City Trail

Traveling Cities, One Step At A Time!

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Acknowledgements

We would like to thank our co-advisors, John Chuang and Kimiko Ryokai. They provided great subject matter expertise in the area of Internet of Things, specifically for wearables, and foundation of incorporating user needs from the perspective of children. We would also like to thank the families who provided insight early on about our project objective and providing feedback throughout the process based on storyboards and usability testing. These invaluable insights allowed us to develop an application that validated our design principles to design for enhancement of fitness activities for families.

And finally, we'd like to thank our friends, family, and peers for their support over the course of the year on this project.

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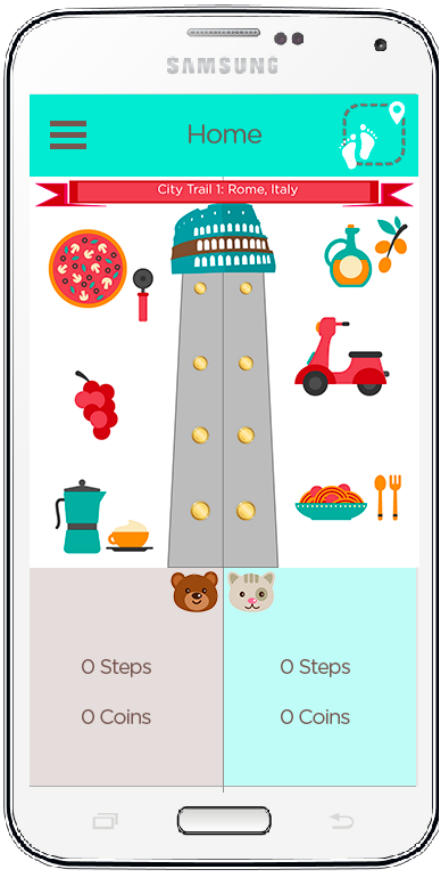
I. Objective & Overview

City Trail will allow for parents and children(ages 6-10 years old) to ensure fitness activities and goals are addressed through collecting data(on mobile and smartwatch) about fitness activities in a gamified manner, while allowing individuals learn about geography through travel. Parents, children, and their peers will set goals to meet in order to go to the next level, called a trail, in City Trail. Participants will have a collective goal to accomplish their personal goals together each day. As a result, they will be awarded to discover and learn about a new part of the world and go on a journey together.



II. Introduction

A. Background and Motivation

According to WHO, childhood obesity is one of the most serious public health challenges of the 21st century - a problem that is now gradually affecting many low- and middle-income countries, particularly in urban settings. We plan to create a product that will use wearable technology to foster healthy habits amongst children in early years of their lives. Figure 1 shows the number of overweight children under the age of five, is estimated to be over 42 million in 2013. [1]

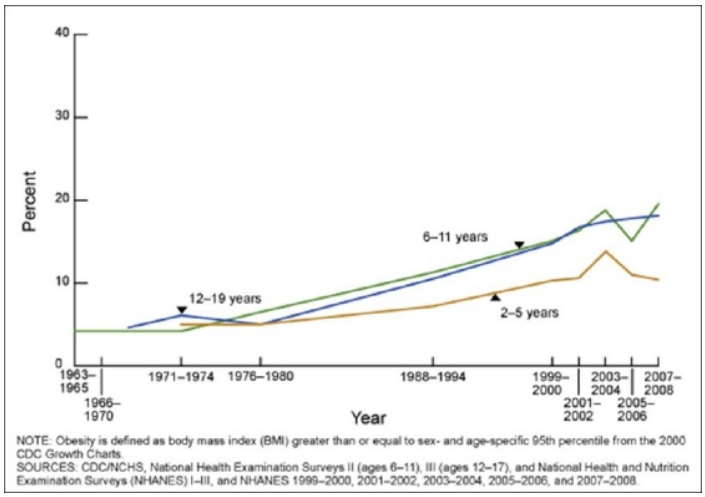


Figure 1. Overview of the number of overweight children in 2013.

According to National Health and Nutrition Examination Survey (NHANES) the rate of childhood obesity has almost **tripled** since 1980, with one out of six children now clinically obese. [2] For the government agencies, obesity poses a heavy burden on taxpayers' coffers. Reuters is reporting that obesity in America is now adding an astounding $190

billion to the annual national healthcare price tag, exceeding smoking as public health enemy number one when it comes to cost [3].

B. Literature and Scientific Review

Childhood obesity can be tackled at the population level by education, prevention and sustainable interventions related to healthy nutrition practices and physical activity promotion. Sedentary lifestyle is an important factor for obesity, as many children spend most of their time in front of multitude of gadgets such as smartphones and tablets. Children snack more when they watch media sources such as video[2]. Not incorporating physical activity can lead to high increase of children enduring a sedentary lifestyle.

Through City Trail, we aim to utilize technology as a medium to inform participants about their physical fitness levels and incorporate gamification to motivate participants to collaborate with each other to make fitness a priority in their lives. City Trail aims to impact not only the individuals involved in the application, but also has the potential to impact and motivate community and government in terms of socio-economic aspects.

Community	**Government**
Improved lifestyle choices for children	Reduced cost of obesity for the government
Better engagement of parents with their children	Incorporated in physical education settings and new way of accurate measures of physical fitness of students

Table 1. City Trail can entail long term impacts for the community and government in strengthening socio-economic values.

Technology Usage By Children:

Understanding the sensitivity of technology usage for children, the team looked into recommendations made by professionals such as the American Academy of Pediatrics (AAP). Recommendations were provided for families and pediatricians to follow such as how much media usage to provide to children. AAP indicated no screen time, or media usage, for children at ages 2 and under. For children above this threshold, however, it is recommended that no more than 2 hours of entertainment or media time is given to children. The AAP also provided concern about not only quantity of time that a child has screentime, but what the quality and content they are being exposed to. As a result, in this screen time, it is to the child's best advantage for developmental purposes to watch pro-social media where children and teens can learn about facts and interpersonal skills. These insights from the AAP influenced how the design of the concept for City Trail will be shaped around time on the application (mobile and smartwatch) as well as type of content and information the participants of the application will be exposed to. Not only can parents influence the health diet of the children, but also their "media diets" to assist children in the type of media they watch for pro-social purposes.

C. Applied Behavioral Economics Principles

Soft Paternalism

Soft paternalism is to design mechanisms that "nudges" users to consider the content and context in helping them make the right decision. Thaler's [4] viewpoints about paternalism are

based on the assumption that people are weak, lazy and irrational and end up making wrong choices for themselves. He believes that responsible organizations must step in and give them a nudge in right direction without blocking choices. This concept of ‘soft paternalism’ is reminiscent of ‘nudge theory’ (popularized by Thaler and Sunstein). City Trail will explore how to incorporate such good nudges in helping families gain the benefits offered by City Trail.

Libertarian Paternalism

Libertarian tries to influence choices in a way that will make choosers better off, as judged by themselves. According to Thales and Glaeser [5] paternalism is a necessary element of good user experience design.

Gamification of Quantified-Self Activities

Gamification combines the playful design and feedback mechanisms from games with users' social profiles (e.g. Facebook, Twitter, and LinkedIn) in non-game applications explicitly geared to drive behavioural change (e.g. weight loss, workplace productivity, educational tools, and consumer loyalty). As critics point out, gamified applications rely on the points, leaderboards, and badges often seen in games, but are not games in themselves (Deterding 2010; Bogost 2011). The current potentials to ‘gamify’ life have incited debate on whether the spread of these points based systems heralds playful utopias or dystopic surveillance societies run by corporations and advertisers.

Current applications focusing on gamification of Quantified-Self include Nike+, which caters to users seeking extreme fitness tracking. The application encourages runners to not only track how long or how far they go but provides feedback that motivates them to do better. Foursquare uses the concept of “participatory surveillance”[7], where users “check in” to various locations over the course of the day tone else. City Trail will explore how to use this concept. Competition and community support could be other key ways to help bring fitness tracking to a broader audience. Nike has excelled in establishing community engagement with its users. City Trail has embraced the style of community Nike has created and put efforts to adapt this model for families to motivate each other to take part in physical fitness and activities rather than directly compete with each other. The challenge is to be able to take that type of competitive environment and translate it from hard-core sports fanatics to consumers who simply need to be more active [8].

D. Design Paradigms

Competition Through Collaboration

Understanding that parents influence their children at an early age, we want to emphasize this in City Trails. Here, the parents and children will have individual and team goals to complete. The individual goals will be with respect to their physical fitness goals to attain based on their age levels. At the same time, to ensure that the participants motivate and work together, these independent goals are combined to form an overarching goal such that both must complete their goals to move onto different aspects of the gamified Quantified-Self activity.

Parallel Interactions and Experiences between Watch and Phone Interfaces; Understanding Affordances

Because one participant is expected to use the smartwatch to track their Quantified-Self Activity, which is steps, we must understand the limitations the constraints of the screen-size and activities that the smartwatch wearable impose. As a result, the limitations of the smartwatch will drive the type of interactions that will be placed on the application to ensure both participants have similar experiences.

Importance of Designing for Children and Parents in One Application

Given the mobile and smartwatch application can be used by either parent or child, interactions and workflows must be easy to understand and work with for each of the user groups. Thus, City Trail has considered the following:

a. Children require emotional support and a feeling of success. This can be achieved by proper guidance. Perhaps a guidance avatar could help them achieve success and create engaging user interface [9].
b. Children perform lower when using the pointing movements, e.g. using a mouse,simple point-and-click interactions. Clickable interface elements should avoid “fat finger issue”.
c. It is key to City Trail to also distinguish between young (3–5), mid-range (6–8), and older (9–12) children. Each group has different behaviors, and the users get substantially more web-savvy as they get older. And, those different needs range far beyond the obvious imperative to design differently for pre-readers, beginning readers,

and moderately skilled readers. We found that young users reacted negatively to content designed for children that were even one school grade below or above their own level. Studies have shown that children are acutely aware of age differences.

d. It's important to retain a consistent user experience rather than bounce users among pages targeting different age groups. In particular, by understanding what attracts children's attention, you can "bury" the links to service content for parents in places that children are unlikely to click. Text-only footers worked well for this purpose.[10].

e. City Trail's screen element layout must be designed for certain age groups. Children are curious and eager to explore in general. They tend to touch everything they see on the screen and notice things adults sometimes miss. For example, they don't experience banner blindness; for them, a banner is just the same as any other object on the screen and they will click it to see where it leads them.

f. Childrens' toys must be designed for childproof navigation to prevent children from accidentally brushing or touching the menu while using the application. One solution is to design menu access for the parent only. Just like a childproof safety cap for a medicine bottle or other devices made safe for young children, we should create a menu system that is childproof. This is important design choice for us because we certainly want to limit the aspect of smartphone interaction only to the gaming part. For an inquisitive child, a swipe is sometimes a clumsy press or an attempt to move things around the screen; "next" and "back" buttons to change a page would be more effective in this case especially when combining other interactive elements on the page.

Generally, I recommend avoiding any sensitive triggers when designing for young children.

