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Exploring Exer-Walls as a Healthy Alternative to Paywalls in Mobile Games

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Exploring Exer-Walls (Exercise Walls) as a Healthy Alternative to Paywalls in Mobile Games

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Abstract

Modern mobile games implement paywalls, a monetization strategy which can frustrate players by forcing them to either wait or pay to continue playing. Our survey results found paywalls to reduce player retention and overall rating. In this project, we explored improving paywalls by replacing waiting for paywalls with step goals. This creates a new form of paywalls called exer-walls, which aim to encourage physical activity. We designed and developed a mobile game called Laser Planets to test exer-walls, and found them to be successful both in reducing frustration and motivating physical activity. Experimental evaluation demonstrated the feasibility of exer-walls as a potential replacement for today's current paywall model.

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1 Introduction

In 2015 alone, the estimated market for mobile games was approximately $30 billion (Pearson, 2014). Surprisingly, 79% of this revenue was generated by free to play games (Grubb, 2014). Free to play games are games that can be downloaded and played for free; players are never required to spend money on the game. They have become successful by incorporating in-app "micro transaction" purchases which get players to spend small quantities of money on items, lives, levels, and more. These micro transactions can take the form of paywalls.

When looking at the paywall strategy that has been incorporated into many games, it is clear to see that improvements can be made to paywall implementations in order to decrease player frustration. We found that the public has a largely negative opinion of paywalls, which can hinder the growth rate and revenue of games that include them. While it is possible for a relatively small group of players to sustain a game by consistently spending money on paywalls, it would be much more beneficial to find a method of retaining a larger player base.

We propose the idea of "exer-walls" as an evolution on these current paywall strategies. Exer-walls give players the option to walk a certain amount of steps rather than to wait a specific amount of time as they are required to do in current paywalls. The main goal of our project was to evaluate the feasibility of exer-walls as a replacement for traditional paywalls without changing developers' current paywall business model.

We started this study by evaluating user opinions of paywalls through a survey of students on the WPI campus. Finding that students considered all forms of paywalls frustrating, we then developed our own mobile game, which we called *Laser Planets*, in which we could compare exer-walls to wait-walls and record data about the player's actions in the game when

faced with the walls. We held a focus group to refine the game design in order to make an enjoyable game that was also capable of implementing exer-walls.

Laser Planets is a game about travelling through the galaxy to have laser battles with other planets. The goal is to collect planets and strengthen them through exploring and winning laser battles so that the player can eventually face Boss Jim to earn mega crystals for points on the leaderboard.

The paywalls implemented into the game consisted of three variants: wait walls, and two exer-wall variants: walk or a choice between walk and wait. These player options allowed us to compare our exer-walls with the traditional paywall option of waiting. We did not incorporate a payment option in our exer-walls for this study.

We tested our game through a one-week experiment where we recorded each player's daily step count, the times they opened or closed the game, and their choices when they experienced exer-walls. We found that, when given a choice, players chose to walk 47% of the time and wait 53% of the time. The fact that these selections were so similar suggests that walking and waiting can be interchangeable, making exer-walls a viable paywall strategy. