Fit to Draw: An Elevation of Location-Based Exergames

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ABSTRACT

Many location-based games have a multiplayer aspect; however, this is typically inconsequential to the actual gameplay, which is usually geared toward a single-player experience. Thus, we present *Fit to Draw*, a multiplayer location-based exergame that combines simple picture-guessing gameplay with physical movement. While other location-based games have the gameplay elements tangentially related to physical movement, *Fit to Draw* requires players to walk outdoors to draw a picture based on a given word. Companion players then guess what other players drew to earn points, providing a multiplayer and social experience that many other location-based games do not have. The goals of *Fit to Draw* are to motivate users to exercise, enjoy the outdoors, socialize, and have an opportunity to be creative.

CCS CONCEPTS

• **Human-centered computing** → *Collaborative and social computing devices*; *Ubiquitous and mobile devices*; **Collaborative and social computing devices**; • **Applied computing** → *Computer games*.

KEYWORDS

Exergames; Arts; Mobile Applications; Pictionary; GPS; Location-Based Games; Unity

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1 INTRODUCTION

While many different genres and styles of video games exist, exergames are unique in how they combine traditional gameplay elements with physical exercise. Initially made for console games (i.e. the Xbox Kinect and Nintendo Wii), exergames have expanded to a mobile platform as well. Mobile exergames are defined as games which use mobile devices to engage players in physical activities to complete tasks within the game [10]. Such tasks (and the activities required to complete them) are enhanced by features like GPS, Bluetooth, and WiFi. In particular, the GPS functionality of smartphones has great potential for elevating and encouraging physical activity in a game setting. Location-based exergames, such as those researched by Boulos & Yang, motivate players to explore new locations they might not otherwise visit, and the general social interaction facilitated through multiplayer/online ranking can further boost the incentive to be active [5]. However, many location-based games do not provide a true multiplayer experience like those found in traditional video games, where players compete and/or cooperate for a common goal.

Thus, we present *Fit to Draw*, a low-intensity exergame for mobile phones that combines the core elements of picture-drawing and picture-guessing games like *Pictionary*, with physical movement in an outdoor environment. Unlike other GPS exergames, where the actual game elements and social interaction are often asynchronous and weak, our game promotes a direct, strong link between social interaction, gameplay, and physical activity. Simplicity and familiarity are the two main design points for our game: the UI of the game is simple and easy to read, and the rules of the game are easy

to understand. Furthermore, the classic "drawing a picture from a word" gameplay loop is also familiar, as is using the smartphone as the gaming device. These factors, in addition to the true multiplayer aspect, make *Fit to Draw* stand out among other games of its type, providing a uniquely entertaining experience to players.

2 HCI DESIGN AND ANALYSIS

The design of *Fit to Draw* evolved from a philosophy focused on four main themes. We wanted to provide players with an experience that encouraged them to spend time outdoors, socialize with others, engage in exercise, and use artistic skills. Our analysis process consisted of reviewing prior research, play-testing existing games, and gathering insight into our target users' gameplay experiences. Following our initial investigation and analysis, we held a group brainstorming session which culminated in our *Fit to Draw* idea. The *Fit to Draw* **game concept** is a multiplayer location-based game where players take turns picking and drawing words while their companion player tries to guess the word drawn. What makes this game **innovative** and unique is the way users interact with our drawing interface. To draw their chosen word, players must physically walk, run, or navigate an outdoor area, while the game traces their path on a map. Users must be deliberate in their movement. This movement includes, their selection of starting position and drawing area, their choice of path to produce a picture of their chosen word, the speed of their movement, and their monitoring of the clarity of their drawing.

Target Audience. From our observations, we identified young adults and adolescents as our target users, for whom we made personas. While we believe that anyone could play our game and have an enjoyable experience, our game is ideal for those who wish to spend time outside, exercise, draw, and/or socialize.

Being new to game design and development, we explored ways to quickly evaluate the viability of our game concept. We realized that an online version of *Pictionary* (*Skribbl.io*) [1] and *Map My Run* [2] were two applications that already incorporated some of the key features of our envisioned *Fit to Draw* game. *Skribbl.io* incorporated the picture-drawing and guessing aspects of our game, while *Map My Run* included features which captured a user's outdoor movement onto a map annotated with an outline of the user's path.