E. Problem Statement & Hypotheses to Test

Design paradigms and applied behavioral economic principles have been considered for joint interactions between a smartwatch, sensors, and smartphones. City Trail will aim to gamify self-tracking activities such as walking and running to keep children participants engaged and continuously use the wearable device. The following hypotheses were tested through user research and usability testing of City Trail:

1. Parents are nudged to play with their children using City Trail. This will not only keep them physically active, it will also serve as an opportunity to increase and improve interactions between family members, such as parent child.
2. Children emulate parents, so *developing healthy habits at an early ag*e will have a positive impact on their future lifestyle choices.
3. Children and parents are not constrained to do physical activities with their parents, rather they can carry out these activities independently with the goal in mind to achieve their personal goals.

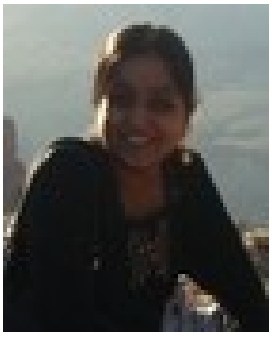
III. City Trail Team

Arezu Aghaseyedjavadi
Role: UX Design and UX Research
Background: Applied Mathematics and Civil Engineering, Product Design for Mobile and Web
# of Siblings: 4 younger sisters, 1 younger brother
Outdoor Activity: Hiking, kayaking

Dheera Prabhakar
Role: Mobile and smartwatch developer
Background: CS, 5 years of Java development experience
# of Siblings: 1 older sister
Outdoor Activity: Hiking, biking, outdoor running

Rahul Verma
Role: App and Smartwatch Developer
Background: Electrical undergrad with 5 years of database development experience
# of Siblings: 1 older sister
Activities: Reading in the park, hiking

Marjan Ghahremani
Role: UX Design, Visual Design
Background: Psychology, Sociocultural Anthropology
# of siblings: 1 younger brother
Outdoor activity: hiking, biking



Ruchita Rathi
Role: User Experience Design, Front-end Development
Background: Computer Science
# of siblings: 1 younger brother
Outdoor activity: Hiking

The team also came together to identify ways to apply City Trail with their families and sibling(s), especially for the outdoor activities that they frequently engage in such as hiking and biking.

IV. User Research & Assessment

A. Competitive Analysis

For the initial stages of user research, we looked into current products in the market to understand if there are any applications or concepts emphasizing family fitness through technology, specifically for wearables. We found that many wearables, aimed for children in our user group, were focusing on safety of children. These wearables provided parents with GPS locations of their child's whereabouts. Many of the wearables were also aimed for independent activities of the children, such as Leapfrog's *Leapband,* rather than have the activities for group settings.

Competitive Landscape

We identified the various applications and devices parents and children use in the space of fitness. We uncovered that many of the current services in the market are exclusive of one target user group over another, i.e. they serve either adults or children but not both. Applications that are family oriented have a focus on tracking, some of which include Life360 and wearables such as the LG Kizon. Thus, this demonstrated an opportunity point for the team to develop a solution integrating family setting for the purpose of physical health as a goal.

Figure 2: Competitive Landscape via Petal Diagram demonstrating the opportunities City Trail aims to address in development of mobile and smartwatch wearable application.

To identify the importance of gamification in self-tracking activities as validation, a feature grid seen in Table 2 was developed on services (apps or devices) that integrated this as their value proposition. Considering the leading apps and devices, it was relevant that gamification and community based interactions were found for adults and not for children. Understanding that at the ages of 6 and up, this is the time where children understand social cues and establish relationships, we found that City Trail can enable this through exercise and strengthening family bonds.

Product and Features	Nike+ Fuelband	NFL Play 60	GeoPalz	Zombie Run	LeapBand
App, Wearable	Both	App	Both	App	Wearable
Quantified-Self for Fitness	Yes	Yes	Yes	Yes	Yes
Family-Oriented	No	No	No	No	No
Gamification	Yes	Yes	Yes	Yes	No
Community Oriented	Yes	No	No	Yes	No

Table 2: Feature Grid informed organization of features to consider for design of City Trail to address gamification of Quantified-Self activities for family/community settings.

The competitive analysis confirmed the opportunity to integrate gamification of Quantified Self activities through group settings, such as parents and their children.

B. Surveys

Following the competitive analysis and market research to understand there is an opportunity for incorporating wearables as part of fitness activities for children, we wanted to gauge interest from families and how technology is incorporated for them. The surveys allowed us to understand the ages of children that have become accustomed to using technologies such as smartphone devices and tablets. Survey can be found at http://bit.ly/1cgpxPN.

Outcomes of the surveys (n=46 Participants)

- Majority of the children were in the age range of 5-10 years old.

- **80%** of parents allow for their children to have screen time with tablets or smartphones (iOS or Android Platforms)
- **60%** of families allow for their children to have 1-2 hours of screen time on these devices
- When asked about the type of applications the children participate in, the games fell under the category of adventure and having characters that moved in order to succeed in the game. Examples included Temple Run and Minecraft.

Importance of the Survey Findings

The survey data aligned with expert research we've found for children and media usage based on recommendations from the AAP in which parents allow their children to have screen/media time for at most 2 hours a day.

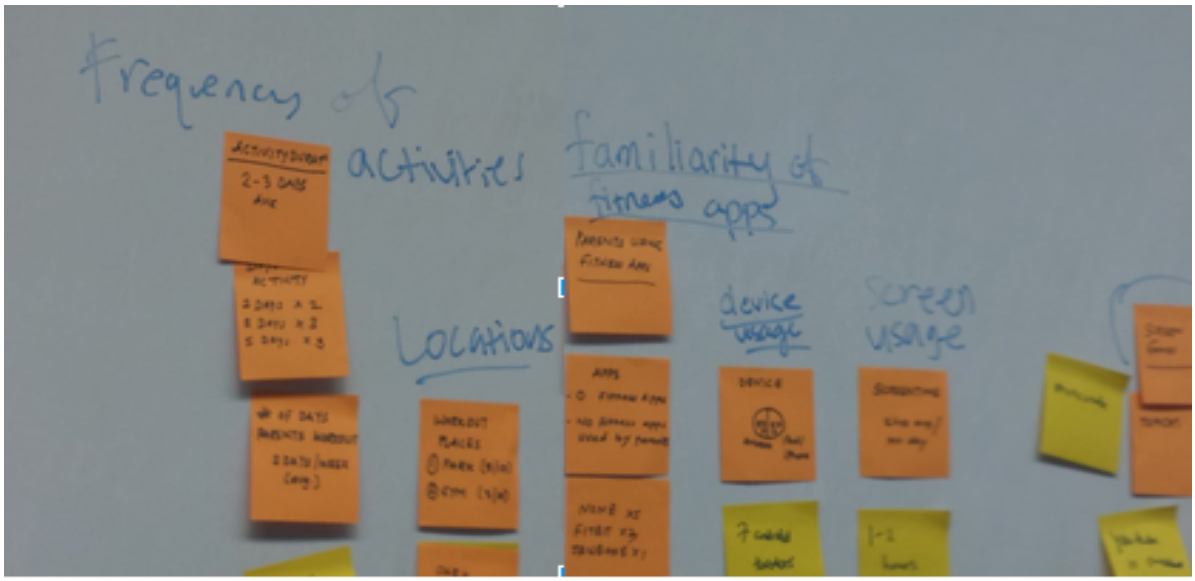


Figure 3: Survey findings organized to segment user behavior and use of technology in daily routines.

C. Interviews

Interviews allowed for us to see how parents incorporate healthy fitness in their families. We found that parents take their children to sports practices, such as basketball or badminton. Parents also indicated that they set out a certain amount of time per week or day to ensure that their children have some physical activity, by means of walking or running around in the park. When asked how children felt about this, parents indicated their children enjoyed this type of activity and also carry this out with other families in the area. We also found how children utilize technology today and the type of technologies they interface with such as smartphones (belonging to the parents) and tablets.

Not only did we want to understand how parents value fitness for their families, we also wanted to ask how parents do their own type of fitness and level of importance for them. We found that parents make it an effort to go to the gym or do physical activities while at work. However, when children are taking part in their activities, we found that they act as the role of supervisors to ensure the safety of their children. At these times, the parents are not taking part in the activities.

As a result, we found that parents and children have separate schedules as well such as going to work versus going to school. Parents want to make sure their children value physical fitness, however, not make it a daunting task or enforce it strictly. This confirmed the hypothesis to allow family members to be able to do their own type of activities with the underlying goal of meeting their personal health goals.

D. Personas

Competitive analysis, interviews, and surveys informed the type of user groups that we will design for and incorporate their routine activities to develop the concept and feature set of City Trail that will align with the user's lifestyles, than act as a form of interference. A persona was developed for a parent and child ages 6-8.

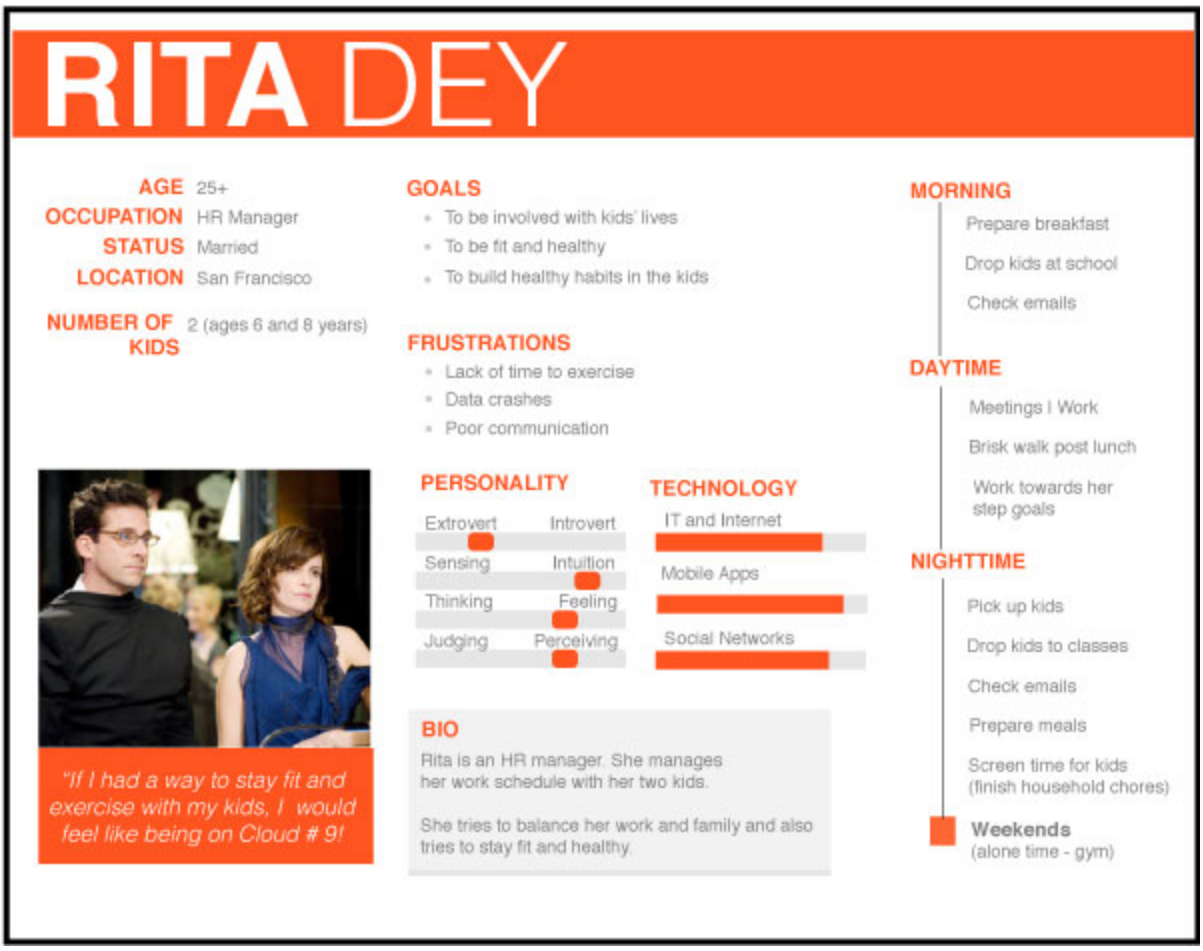


Figure 4: Parent Persona and user journey of Rita Dey.

Figure 5: Child Persona and user journey of Elsa Dey. .

E. User Needs to Address

Keeping the users in mind through the personas, the findings led us to emphasize the **how might we** address the needs uncovered in the qualitiative research of speaking with prospective users through interviews and surveys. The following are the top needs City Trail aims to address and design for:

1. To ensure physical fitness threshold goals are met
2. To communicate on how to fitness goals are met and motivate peers

3. To provide encouragement to meet goals
4. To improve interactions between parents and children about the area of physical fitness
5. To take into consideration various activities that require physical involvement?

F. Approach to CPHS Protocol

Understanding our objective was aimed at family settings, we needed to take the necessary steps to ensure participants (parents and children) were cooperated with in a reasonable and safe manner. To do so, we worked with IRB to follow their protocol of sharing details on how this study was going to be carried out.

The experience of seeking CPHS approval entailed understanding how to design and conducts studies for various user groups, such as parents and children. We learned to take into consideration how one might interact and communicate with a child versus an adult. These factors were incorporated in the development of the documents for outreach about the study, consent forms for parents and children, usability test protocols for both user groups and assent form.

VI. Design Approach

A. Design Sprint for Game Conceptualization

Utilizing the survey findings, we understood the type of games parents and children have familiarity with and type of features they value. Each team member was then responsible to utilize these aspects in coming up with game design concepts. Example features to address included leaderboards, badges, geo-caching, media incentives, and access to virtual goods.

These were factored into the design sprint where team members developed game concepts focusing on the age group of children ages 6 and up with their parents. Concepts related to games that children have familiarity with such as in terms of characters and workflow of games that they have become accustomed to.

Figure 6: Scenarios to identify gamification opportunities for family settings.

The design sprint informed team members how they viewed the problem statement and various ways to address the user needs. By doing so,the team was able to diverge in the theme of the game concept and converge based on which parts of the individual concepts focused highly on the user needs. Evaluation was done by incorporating aspects of each game that showed greatest adherence to a user need. Once agreement was reached, a game theme was voted upon to go forward with concept testing with parents and children. Figure 7 is a preview of the storyboard created to share with user groups to gage initial user interest.

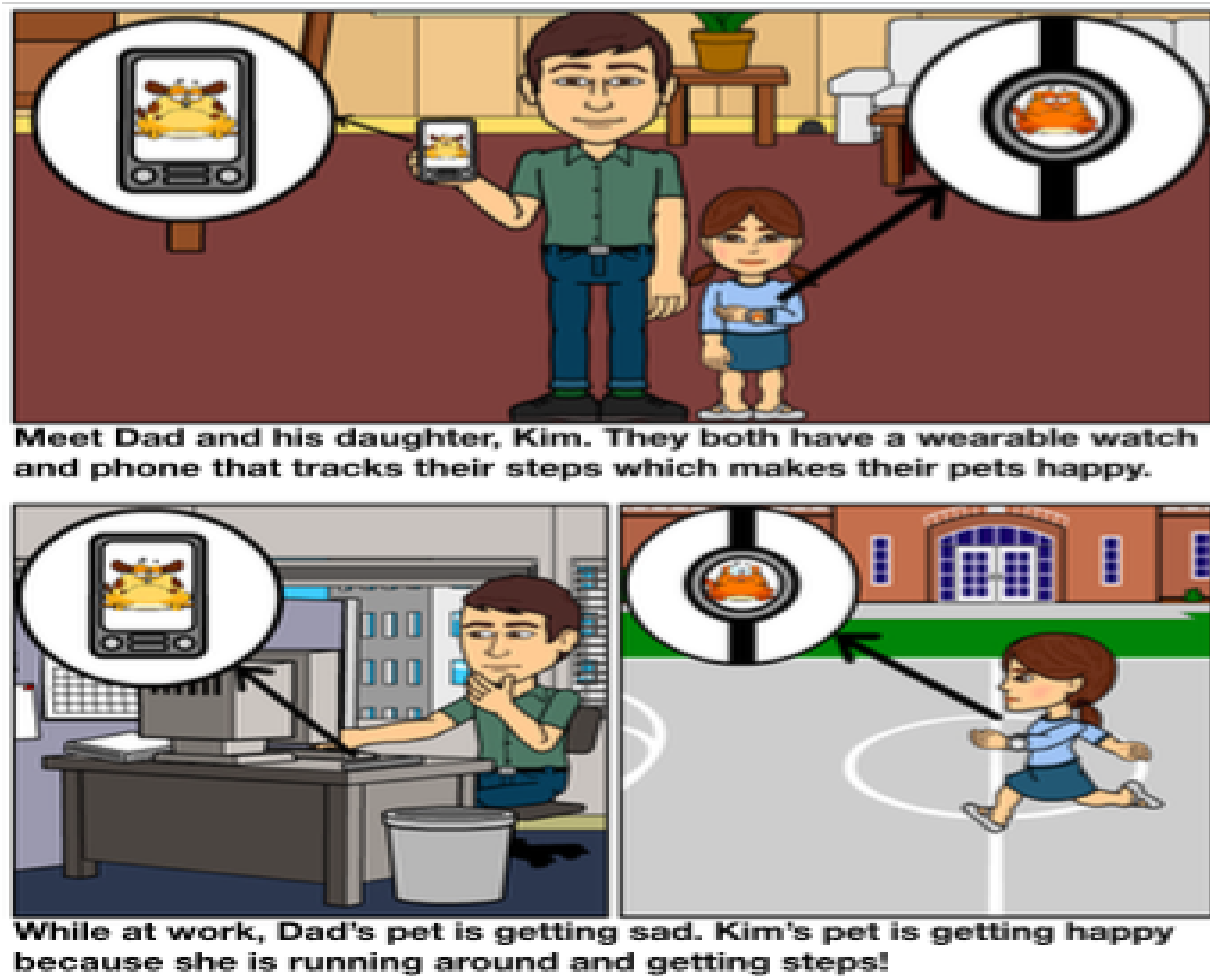


Figure 7. Preview of Storyboard shared with Target user groups to scope interest.

Parents shared insight on how to modify the theme and how they felt about their child using the smartwatch. Insights included having the smartwatch only have that application so the children do not get distracted and lose focus of why they had the application

.

Figure 8. Team members asked parents their view on the theme and workflow of game proposed.

To outreach to as many parents and families that fit the target user group, storyboards were sent to families through social media, personal network, and meetup organizations.

Insights

The goal of sharing the game concept was to understand how parents viewed comparing their self-tracking data with that of their child and how they felt about gamifying their goals. Parents such as **Maz Jobrani**, indicated interest and suggestions by by articulating:

“It seems fun. So it's like having a race with your kid all day when you're apart. That seems pretty cool. I guess it would be even cooler if you could know how far each pet went that day. Maybe add stuff like reminding the kids that they should stop for a drink of water because their pet is thirsty. I know that's one of my son's problems - he forgets to drink.”

Additional Insights we uncovered were :

- Driving motivation from both players to stay involved and accountable to meet their goals.
- Identify a way of which working together has greater value than individually.
- Support for being able to monitor child’s physical activity .
- Through a wearable, it is not intrusive to their personal routines and not a distraction that would come from using a smartphone or tablet device
- The wearable doesn’t limit the type of activities the children can take part in.

Modifications

Parents indicated wanting their children to learn the importance of what each step means and how it affects them or what applications it can have, such as visual understanding of distance through the accumulation of steps and ensuring daily goals are met. Given at ages 6 and up, parents demonstrate how children should build relationships and children look to their parents for guidance.

Thus, we came up with the following modifications to improve the design of the game and watch application:

- Design a workflow that emphasizes collaboration of working together.
- Show distance in what the total number of steps mean.
- Be able to see how individuals are doing for the day and overall.
- Show trends or statistics of improvement.

B. Design 2 and Expert Review

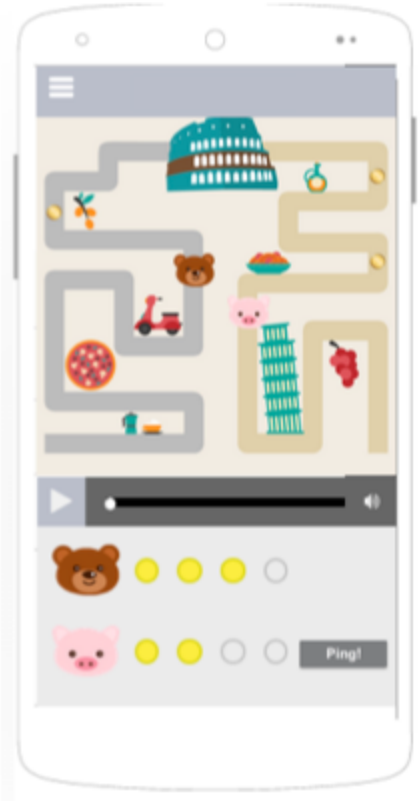


Figure 9. Home screen of Design 2 tested through Expert Review.

Insights for Design 2

We interviewed a design expert, who has worked in the area of children's applications and technologies with a Master's in Product Design. Through her expert advice, we were able to finalize a work flow that is intuitive for children and emphasize applied behavioral economics principles to ensure parents and children are engaged. The expert review informed us to allow additional learning to occur based on the individual's activities and actions. This validated the theme of having participants "travel" from city to city so they can see how their steps can be translated into distance and show how steps can be represented in a new dimension.The design principle of competition

through collaboration was supported especially for the age group of 6-8 years old, where children look to their parents as role models.

Modifications for Design 2

To ensure that participants have a unique experience, the expert articulated asked “So what” in terms of going from one level/trail to another. The design needed to incorporate a way to ensure that the experience on each trail differed from one another to keep users engaged. We adapted the design to do so to provide users with new information about travels based on their level of completion.

The following were incorporated and considered:

- Addition of a feature to allow families to celebrate their achievements and have memory of completing the team goal together by allowing participants to document the celebration over taking a photo at the level that they completed. For example, if the family was in Italy, they would take a photo with Italy in the background.
- Show map coverage of all the cities travelled so users know what the step data is being used for.
- Provide users with a history of their travels from trail to trail as a travel record.

C. Design 3

For this iteration of the design of the application, we explored various themes for colors and visual design and came up with several iterations of color palettes for the app.

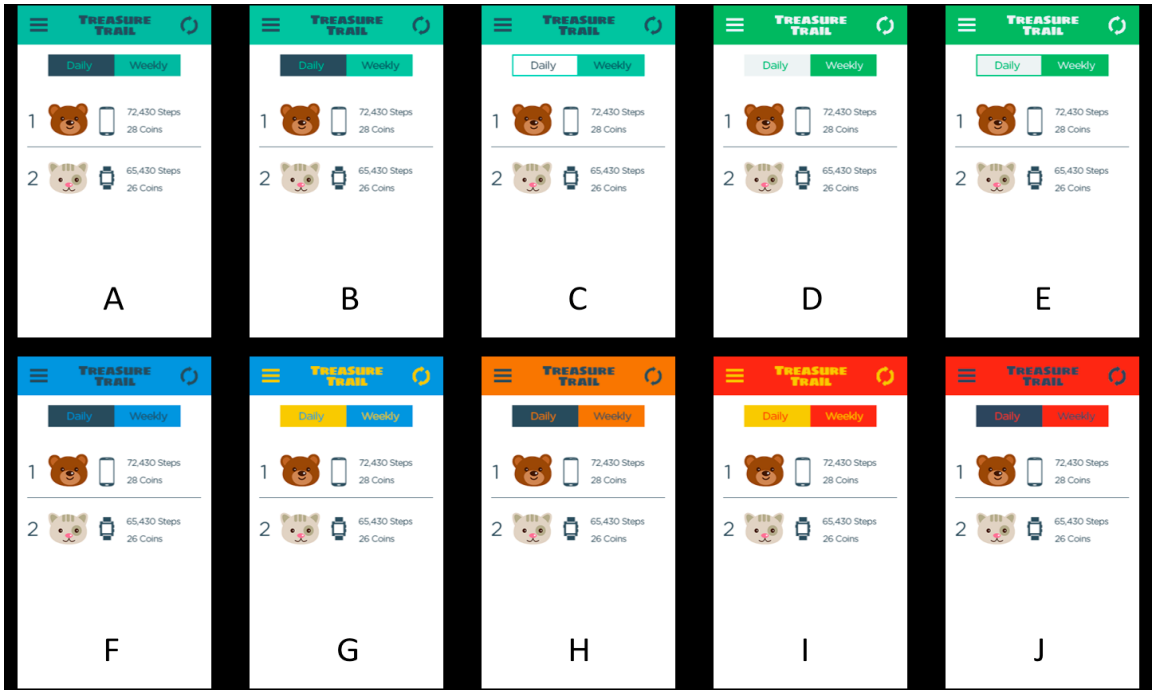


Figure 9. Proposed Visual Design Palettes for Design 3 of City Trail.

Insights for Design 3

Based on the usability testing with 20 users in the Interface Aesthetics class (Info C265, UC Berkeley School of Information), we learned the importance of color palettes and how to use colors for various purposes and messages to display. We chose a single underlying color theme for the layout of the Android app that drove the meaning of travel through Quantified-Self.

Modifications for Design 3

Through research into visual displays and layout for children's applications, the visual design was finalized and style guide was developed to drive the user experience of the application's layout.

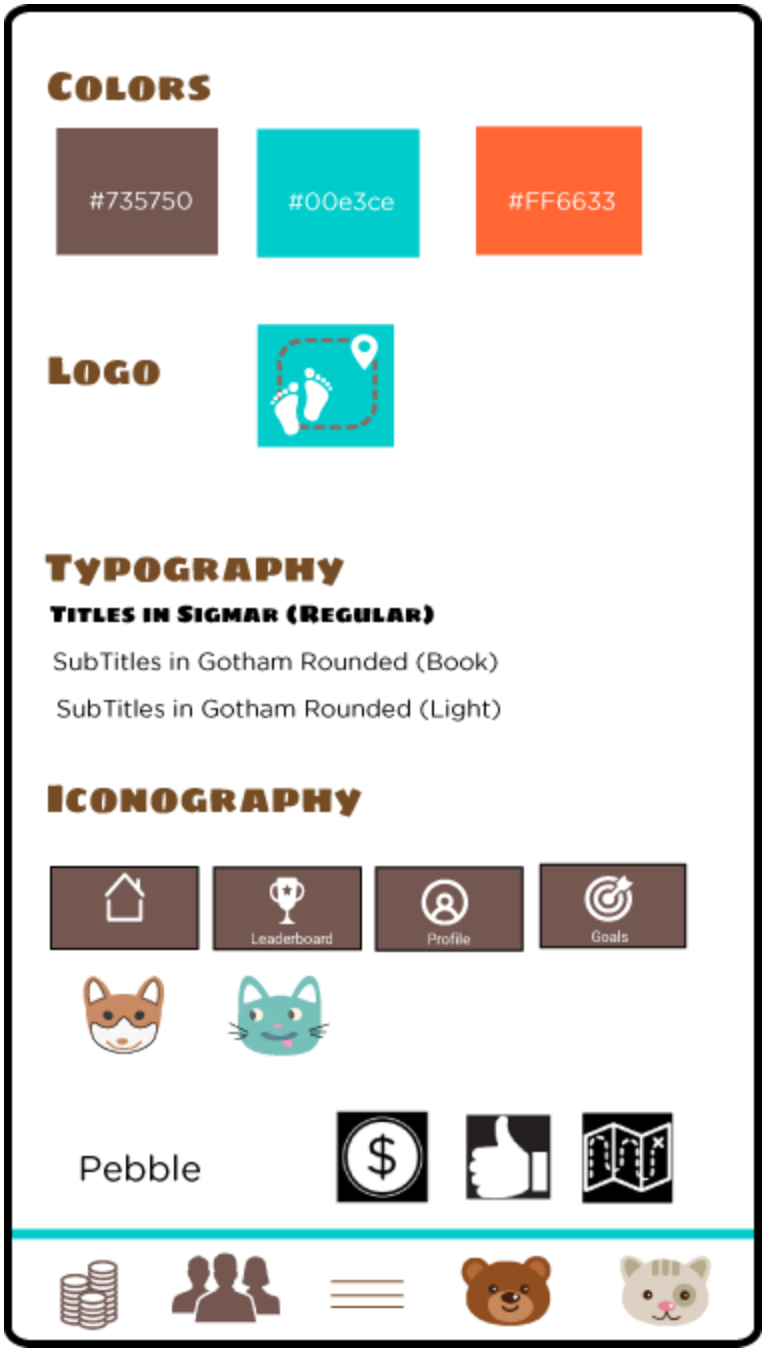


Figure 10: Finalized Style Guide for mobile application design.

VI. Technical Implementation and Stack

A. Technical Architecture

Below in Figure 11 is the architectural diagram of the stack incorporated to design and implement City Trails:

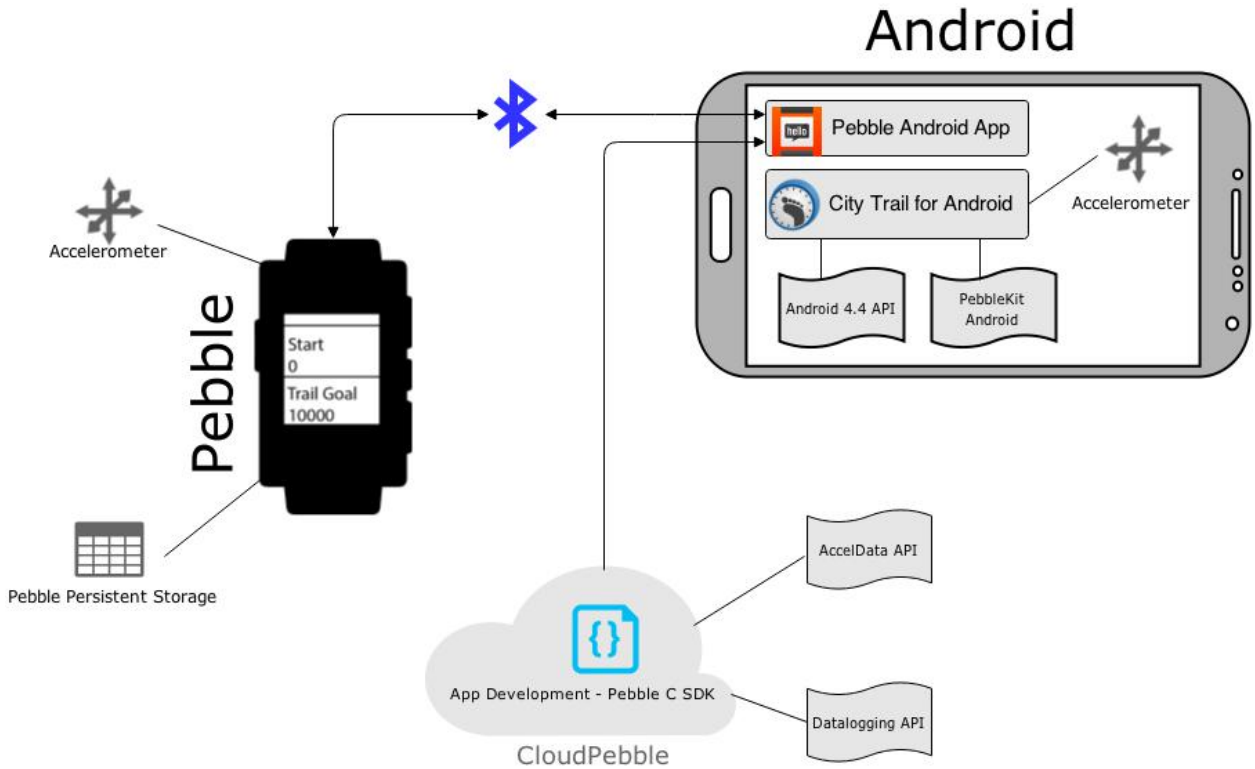


Figure 11: Architectural diagram of Technology Stack of City Trail.

For the technical infrastructure, we explored following platforms:

1. Game development for Android or iOS

2. Game development using generic frameworks like Cordova and developing HTML5 app

We decided to develop the game using Android platform given our familiarity with the platform.

This section covers the following aspects of technical infrastructure:

1. Alternative solutions explored by the team
2. Wearables option
3. Technical architecture of the system
4. Game development for wearables on Android

B. Alternative Solutions

We explored the following alternatives for game development on Android:

1. Game engines
2. WebGL and Drawables

Game Engines

We explored the following game engines for game development:

Corona

A game written with the Corona SDK, is platform agnostic (works on both mobile devices and PCs). The code is written once with conditional code for all platforms. The SDK app uses a lot of music files and images, where game designers are given the opportunity to focus on

both the design and user experience of the app that they are creating. It also features the fastest and the most responsive emulator that refreshes the project each time you save a file.

Advantages of Corona	**Disadvantages of Corona**
Corona SDK runs quickly, is easily adjusted for various screen resolutions and allows you to add audio/visual elements with one or two lines of code.	The emulator is easy to use and fast, but it has limited plugins and game network integration. We were unable to integrate Pebble JS plugin with Corona's interface and we also failed to integrate multiplayer gaming environment with Corona.

Table 3: Advantages and Disadvantages of Corona.

We developed an early game using one of the samples distributed with the SDK and integrating accelerometer feature in the game.

We observed the following issues with this game:

1. It was difficult to integrate Cloud Pebble with Corona SDK because of the limitations with the plugin
2. It was also difficult to create a multiplayer gaming environment where the step count for both players were simultaneously displayed and the animation would respond according the the accelerometer data.

Unity

Unity is a feature rich, fully integrated development engine for the creation of interactive 3D content. Unity supports both 2D & 3D game development. Unity has a very strong community of asset and plugin creators. It also allows for easy drag and drop interface for gaming.

However, we found the following issues with Unity's ecosystem:

1. Lack of support for accelerometer integration
2. Lack of support for Pebble JS integration within the game engine.
3. Difficulty in using the interface and Unity scripting language

Additional Technologies Considered

Cordova and PhoneGap are wrappers for JavaScript and based on the opinions expressed in the developer communities, we saw that these two frameworks were slow especially for handling anything with data or graphics. Corona seems to be some kind of wrapper on top of Mono much like Xamarin.

We also explored the drag and drop interface of GameSalad but we decided to use native Android features for game development because of our familiarity with the development process and issues with developing a multiplayer game using Pebble integration.

C. Minimal Viable Product (MVP) of City Trail

We chose native Android development and decided to use Drawables and WebGL. A drawable resource is a general concept for a graphic that can be drawn to the screen and which you can retrieve with APIs such as getDrawable(int) or apply to another XML resource with attributes such as android:drawable and android:icon.

For our project, we decided to use the BitMap drawable because we wanted a simple animation on the screen and focus more on the activities.

Methods, Tools, and Techniques:

- Programming language: Java, C
- Development tools: Android SDK, PebbleKit SDK for Android, Android Studio, Eclipse, Pebble Cloud
- Database: SQLite
- Other technologies: Python, Javascript, Sql, C
- Defect Logging and tracking: Git Issues
- Configuration Management: Github
- Development platform: Mac OSX

Pebble Smartwatch

The code for the Pebble watch was written on CloudPebble which provides the functionality to write/build C programs and upload supporting images to a personal account. CloudPebble

provides emulators as well in case an actual Pebble watch is not available. Figure 12 gives a detailed representation of the execution flow in the Pebble app.

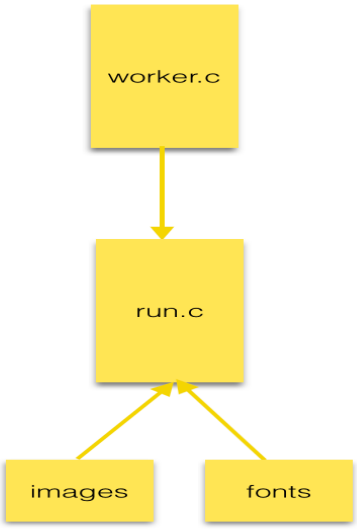


Figure 12: Execution flow of Pebble app.

1. The worker.c file is the primary file that is initialized when the app is started. This is a standard file meeting Pebble development specifications. This file is used to specify if we want to run the Pebble app in the foreground or in the background.
2. The run.c is the primary app file that includes the logic for calculating step count using the x,y and z coordinates provided by the Pebble watch accelerometer. The step count is calculated by looking at the delta for each of these coordinates. If we have a minimum specified change in any of the coordinates, we consider the change as a step and increment the step counter by 1. In this particular app, the milestone is achieved for every quarter of the step goal. An example would be if the step goal is defined as 100, a milestone is reached whenever the step counter reaches 25, 50, 75 and a 100 steps. For every milestone, a coin counter is also incremented to indicate the number of milestones completed by the user.

3. The images and font files are used to create and display certain notifications which are issued when the user reaches a certain milestone. The images are .png files having a dimension of 75X75 pixels. The size of the images is decided by the size of the pebble watch screen and the notification that we would like to display.

Figure 13 shows the MVP used for usability testing with families.

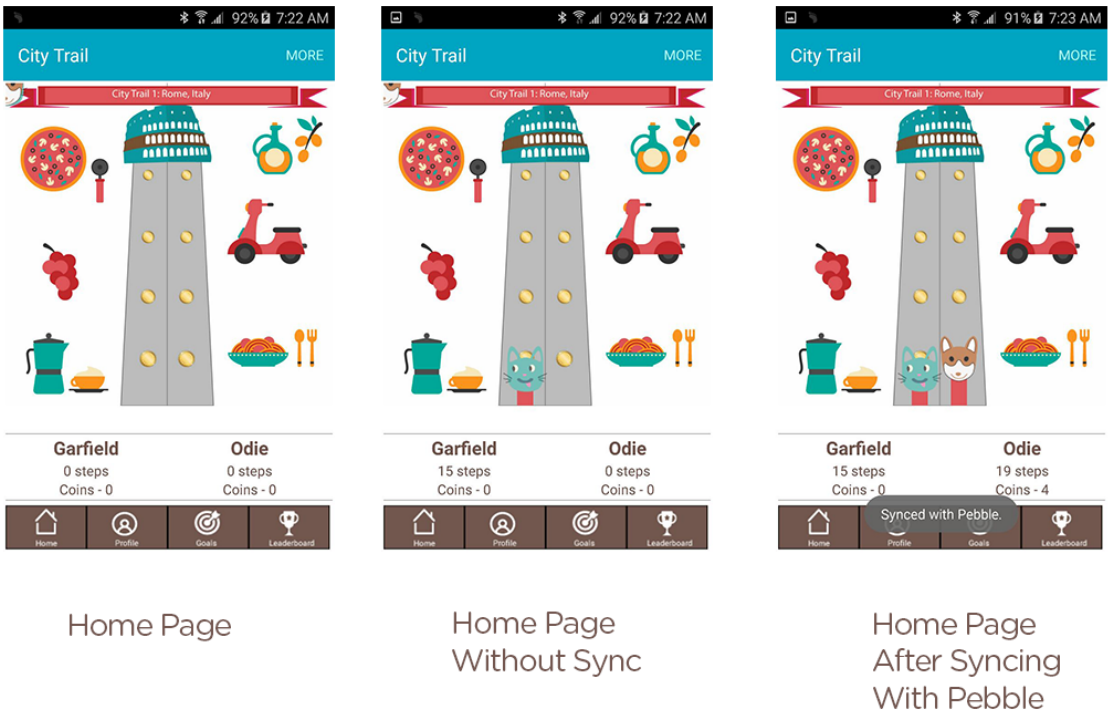


Figure 13: Working Prototype on Android Application

D. Data Logging With Pebble

The Pebble watch data logging API provides a means to save data on a 64kb storage area on the Pebble watch flash drive. For our project we have saved the step count, the number of coins/milestones and the total number of steps on the flash drive using the API. This API

flushes this data to the smartphone as soon the watch is connected to the phone using bluetooth. This data is received by the smartphone using a Receiver() function which constantly listens for data being sent by the watch. Different data variables are extracted from this one single channel using a 'key-value' approach, as every data point while being logged is provided its own key to differentiate among different types of data that are logged.

E. Technical Challenges and Known Issues

1. One of the major challenges we faced early on in the project was setting up the environment for the Pebble app to work with Android Studio. Even though pebble developer network is active, there are a lot of gaps in knowledge available out there making it tough to debug some of the setup issues.
2. Learning to use accelerometer data and data logging APIs of Pebble was challenging because there are no openly available algorithms for calculating step-count for the watch. It took a lot of code analysis of existing phone algorithms and a little bit of creativity to make the app work as accurately as we currently have.
3. Since pebble has low storage capacity, we were restricted in our ability to provide better features involving pebble data. This limitation also forced us to tweak our requirements to involve the child sync with the phone once everyday.
4. Receiving data logs on the android app was challenging mostly because the callback function provided by PebbleKit needs to be implemented on a separate thread and handled accordingly.

5. Animation, data-logging are processing heavy. We needed to take care not to overwork the app.
6. Midway through the development phase, we noticed that the mobile app kept crashing and restarting whenever the dalvik thread states changed. It was a fatal issue because the app kept losing its data after the crash. It was hard to diagnose it at first. But after a lot of research on Android API and Java multithreading, we were able to mitigate the issue by overriding necessary callback functions and proper exception handling.

VII. Usability Testing

A. Preparation of Testing Mobile and Smartwatch Application

Once the implementation was carried, a mobile app following the workflow of Design 3 was designed in parallel. The application was developed on the Android platform to ensure accurate data was logged from both devices. To prepare for testing, arbitrary step goals were set and interactions were tested such that if both players completed their goal they would go to the next level/trail. However, if one or both individuals did not complete their personal goals, both individuals would stay at the same trail. To inform users that their steps were valuable for the overall application, these step data were added to the overall leaderboard table. This would lets users see that their steps are being valued rather than diminished.

B. Usability Testing Protocol

The usability test protocol was designed with the CPHS rules and regulations in mind to ensure the safety and interests of the participants were considered and carried out through recruiting of participants and involving them in the study.

Interface Tour:

Given the design of the application was designed for two extreme populations, children and adults, the team wanted to confirm the interface flow and features made sense to both target user group and each had the same expectation when an action was selected. Through the Interface Tour we wanted to also understand how the users viewed hierarchy and organization of information to align both perspectives.

Testing of Design Principle:

Competition through Collaboration

Through the usability test protocol, we developed tasks around the design principle of competition through collaboration. Participants were given the opportunity to complete a trail. After a certain amount of time, we assume the day was over to see whether or not participants completed that trail together. If they did not they would stay in the same trail the next day. All participants fell under this category of testing and needed to start in the same level the next day. By doing this, follow up questions followed to ask how participants felt about collaborative trail/level completion and likelihood of continuing use of City Trail for a longer duration of time. The usability testing was carried out in the homes of the participants and took one hour at most including pre-usability test interviewing and follow-up questions that were asked post the test

C. Outcome of Usability Testing

6 Usability tests were completed in the homes of families with children ages 6-10 years old. From the usability tests we learned how intuitive the suggested workflow was to the users and ways to continue to keep them engaged. We asked their levels of satisfaction in using the application and watch and parents felt about the use of smartwatches for their children.

Figure 14: Follow-up and Debrief with family about their experience using City Trail Mobile and Smartwatch App.

Areas of Positive Support of City Trail Application

User Progress on the Homescreen

Users enjoyed seeing how they were doing relative to their peers on the homescreen. Given the limitations of the watch technology, users had to wait till the watch was synced with the phone app

to see where all players were positions based on the number of steps collected. Users were informed of the technical constraint and were understanding about it.

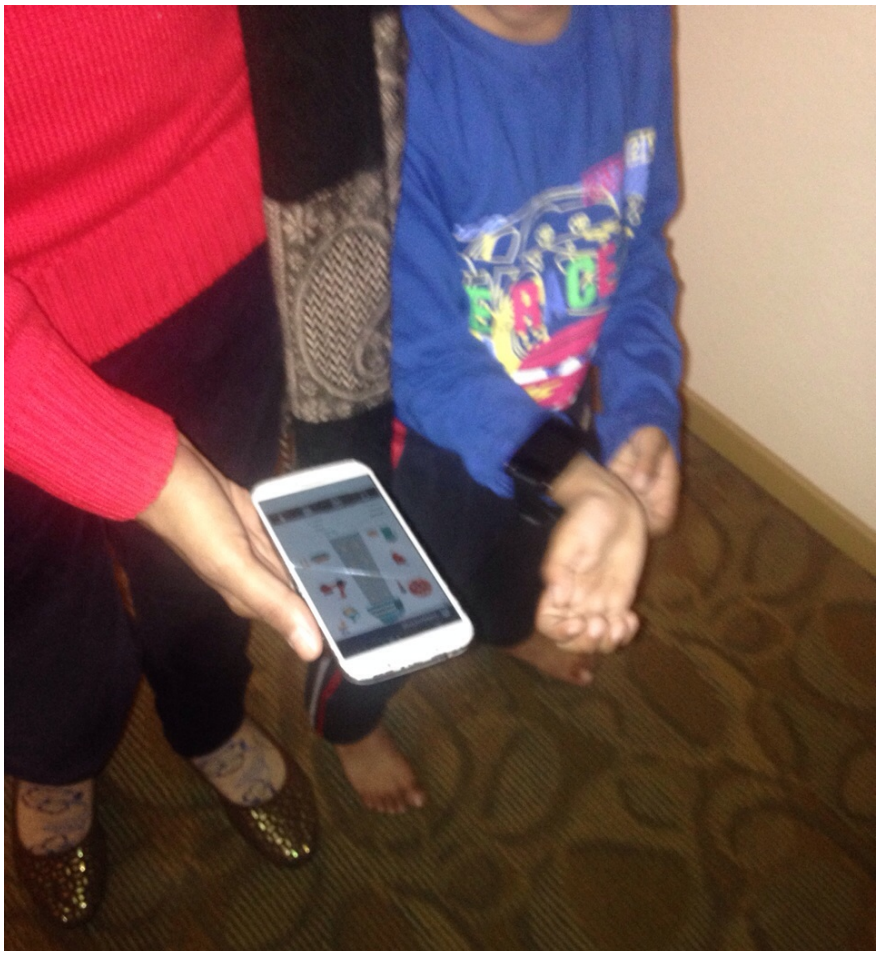


Figure 15: Participants enjoyed seeing movement of their players on the application.

Travel Album Experience at Each Trail

Parents and children enjoyed taking a photo at the landmark of each city. They liked that it was in the background in their photo. They also liked that they could refer to it as confirmation of completing a level. Responses from children included "My friend recently came from a vacation to italy, now I can tell him, I won italy" and "I wonder what else is in Italy." This inferred children wanting to know more about the regions that they were visiting.

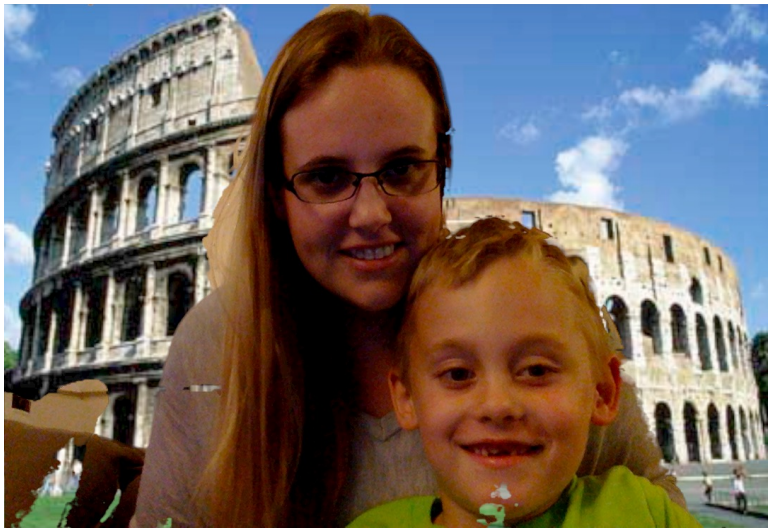


Figure 16: Parent and child celebrate trail completion by taking a photo in the city where the trail was completed.

Support for Competition with Family Members

Family members confirmed their support to build a competitive environment to motivate members to meet their goals. Parents and children suggested that they would want their siblings involved in the game to make it an entire family effort.

Average rating was 4 out of 5 on a Scale of "Awesomeness"/Satisfaction

Understanding that the usability test was for both parents and children, questions were framed differently depending on the audience that was asked. Parents provided an average score of 4 out 5 for level of satisfaction (1:least satisfied, and 5:most satisfied), whereas children provided a score of 4 out 5 for level of "awesomeness" (1:not awesome, 5: most awesome)

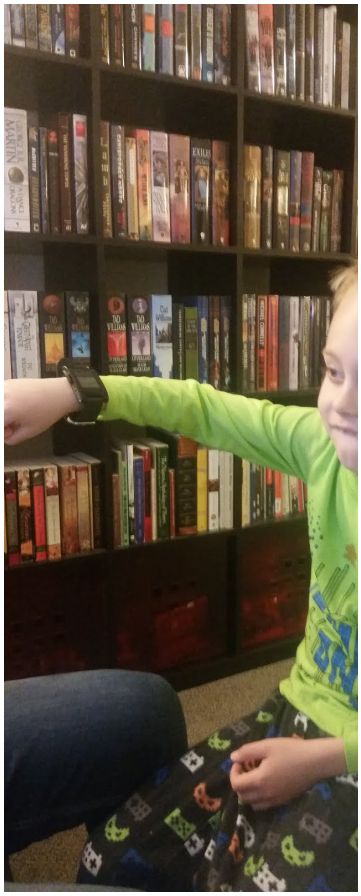


Figure 17: Child participant expresses excitement for using the Pebble watch app.

Modifications Based on Usability Test Findings

Participants wanted to learn more about the Trails They Traveled

In addition to taking a photo to celebrate the moment in the trail, children wanted more facts about the place they were visiting. For the next iteration of the design, facts and supplemental information have been provided to users especially with the iconic elements placed in each region.

Ability To Continue to Next Trails

Understanding there may be times in which a participant may not be consistent in following their goals and other participants want to continue to the next trail, City Trail must keep them the participants engaged and motivated. To do so, if members are in the same trail for more than 3 times, the participant with greater points will have added features to add to their Travel Album record such as editing of photo features and taking multiple snapshots.

Community Based City Trail

Children indicating wanting to play City Trail with their peers and families. Many of the families mentioned they have family circle and support groups that they feel would enjoy using this to drive community participation. For the next iteration of the design, a feature considered called Travel Groups will be implemented to allow for group participation and competition.

Confirmation Trail is Complete and Celebration on the Watch:

Children enjoyed collecting coins and knowing that 4 coins meant their Trail was complete. They mentioned wanting a way to celebrate on the watch such as seeing a celebration interaction.

Coins Versus Step Data View Was Confusing

Some parents enjoyed viewing if their goal was complete by means of steps, whereas children favored seeing their goals complete via coins. On the Pebble smartwatch app,

hierarchy is given to coins. For the next iteration of the mobile app design, users will be given the option to decide the view by coin, steps, or both.

VIII. Final Design

A. App Map

The app map outlines the key flows and possible interactions individuals have with the City Trail mobile application. For this project we focused on prototyping and testing the interaction flow with Pebble and smartphones. We did not include the login / sign up flow because it was not central to the hypothesis. The login flow is, however, an integral part of the overall product idea because it helps us support collaboration amongst users.

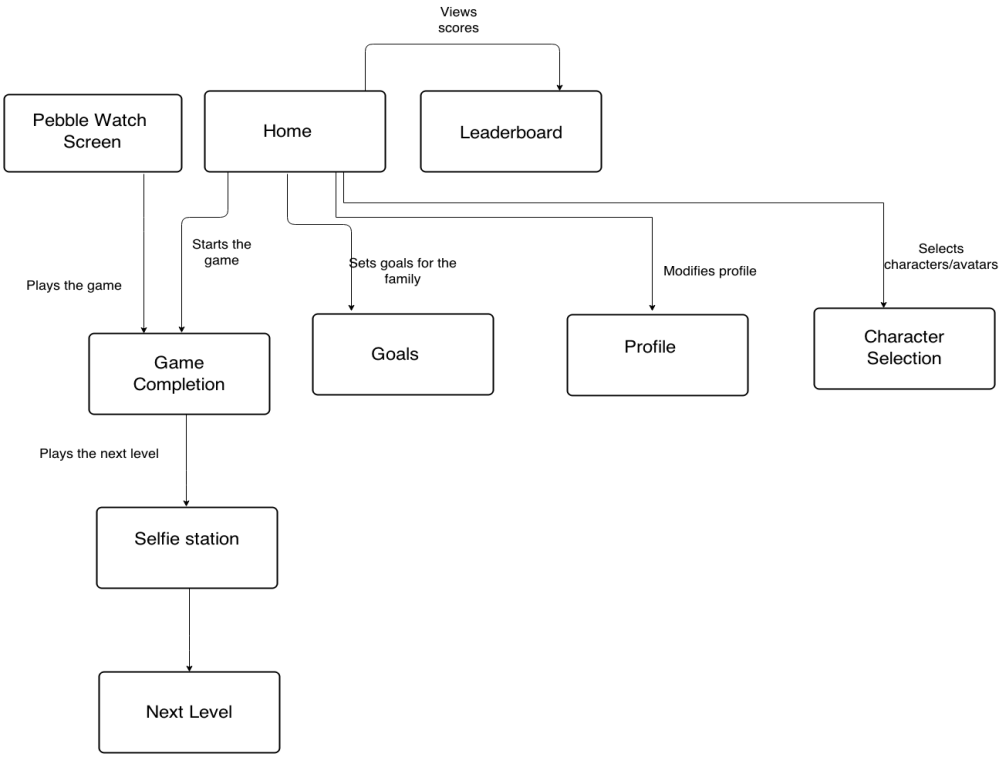


Figure 18: App Map of Features for City Trail Android App.

B. Features and Screenshots

Phone App

Figure 19: Homescreen.

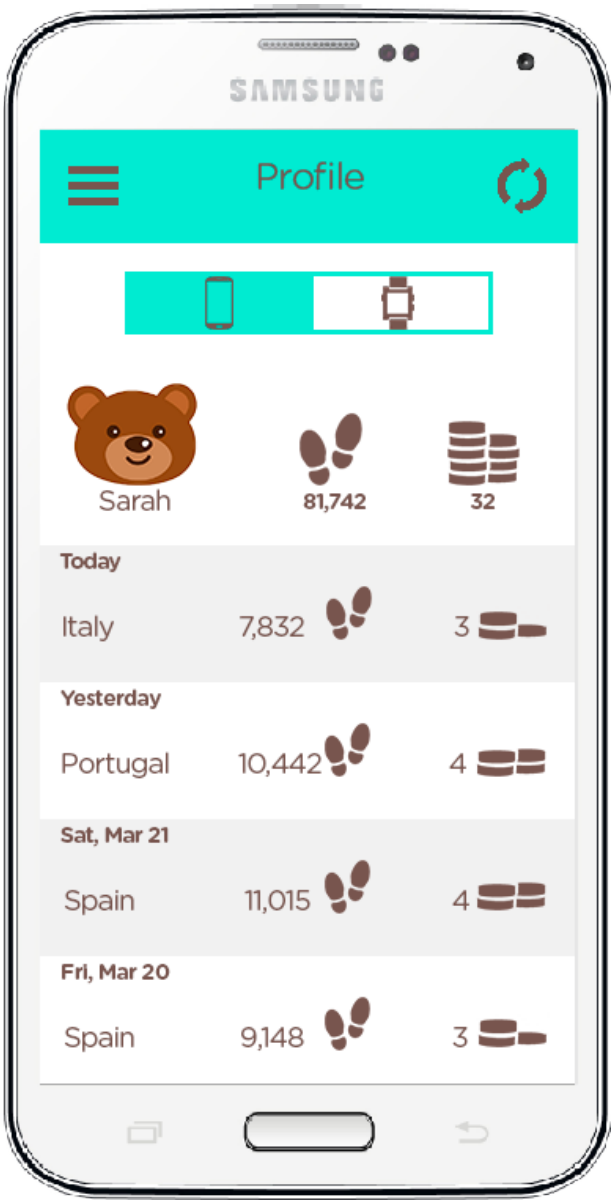


Figure 20: Profile View.

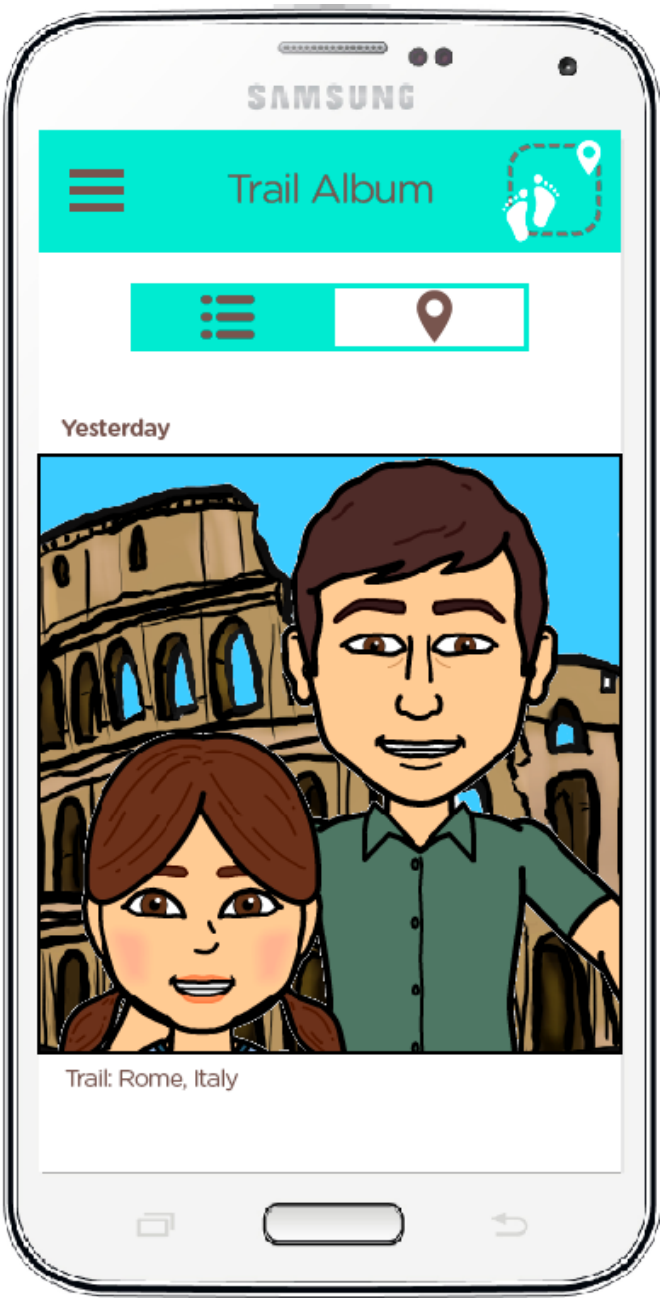


Figure 21: List View of Trail Album showing photo record of trails completed with participants in different cities.

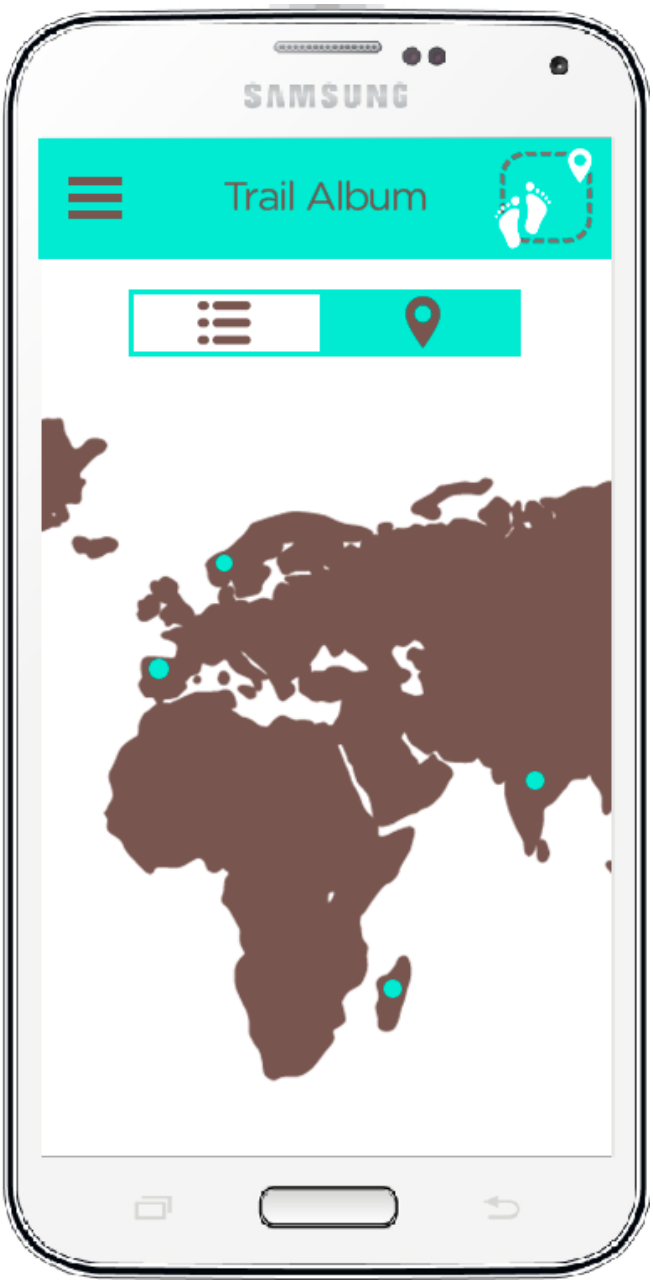


Figure 22: Map View of Trail Album showing participants where trail photos have been taken around the world.

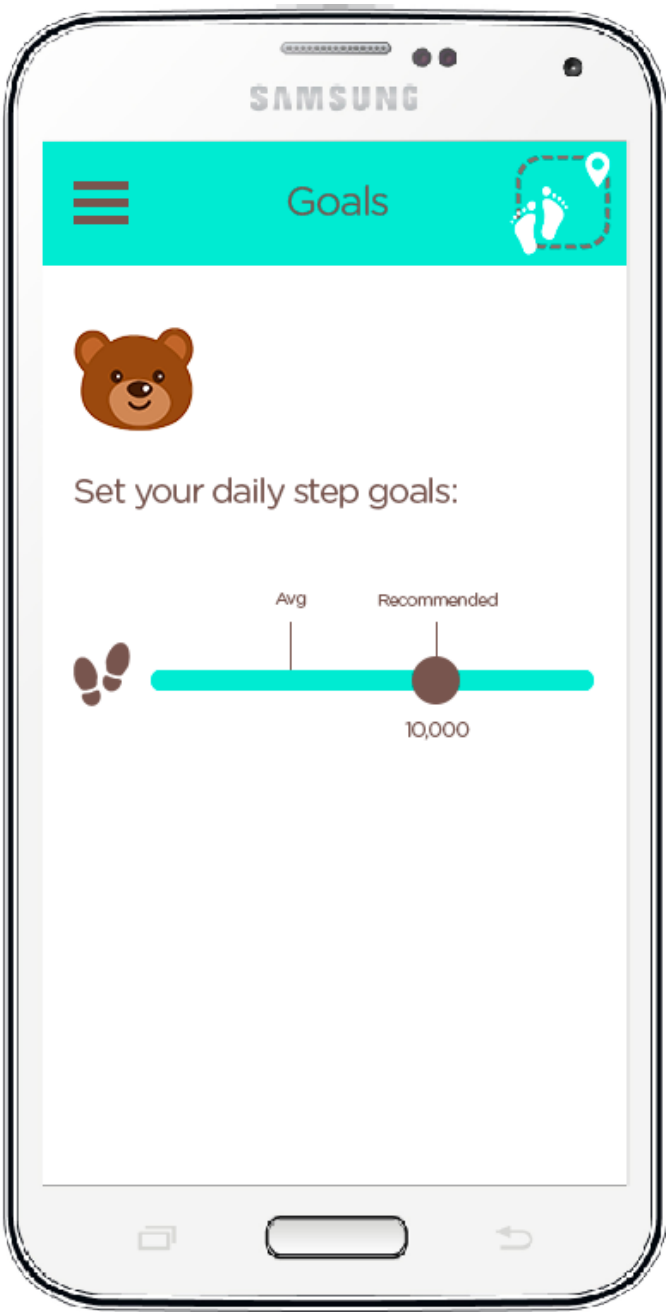


Figure 23: Goals page where participants set goals based on age and recommended steps are provided for the age group.

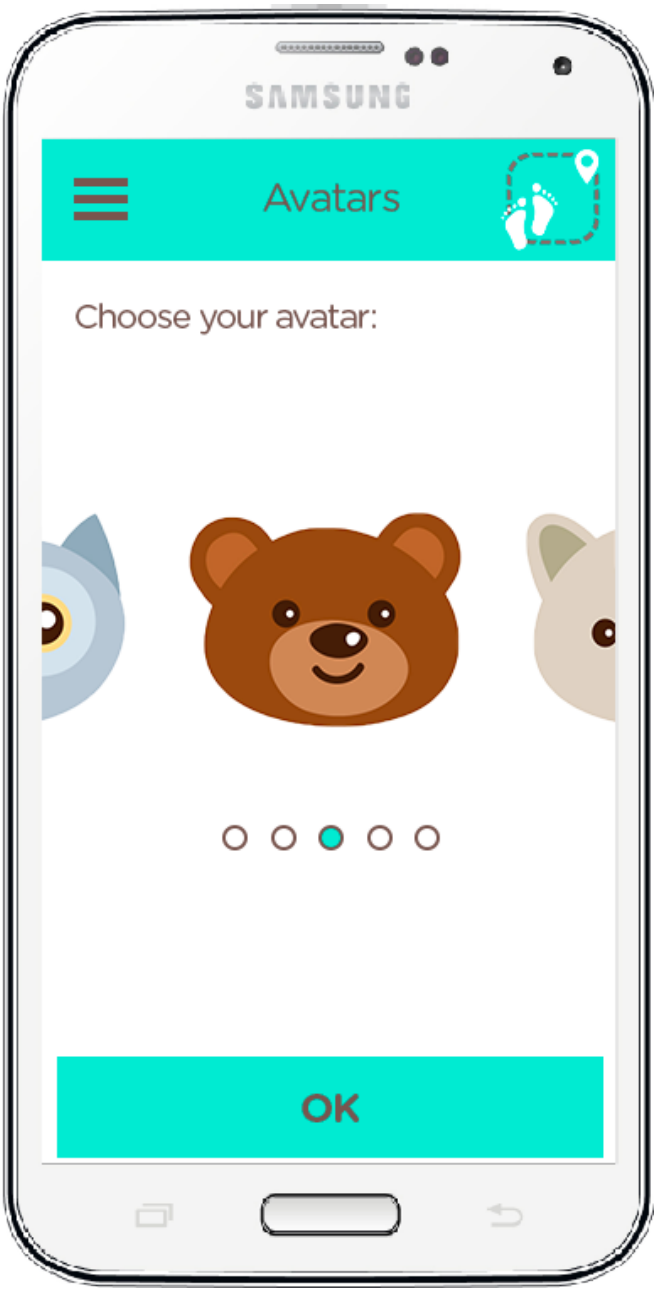


Figure 24: Customization of avatars for participants to pick from and personalize.

Pebble App

Home Page

Set the Goal

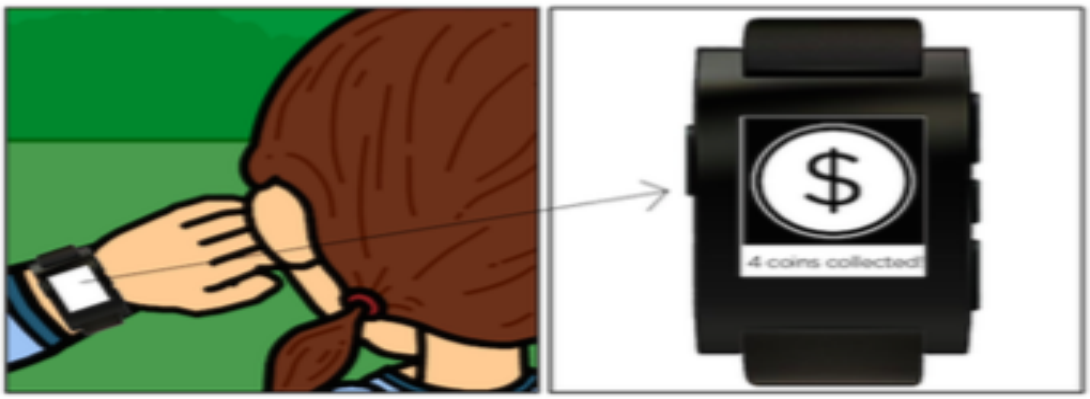
Step Information

Goal Completed

Figure 25: Overview of Pebble application.

Final Storyboard Preview

While Dad walks home, he sees he has went from 0 coins to 3 coins!



Kim meets her trail goal of the day to get 4 coins by receiving an alert that she has received the coins she needs in Italy.

Figure 26: Preview of Finalized Storyboard.

IX. Future Considerations

A. Future Applications for Internet of Things

We have extended the use case of our project by implementing some of principles highlighted by Info 290t: Internet of Things course that most of our team has enrolled in. Activity Subscriber Base is an online database that is used by many different IoT sensors to publish activities that they track. This information can then be used by other services to modify the behavior of other sensors to provide an intelligent ecosystem that enhances user experience.

We are publishing the number of steps that a user takes in a day to ASBase so that other services can see the data and decide whether they would like to use this step count information to offer any other service. We are mashing up our concept with that of another IoT concept called ‘Seats and Places” where every seat and room in the a particular location is sensor enabled so that these resources can be efficiently allocated. As a means of incentivizing physical activity, we have implemented a system which would automatically reserve an I School meeting room depending on which user among a given list of smartwatch wearers is the most active. The activity level is calculated by the number of steps taken by the user by a fixed time, say 11:00 am. ASBase makes it really easy for dumb sensors to act in more intelligent ways by introducing a means of communication and a layer intelligence between them.

B. Additional Uses

We've found that City Trail can also be applicable to physical education system in elementary schools. Here students can learning how they are doing with their step goals during their Physical Education (P.E.) courses but also apply it to learning about geography. Data collected from usage of City trail can also show trends of improvement or children meeting recommended step goals. These findings can inform how to improve P.E. in elementary schools and emphasize the importance of attaining health goals for students.

XI. Appendix

A. Initial Storyboard

Initial storyboard found at http://bit.ly/1KRCBah

B. Final Storyboard

Final storyboard found at http://bit.ly/1IoFtM8

C. Software (Android and Pebble Source Files)

Android and Pebble source files are at http://bit.ly/1zKfwVG

D. Survey

Online Survey can be found at http://bit.ly/1cgpxPN

E. Interview Debrief Protocol

User/Customer Name:
Age:
Occupation:
Number of Children and respective ages:
Telephone:
Interviewer:
User Address:
Interview Location:
Date:

Competing Product (if mentioned):

Question/Prompt	**Customer Statement**	**Interpreted Need**
How does Child use the smartphone/Tablet? · Include type of games/activities · Duration · Expressed Limitations of Screen-time?		
How is “Soccer Mom Dilemma” Addressed? (i.e. what does the mom do when they’re kid is playing at practice or park, why and how do they feel?)		
View on Wearables		
How is physical fitness/exercise valued in the family?		

Likes about Storyboard Proof of Concept		
Dislikes about Storyboard Proof of Concept		

F. Usability Test Protocol

Interview Guide Protocol/Script:

Introduction Script:

Hi we are students at UC Berkeley doing a study on the usage of wearable devices tracking physical fitness activities in a gamified way. We would like to know how felt about using the Pebble watch and the user experience found on the mo application associated with the step collection.

Today's usability test and interview should take at most 1 hour of your time. We're going to be video recording what happens today.

Before we start the study, we would like to get to know about you and your interests.

[After student investigator reads the intro, they will ask the participant questions about their background/demographics and understanding of wearables.]

Background Interview Questions:

Questions for child participants: [Carried out by Researcher 1]

- Did you wear the watch yesterday for at least 6 hours? If no, then what did you not like about the watch?

- Did you like wearing the watch?
- How long did you wear the watch?
- How did the watch affect your involvement in sports/exercise/physical activities?
- How do you feel about the character on the watch?
- Would you wear the watch again? Why or why not?
- How did you feel when you saw the number of steps you were walking?
- Was the vibration in the watch too distracting or too strong?

Questions for parent participants: [Carried out by Researcher 2]

- Did you check the activities and engagement of the other players in the game?
- Do you like to check your goals with your family? How often do you do that?

[Following the background questions, the student investigator will start the usability test of the mobile application where the application will be opened from an Android device.]

<u>Usability Test Questions:</u>

Student investigator script:

Now that we know how you felt about using the Pebble watch, we want to see your input on using the mobile application. So let's open the app now and complete tasks associated with the application.

Questions for parent participants: [Researcher 1]

1. What is the first thing that catches your attention on the home screen? Why?
2. Where would you go to see your ranking?
3. How would you go about checking the activities of the other player?
4. In what ways would you customize the character?
5. How often did you use mobile/smartphone devices to check the progress of the avatar?
6. How did the notifications affect your progress?

[Following the usability test of the mobile application, the participant will be asked further questions about their experiences of using the wearable device and mobile application.]

Interview Follow up Questions: [Researcher 1]

Questions for parent participants:

On a score of 1 to 5 (1:least, 5: greatest), were you satisfied with the application?

How did the video playback of your avatar affect your involvement?

How many players are you interested to compare yourself with? Why? Are these players family members or peers? Please explain.

Please let us know if you have any additional comments or concerns about the application.

Interview Guide Protocol/Script:

Introduction Script:

Hi we are students at UC Berkeley doing a study on the usage of wearable devices for tracking physical fitness activities in a gamified way. We would like to know how you felt about using the Pebble watch and the user experience found on the mobile application associated with the step collection.

Today's usability test and interview should take at most 1 hour of your time. We're going to be video recording what happens today.

Before we start the study, we would like to get to know about you and your interests.

[After student investigator reads the intro, they will ask the participant questions about their background/demographics and understanding of wearables.]

Usability Test Tasks:

Task 1:

1. We will have you both go walk/run for about 5 minutes. You are free to do this together or by yourselves. After 5 minutes please return here.

[After 5 minutes]

2. How did that feel? What was on your mind while doing this?
3. Now we will sync the steps from the watch to the App. Let's see where you are now.
4. For this part the users should still be on the same level.

Task 2:

1. Have users do it again as task 1 but they will now have that level completed.
2. A notification should come up indicating that the level is complete and let the user take a photo.
3. The team will take the photo using a Macbook Air with Italy in the background.
4. This photo should then be on the leaderboard and show the user on Level 2

Post Interview Questions:

Questions for child participants:

- Did you like wearing the watch?
- How did the watch affect your involvement in sports/exercise/physical activities?
- How do you feel about collecting coins on the watch?
- Would you wear the watch again? Why or why not?
- Was the vibration in the watch too distracting or too strong?

Questions for parent participants:

- Did you check the activities and engagement of the other players in the game?
- Do you like to check your goals with your friends and family? How often do you do that?

- How did seeing where you are with the other players on the map affect you?

[Following the background questions, the student investigator will start the usability test of the mobile application where the application will be opened from an Android device.]

<u>Usability Test Questions:</u>

Student investigator script:

Now that we know how you felt about using the Pebble watch, we want to see your input on using the mobile application. So let's open the app now and complete tasks associated with the application.

Questions for parent participants:

1. What is the first thing that catches your attention on the home screen? Why?
2. Where would you go to see your ranking?
3. How would you go about checking the activities of the other player?
4. In what ways would you customize your character?
5. How often did you use mobile/smartphone devices to check the progress of the avatar?

[Following the usability test of the mobile application, the participant will be asked further questions about their experiences of using the wearable device and mobile application.]

<u>Interview Follow up Questions:</u>

Questions for parent participants:

- On a score of 1 to 5 (1:least, 5: greatest), were you satisfied with the application?
- How did the video playback of your avatar affect your involvement?
- How many players are you interested to compare yourself with? Why? Are these players family members or peers? Please explain.
- Please let us know if you have any additional comments or concerns about the application.

Questions for child participants-Usability Test and Follow up: [Researcher 2]

1. Now, lets look at where you are on the CityTrail. What did you like most on the game? Why?
2. What did you like least on the game? Why?
3. How did looking at your trail make you feel?
4. What is it like having to wait for your parent to get to the end with you?

Student Investigator Script:

This concludes the usability test and interview about your experiences of using the wearable/app. Please let us know if you have anymore questions. Thank you for your time.

Conclusion:

This concludes the usability test and interview about your experiences of using the wearable/app. Please let us know if you have anymore questions. Thank you for your time.

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