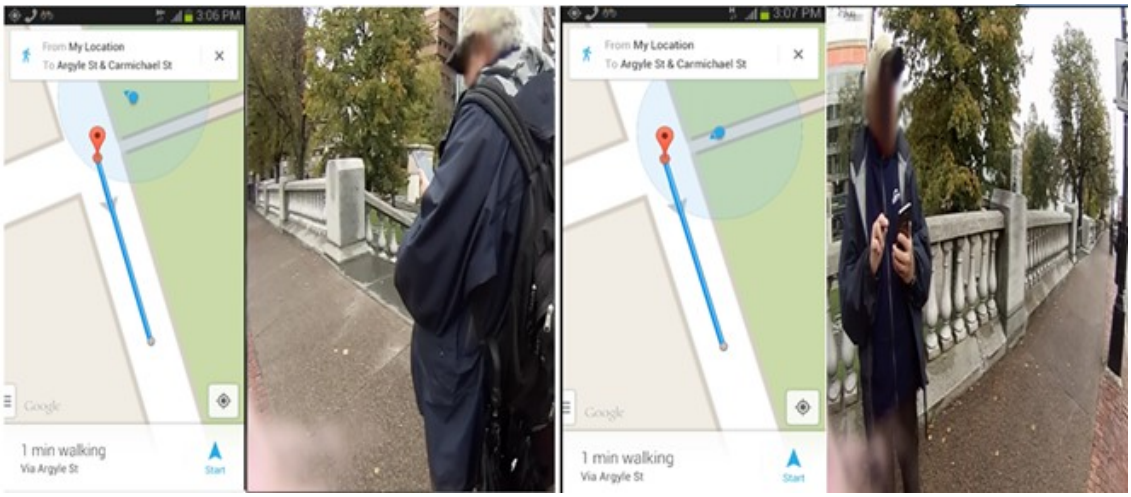


Figure 5.16 Pointing to the clock tower.

The other 4 participants did not use voice guidance. Three out of four Participants (106, 113 and 116) reported that the voice guidance was annoying and did not like the instructions given to them by the voice. Participant 113 said "I found the voice is annoying I can follow the map and I can see where I need to go fine, I do not need the voice to tell me". Participant 118 did not use the voice but stated "I think voice might give some information whether you are going in to the right or to wrong direction".

5.5.2 Street View

All participants used Street View at least one time. Street View was used in different reasons in the study. Most of them used Street View when they had difficulty finding their destination. Of all the participants who used Street View 4 out of 10 participants used Street View to see what the destination looked like or to match what they found on the screen to what they could see around them, or to see what the surrounding area looked like after they arrived at the destination. For example, Participant 102 at the Post Office and Two if by sea café and participant 115 at the Post Office.

Switching to Street View was a common strategy for reorienting but in many cases using Street View was not helpful in identifying a destination. Nine out of ten of our participants switched to Street View when the destinations were located inside a building with no visible signs, no name, or the businesses had changed or did not exist, if the image was old or outdated, or if expectations did not match the appearance of the destination (as what we have discussed in the getting lost section above). Participant 116

mentioned “the major problem with the Street View is what you can see in the picture and what you see in the street might be very different. A taller building, new store or the house with different color. Street View is also very confused because a lot of time the images are too old to actually reflect reality". Participant 100 switched to Street View for 22 North Street but the system displayed the house 20 instead of 22. He was confused because "When I typed 22 it finds me 20 ".

As Figure 5.17 shows that the Street View showed house 20 North Street instead of 22 North Street.

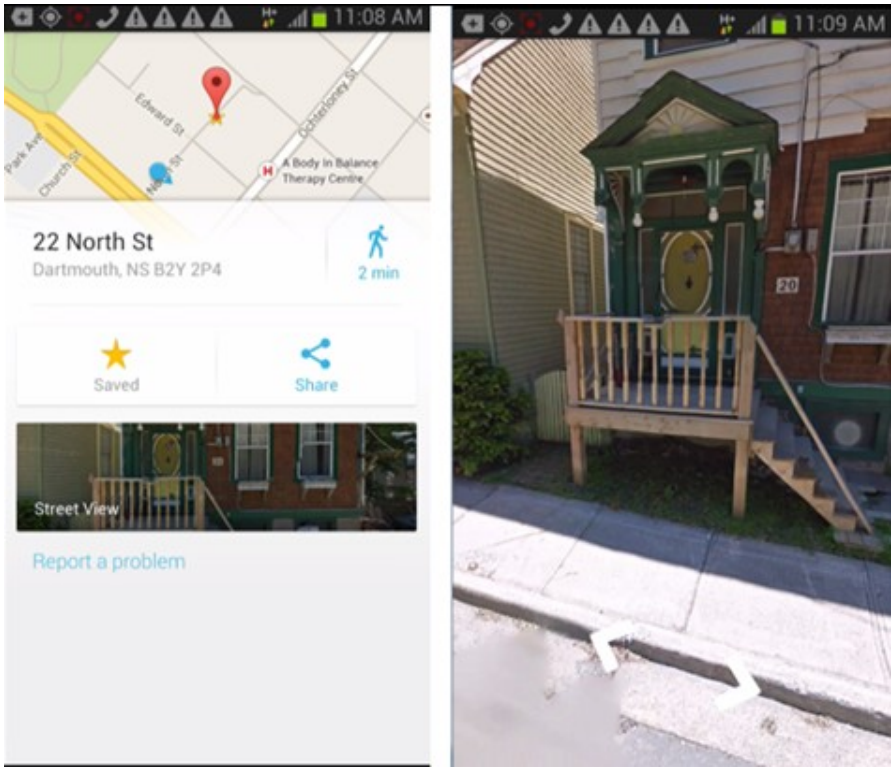
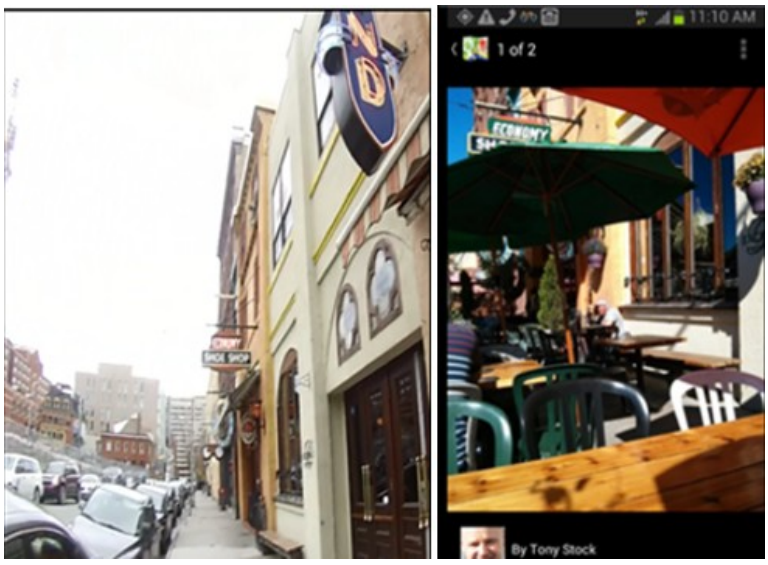


Figure 5.17 Using Street View for Dartmouth house.

You can see the (Figure 5.18) there were 2 different pictures which was taken from the same location. Picture (1) was taken in the day we did the study (in winter) which matching the reality while picture (2) was downloaded from Google Maps app and apparently it was taken in the summer. There is a problem with Google Maps application causing confusion because they did not get update regularly. Participant 117 reported that

“I saw the photo uploaded to the location and it did not give me the exact location.” See Figure 5.18.



(1) Image captured in the study (2) image taken by Google Map

Figure 5.18 **At Economy shoe shop image (1) and Google Map image (2).**

5.5.3 Map View and the Pointer

Six participants switched to Map View when they needed to search either by typing the address in the search field or when looking through the starred locations to find the one they were looking for. Seven participants switched to navigation and oriented the navigation arrow to point to their next destination. Five participants inferred from the distance information (e.g 2 minutes) that the destination was somewhere. When participants got lost and took the opposite direction, the pointer was helpful to get back to the track. Participant 118 while he was going to Grand Parade and Split Crow as well participant 117 while he was going to doctor office, he indicated that “when you start moving the pointer move along with the route. it shows me the correct direction now it shows me the pointer the way we are going".

5.6 Issues with switching views

All participants repeatedly tried to click on saved stars of POIs when they were on other views like Route View or Navigation View instead of Map View. Stars would only reveal the location’s data if they were clicked on while in Map View. Participants often faced difficulty switching back and forth between views, as described in this section.

One issue with switching to Street View is that it can only be accessed via clicking on a red marker on Map View. As when trying to access star information, participants had to switch to Map View so they could click on the Street View icon. Often participants seemed to get lost using the interface, switching across several views until they reached Map View, and sometimes they would close and reopen the application in order to go back to the Map View, losing some of the application's state in the process. Sometimes they searched again to get the points. This is caused distraction and going out of the current action

As shown in Figure 5.19 Participant 113 tried to click on the "Two if by Sea Café" star in Route View but found that he couldn't. Instead, the semi-transparent dot was displayed over the touched location. The participant switched to Map View after this, and was able to retrieve location details from there.

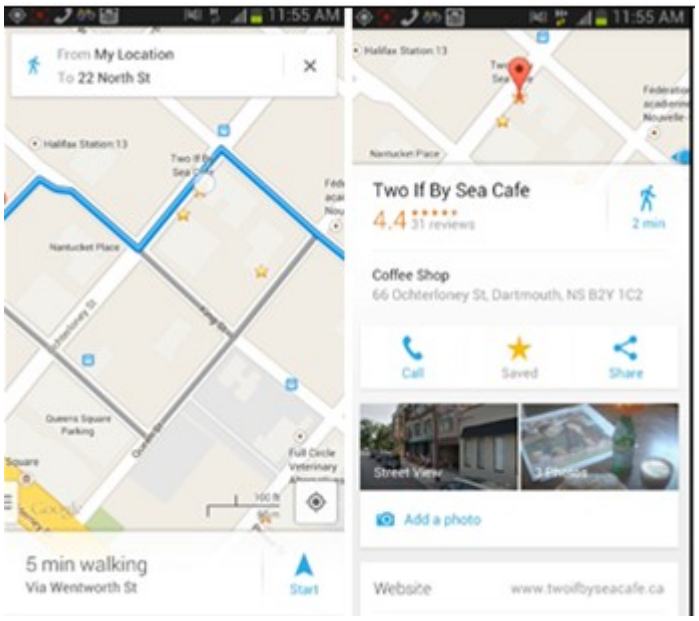


Figure 5.19 Rout View does not present the star's name. The user must switch to Map to bring up details about starred locations.

At the Spa, Participant 100 tried to select the next destination (the Post Office) on the Navigation View but could not. He switched back through Route View and on to Map View in order to get the star's name (see Figure 5.20).

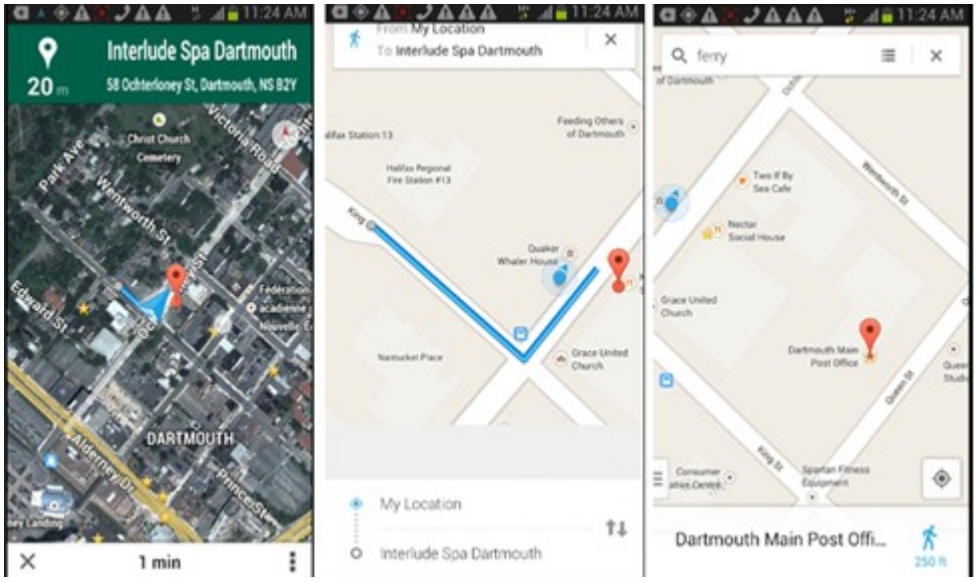


Figure 5.20 Trying to get the Post Office star.

The participant had to switch from Navigation to Route View then to Map View to get the Post Office star on the map. Figure 5.21 illustrates a similar issue getting to Street View. Partcipant102 was trying to get Street View for the Two if by Sea café, saying "I am trying to push Street View" but could not because he was in Navigation View. He then switched back through Route to Map View, selected the destination, then clicked on the Street View icon to bring up Street View.

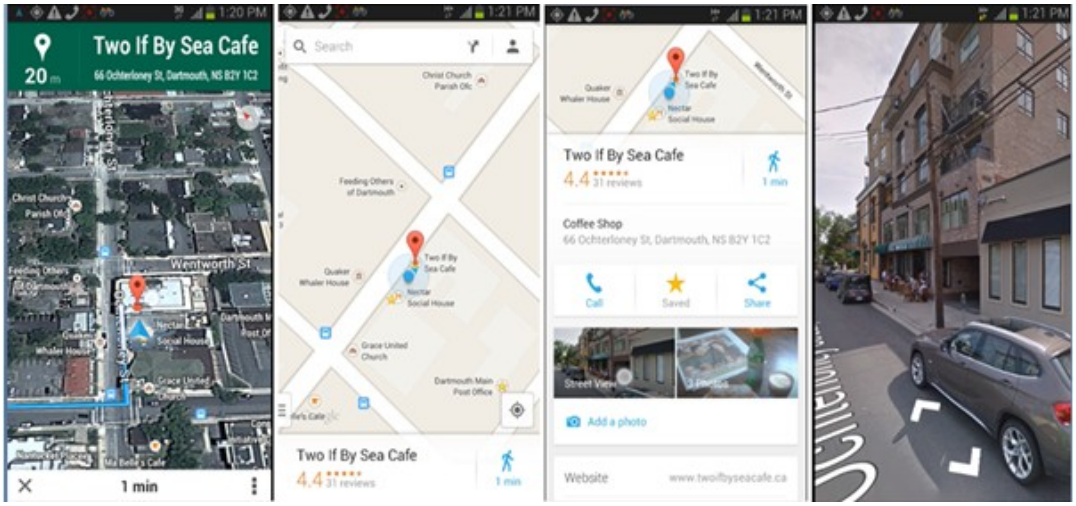


Figure 5.21 At two if By Sea café, trying to access Street View.

Sometimes participants had significant difficulty getting to the view they wanted to use. As Figure 5.22 shows after participant 115 arrived to the Post Office she attempted to use Street View to see the area surrounding the Post Office. She had to go back by clicking on the back button several times, moving sequentially through her previous operations: from Navigation View to the textual Step-by-step List View, and then to Route View. The participant tried to click on the Post Office at this point, but instead of bringing up location detail a transparent dot was displayed.

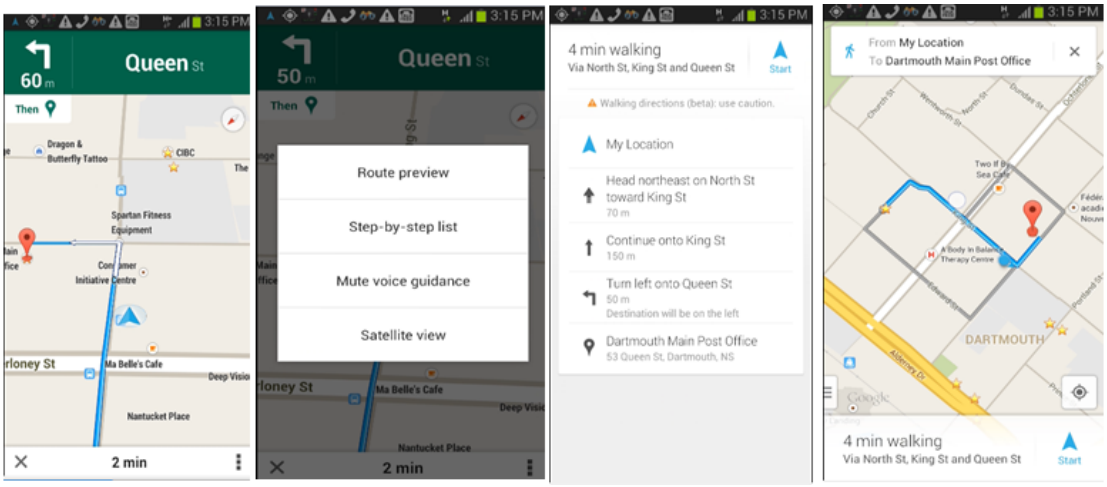


Figure 5.22 Participant 115 tried to switch to Street View.

As shown in Figure 5.23 the participant continued to use the back button until eventually landing on a Map View screen, at which point she was able to select the Post Office and move to Street View.

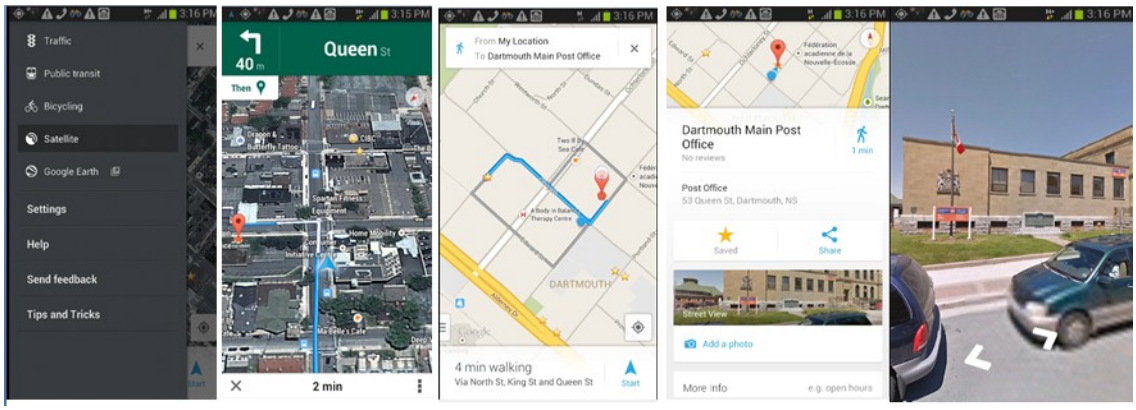


Figure 5.23 Moving sequentially through previously used screens via the back button until reaching the desired view (Street View).

Another interesting observation we found was that switching views would sometimes lead to loss of information (application state) and would interrupt the current navigation task. This occurred on three different occasions. For example, this happened while Participant 101 was navigating using Navigation View, and when Participant 115 was navigating using Route View. They found POIs that they were interested wayfinding in their neighborhood (e.g. fire station and Baan Thai), but they weren't able to save or search without firstly switching to Map View. Then they lost their current location and their progress along the route.

Also, we found for each location two participants would go back to check a starred destination several times. Since the stars were identical and unlabeled, and they often had to zoom out to identify the locations, locating the correct saved destination could take several tries. Some participants suggested that a list including all saved points would save time. Participant 106 reported that "… I would like to have a list of the points by name or numbers ". As well, Participant 117 indicated that "… suppose when I was there in the Condo I selected many places and saved and marked stars but when you asked me to go somewhere I have again to check the stars. If there is a list of the places which I marked so when you told me to go somewhere, I just can click on the list of the items and go there".

5.7 Issues with Searching

In general, in both Neighborhoods the system did not always display the closest location to the condo or to the house when participants were searching for nearby services. Google's search results are graduated, with results deemed "more relevant" shown more prominently on the map. In many cases, the nearest and most convenient services appeared as smaller, more transparent red dots (Figure 5.24). For example, at the Halifax condo Participant 115 was searching for the closest Sushi restaurant and the result prominently displayed one that was far away even though there were a set of Sushi restaurants close to the condo. The participant had to zoom out, check all of the smaller dots, and select one closer to them.

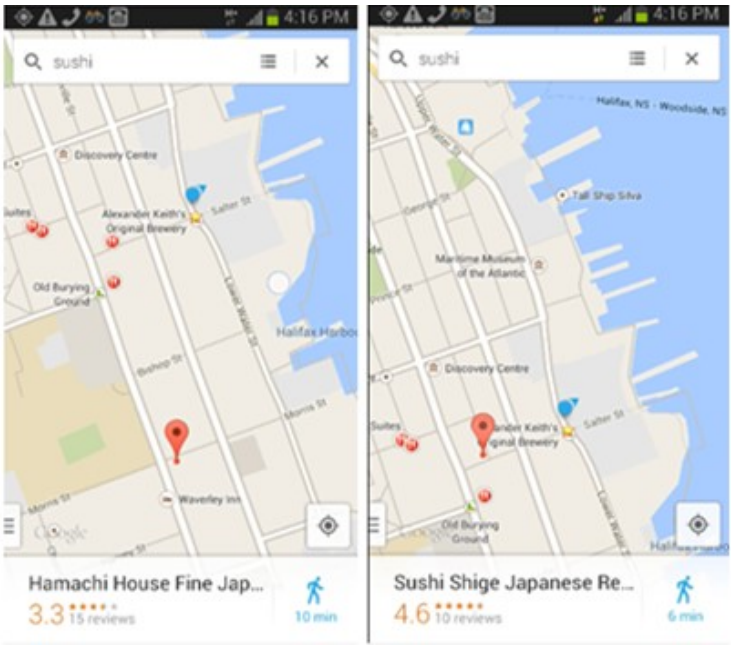


Figure 5.24 Searching for a nearby Sushi restaurant. The closest options are not prominently displayed in the search results.

On the other hand the system would display the closest option if the service was the only result available in the wider neighborhood, as was the case for more specific destinations such as the Economy Shoe Shop, Celtic Corner, Grand Parade or World Peace Pavilion. Another issue encountered with search-based results was when participants entered search terms sometimes no results were displayed. For example, Participant 102 searched for "Happy Face Museum" but the search yielded no results. He found the museum only when instructed to type "22 Wentworth Street".

Another problem was that different search terms led to different results see Figure 5.25. Searching with or without "and", typing “medical Centre” or "doctor office", typing “dry cleaner” or "dry cleaners" could affect the results that were displayed. Participants 106 and 102 changed from “doctor office” to “medical Centre” to find a result that was closer to them. While searching, Participant 102 reported “it is funny; there must be a doctor office around”.

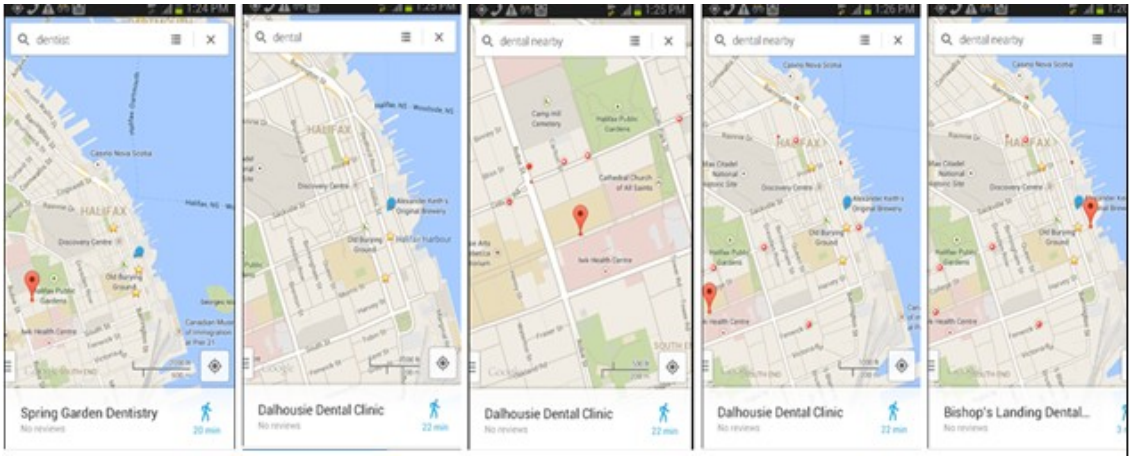


Figure 5.25 Trying search terms to locate nearby dentists in Halifax.

Another interesting observation we found was seeming inconsistency in search results. Five of ten participants tried to search for TD Bank in Dartmouth. Two of them (participants 106 and 108) could not find any results on the map, even after varying search terms. The other 3 participants (116,117 and 118) used similar terms to the other participants, but they did find the nearby TD Bank on the map. Participants who could not find TD bank switched to Scotiabank instead. While walking, both participants passed by a TD Bank, stopping there and expressing surprise and confusion. The discrepancy may be due to the dynamic nature of Google’s local search results; perhaps the TD Bank in downtown Dartmouth was a new branch.

5.8 STARS SYMBOLS

Using the stars symbols was helpful for storing destinations. Once stars were saved, there was no need to search for or type in the locations again. Participant 101 said "stars helped me when I turn to see what the location is. I do not have to type it again if I want to search it I click on them and then view all-stars". Furthermore, stars appeared to assist in

spatial visualization, since by clicking on them we can see the relationship between points. Participant 106 indicated that “I like the stars because you can visually see where all the points are and create a route". They were also useful for retrieving the distance to the location among other details. Participant 115 reported “once you saved, click on it, it shows name, how far it is and how much time it takes to get there ".

As mentioned previously, when participants searched for specific destinations they had to go from one star to another to check the name of the stars. Participant 106 indicated that “I like the stars feature but I wish when you had a map with those stars it would have like sushi on top of it. I do not have to click on each star where even a few words would be helpful". As well, there was no way to indicate an itinerary order for multiple stars, leading to extra searching and not remembering their itinerary. Participant 108 referred that as” if it ask you your priority of the route”.

Participants could recall and navigate to the first point in their itinerary, but after that they all asked the researchers to remind them of their itinerary order. Participant 106 reported that “I like the stars but not completely because you cannot number them to create a route".

5.9 ROUTE ADJUSTMENT DURING NAVIGATION

Another issue was encountered when participants needed to backtrack on their current itinerary selections. This problem occurred during the study. In Halifax, Participant 100 selected "Spicer F R Dr." as a doctor when he was at the Condo (the starting point), but while he was walking he stopped to search for the doctor and realized it was far away from his current location, so he switched to the closest one based to his current location. It was sometimes difficult for participants to follow the route they had planned at the outset, leading to revisions and short cuts such as this one.

At the home when participants created the route they chose based on the closest points to the house or the condo, while trying to pick an efficient path without a lot of backtracking. This could be somewhat difficult to do without any system support. As Participant106 said, “you are creating your route yourself and I do not like that”.

5.10 PARTICIPANTS' FEEDBACK FROM FIRST VERSION OF BLOCK PARTY

After participants completed the itinerary in both Neighborhoods participants were showed to them the first version of the Block Party prototype to understand and to gather feedback about the prototype and how the prototype could help users to explore the neighborhood. Nine of ten participants provided their feedback about the new designed application. In the second design 2 out of 6 recommendations in Map View were satisfied and 2 out of 6 suggestions in Immersive view were corroborated based on their feedback. We corroborate the some of these feedback to resolve some of the occurred issues and the others are also important and interesting but out of scope of this particular project and we recommended these will be considered continued as future work. The given feedback is described as follows:

5.10.1 Map View

- The participants suggested having the order which allow user to number or name the selected POIS. Participant 101 “I think the route is useful because Google Maps does not do that”. On the other hand when there were many places to visit it is better to mark the points by letters.
- Inside the marker, it can be icon referred to what is the point, like icon for each category, for example icon for restaurants, financial and so on. Participant 115 indicated " . " if you have separate icons for each those category "like when I look at the map I already know that ok I am going to the bank first then i am going to here and I am going there."
- The route was useful but needed to include either time or distance. As well as street name to be on the Map View. As well participant 116 reported that having "more information on the map, street names since some streets without names, transit stops and buses". Participant 113 suggested adding that "small information like phone number, website at the bottom"
- Route optimization participant 102 indicated that “Google Maps does not do it”. The best route can be based on time or priority. Participant 108 observed that “if it showed me the best route in terms of time or of priority on my choice”.
- Stars displayed as a list with numbers or priority.

- Numerous categories for different points, like category for Sushi restaurant, Middle Eastern restaurant. It will be easy to identify on the Map. As well as for each point some information.

5.10.2 Immersive View

- Avoid overlapped and the POIs should be stable displayed.
- Information, name, address, distance, pictures of the points as well as link to website and contact information. Participant 113 indicated that “it is very cool if we can see the name of the points or the picture or click on the link and led you to website, phone number".
- Colors depending on the distance or depending on each category. Participant 115 reported that "Color depending on the distance, either doing color or size of the circle, you could do the same size circle but with different color code the closet one is green and the further one is red".
- Adding planning and viewing modes to Immersive view.
- Nine of ten participants reported that Immersive View is very helpful. This is useful for people who got lost. It might help to identify the right direction.
- Only one participant reported that Immersive view is not useful especially in urban environment. Participant 116 reported that "I think dangerous actually because you do not where you are going you look at the screen..... I do not think it will be helpful for me.... if you are in large urban Centre what happen you will have a lot of dots, now it will be very confusing not helpful". Also another one mentioned that “If I used my phone will be out my battery since it has camera". The third one recommended including Satellite View in Block Part app.

Table 5:3 Summary of participants' feedback from the First Version of Block Party

Map View Features	# of participants making request	Improved in second version of Block Party app
1- Order or number of points	6	Yes
2- Including more information on the Map	3	
3- Displaying the stars as a list	5	Yes
4- Adding more categories	3	
Immersive View features		
1- Avoid overlapping POIs	3	
2- Different color depending on distance	4	
3-Adding planning and viewing modes to all views	2	Yes
4- Detailed information for POIs(name, address , website)	5	

The main themes from the results were the proportion of time spent using different views (while Planning, On Path and when Pointing (at selected targets), a sequence analysis to illustrate common view use patterns, and qualitative reports on when participants got lost, strategies for reorienting, the use of stars), issues with switching views and issues with searching. Participants' feedback based on the first version of the app is also listed. The next chapter will discuss each of these themes in terms of how they are incorporated into the Block Party application. A Summary of participants' feedback from the First Version of Block Party illustrated in Table 5.4.

CHAPTER 6 DISCUSSION, LIMITATIONS AND FUTURE WORK

The results of this study make it clear that the existing tool "Google Maps" is useful but has some limitations for homebuyers and others exploring neighborhoods. This chapter discusses the findings from the current study, how the findings have informed revisions to the Block Party application, and plans for future work. Finally, a discussion of the limitations of this study is provided. We begin with a description of the second version of the Block Party application.

6.1 THE SECOND VERSION OF THE BLOCK PARTY PROTOTYPE

We created a modified version of the Block Party prototype, reflecting participants' feedback and observations from the study. We addressed some feedback directly, while other feedback will be considered as future work. We considered how Google Maps views were used and tried to resolve the issues that users encountered to enhance Block Party and to support navigation and related activities when discovering neighborhoods. The prototype still has the three views: Map, List and Immersive, with some changes. Each view has two modes: Plan and View. In this way, users have two switching axes (between planning or viewing/navigation activities, and between map, list, or immersive forms of spatial presentation). Users have the ability to select POIs in the order they would like to visit and automatically generate a route that includes all these points. This tool is targeted to users who wish to become familiar with urban neighborhoods, not exclusively to homebuyers. These features are summarized in Table 6.1

Table 6.1 Summary of Features for Modes and Views

	Map View	List View	Immersive View
Planning Mode	Shows curated list, categories are clear. Items are not magnified according to search term relevance.	Easy to scroll through see distances from your current location and group by category.	Gives a sense of where clusters of services are located.
Viewing Mode	Build, retrieve and save multi point, routes to navigate (like routes in Google Maps).	Quick view of itinerary in order, with access to by step by step instructions.	Visualize relative location of next destination, then disambiguate destination upon arrival.

We wanted our participants to be able to easily switch between views and know what point was next. In Google Maps all points appear as stars without names or numbers. When our users wanted to know where they would be going next, they always had to ask researchers. Using Block Party when they would be doing the same thing, they had a numbered list which was already saved and could be easily viewed when they wanted to go to the next location. Having a distinct number meant that they could switch between views and not have to ask the researcher for assistance.

Participants could use the numbered list to easily change the order "for where to go next." In the Planning mode of Block Party you could add a new location selected from a category, reorder your list, and then generate new directions for the route in the Viewing mode. Supporting synchronization between the views is an important feature for usability. In Google Maps, the user's current location is lost when they switch views and new points can only be added to the end of the list.

When participants tried to use Street View in Google Maps, sometimes the pictures were out of date and they could not confirm their location. Another task which demonstrated a limitation of the Google Map Street View is when the participants were trying to locate

the Tim Horton in Dartmouth, which was inside a larger building. They would switch between all the views available and still could not locate it. In Block Party, we have a feature in the Immersive View when going to destination that could display a hint, such as "inside the building."

When users are unfamiliar with the new neighborhood they might not use Map View because they have less experience with Street names for the area they might use Street View but in many cases this was not helpful e.g when the location had no sign, or was inside the building as well as when the pictures were out of date. When using Block Party in Immersive View in planning mode they could see the locations with the distance and the building with up to date pictures. Since the pictures are up to date they could be used to discover the new unfamiliar neighborhood.

The reflection of the study results in the Block Party app is described below:

6.1.1 The Order of Waypoints as a List

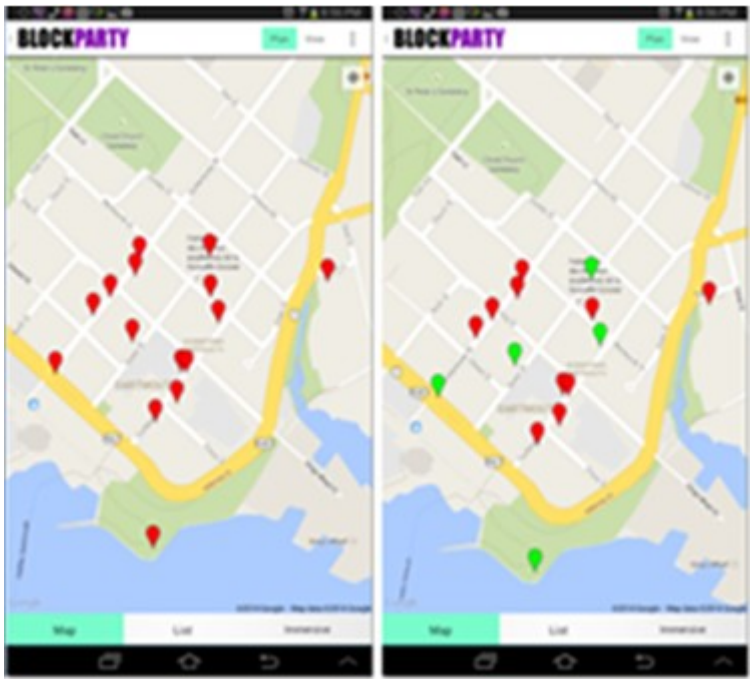
Most of the participants requested that the order or priority of the waypoints be included in the app. The points were displayed on the map without numbers, which can be an issue when people had an itinerary they wanted to follow. A limitation of Google Maps was that they had to check the stars/points when they plan for the next destination by switching to the Map View to see the name of the locations. In general participants could not remember what the next locations they had to visit were. As a result, they spent more time going back and forth to check the points or sometimes to search again. Users encountered a limitation with Google Maps related to ambiguity of the points/target identification. Participants asked the facilitators about their next destinations, or to remind them for the next target. They complained about the lack of detail associated with starred locations. This would be even more difficult if the itinerary contained a larger set of points. As Church and Smyth (2009) mentioned, changing locations can affect information needs, in particular with unfamiliar environments. Even so, the highest number of users they studied were looking to get these three pieces of information in turn: 1) where can people access services such as a drycleaner, 2) which is the nearest

drycleaner and 3) what are the directions to from the current location to the nearest drycleaner. We find that while Google Maps supports this common workflow, it does so only for single destinations, and does not readily support breaking away from the main workflow, for example to add a new POI to an itinerary while walking. As a result, there was a need to support editable itineraries. We do this by assigning numbers and labels on the waypoints. The Block Party app was redesigned to support the priority or the order by numbering the selected points and adding them to the route as shown in Figure 6.2 (B) and (C). This will enable people to navigate more easily, since they just have to follow the itinerary order and can easily identify the next locations (see Figure 6.3 List View). Itineraries are created by selecting waypoints in the desired order when in Map View, and waypoints are then numbered on the map. Switching to List View shows the names and addresses of each waypoint in itinerary order. Currently, orders cannot be modified from within List View (for example by dragging), but this is a planned feature.

Map View

The Map View is top down map displaying the locations of the neighborhood with the points shown as markers. It shows the location of the requested POIs (e.g., cafe) in relation to where the user is located in a street layout (the current location is indicated with small blue point).

In *planning mode*, if the user selects a location category from the menu (medical services, for example), it will present all related waypoints in the neighbourhood on all three views (Map, List, Immersive). On the map, each location is shown with a red marker. The user can select which point he is interested in by clicking on it and an information window appears above the marker which displays the name and address of that location as shown in Figure 6.1 (A). Clicking on the item again will add it to the set of selected items as shown in Figure 6.1 (B). In List View, selected and unselected waypoints are differentiated using the same markers.



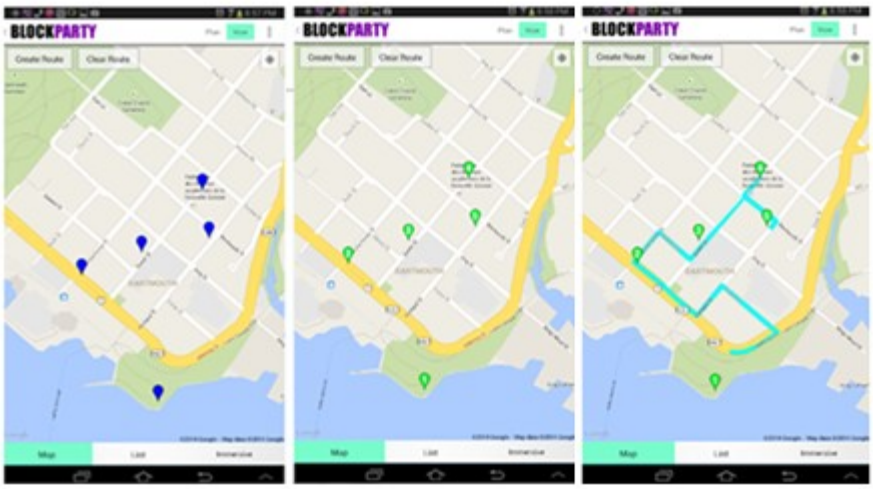
Planning mode (A) Planning mode (B)

Figure 6.1 Map View in planning mode for Exploring Neighbourhoods

If the user then switches to viewing mode, only the selected locations appear on the map. As the itinerary order has not yet been specified, these items are displayed with a blue marker see Figure 6.2 (A). Users then click on POIs, bringing up a small description popup, and if they desire the POI can be appended to the route. If so, the marker changes to green and becomes numbered according to its order in the itinerary as shown in Figure 6.2 (B). Then user created the route which includes all the chosen location assigned with numbers as shown in Figure 6.2 (C).

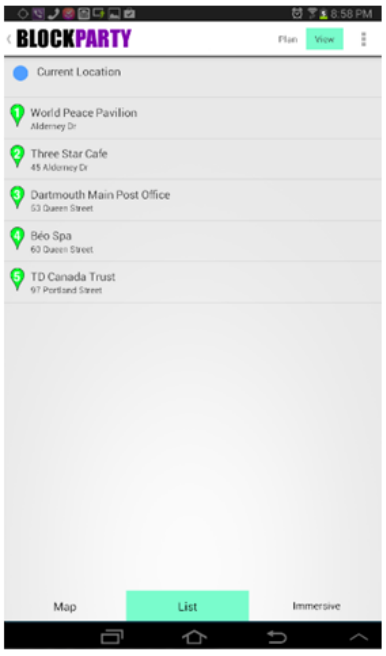
New POIs can be added at any time from Plan Mode, and they will be shown (in blue) when in View Mode. Currently the user must either add the waypoint to the end of the route, or clear and redo a route by selecting a new itinerary ordering, however in future we will support waypoint insertion.

List View in viewing mode shows the points' order selected by the user as shown in Figure 6.3.



Viewing Mode (A) **Viewing Mode (B)** **Viewing mode (C)**

Figure 6.2 Map View of viewing mode for Exploring Neighbourhoods



List View in Viewing mode

Figure 6.3 List View in viewing mode for exploring neighbourhoods. It shows the points' order selected by the user.

6.1.2 Switching views

The study provided evidence that the existing Google Map application does not support rapid switching and synchronization between views. A major issue both observed and reported by participants was the requirement to get back to Map View either to search for the next target, estimate distance or to use Street View. Clicking repeatedly on the back button sometimes caused participants to exit out of the application entirely, leading to frustration. Teevan et al. (2011) and Inbar et al (2009) reported that when people tried to find nearby services time was important because they liked to use information they receive during navigation immediately. We suspect that the time spent switching between views in Block Party will be less than in Google Maps. Block Party attempts to reduce the cost of switching by offering both activity-based and view-based switching as prominent UI elements (see Figure 6.4 and Figure 6.5), and by reflecting the actions done in one view across all other views (i.e., by keeping the views synchronized).

Figure 6.4 Synchronization and switching between views

Figure 6.5 The two mode buttons (planning and viewing)

6.1.3 Searching

The findings of the study showed that participants were faced with search-based issues, when no nearby results were displayed or when they had to search again to find locations. The results showed that Google Maps local search provided widely varying results based on slight variations in search terms, included defunct businesses or did not include new businesses (although this updates over time as seemed to occur with TD Bank in Dartmouth), or provided wrong addresses (for example, a medical centre actually located in rural NS was pinned in downtown Halifax). Search was therefore another source of frustration for participants. Rao et al (2012) found that when people navigated in unknown urban environments, service availability(the ability for people to find all nearby points of interest in their neighborhood such as cafes, grocery stores, dental clinics etc.), is an important factor that might result in the system displaying no results to the user . In addition, people use mobile location based services (including search) to become familiar with new areas including finding all POIs nearby.

Mobile search differs from desktop search terms of search term and desired results are often very specific (Zipf and Jost, 2012). Also, the previous study by Zipf and Jost (2012) indicated that the level of detail of the data must be appropriate for the user's needs and the designed app should accomplish the task. Block Party was designed based on curated lists of nearby POIs (see Figure 6.6), reducing the scale of the linked data to a very targeted set. We believe this approach is suitable for targeted kinds of neighbourhood exploration (homebuying, for example), where there are a set of categories that many homebuyers are interested in (as indicated from early discussions with HomeZilla and from the interviews described in Chapter 3). One disadvantage is that the lists need to be

maintained. Another disadvantage is the lack of location search; there is currently no capability to type the address or the target name. A desired future enhancement is to integrate local search (such as Google's) with the category-based selection.

Figure 6.6 shows that first the user clicks on the Block Party icon Figure 6.6 (A) then the first screen of the Block Party prototype shows the main menu which has all the categories of locations in neighbourhoods as shown in Figure 6.6 (B). Then homebuyers can select the categories that they are looking for, then start planning navigation. The categories can be returned to again from the drop-down menu on the top-right of the app. Once the participant has selected the specific categories, the checkbox becomes selected. As shown in Figure 6.6 (C), the participant has chosen cafe, bank, post office, spa and restaurant. Once the user selected the points based on selection categories then what he has selected is added to the route, saved and displayed with the address and the name.

The Block Party icon(A) the main menu of the prototype (B) The chosen categories(C)

Figure 6.6 The main menu and the chosen categories of the Block Party prototype.

There was inconsistency in search results for TD Bank in Dartmouth. Two participants could not find any results on the map, even after varying search terms. The other 3 participants used similar terms to the other participants, but they did find the nearby TD Bank on the map where caused confusion. The discrepancy may be due to the dynamic nature of Google's local search results; perhaps the TD Bank in downtown Dartmouth

was a new branch. The Block Party app resolves the searching issues. As result, when users search For the TD Bank, they can easily find it on the map as shown in Figure 6.7.

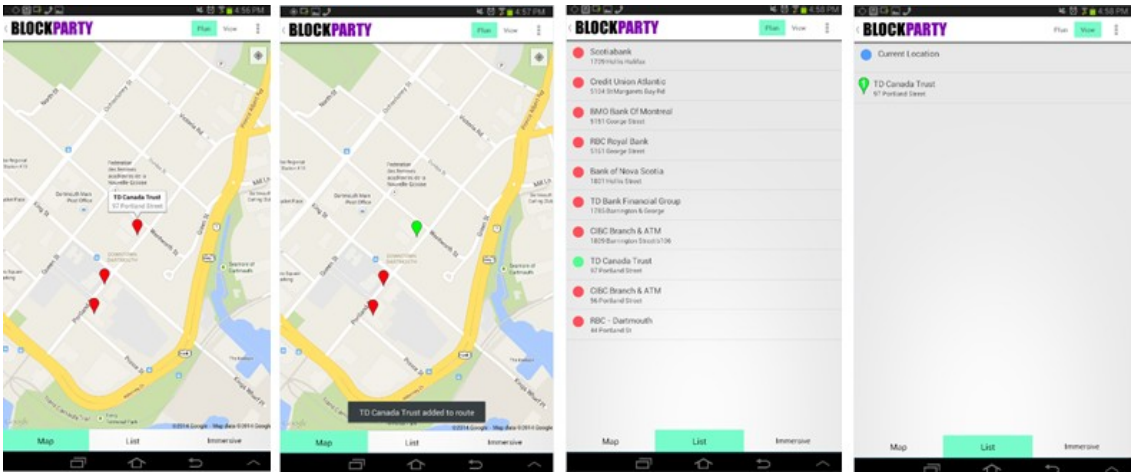


Figure 6.7 The Block Party app resolves the searching issues for TD bank in Dartmouth

Viewing and switching modes is straightforward, switching views is done using a navigation bar at the bottom of the screen. In the top right corner of each view are two buttons used to switch between the two modes.

6.1.4 Street View and getting lost

It was mentioned by 9 participants while trying Block Party that the Immersive View was very helpful. Sometimes users were not aware of what was around them in the particular neighbourhood, but if they used the camera, they would be able to see, for example, the art gallery close by; they would immediately go there, as this would spring an interest. One participant questioned what would happen if users were in large urban centers and used the camera, and were overwhelmed by the number of points of interest displayed on the screen; that might be very confusing. This potential problem could be addressed by switching from planning to the viewing mode, which would reduce the points of interest and give a limited selection to view. Another strategy would be to select only one or two categories of item (e.g. Park, Landmark) to be displayed while in Plan Mode. In general, people tended to use the graphic interface when they were interested in seeing what the

location looks like or when they were unfamiliar with using the map interface or when they could not identify the targets.
In the study there were several reasons why Street View was not helpful in identifying locations: pictures were out of date, targets were sometimes inside the building with no sign on the outside, or the business had been changed.

There were 9 participants who switched to Street View when they arrived at the targets, but when they got to the destinations, they became confused, looking around and trying to read street and building signs since the system told them they were at the destinations. However, they could not identify where the target was. As a result, when they could find the targets many did not switch to Street View. In general we concluded that the participants that did use Street View did so as a strategy to help them identify the location just because of these aforementioned reasons. Our findings were supported by prior work by Partala and Salminen (2012) and Beeharee and Steed (2006). A prototype presented by Beeharee and Steed (2006) had two modes: graphical mode and text mode (Map). Pedestrians used photos when they got lost in order to get back on track. Photographs were helpful to stay on the right way and made pedestrians feel more confident but there were issues with graphical mode, since it was often out-of-date. At Economy Shoe Shop a participant who had used Street View, which displayed a photo, found that when he had arrived, the photo was old and different from what was there in reality. It seems the photos were taken in the summer and looked very different than what was presently there. There were downloading issues as well when some users used the Street View, as more time was needed in order to download it. The result presented by Partala and Salminen (2012) was that Street View was effective in displaying locations, but users required more time to compare between what was on the screen and what was there in reality. This was supported by what our participants faced, in that they used Street View only when they reached the target. Graphical maps were more preferable to use by navigators than regular maps when they had difficulty reading the information or had less experience with the map (Partala and Salminen ,2012; Beeharee and Steed ,2006).

The findings presented by May et al. (2003) and the previous study presented by Beeharee and Steed (2006) mentioned above, reflected why we needed to redesign our prototype. Images presented by using Immersive View are always up to date but the issue remains with POIs, as they might still be out of date. In addition, Immersive Views are inherently local – unlike Street View, it isn't possible to see exactly where POIs are located using Immersive View without physically moving.

There is a related limitation when using Immersive View where if there is a wall or other obstruction between the user and the target, there will be an issue in trying to identify the POI. The Immersive View is most useful when the user has a clear line of sight of the POIs. This was demonstrated in work by Dunser et al. (2012). Immersive view is available in both *planning mode* and *viewing mode*, and is shown in Figure 6.8. A user holds the phone up in the direction that they want to find any point of interest (POI) (e.g., cafe, spa). The camera overlays all the requested POIs with their distances. If the user pans the phone, just like when taking a photo, the image changes on the phone and other POIs are displayed as a white circle with a box that includes the name, address and distance of the POI. In *planning mode*, the points reflect the categories chosen by the user. In viewing *mode*, the camera displays the locations that were added to the route (see Figure 6.8).

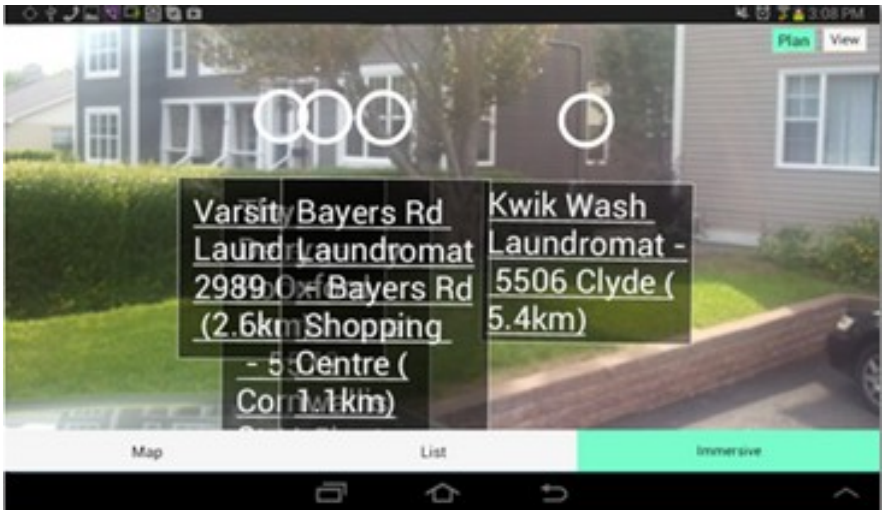


Figure 6.8 Immersive View

6.1.5 Route design to choose and follow

According to Agrawala and Stolte, it is important to display the entire route on the one screen annotated with useful information such as street names and distances (Agrawala and Stolte, 2001). In our study, participants used a range of views while traversing a route, not always keeping the entire route in view. Instead, they zoomed in and out to see their location, route and destination, and also zoomed and panned to view search results and starred items. Unlike Google Maps, Block Party links waypoints in a multi-destination itinerary (Figure 6.2). Block Party also relies on zoom and pan, rather than apply the route simplification techniques recommended by Agrawala and Stolte. A potential future improvement to Block Party would be to allow different route choices. At present the route chosen is the concatenation of the best point-to-point routes from the Google Map API.

Street density made following a route in Dartmouth a different experience than following a similar route in Halifax. For example in Dartmouth when participants got lost finding Tim Hortons and the dentist they spent more time in Street View walking back and forth on the wide streets with few street addresses, but in Halifax less time was spent using Street View when lost, and instead of walking distances back and forth they would simply look around nearby.

6.1.6 Route adjustment during the navigation

Since Google Maps app did not support creating a multi-stop route, participants forgot what the next destination was. The need to keep a reminder of each place to visit was an issue, although itinerary adjustments mid-route due to a need to backtrack occurred only twice in our study.. Block Party builds the route for users and keeps track of all the places they are supposed to visit. As well, Block Party assigns numbers on the points in their desired order of visitation. Since Google Maps does not build the route, participants would create the route based on distance to the house. Some participants tried to optimize the route in relation to each point to make the route convenient to walk, but this was laborious and time consuming without direct support from the application. Block Party

tries to optimize the route and maintains a visual representation of it, both of which should minimize the need for adjustment or backtracking.

6.1.7 Familiarity test score

From demographic questionnaires we reported that the average self-reported sense of direction, scoring 61.5 (SD=8.2) on SBSOD with possible score range from 15-105. Also, All our participants currently live in Halifax. Half of participants (5/10) were familiar with Halifax and 8 out of 10 were unfamiliar with Dartmouth**.**
We found no difference in overall test score and the test score for the first three tasks: draw routes, mark locations and draw arrow; but there was a slight difference in the fourth task score (labeling photo).

From demographic questionnaire, 5 out of 10 participants were quite familiar with Halifax and the other 5 were somewhat familiar with Halifax. The result reported from the familiarity test did not reflect their level of familiarity with Halifax since (5 Participants were familiar and the other 5 were somewhat familiar with Halifax). The results showed that they did very similar in the first 3 tasks in both areas although they were 5 of them familiar with Halifax. However, the difference was only on the fourth task (labeling) they did slightly higher (M=2.5 Halifax and 1.4 in Dartmouth).

Although our participants were generally more familiar with Halifax (5 familiar and 5 somewhat familiar) than Dartmouth (8 unfamiliar and 2 somewhat familiar), they didn't perform better in the familiarity test. There are several possible explanation to this result: first of all, participants were not familiar with all the services/targets in the study. Halifax area is a very high-density area with a lot of stores and turns that participants hadn't visited the locations before the study. Secondly, while participants were navigating, some of them didn't follow certain route to get to the destinations. Instead, they went through another route. For example, at the corner participant searched to visit split crow then he followed the route via Argyle Street, he did not cut Grand Parade as planned when he was navigating so he could not see TD Bank, which was on Barrington street. Thirdly, it might be because they were talking while walking and they didn't pay attention to what

was around them. Lastly, some photos of Halifax in the familiarity test were taken in Summer but they looked different when the study is conducted (e.g. Economy Shoe Shop). That may also result in low scores in Halifax.

6.2 Limitations of the Study

Having more participants might give more interesting results, however the detailed data collection with video was very time consuming. Also, since nine participants were from the Faculty of Computer science, these students might not reflect the homebuyer scenario extremely well, although they were renters. Ideally, conducting a study with larger sample size and background diversity would improve the external validity of the research results.

The difference in familiarity might have played a role in comparison between the two neighborhoods. Having half of the participants familiar with Halifax and second half familiar with Dartmouth would allow us to assess the impact of familiarity.

There was a button on the right side of the device which some participants mistakenly clicked on for approximately 7 times in total across the whole study, which caused the phone to close while they were doing the tasks; this interruption meant that POIs needed to be identified again, wasting time. A Summary of how Block Party addressed Google Maps flows illustrated in Figure 6.2.

Google Map limitations	Block Party Features
1- Limited the ability to switch between views. As a result, sometimes led to loss of the user's current action .	Synchronized the views without interruption of the current action progress. Also, the two modes were Synchronized too.
2- Limited support for creating the route for multiple locations using stars.	Support build the route which is assigned with users' present order.
3- Search often led to inconsistent or incorrect results	Using category – based list to find location, which displayed all users' requests POIs
4- Street View required the user to switch from their current screen to Map View. Also Street View is sometimes out of date pictures.	Using Immersive view, is easily accessible from any other view and always has up to date pictures pictures.

Figure 6.9 Summary of how Block Party address Google Maps flows

6.3 FUTURE WORK

The results of our current study also identified some possible areas of improvement for the Block Party application. We have a number of candidate features for Block Party that are under consideration, including support for personal annotations, location search, adding more categories, adding waypoint hints/labels, reintroducing the textual Step by Step View and adding different colors for each category. While we didn't explicitly evaluate whether annotations would be useful in our experiment, the ability to add personal notes about locations seems valuable when exploring a neighborhood. A second feature that is currently lacking in Block Party is a step by step View (it was available in an earlier iteration); it would show route information between two locations depending on where you are on the itinerary. Also, it would increase consistency with the other views. When a user clicks on 2 points in viewing mode then the directions would also pop up between these points. The current Block Party version has 10 categories; we plan to add more categories, some of which are taken from the original HomeZilla application. Since participants had difficulty identifying the target when it was inside a building (for example), it would be helpful to have a special identifier, for example a little circle around the waypoint's marker, indicating that the location is inside the building (e.g "Tim Hortons is inside the building"). Using different colors for each category might be useful during planning mode. Finally, we are planning to conduct a controlled study in order to evaluate our design decisions in Block Party; in particular to assess the benefits of our multiple synchronized views approach for neighborhood expedition support. We will follow exactly the same methodology as the previous study but because the interface is slightly different there will be a few differences as listed below:

- Participants find locations using a category-based list instead of searching.
- Instead of using the stars, participants will use the route order feature.
- Street View and Navigation Views are not available, but Block Party adds Immersive View.

CHAPTER 7 CONCLUSION

Mobile Wayfinding applications have become necessary tools for pedestrians who are unfamiliar with urban environments. Smartphone applications can help navigators more effectively and easily identify specific locations nearby. Using mobile devices in the real estate domain has been shown by Zipf et al., (2012) to be more effective than general web sites for new homebuyers for finding points of interest (POIs) since they are designed and implemented for that specific purpose. The goal of this research was to explore how neighborhood data could be used by potential homebuyers and renters while visiting prospective homes.

The first phase of the research was a preliminary study assessing how participants used existing mobile mapping applications other online tools to help pedestrians with neighborhood exploration. The preliminary study was conducted in an urban Toronto neighborhood and in Quinpool in Halifax neighborhood. The research began by evaluating an original online service and related mobile app for homebuyers created by our partner HomeZilla. We then conducted interviews with a real estate agent and a home buying couple, and also developed early prototypes and conducted UI mockup design work. We then tested an initial prototype in the Quinpool neighborhood in Halifax. Because of issues with the prototype we revised an original study design intended to evaluate the prototype in Riverdale Toronto to instead focus on using Google Maps and other generic mobile tools (including Yelp) for discovering a neighborhood. Two out of four participants reported that Street View was helpful to identify POIs that were not always easy to locate and the other two found that Map View was helpful to find closest POIs. The stars were helpful to help plan and keep track of progress. Also, participants reported that Immersive View would be helpful to identify POIs, and thought it may be beneficial for people who are poor at translating maps. Results from the preliminary evaluations were combined with interviews with a real estate agent and a home buying couple, and discussions with HomeZilla, and lessons learned from the early prototyping work, to establish a set of features for a more targeted application design to help homebuyers explore potential neighborhoods. The result from this preliminary study led to the design refinements of the current research study that was described in this thesis.

Our design included several elements, including rapid transitions between synchronized spatial views, and easy transitions between planning, wayfinding and exploration modes of use. The first version of the new app, called Block Party, was developed to reflect these design goals.

We then conducted a wayfinding study considering a home buying scenario in two different urban neighborhoods (downtown area of Halifax) and the downtown area of Dartmouth, to assess limitations of a popular existing mobile based navigation and search application (Google Maps) for neighborhood discovery.

Participants were told to imagine that they were interested in purchasing a home in two neighborhoods using Google Maps to perform a set of tasks based on a home-buying scenario. In general, all participants were asked to find a set of points of interest (POIs) in both Halifax and in Dartmouth and to build their own route involving a subset of the POIs before navigating. We also asked them to establish their location relative to a prospective home, while they were walking from one POI to another. We stopped participants at particular points along routes and asked them to point in the direction of a fixed landmark that they had visited and estimate the walking time to get there. After completing the itinerary, at the end of the study we showed the designed prototype to participants to get feedback further design improvements.

Data was captured in the control study in the form of a logged screen capture data log and video recordings. In our analysis we calculated the proportion of time spent using the different screens/views in three phases: planning phase (determining their next destination), on path phase (walking to their next destination) and answering questions posed by the experimenters. These phases occurred after participants had built their initial itinerary and had begun exploring the neighbourhood on foot. We considered each phase in Halifax vs Dartmouth and across both locations. We also considered the total proportion of time using each of the views across both Halifax and Dartmouth.

We found interesting results in the planning phase, when the participants were planning to go to the next location the most common approach was they used Map View and Search. On the path phase, the proportion of time spent in Navigation View was higher in Halifax than Dartmouth while Route View findings were similar in both areas. In pointing (answering question) phase, Map View was the most common view in both

Halifax and in Dartmouth while the second approach No Vie/sequence analysis illustrated common transition patterns of view usage. We found that while the application's design influenced the choice of view used by our participants, individual preferences and the complexity of the task also played a role. From our results we determined some limitations of using Google Maps for neighborhoods discovery: view selection was often impeded by application design, which limited the ability to switch between views; and support for creating a route for multiple points using the locative search often led to inconsistent and sometimes misleading or incorrect results. We also found issues with switching between spatial views which required the user to switch from their current screen to Map View, leading to confusion and sometimes loss of application state as users restarted the app accidentally or out of frustration. Participants tried to switch to Street View to find locations when they got lost but it did not help to identify targets (pictures were sometimes out of date, destinations were sometimes inside a larger building with no sign indicating so on the outside, or the business had changed). There were further issues with searching (e.g. when no result was displayed even when participants used different search terms or when the system was not stable for displaying the locations on the map), with losing one's place in the application, and with visualizing a multi-stop itinerary.

Feedback from participants on the Block Party design was encouraging, and we identified a number of candidate features for Block Party, including support for personal annotations, location search, adding more categories, adding waypoint hints/labels, reintroducing the textual Step by Step View and adding different colors for each category.

A number of existing design elements were validated by the study results, including allowing the users to change the order POIs for a multi-stop itinerary; the synchronization of the switching panel across the three views without interruption of the current action progress whatever view users were in; and searching for points based on selection from the curated lists, rather than conducting a search. The next phase of this research will be to further refine the Block Party app, and then to conduct a field study similar to the Halifax Dartmouth study, allowing us to evaluate the design of version three of the app.

References

Agrawala, M., & Stolte, C. (2001). Rendering effective route maps: improving usability through generalization. In *Proceedings of the 28th annual conference on Computer graphics and interactive techniques* (SIGGRAPH '01). ACM, New York, NY, USA, 241-249.

Arikawa, M., Konomi, S. I., & Ohnishi, K. (2007). Navitime: Supporting pedestrian navigation in the real world. *Pervasive Computing, IEEE*, *6*(3), 21-29.

Beeharee, A, K., Steed, A (2006). A natural wayfinding - exploriting photos in pedestrian navigation systems, *Mobile HCI* , 81-88.

Church, K ., Smyth, B. (2009). Understanding the intent behind mobile information needs. In *Proceedings of the 14th international conference on Intelligent user interfaces* (IUI '09). ACM, New York, NY, USA, 247-256.

Church, K., Cousin,A., & Oliver, N. (2012). I wanted to settle a bet!: understanding why and how people use mobile search in social settings. In *Proceedings of the 14th international conference on Human-computer interaction with mobile devices and services* (MobileHCI '12). ACM, New York, NY, USA, 393-402.

Dabbs, Jr, J. M., Chang, E. L., Strong, R. A., & Milun, R. (1998). Spatial Ability, Navigation Strategy, and Geographic Knowledge Among Men and Women. *Evolution and Human Behavior,* 19 (2),89-98, ISSN 1090-5138.

Draper, M. (1995). Exploring the influence of a virtual body on spatial awareness. *Context*, *10*, 35.

Dünser, A., Billinghurst, M., Wen, J., Lehtinen, V., & Nurminen, A. (2012). Exploring the use of handheld AR for outdoor navigation. *Computers & Graphics*. 36(8). 1084-1095.

Gong, J., & Tarasewich, P. (2004). Guidelines for handheld mobile device interface design. In *Proceedings of DSI 2004 Annual Meeting* 3751-3756.

Google Mobile.(2014). https://www.google.ca/mobile/maps/

Gotow, J. B., Zienkiewicz, K., White, J., & Schmidt, D. C. (2010). Addressing Challenges with Augmented Reality Applications on Smartphones. In *Mobile Wireless Middleware, Operating Systems, and Applications*. 129-143. Springer Berlin Heidelberg.

Inbar, O., Lavie,T., & Meyer, J. (2009). Acceptable intrusiveness of online help in mobile devices. In *Proceedings of the 11th International Conference on Human-Computer Interaction with Mobile Devices and Services* (MobileHCI '09). ACM, New York, NY, USA, 26-4.

Kallioniemi, P., Turunen, M. (2012). Model for landmark highlighting in mobile web services. In *Proceedings of the 11th International Conference on Mobile and Ubiquitous Multimedia* (MUM '12). ACM, New York, NY, USA, 25-10.

Kray,C., Elting, C., Laakso, K., and Coors, V. (2003). Presenting route instructions on mobile devices. In *Proceedings of the 8th international conference on Intelligent user interfaces* (IUI '03). ACM, New York, NY, USA, 117-124.

Liarokapis, F., Raper, J., & Brujic-Okretic, V. (2006). Navigating within the urban environment using Location and Orientation-based Services. *In European Navigation Conference & Exhibition.* 7-10.

May, A. J., Ross, T., Bayer, S. H., & Tarkiainen, M. J.(2003). pedestrian navigation aids: information requirements and design implications. *Ubiquit Comput.* 331-338.

Millonig, A., & Schechtner, K. (2007). Developing landmark-based pedestrian navigation systems. *Intelligent Transportation Systems, IEEE Transactions on*,*8*(1), 43-49.

Nilsson, S., Arvoa, M., Szczepanski, A., & Bång, M.(2012). Exploring place and direction: mobile augmented reality in the Astrid Lindgren landscape. In *Proceedings of the 24th Australian Computer-Human Interaction Conference* (OzCHI '12), Vivienne Farrell, Graham Farrell, Caslon Chua, Weidong Huang, Raj Vasa, and Clinton Woodward (Eds.). ACM, New York, NY, USA, 411-419.

Partala, T. Salminen, M. (2012) . User experience of photorealistic urban pedestrian navigation. In *Proceedings of the International Working Conference on Advanced Visual Interfaces* (AVI '12), Genny Tortora, Stefano Levialdi, and Maurizio Tucci (Eds.). ACM, New York, NY, USA, 204-207.

Popa, M., Argesanu, V., & Popa, A. S. (2010). Car finding with a pedestrian navigation system. In Human System Interactions (HSI), 2010 3rd Conference on 406-411. IEEE. Chicago.

Rao, B., & Minakakis, L. (2003). Evolution of mobile location-based services. *Communications of the ACM* , 61-65.

Reitmayr, G., & Schmalstieg, D. (2004). Collaborative augmented reality for outdoor navigation and information browsing. In *Proc. Symposium Location Based Services and TeleCartography* . 31-41.

Sas, C. (2004). User model of navigation. In *Computer Human Interaction*. 379-388. Berlin Heidelberg.

Sohn, T., Li, K. A., Griswold, W. G., & Hollan, J. D. (2008). A diary study of mobile information needs. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (CHI '08). ACM, New York, NY, USA, 433-442.

Teevan, J. Karlson,A., Amini,S., Brush, A, J., & Krumm, J. (2011). Understanding the importance of location, time, and people in mobile local search behavior. In *Proceedings of the 13th International Conference on Human Computer Interaction with Mobile Devices and Services* (MobileHCI '11). ACM, New York, NY, USA, 77-80.

Tversky, B. (1993). Cognitive maps, cognitive collages, and spatial mental models. In *Spatial Information Theory A Theoretical Basis for GIS* (pp. 14-24). Springer Berlin Heidelberg.

Zipf, A., M, Matthias., & Jost. (2012). Location-Based Services. In *Springer Handbook of Geographic Information* . 417-421. Springer Berlin Heidelberg.

Retscher, G., & Thienelt, M. (2004). NAVIO–A navigation and guidance service for pedestrians. *Journal of Global Positioning Systems*, *3*(1-2), 208-217.

ChenP,T.,Lin, Y, S.(2011). Mobile Location-Based Services: An Empirical Study of User Preferences. *International Journal of Information and Education Technology, Vol. 1, No. 5,*

Appendix A1 - Waterfront Scenario to Dartmouth

[Script if they are doing Waterfront First]

We are going to start by exploring the waterfront area of Halifax. Once we finish in Halifax, we will take the ferry to Dartmouth and then explore the downtown area.
We would like you to use the Smartphone and Google maps to find the condo that you are considering to purchase. Once you get to the condo, we will provide you with a list of different services and amenities that we will ask you to find using Google maps and then to visit these services.
Before we start the study we want to show you the different features of Google Maps. We can use the following features:
1- click on Apps icon then select Maps icon. It will pop up the map. Then you will see in the above field called search, this space allows you to type locations/addresses that you want to search for. Try to type Citadel school and press the search button.
2- You can always locate your current location by clicking on the icon at the bottom right. Now click on the red marker. You will see options such as estimated time to get to the destination, save, share and street view. When you flip the screen up, you will see other information such as website, reviews.
*3.*click on the little walking man, it will show you different routes to get to the destination from your current location with the expected time. Select a route, click on the "Start" button on the right, it will start to navigate. If you click the button on the right bottom, you will see options (route preview, step by step, unmute voice guidance).
4- You can use Satellite view , it gives a top down picture of the location and then if you click on a little man walking direction then it gives you options to which directions you want. When you select the direction it will provide you a route between 2 points(from your current location to the point with the distance to get there). You can start to navigate by clicking on Start button it will give you instruction to get to the destination supported by the voice guidance .
5- You can use Street view , it shows you a picture of the location and you can control the navigation by moving your finger. If you click on the left option , you will control it by the movement of the device. When you are close to the general area of the home, I would like you to use street view to get a sense of what the destination looks like (you will select Street View for your target destination). Then when you get very close to the house, Could you please use street view again to see the house (here, you will select Street View for your current location).

[Once you show all the features]

Like we mentioned, we would like you to use the Smartphone and Google maps to find the condo that you are considering to purchase or rent. Once you get to the condo, we will provide you with a list of different services and amenities that we will ask you to find using Google maps and then to visit these services. While getting to the condo, I'm going to ask you to use the different features that we just looked at. The condo is located at the corner of Lower Water Street and Salter Street.
You can find the corner of Lower Water Street and Salter Street and star it (or save it) on the map once it comes up.
Great, now we can go to visit it. We will try out the different features while going to the condo.
First, you can get the directions to the condo, by selecting the walking person icon on the bottom right side. You can select the first option which will visually show you where you currently are and where the home it on the map. The blue line shows the route on the map.
* when part way to the condo * -- now I will ask you to use Street View to get a sense of what your destination looks like
* when within 1 block of the condo * -- now I will ask you to use Street View to locate your destination
[At the condo]

Please note that while I have asked you to use specific features on the way to the condo, we want you to use whichever features you want for the rest of this study - you are not required to use the features in the way we just instructed you to.

We have a list of services and amenities for you to locate. We want you to find these and then star/save them on the map. Once we go through all the places, you will create a route so we can visit the places to help you explore the neighbourhood. Remember you need to consider both neighbourhoods and decide on a neighbourhood to live after you finish visiting both.

Locations:

1. Find a close by Sushi restaurant and star/save it. Which one do you choose -----
2. . Find close by dry cleaners and star/save it. Which one did you choose: _____

3. Find a nearby doctor's office or medical centre and star it. Which one did you choose: _____

4. Find nearby a dentist and save/star it. Which one did you choose: _____

5. Find the closest .....bank and save it.

6 - Find a close by supermarket and save it . Which one did you choose: _____

7- Find and save a nearby park. Which one did you choose: _____

8- You heard that the Economy Shoe Shop is a nice place to take out of town business visitors. Find it and save it on your map.

9- The final location is the ferry terminal save/stat it on the map.

Next, we would like for you to create a route to visit each of these saved locations. We understand that some of the items that you have found may be too far to walk today. So for the supermarket and maybe the park, I will ask you to just point in their direction when you are close to it while on route to the other locations. You can now use whatever features of Google maps that you want to navigate to the locations.

Please tell me the order that you will visit the different locations:

1.
2.
3.
4.
5.
6.

Point out:
1. Citadel Clock Tower
2. Supermarket
3. Park (optional)
_____
_____

[While walking the routes:]

You can watch out for any restaurants, other coffee shops, shops or any other services that they think look interesting and to star them on the map. [you can remind them a couple of times]

“While you’re walking to the different locations, please watch out for any restaurants, other coffee shops, stores or any other services that you think look interesting and to star them on your map”

[At the Economy Shoe Shop]

Great you found the Economy Shoe Shop. While you are here you get a call from your friends [.....and.....] that they will meet you at Grand parade. Please go to this location..

[At Grand Parade:]

Please point in the direction of the house you looked at. How far away is it:

_____

Please go to the Corner of Argyle street or Carmichael st. and point to the Citadel Clock Tower..

Your friends have sent you a text message indicating that they will meet you instead at the fountain outside the Split Crow pub. Please locate the Split Crow and walk there.

[At other locations – depending on the order they choose you need to ask the above question a couple more times.].

Location you are at:

Where you asked them to point to: How far is it? you can use the device if unsure

Location you are at:

Where you asked them to point to: How far is it?

[Back At the Ferry Terminal]

1. Ask them to point in the direction of the home they looked at and the park. And tell how far away it is.

---

2. Now you need to do the familiarity test [on the ferry or while waiting]

Dartmouth Side

[on ferry or right when get off]
Now, we are going to explore the downtown neighbourhood in Dartmouth. Once we finish in Dartmouth, we will take the ferry back to Halifax where the study will end.
In Dartmouth, you will use the Smartphone and Google maps again to find the house that you are considering to purchase. Once you get to the house, we will provide you with a list of different services and amenities that you will find using Google maps and then to visit these services.
[at the ferry – Dartmouth side]
The house you are considering is at 22 North Street.
S*earch for the house to 22 North St* using Google maps. You can use any features of Google maps to find it and the services. And remember that we will ask you at the end which neighbourhood you would like to live in.
* when part way to the house * -- now I will ask you to use Street View to get a sense of what your destination looks like
* when within 1 block of the house * -- now I will ask you to use Street View to locate your destination

[At the house]

Please note that while I have asked you to use specific features on the way to the house, we want you to use whichever features you want for the rest of this study - you are not required to use the features in the way we just instructed you to.

[At the House]
Like we did in Halifax, We have a list of services and amenities for you to locate. We want you to find these and then star/save them on the map. Once we go through all the places, you will create a route so we can visit the places to help you explore the neighbourhood.

- find nearby Celtic Corner pub and restaurant and star it
- Find a close by [.....] coffee shop and save it _____
- Find where the closest post office is and star/save it.
- Find the World Peace Pavilion and star/save it.
- Find a close by dentist office and star/save it.
- Find the closest [.....] bank and star/save it.
- Find nearby a spa and save/star it.
- find a nearby park and star/save it.
- We are going to end up back at the ferry terminal save it on the map.

Next, we would like for you to create a route to visit each of these saved locations. Similar to Halifax, we know some of the locations that you have found may be too far to walk today. So for the *curling club*, *World Peace Pavilion* [and maybe the *park* depending on which one they chose], I will ask you to just point in their direction when you are close to it while on route to the other locations. You can use whatever features of Google maps that you want to navigate to the locations.

Please tell me the order that you will visit the different locations:

1.
2.
3.
4.
5.
6.
7

Point out:
1. Curling club
2. World Peace Pavilion
3. Park (optional)

_____

_____

[While walking the routes:]

- You can watch out for any restaurants, other coffee shops, shops or any other services that they think look interesting and to star them on the map. ----------
---

- “While you’re walking to the different locations, please watch out for any restaurants, other coffee shops, stores or any other services that you think look interesting and to star them on your map” .----------
---

[At the Post Office:]
Great you found the post office. While you are here you get a call from your friends < names [.....and.....] and they have heard that there is a quirky museum here in Dartmouth called the Happy Face Museum on 22 Wentworth Street. Look this up and go check it out whether it is still there – see if you can find the hours for the museum.

[At the Museum]

Please point in the direction of the house you looked at. How far away is it:

_____

Your friends also mentioned that they would like to try curling the next time they visit. While we haven’t required you to go directly to the curling club, walk to the corner of *Dundas Street and Portland Street* and point to the direction of the curling club.

[At other locations – depending on the order they choose you need to ask the above question a couple more times.]
Location you are at:
Where you asked them to point to: How far is it? you can use the device if unsure
Location you are at:
Where you asked them to point to: How far is it?

[Back At the Ferry Terminal or a coffee shop]

1. point in the direction of the home they looked at and the park. And tell how far away it is.---------- ----------
2. Do the familiarity test
3. which neighbourhood they would like to live and why.
4. Ask them to look up on their maps some of the places that they stared while on route and ask them why they choose these places and whether do you think you would go to them or find out more about them.
5. Do the interview and the prototype question

Appendix A2 - Dartmouth Scenario to Waterfront

[Script if they are doing Dartmouth First]

We are going to start by exploring the downtown neighbourhood in Dartmouth. Once we finish in Dartmouth, we will take the ferry back to Halifax and then explore the waterfront area.
[This next part can be done on the Ferry or while waiting for the ferry]
Once we get to Dartmouth, we would like you to use the Smartphone and Google maps to find the house that you are considering to purchase. Once you get to the house, we will provide you with a list of different services and amenities that we will ask you to find using Google maps and then to visit these services.
Before we start the study we want to show you the different features of Google Maps. For example, if we use the Ferry terminal on the Halifax side as our destination, we can use the following features to help us navigate:
1- click on Apps icon then select Maps icon. It will pop up the map. Then you will see in the above field called search, this space allows you to type locations/addresses that you want to search for. Try to type Prince Andrew High school and press the search button.
2- You can always locate your current location by clicking on the icon at the bottom right. Now click on the red marker. You will see options such as estimated time to get to the destination, save, share and street view. When you flip the screen up, you will see other information such as website, reviews.
*3.*click on the little walking man, it will show you different routes to get to the destination from your current location with the expected time. Select a route, click on the "Start" button on the right, it will start to navigate. If you click the button on the right bottom, you will see options (route preview, step by step, unmute voice guidance).
4- You can use Satellite view , it gives a top down picture of the location and then if you click on a little man walking direction then it gives you options to which directions you want. When you select the direction it will provide you a route between 2 points(from your current location to the point with the distance to get there). You can start to navigate by clicking on Start button it will give you instruction to get to the destination supported by the voice guidance .
5- You can use Street view , it shows you a picture of the location and you can control the navigation by moving your finger. If you click on the let option , you will control it by the movement of the device. When you are close to the general area of the home, I would like you to use street view to get a sense of what the destination looks like (you will select Street View for your target destination). Then when you get very close to the house, Could you please use street view again to see the house (here, you will select Street View for your current location).
[Once at the Dartmouth Terminal]

Like we mentioned, we would like you to use the Smartphone and Google maps to find the house that you are considering to purchase. Once you get to the house, we will provide you with a list of different services and amenities that we will ask you to find using Google maps and then to visit these services. While getting to the house, I'm going to ask you to use the different features that we looked at while on the ferry.
-The house you are considering is at 22 North Street.
You need to *search for the house to 22 North St* using Google maps. You can type in the addresses and then star it (or save it) on the map once it comes up. Great, now we can go to visit it. We will try out the different features while going to the house.
First, you can get the directions to the house, by selecting the walking person icon on the bottom right side. you'll see an icon of a man walking, select this to get the walking directions. You can select the first option which will visually show you where you currently are and where the home it on the map. The blue line shows the route on the map.
* when part way to the house * -- now I will ask you to use Street View to get a sense of what your destination looks like
* when within 1 block of the house * -- now I will ask you to use Street View to locate your destination
[At the house]

Please note that while I have asked you to use specific features on the way to the house, we want you to use whichever features you want for the rest of this study - you are not required to use the features in the way we just instructed you to.

[At the house]

we have a list of services and amenities for you to locate. We want you to find these and then star/save them on the map. Once we go through all the places, you will create a route so we can visit the places to help you explore the neighbourhood.

1) The Celtic Corner is suppose to be a nice neighbourhood pub and restaurant. You've heard that the food is great. Please find and star the "The Celtic Corner".

- You have also heard that this area has some great coffee shops. Find a coffee shop in the neighbourhood and save/star it. Which coffee shop did you choose: _____
- While you do a lot of correspondence by email now, you still like to have a post office nearby to send packages and to mail the occasional letter. See where the closest post office is and star/save it.
- You read that different outdoor events occur at the World Peace Pavilion, locate the Pavilion and star/save it.
- You have been considering taking up Curling. You know that Dartmouth has a well known curling club but aren't sure of where it is located. Find the corner of *Dundas st and Portland st* to point the direction of the curling club star/save it.
- If you relocate to this neighbourhood you will need to find a new dentist. Find a close by dentist office and star/save it.
- You indicated that you use [add bank name], find the closest branch to the house and star/save it.
- You have heard that Dartmouth has some fantastic spas. You have a good friend who loves to go to the spa – find a spa in your neighbourhood and save/star it.
- Green spaces is important to you [if they have a dog then say – especially for <insert dog's name>], so you should find a nearby park and star/save it.
- We are going to end up back at the ferry terminal, so if it's not already stared/saved, you should do that now.

Next, we would like for you to create a route to visit each of these saved locations. We understand that some of the items that you have found may be too far to walk today. So for the World Peace Pavilion [and maybe the park depending on which one they chose], I will ask you to just point in their direction when you are close to it while on route to the other locations. You can use whatever features of Google maps that you want to navigate to the locations.

Please tell me the order that you will visit the different locations:

1.
2.
3.
4.
5.
6.
7.

Point out:
1. Curling club
2. World Peace Pavilion
3. Park

_____
_____

[While walking the routes:]

- You can watch out for any restaurants, other coffee shops, shops or any other services that they think look interesting and to star them on the map. [you can remind them a couple of times]

- "While you're walking to the different locations, please watch out for any restaurants, other coffee shops, stores or any other services that you think look interesting and to star them on your map"

[At the Post Office:]
Great you found the post office. While you are here you get a call from your friends (.....and .....) and they have heard that there is a quirky museum here in Dartmouth called the Happy Face Museum on 22 Wentworth Street. Look this up and go check it out whether it is still there – see if you can find the hours for the museum.

[At the Museum]

Please point in the direction of the house you looked at. How far away is it:

_____

Your friends also mentioned that they would like to try curling the next time they visit. While we haven't required you to go directly to the curling club, walk to the corner of *Dundas Street and Portland Street* and point to the direction of the curling club.

[At other locations – depending on the order they choose you need to ask the above question a couple more times]

Location you are at:

Where you asked them to point to: How far is it? you can use the device if unsure

Location you are at:

Where you asked them to point to: How far is it?

[Back At the Ferry Terminal and on the Ferry]

1. point in the direction of the home they looked at and the *curling club*. And tell how *far away* it is._____

2. Do the familiarity test while on the ferry

[At the Waterfront]

Now we are going to explore the waterfront area. You have to find a Condo that you are considering. The condo is located at the corner of Lower Water Street and Salter Street.

We would like you to first navigate the location of the condo from the ferry (the corner of Lower Water Street and Salter Street). Once at the condo, I'll provide you with a list of places to find and navigate to.

You need to *search for the condo at the corner of Lower Water Street and Salter Street* using Google maps.
* when part way to the condo * -- now I will ask you to use Street View to get a sense of what your destination looks like

* when within 1 block of the condo * -- now I will ask you to use Street View to locate your destination
[at the condo]

Please note that while I have asked you to use specific features on the way to the condo, we want you to use whichever features you want for the rest of this study - you are not required to use the features in the way we just instructed you to.

Similar to Dartmouth, we have a list of services and amenities for you to locate. We want you to find these and then star/save them on the map. Once we go through all the places, you will create a route so we can visit the places. Again, remember you need to consider both neighbourhoods and decide on a neighbourhood to live after you finish.

Locations:

1. Find a close by *Sushi restaurant* and star/save it: _____
2. Find a close by *dry cleaners*. Find one and star/save it.: _____
3. Find a nearby *doctor's office* or medical centre and star it. _____
4. Find nearby *dentist* and save/star it. _____
5. find the closest [.....bank] and star/save it. ----------
6. Find a close by *supermarket* (e.g., Sobeys or a Superstore) save it : _____
7. Find and save a nearby park and save it _____
8. 9- You heard that the Economy Shoe Shop is a nice place to take out of town business visitors. Find it and save it on your map.
9. Find the Ferry Terminal. save it.

Next, like we did in Dartmouth, we would like for you to create a route to visit each of these saved locations. We understand that some of the items that you have found may be too far to walk today. the supermarket [and maybe the park depending on which one they chose], I will ask you to just point in their direction when you are close to it while on route to the other locations. Again, you can use whatever features of Google maps that you want to navigate to the locations.

Please tell me the order that you will visit the different locations:

1.
2.
3.
4.
5.
6.

Point out:
1. Citadel Clock Tower
2. Supermarket
3. Park

_____
_____

[While walking the routes:]

- You can watch out for any restaurants, other coffee shops, shops or any other services that they think look interesting and to star them on the map. [you can remind them a couple of times].....

- "Like in Dartmouth, while you're walking to the different locations, please watch out for any restaurants, other coffee shops, stores or any other services that you think look interesting and to star them on your map"

[At the Economy Shoe Shop]

Great you found the Economy Shoe Shop. While you are here you get a call from your friends [.....and.....] that they will meet you at Grand parade. Please go to this location.

[At Grand Parade:]

Please point in the direction of the house you looked at. How far away is it. ----------

Please go to the Corner of Argyle street or Carmichael st. and point to the Citadel Clock Tower..

- Your friends have sent you a text message indicating that they will meet you instead at the fountain outside the Split Crow pub. Please locate the Split Crow and walk there

[At other locations – depending on the order they choose you need to ask the above question a couple more times.]

Location you are at:
Where you asked them to point to: How far is it? you can use the device if unsure

Location you are at:
Where you asked them to point to: How far is it?

[Back At the Ferry Terminal or a coffee shop]

a) point in the direction of the home they looked at and the park. How far away it is.

b) Do the familiarity test

c) Ask them which neighbourhood they would like to live and why.

.

Do the interview and the prototype question [note the above Q3 and 4 could be added to the interview.]

Pay them and get them to sign the reimbursement forms

Appendix B – Recruitment Notice

Part1

We are recruiting participants to take part in a research study using existing mobile applications to help investigate different services in two neighbourhoods. The neighborhoods are the Halifax waterfront and downtown Dartmouth. You will use a provided Smartphone and will use Google Maps and any other online apps to perform a set of tasks while being videotaped to find and locate different points of interest (e.g., a coffee shop) that you might look for before renting or purchasing a home in a neighborhood.

To participant you:

- need to be comfortable walking for an hour with stops
- need to have some experience using a Smartphone or a small screen device
- agree to be videotaped while performing the study

The study will be conducted in the waterfront area and downtown area of Dartmouth (we will take the ferry across the harbour). The study will take about two and half hours to complete (2.5 hours). If you are interested, you should email the researcher listed below. The researcher will send you a pre-session questionnaire that will ask you a few questions to help us design the tasks. You will also fill in short survey where you will self rate your sense of direction. We will arrange a time to meet with a research team in the one of the locations. When we meet, you will give consent to do the study and then complete a set of tasks using the mobile map application. Compensation is a $30 Amazon gift card and reimbursement for taking the ferry.

If you are interested in participating, please contact Aisha Edrah (edrah@cs.dal.ca).

Appendix C– Informed Consent

DALHOUSIE UNIVERSITY
Inspiring Minds

Exploring New Neighbourhoods Using a Smartphone App

Investigators:
Aisha Edrah, Faculty of Computer Science (edrah@cs.dal.ca)
Ben Swinden, Faculty of Computer Science (benswinden@dal.ca)
Dr. Bonnie MacKay, Faculty of Computer Science (bmackay@cs.dal.ca)
Dr. Derek Reilly, Faculty of Computer Science (reilly@cs.dal.ca)
Huiyuan Zhou, Faculty of Computer Science (zhou@cs.dal.ca)

Contact Person:

Aisha Edrah, MCS, Faculty of Computer Science (edrah@cs.dal.ca)

We invite you to take part in a study being conducted by Aisha Edrah, Bonnie MacKay and Derek Reilly from Dalhousie University. Participation in this study has no bearing on any academic or employment-related evaluation. The risks involved in participating in this study are the same as those inherent in being a pedestrian in an urban neighbourhood. For your safety, we ask that you do not use the Smartphone app while walking, and that you maintain an awareness of your surroundings while completing the study. The study is described below. Participating in the study might not benefit you, but we might learn things that will benefit others, and your participation will also provide feedback useful for the development of mobile applications to support homebuyers. You should discuss any questions you have about this study with Aisha Edrah.

You will first complete a pre-session questionnaire online that will help us develop personal tasks for when we meet. There are also questions about how you navigate areas and use maps. This should take about 5 minutes to fill in.

After you have completed this pre-session questionnaire, we will arrange a time to meet. This part of the study will take approximately two and a half hours to complete (2.5 hours). You will use a provided Smartphone that includes a mobile map-based prototype that you will use for the study. You will use the Smartphone app to assist you in exploring two neighbourhoods that you could conceivably live in as a prospective homebuyer or renter. After a brief training session to become familiar with the app, you will use it to build an itinerary of locations to visit, to follow routes between locations of interest, and to understand where certain facilities or businesses are located relative to each other and to a hypothetical prospective dwelling. Study facilitators will accompany you from a short distance at all times. Once each neighbourhood is complete we will administer a test to assess your familiarity with the neighbourhood. At the end of the study we will ask you to take part in a short interview to get your impressions and feedback.

You will be compensated with a $30 Amazon gift card for participating in the study and be reimbursed for the ferry trip across the harbour; you can withdraw from the study at any time without consequence. A researcher will be available in person during the study or afterward by email to answer any questions you may have or address any problems that you may experience with the tasks.

All personal and identifying data will be kept confidential in academic publications and in reports to our industrial partner. Anonymity of textual data will be preserved by using pseudonyms. All data collected in the logs, questionnaires and interview will use pseudonyms (e.g., an ID number)

to ensure your confidentiality. The informed consent form and all research data will be kept in a secure location under confidentiality in for 2 years post publication.

In the event that you have any difficulties with, or wish to voice concern about, any aspect of your participation in this study, you may contact Catherine Connors, Director, Office of Research Ethics Administration at Dalhousie University's Office of Human Research Ethics for assistance: phone: (902) 494-1462, email: catherine.connors@dal.ca.

"*I have read the explanation about this study. I have been given the opportunity to discuss it and my questions have been answered to my satisfaction. I hereby consent to take part in the study. However, I understand that my participation is voluntary and that I am free to withdraw from the study at any time."*

Participant	Researcher
Name: _____	Name: _____
Signature: _____	Signature: _____
Date: _____	*Date:* _____

"*I understand and consent that my participation will be video recorded and photographed for the purpose of analysis. I understand that this is a condition of participation in the study, and I understand that this video and photo record will not be used in publication without my express consent.*"

Participant	Researcher
Name: _____	Name: _____
Signature: _____	Signature: _____
Date: _____	*Date:* _____

Please fill in the following:

"*I agree to let you directly quote any comments or statements made in any written reports without viewing the quotes prior to their use and I understand that the anonymity of textual data will be preserved by using pseudonyms.*"	☐ Yes ☐ No
"I agree to let you use video and photos taken of my participation in publication or presentation of results, only after anonymizing by blurring faces."	☐ Yes ☐ No
"I would like to be notified by email when results are available via a publication." If you select Yes, please provide your email address: _____	☐ Yes ☐ No

Appendix D- Demographic Questionnaire

1- Rate your level of familiarity with the Waterfront area of Halifax

Really Familiar (I go there frequently or live there)	Familiar (I visit shops or services often)	Somewhat Familiar (I sometimes visit a few shops or services)	Pretty Unfamiliar (I have visited one or two places a couple of times)	Not Familiar (I have never down to the waterfront area)
1	2	3	4	5

2- Rate your level of familiarity with the downtown area of Dartmouth

Really Familiar (I go there frequently or live there)	Familiar (I visit shops or services often)	Somewhat Familiar (I sometimes visit a few shops or services)	Pretty Unfamiliar (I have visited one or two places a couple of times)	Not Familiar (I have never down to the downtown area)
1	2	3	4	5

If you are a student, please fill in the following:

University: _____

Faculty: _____

Level/Year: ☐ 1st Year Undergraduate ☐ 2nd Year Undergraduate
☐ 3rd Year Undergraduate ☐ 4th Year Undergraduate
☐ Graduate – Masters ☐ Graduate – PhD
☐ Other _____

Do you currently rent or live in residence: (please circle) RENT RESIDENCE

When did you start at university: _____

If you are a professional, please fill in the following:

What is your job: _____

What industry are you in: _____

Where do you work (location/neighbourhood): _____

If you have children, please fill in the following:

How many children do you have?

For each child, please tell us their age range and gender:

Child	Age Range	Gender
Child 1	☐ Baby (under 2) ☐ Pre-school (2-4)	☐ Male ☐ Female

	☐ Elementary Age (5-11) ☐ Jr. High Age (12-13) ☐ High School (14-18) ☐ 18+	
Child 2	☐ Baby (under 2) ☐ Pre-school (2-4) ☐ Elementary Age (5-11) ☐ Jr. High Age (12-13) ☐ High School (14-18) ☐ 18+	☐ Male ☐ Female
Child 3	☐ Baby (under 2) ☐ Pre-school (2-4) ☐ Elementary Age (5-11) ☐ Jr. High Age (12-13) ☐ High School (14-18) ☐ 18+	☐ Male ☐ Female
Child 4	☐ Baby (under 2) ☐ Pre-school (2-4) ☐ Elementary Age (5-11) ☐ Jr. High Age (12-13) ☐ High School (14-18) ☐ 18+	☐ Male ☐ Female
Child 5	☐ Baby (under 2) ☐ Pre-school (2-4) ☐ Elementary Age (5-11) ☐ Jr. High Age (12-13) ☐ High School (14-18) ☐ 18+	☐ Male ☐ Female
Child 6	☐ Baby (under 2) ☐ Pre-school (2-4) ☐ Elementary Age (5-11)	☐ Male ☐ Female

	☐ Jr. High Age (12-13) ☐ High School (14-18) ☐ 18+	

3- Do you have a pet? YES NO

If yes:

What kind of animal is your pet? _____

What is your pet's name? _____

If No:

What kind of pet would you like to have?

_____

4- What banks do you use (check all that apply):

☐ TD
☐ Bank of Montreal
☐ CIBC
☐ Scotia Bank
☐ Royal Bank
☐ Other: _____

5- Do you have your own car? YES NO

6- How do you get to work/school? (select all that apply)

☐ Drive
☐ Walk
☐ Take public transit
☐ Bike

6- What are your top three types of restaurant food? (e.g., Italian, Sushi)

1. _____
2. _____
3. _____

7- Do you currently own or rent your home/apartment? (please circle) OWN

RENT N/A

If you OWN your home:

How long have you lived in your current home: _____

8- [For People who own or rent]

What tools did you use to help you choose your current home (select all that apply)

☐ Real Estate Agent
☐ Newspaper
☐ GPS
☐ Paper Maps
☐ Other: _____

☐ Property Management Company
☐ Online sources (e.g., kijiji, MLS)
☐ Mobile Maps
☐ Service Rating Applications (e.g., Yelp)
☐ Other: _____

☐ Online Apps (please list) _____

What neighbourhood do you currently live in?

_____

9- What features and services were important to you for choosing to live in this neighbourhood? (select all that apply)

☐ Restaurants/Bars
☐ Coffee shops
☐ Parks and green spaces
☐ Grocery Stores
☐ Stores (e.g., clothes, gadgets)
☐ Banks close by
☐ Laundry/dry cleaning
☐ Other: _____
☐ Other: _____
☐ Other: _____

☐ Transit/transportation
☐ Specialty Shops (e.g., bakery, butcher, deli)
☐ Community Centre
☐ Gym/exercise options
☐ Schools close by
☐ Work near by
☐ Entertainment (e.g., movie theatre)
☐ Other: _____
☐ Other: _____
☐ Other: _____

10- What banks do you use:

☐ TD
☐ Bank of Montreal
☐ CIBC
☐ Scotia Bank
☐ Royal Bank
☐ Other: _____

11- Which of the following is your preferred type of coffee shop?

☐ Tim Horton's

☐ Second Cup

☐ Starbucks

☐ Local, fair trade, organic or specialty

☐ Other

12- How many people currently live in your home: _____

13- Did you do your home search alone or with others: (please circle) ALONE OTHERS

[for OTHERS]

What was the relationship with those with whom you looked for your home (e.g., partner, roommate):

_____

14- Please tell us the first name of two friends of yours from out of town.

1- _____

2- _____

Appendix E– Santa Barbara Sense of Direction Questionnaire

Sex: F M Today's Date: _____

Age: _____ V. 2

This questionnaire consists of several statements about your spatial and navigational abilities, preferences, and experiences. After each statement, you should circle a number to indicate your level of agreement with the statement. Circle "1" if you strongly agree that the statement applies to you, "7" if you strongly disagree, or some number in between if your agreement is intermediate. Circle "4" if you neither agree nor disagree.

[www.psych.ucsb.edu/~hegarty/instruments/sbsod.pdf]

1. I am very good at giving directions.

Strongly agree 1 2 3 4 5 6 7 strongly disagree

2. I have a poor memory for where I left things.

Strongly agree 1 2 3 4 5 6 7 strongly disagree

3. I am very good at judging distances.

Strongly agree 1 2 3 4 5 6 7 strongly disagree

4. My "sense of direction" is very good.

Strongly agree 1 2 3 4 5 6 7 strongly disagree

5. I tend to think of my environment in terms of cardinal directions (N, S, E, W).

Strongly agree 1 2 3 4 5 6 7 strongly disagree

6. I very easily get lost in a new city.

Strongly agree 1 2 3 4 5 6 7 strongly disagree

7. I enjoy reading maps.

Strongly agree 1 2 3 4 5 6 7 strongly disagree

8. I have trouble understanding directions.

Strongly agree 1 2 3 4 5 6 7 strongly disagree

9. I am very good at reading maps.

Strongly agree 1 2 3 4 5 6 7 strongly disagree

10. I don't remember routes very well while riding as a passenger in a car.

Strongly agree 1 2 3 4 5 6 7 strongly disagree

11. I don't enjoy giving directions.

Strongly agree 1 2 3 4 5 6 7 strongly disagree

12. It's not important to me to know where I am.

Strongly agree 1 2 3 4 5 6 7 strongly disagree

13. I usually let someone else do the navigational planning for long trips.

Strongly agree 1 2 3 4 5 6 7 strongly disagree

14. I can usually remember a new route after I have traveled it only once.

Strongly agree 1 2 3 4 5 6 7 strongly disagree

15. I don't have a very good "mental map" of my environment.

Strongly agree 1 2 3 4 5 6 7 strongly disagree

Participant ID...

Appendix F- Participant Payment Receipt

My signature below confirms that I received an Amazon Gift Card in the amount of $30 (CDN) from Aisha Edrah as an honorarium payment for participating in the "Investigating Different Map Views for Exploring Neighbourhoods" research project.

Name (please print): _____

Signature: _____

Date: _____

Appendix G - Participant Reimbursement for the ferry transportation Receipt

My signature below confirms that I received reimbursement in the amount of $_____ (CDN) from Aisha Edrah as reimbursement for needing to take the ferry in the "Investigating Different Map Views for Exploring Neighbourhoods" research project.

Name (please print): _____

Signature: _____

Date: _____

Appendix H- Neighbourhood Familiarity Quiz (Waterfront)

Please answer all questions directly on the map provided | Participant ID...

Part 1

Draw the route between two locations. Trace the route you followed on the map. Clearly mark your start and end points.

1. Draw a route from the *condo you looked at* to *the Split Crow pub.*

2. Draw a route from the *dry cleaners* to the *Sushi restaurant*

Part2

Mark the locations of the following landmarks using the associated letter. If you have no idea where the landmark is located, do not write the letter on the map.

Landmark	*Letter*
The Economy Shoe Shop	A
The dentist	B
The supermarket you found	C
The doctor's office	D
The bank that you found	E
The Citadel (Clock tower)	F
The park you found	G

Part 3

b1. Draw an arrow on the map starting at the *condo* you might buy, pointing in the direction *Citadel Clock Tower*. Label this arrow (1).

b2. Draw an arrow on the map starting at the *Grand Parade*, pointing in the direction of the *Dartmouth*. Label this arrow (2).

b3. Draw an arrow pointing from your *current location towards to the* Economy Shoe Shop

where you take out your friends there (3).

--

Part 4

Mark the locations of the following images using the associated letter. IF you have no idea where the image was taken, do not write the letter on the map.

Image	*Letter*	*Image*	*Letter*
	R		S
	T		U
	P		Q

	L		M
	N		O


Halifax
Duke St
George St
Bedford Row
Carmichael St
Argyle St
Prince St
Granville St
Sackville St
Lower Water St
Market St
Grafton St
Blowers St
Salter St
102
Sackville St
Doyle St
Bishop St
Dalhousie University-Sexton Campus
Hollis St
Spring Garden Rd
Dresden Row
Birmingham St
Clyde St
Queen St
Brenton St
Morris St
Barrington St
Terminal Rd
Martello St
Harvey St
Church St
Wright Ave
S Park St
Tobin St
Marginal Rd
Q.E.II Health Sciences Centre
South St
Kent St
Fenwick St
Green St
200 m
500 ft

Appendix I-Neighbourhood Familiarity Survey (Dartmouth)

Please answer all questions directly on the map provided

Part 1 – Draw the route between two locations. Trace the route you followed on the map. Clearly mark your start and end points.

1. Draw the route between the house that you found and the coffee shop you chose to visit

2. Draw the route from the Curling Club to Celtic Corner.

Part 2

Mark the locations of the following landmarks using the associated letter on the given map. If you have no idea where the landmark is located, do not write the letter on the map.

Landmark	*Letter*
The World Peace Pavilion	A
The Happy Face Museum	B
The spa you found	C
The post office	D
Your bank that you found	E
The dentist	F
The park that you found	G

Part 3

b1 - Draw an arrow on the map starting at the *house* you might buy, pointing in the direction of the *restaurant* you found. Label this arrow (1).

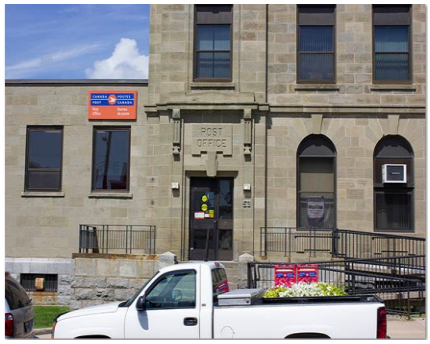
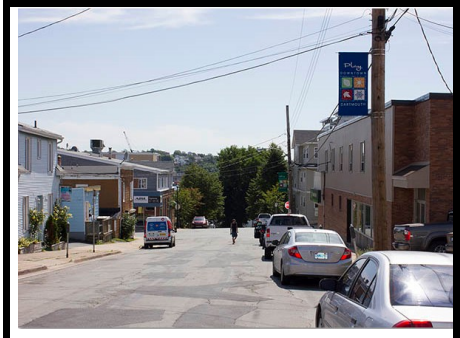
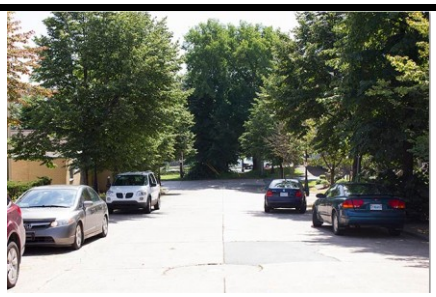
b2 - Draw an arrow on the map starting at the *dentist*, pointing in the direction of the *Happy Face Museum* . Label this arrow (2).

b3 - Draw an arrow pointing from *your current location* to *the Halifax Ferry Terminal*.

Part 4

- Mark the locations of the following images using the associated letter. IF you have no idea where the image was taken, do not write the letter on the map.

Image	*Letter*	*Image*	*Letter*
	L		M
	N		O
	P		Q

	R		S
	T		U


200 m
500 ft

Appendix K- Post-task Interview

Participant ID…

Part 1 with Google Maps and possibility other mobile apps that the participants choose to use (e.g., Yelp),

1. Did you use any other applications besides Google Maps to help you locate places or navigate to these places and locate areas in the past? If yes What were they and how did you use them?? why did you use them and when did you use them?

.....
.....
.....
.....

Part 2 creating a route from the different locations

1- a) - In both areas you chose to go to [first location] followed by [list of other ones]. Why did you create this route?

.....

.....

.....

2- What map views did you use to help you create each route? Give an example of how you used each when building a route in both locations. (Halifax - Dartmouth)

.....

.....

.....

.....

3-What are the benefits and the drawbacks of each one that you used? How did these views/apps help you?

.....

.....

.....

4- Based on your previous experiences and with the study, can you recommend or make suggestions to any features that you wished an app would have that would help you navigate and learn about a neighborhood?

.....

.....

.....

3- Do the stars help you create your routes? can you explain?

.....

.....

.....

..... .

Part3 - Selecting one location from many (e.g., one coffee shop, bank and restaurant over another). We will ask this question for each location that had more than one choice

1- a) For the item [the location] you chose to visit [name]. Why did you choose this location over the others? In both locations(Dartmouth and Halifax)

.....

.....

.....

Part 4. Finding the locations

1) What map views while you were walking to the different locations and how did these help you? (Halifax - Dartmouth)

.....

.....

.....

.....

2) Did you switch map views when locating a particular location? Why? How did this help?

.....

.....

3) While finding the different locations in Dartmouth and Waterfront , did you get lost?
If NO

- Were you unsure of your location and what happened to get back to track?

If YES

- How many times did you get lost? Can you tell me about it / them?
- Why do you think you got lost?
- How did you get back on route? What helped you?

.....

.....

4- Reorienting tasks (participants stopped and pointed to a landmark and far away locations). This will be asked for each landmark (landmark Halifax- landmark Dartmouth) Clock tower , Curling club and other locations that you pointed them

- When you were asked to point to [landmark] which map view helped you? Why did you use that view?

.....

.....

Part 5 General Questions

1 - were there any times when a particular view was not helpful… when?

.....

.....

.....

2 - Did you find different map views to be more helpful for certain navigation tasks? Which ones?

.....

.....

.....

3- Q8 - in the past have you used Google maps or another lcoation-based application to help you navigate an area? How was it helpful?

.....

.....

4- Do you have any suggestions for improvements for any of the views? What are these?

.....

.....

.....

3- In general

1- In general how well do you feel you know the neighborhood now?

Would you consider renting/buying in either of these neighbourhoods? Explain your answer for each

What neighbourhoods you consider to live ? why

.....

.....

.....

2- look up on their maps some of the places that they starred while on route and ask them why they chose these places.

.....

.....

Appendix L- FAMILIARITY TEST SCORE

The average and stdev for test scores for each category of question and in total.

Neighborhood	Route (Mean)	Route (STD)	Mark (Mean)	Mark (STD)	Arrow (Mean)	Arrow (STD)	Label (Mean)	Label (STD)
Halifax	1.1	0.74	4.2	2.35	2.3	0.95	**2.5**	1.65
Dartmouth	1.1	0.88	4.3	1.42	2.1	0.88	**1.4**	1.07

Labeling test score for Wilcoxon Signed Ranks Test

		N	Mean Rank	Sum of Ranks
DLABEL - HLABEL	Negative Ranks	6a	5.17	31.00
	Positive Ranks	2b	2.50	5.00
	Ties	2c		
	Total	10		

a. DLABEL < HLABEL
b. DLABEL > HLABEL
c. DLABEL = HLABEL

Test Statistics for Wilcoxon Signed Ranks Test

	DLABEL - HLABEL
Z	-1.845[b]
Asymp. Sig. (2-tailed)	.065

a. Wilcoxon Signed Ranks Test
b. Based on positive ranks.

```
NPAR TESTS
  /WILCOXON=VAR00002 WITH VAR00003 (PAIRED)
  /MISSING ANALYSIS.
```

Overall test score for Wilcoxon Signed Ranks Test

		N	Mean Rank	Sum of Ranks
VAR00003 - VAR00002	Negative Ranks	6[a]	6.17	37.00
	Positive Ranks	4[b]	4.50	18.00
	Ties	0[c]		
	Total	10		

a. VAR00003 < VAR00002
b. VAR00003 > VAR00002
c. VAR00003 = VAR00002

Wilcoxon Signed Ranks Test Statistics

	VAR00003 - VAR00002
Z	-.971b
Asymp. Sig. (2-tailed)	.332

a. Wilcoxon Signed Ranks Test

b. Based on positive ranks.

Appendix M – Social Sciences & Humanities Research Ethics Board
Letter of Approval

Social Sciences & Humanities Research Ethics Board

Letter of Approval

April 10, 2013

Ms Aisha Edrah

Computer Science Computer Science

Dear Aisha,

REB #: 2013-2948

PROJECT TITLE: Investigating Different Map Views for Exploring Neighbourhoods

Effective Date: April 10, 2013

EXPIRY DATE: April 10, 2014

The Social Sciences & Humanities Research Ethics Board has reviewed your application for research involving humans and found the proposed research to be in accordance with the Tri-Council Policy Statement on _Ethical Conduct for Research Involving Humans._ This approval will be in effect for 12 months as indicated above. This approval is subject to the conditions listed below which constitute your on-going responsibilities with respect to the ethical conduct of this research.

Sincerely,

Dr. Sophie Jacques, Chair