We had doubts about using GPS to capture a person's location and movement and using that information to accurately draw a picture representing some word prompt. We decided to simulate our design and envision gameplay by using *Map My Run*. *Map My Run* is an exercising tool that tracks users as they walk or run outside and provides them with information about calories burned, mileage, and session duration. Most important to us, *Map My Run* includes a feature which captures and traces a user's location and movement on a map. This creates a map drawing of the user's path, conceptually similar to what we planned to do in our game.

First, all group members used *Map My Run* independently, with each member attempting to test out our smartphone map drawing concept by walking a path to draw a word from our curated selection.

We play-tested *Skribbl.io* together as a group, made personal observations about the game and play experience, and then held a roundtable discussion. In our discussion, we shared what we liked and disliked about the game, our thoughts about movement-based drawings, and other ideas to consider when designing our *Fit to Draw* game. We decided to incorporate features from *Skribbl.io*, such as how time to answer affects the players' score, a clear drawing button, an eraser, multiple colors, and hints as the timer dwindled. Since the game centered on drawing and guessing pictures based on a word prompt, we decided to curate a word bank with words that could reasonably be drawn by tracing a person's walking route.

The *Map My Run* drawings were more accurate than expected, which gave us confidence that our app would work as intended. We subsequently invited a few other people outside our group to try drawing something with *Map My Run* as well, just to get new perspectives, especially from those without insider knowledge of our project (i.e. potential users). We went through a couple iterations of developing our game. In our first iteration, we only had basic features including only one color, no instructions, and design flaws such as text boxes that people couldn't tell were text boxes. Our design-making process consisted of considering what would result in the best user experience. We provided users with the options to change the game settings, a word bank with relatively easy words to draw, and features to allow the user to clear their drawing, erase, and choose from multiple colors. These design ideas decrease user frustration.

2.1 Related Works

Location-based games (LBGs) are games which incorporate player location, movement, and the surrounding environment as game elements [4]. LBGs often encourage movement and exercise. Since our game idea included elements often found in location-based exergames, we explored research that studied different types of location-based exergames. For example, *Can You See Me Now?* [3] is an LBG game that involves online players who are being chased and runners who are chasing the online players in a city landscape outside. The game relies on GPS and WiFi to conduct the gameplay, similar to the game we planned to create, *Fit to Draw*. The designers of *Can You See Me Now?* revealed that the sociality of gameplay is important, and working with the uncertainties of GPS and WiFi connectivity is also essential to a positive user experience. We similarly designed our game, *Fit to Draw* to be a social exergame reliant on strong WiFi. Our game encourages exercise because people must walk or run around outside to draw their selected words. Furthermore, this article discussed how the game creators worked with the WiFi uncertainty to make sure users could still have fun. Thus, we made sure users could still have a good time playing together, regardless of being disconnected a couple of times in our game by including a feature that allows users to reconnect to the game if they get disconnected while drawing. Similarly, *Uncle Roy All Around You: Implicating the City in a Location-Based Performance* [4] is a paper discussing a game that also encourages physical movement in a city landscape. The game allows both street and online players to try to locate a person called "Uncle Roy" by receiving clues and talking to strangers. This game encourages exercise for in-person players because they can walk around the city while they play the game.

While *Can You See Me Now?* and *Uncle Roy All Around You* leverage mostly competitive gameplay, cooperative gameplay is also a

common design theme in exergames, as the majority of exergames are played socially in close physical proximity to other players.

Additionally, in a paper titled *Better Together: Outcomes of Cooperation Versus Competition in Social Exergaming*, 2015 [9], researchers discuss the differences in exercise benefits motivated by social factors in cooperative versus competitive exergaming. Researchers synthesized a multitude of cooperative and competitive social exergame studies on health benefits; effects on behavior such as motivation, self-efficacy, and aggression; and effects on a diverse range of individuals. The research indicates that cooperative exergames lead to slightly more weight loss than competitive exergames and that cooperative play, in particular, is more beneficial for overweight and obese adolescents. The authors recommend game developers tailor the social exergames to player preferences and seek to include both cooperative and competitive elements in games.

Research and practice has explored how movement can be used to support creative expression. For example, Richard Long, an artist born in 1945, created the art piece, "A Line Made by Walking", by walking through a field to St Martin's from his home in Bristol repeatedly until a line was visible [7]. It is part of an artistic movement that emphasizes participation and action, and isn't stagnant like traditional art forms. *Fit to Draw* relies on perception and open-endedness due to its nature of being timed and not using the traditional pen-and-paper approach. Therefore, *Fit to Draw* requires players to use their own interpretation when guessing what drawings represent.

2.2 Ideation

From our research on GPS accuracy, we guessed players would need a large amount of physical space to draw and would therefore need at least several minutes of drawing time. If all phases needed to repeat for each user drawing, each game would be magnitudes longer than the typical *Pictionary* or *Skribbl.io* game with the same number of players. Additionally, if drawing and guessing occurred simultaneously, because of the lower speed of drawing by foot compared to on paper or digitally, the game would involve large amounts of idle time for the guessers waiting for the drawing to become recognizable enough to guess.

A potential solution to reduce the total and idle time of the game would be to make the phases synchronized for all of the players. At the same time, players would choose a word, draw their word, and see the scores. For the guessing phase, each player could guess the drawer's picture at the same time, while the drawer waits for the other players to finish guessing. This process would repeat for each player's drawing, then the guessing phase would complete. While this approach still includes some idle time on the part of the drawer, we believed the benefits of being able to see other players' incorrect guesses within a live text chat would outweigh the cost of idle time. Players could use other players' guesses to aid their own guesses, as is done in *Skribbl.io*. One disadvantage of this approach is that the drawer would be unable to make amendments to their drawings as other players are guessing. Another important element of *Skribbl.io* that we identified for our gameplay was a timer. Drawing by foot would take several minutes, so it would be important to our game that none of the phases take too long.

Having narrowed down the idea of the core gameplay to making a drawing guessing game where drawings are made by physical movement in outdoor environments, we found several games that embody interactions and features we envisioned incorporating within our game. One such game we considered was *Pokemon Go* [12]. *Pokemon Go* makes use of GPS tracking in the player's mobile device where they can walk around capturing virtual monsters called Pokemon. In Summer 2016, *Pokemon Go* gained rapid mainstream popularity among children and young adults, motivating users to form groups to walk outside and capture Pokemon.

Additionally, we wanted to create a game that appeals to college students who want to exercise and socialize more. With our experience playing *Skribbl.io* and *Pokemon Go*, we created an outline for our own gameplay and identified four important "phases" for our game: choosing a word, drawing the word, guessing other players' words, and displaying the scores. Both original *Pictionary* and *Skribbl.io* incorporate these phases, however, to achieve our goal of drawing by foot, we made an informed guess that we would need to change the order of the phases.

We produced a storyboard to capture our four phase game play. This allowed us to share our idea visually with our peers. Our storyboard features a persona that we designed who can be regarded as a typical user of *Fit to Draw*. For the design portion, we utilized concepts we learned previously, including storyboarding, making user personas, and wireframing. For the storyboards, we used three perspectives: ecological, emotional, and interactive. For the user personas, we included goals, frustrations, skills, devices, hobbies, and other information. For the wireframes, we drew a basic concept of how the game would flow, from the start screen to the room creation screen, to the drawing screen, to the results screen. Outside of HCI knowledge, our prior experiences helped with designing the game: we all had experiences of "phone isolation", where we would find ourselves on our phones and not interacting with others, and we wanted to break this habit. We all wished to go outside and exercise more, and needed some motivation to do that. Similarly, we all had prior experience with the game *Pictionary*, which was helpful for coming up with our design.

3 IMPLEMENTATION

Tools. We implemented our project using the Unity game engine because it simplifies the development of multi-platform applications for Android and IOS. The project was programmed using Microsoft's C#. For multiplayer functionality, we used the Photon Unity Networking 2 [6] framework. Our approach used the multiplayer game host client as the "server" responsible for maintaining game data and other tasks, such as distributing word options from the word bank and storing players' word choices. Finally, for GPS location services and global map imaging we chose to use the Mapbox[8] maps software development kit.

To start a game of *Fit to Draw*, players must create or join a room. Once all players have joined, they enter the "core game." In the "core game," there are four phases: choosing a word, drawing the word, guessing the words, and viewing the scoreboard. Between all phases, there are several consistent design choices. Timers between all phases inform the user how long they have until the next phase. Delays in the transitions between phases to allow players to move

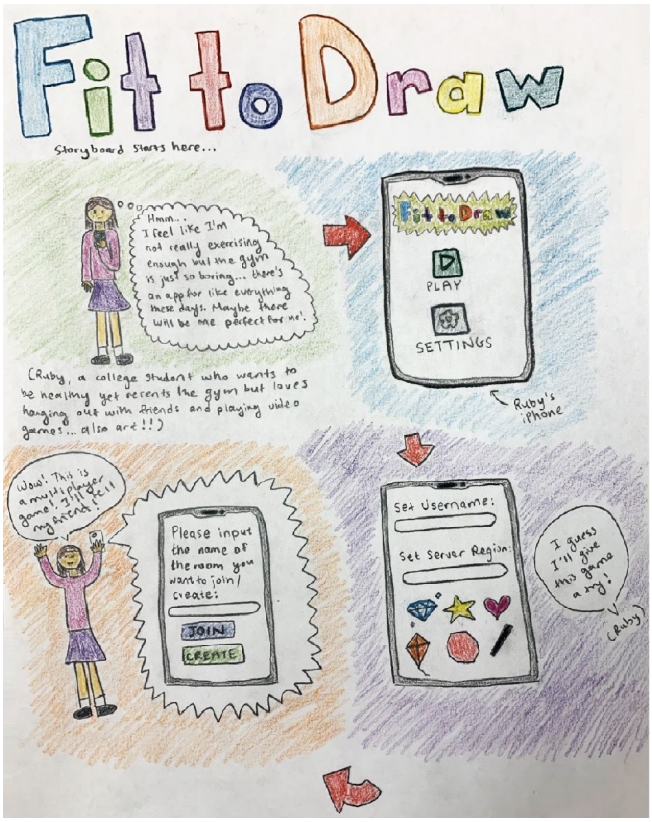

Figure 1: First storyboard image

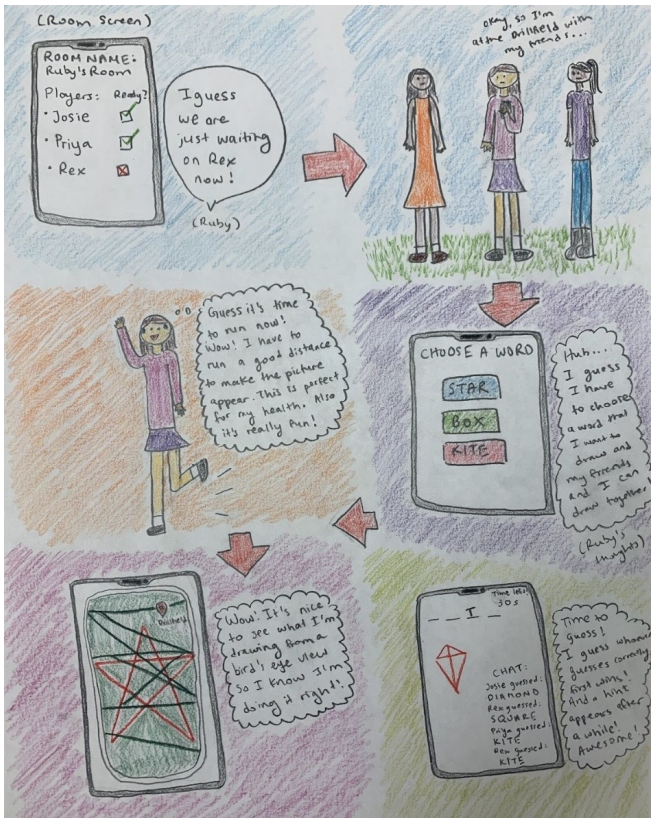

Figure 2: Second storyboard image

to a more favorable location, such as moving closer to other players so they can socialize. Another design choice was that all players remain on the same phase to allow them to socialize, particularly during the guessing phase. Configurability of the phases was also a focus. The host client is able to set a custom time, number of hints, and number of word choices. This helps accommodate both casual and competitive users. If players wish, they can give themselves fewer choices of words to draw to stimulate the imagination, or give themselves a short amount of time to draw to encourage quick thinking and rapid physical movement in order to finish their drawing in time.

3.1 Choosing a word

In the first phase, choosing a word, players have a short amount of time to choose one word displayed as a button on the screen. These words are drawn from a large, shuffled word bank. Players are all given different word options, and words they chose are removed from the word bank, whereas the other options displayed are added back into the word bank. Players may see them again in following rounds of the game. All word choices are sent back to and stored by the host client, so if one player were hacking they wouldn't be able to see other players' words stored on their phone. Normally, an off-site server would store this information, but since we're using the host client, we assume they're playing in good faith. The choosing a word phase ends after all players have chosen their word, or after the time runs out, in which case a random word is chosen from the words displayed on the screen.

3.2 Drawing the word

The next phase is drawing the word. By default, players have ten minutes to draw. Players are shown a map along with an avatar that tracks their location using GPS and device direction using the device compass. On the left side of the screen are the drawing related buttons such as the color options and a button for clearing the drawing. On the right side of the screen are the finished drawing button, re-center view button, and show/hide word buttons. The game drawing functionality was implemented in such a way that it is possible to erase part of the drawing if the player makes a mistake. This functionality was adapted from a Virtual Reality drawing tutorial on YouTube made by Valem Tutorials[11]. The trade-off with the approach was that the drawing is stored like an image, meaning that the player was limited to a square area relative to where they first started drawing. The size limit of the image has never been a problem, as it is about a kilometer squared in area, and the edges are denoted by gray X's. In addition to the erase function, players are given the colors red, green, blue, yellow, black, and white to draw with. They can start and stop drawing with each color at will. The limited number of color options helps keep the amount of drawing data sent to other players during the drawing phase small. The color buttons are contained in a collapsible menu

Figure 3: Word bank

Figure 4: Drawing the word

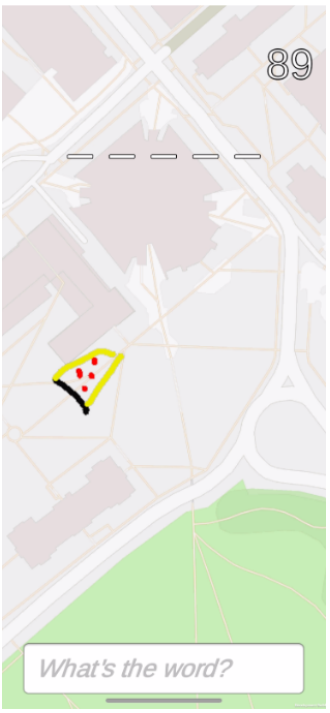

Figure 5: Guessing the word

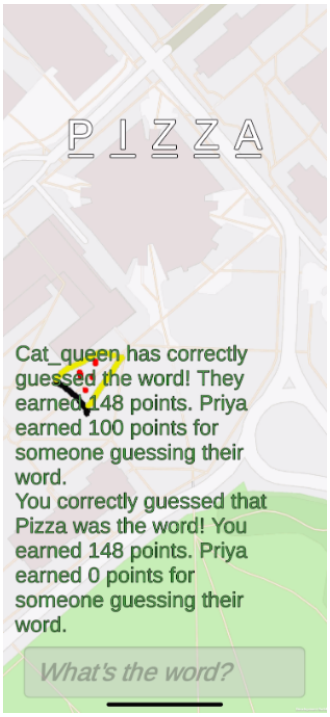

Figure 6: Points rewarded

to keep the map uncluttered while the player is drawing. For the left side buttons, the re-center view button re-centers the view upon the player avatar. There is basic map functionality for zooming and moving the view around as well. The show word button shows the chosen word on the screen and the hide button can take its place so the word can be hidden. We wanted players to be able to remind themselves of their word but also be able to hide it from other players looking at their screen if they are playing together locally. The drawing the word phase is finished when all players press the finished button or when they run out of time.

3.3 Guessing the word

After players finish drawing, they enter the guessing the word phase. The drawings made by each player are sent over the network to the other players. There are several rounds to the guessing phase, as all players guess upon the same image at a time, allowing for discussion during guessing and allowing other peoples' guesses to inspire each other. Players input their guesses into a text chat at the bottom of the screen. When players guess correctly, points earned by the successful guesser are announced to the other players, but the word remains hidden so they can continue to guess. When a player guesses incorrectly, their guess is shown to the other players, which can help clue them into the other guessers' line of thinking. During their round, the owner of the drawing is waiting for the other players to finish guessing and is unable to use the text chat. The guessing phase also has underscores representing how many letters are in the word. Once half of the time for guessing has passed, random single letter hints appear to help with guessing. A round of guessing ends when all players have guessed correctly or if time has run out. The guessing phase ends when each player's drawing have been guessed on.

3.4 Scoreboard

The final phase is the scoreboard phase. This shows the points earned during the current phase as well as the points earned during the previous phases for all players. When players guess a word correctly, they earn a minimum of 100 points and can earn up to 50 additional points for guessing quickly. The drawer will also earn a total of 100 points in a round of guessing if any of the players guess their word correctly.

4 RESULTS

We recruited seven people to play our game: two groups of two people, and one group of three people. We played at least two full rounds of our game together. After playing, we asked participants to complete a post-experience survey. From the testing and the post-experience survey results, we were indeed able to gain new insights into considerations for our project. For example, we noticed that a participant unfamiliar with the concept of *Pictionary* tried to spell out the word rather than draw it. Thus, we realized that we needed to provide players with clearer instructions. Also, we realized how critical the ability to erase was to users, and that they wished for a feature to rotate the image since they would often draw it upside down.

Despite setbacks such as GPS drifts and internet instability, our survey results showed that our users had a high level of enjoyment while playing the game, rating the game an average of 8.8/10. Users reported enjoying exercising while having fun. In a few instances, our participants found it difficult to draw their chosen word due to unfamiliarity with drawing using physical movement and the challenge of accurately envisioning a path that traced a suitable representation of the word drawn. Nonetheless, based on feedback and observations, all of our users enjoyed playing. We displayed *Fit to Draw* at Virginia Tech's Institute for Creativity, Arts, and Technology (ICAT) day, where we saw several people thoroughly engaged, trying to perfect their drawing as much as possible, and smiling or laughing when others tried to guess their drawing. We observed positive emotions and social interaction, especially during the guessing phase, where users would usually discuss their drawing and thought process with other players. We noticed how our game design allowed users more flexibility because of the variety of features, such as the ability to change the drawing's color. The features included in our game design led to increased user satisfaction with their drawing as it allowed them to customize it more. Our game design promotes entertainment by allowing more ways to express artistic creativity and have fun with friends. Additionally, one of our clients played *Fit to Draw* with two other people. One session was remote, while another session was in person. He found our game mechanism interesting because our game is unique compared to most mobile games, since our game must be played outside and with other people. Furthermore, he enjoyed playing in person more than remotely because he got to talk with his fellow players, and primarily played the game for social interaction. Finally, he enjoyed the added benefit of exercising with others.

5 DISCUSSION

From our review of literature, we were unable to find a previous walking version of drawing and guessing games like *Pictionary*. We were aware that games could lead to a sedentary lifestyle, so we decided to create a game as a means of helping people be more active as well. From our observations of *Skribbl.io*, we noticed that some of the words were difficult to draw with a mouse, and we realized that it would be nearly impossible to draw them by foot from a birds-eye view. Therefore, we decided to stick to simple, fun words, such as "star" or "cherry". We considered many possible scenarios that came with playing outdoors. For example, players had to be warned to watch out for obstacles or traffic since they would be looking at their phone. Additionally, weather would impact the level of enjoyment of the game, and a large open space would make it more accessible. Also, the game would be harder for people who have difficulty walking, but any way of movement should work and satisfy our goals of exercise, social interaction, and outdoor time. We can make our game more accessible as well by including audio cues, a high-contrast theme option, and an audio chat option for those who are visually impaired.

Finally, our game mechanics successfully align with our goals of encouraging users to spend time outdoors, socialize, exercise, and be artistic. Since our game cannot be played indoors, because indoor spaces are usually not big enough for the GPS to pick up on one's movement path, our game must be played outdoors. Continuing on, *Fit to Draw* promotes social interactivity by being a multiplayer game. Additionally, to draw pictures, users must walk or run outside, which is a healthy form of exercise. Finally, users can be creative because they have an opportunity to draw fun pictures, and the better they draw, the easier it is for their fellow players to guess what they drew, earning both the drawer and guesser more points.

6 CONCLUSION

In the future, we plan to make changes to improve the user experience of the game. These changes will consist of improving the graphics, solving problems for handling internet disconnections and GPS drifts, making the UI more user friendly by moving the clear button since people kept accidentally pressing it, and improving the overall visual aesthetics. We also plan to extend the social opportunities offered by the game by including a leaderboard for players and teams, and an option to share drawings to social media, so that other friends can share in the guessing aspect of the game or reflect on their experience in amusing conversations. For our future tests, we plan to assess how many calories each person burned by having them wear a Fitbit or use a mobile app. We also plan to test more how the game works if people play with each other remotely, and possibly add an additional text chat feature in the game so that players can socialize without having to be physically close.

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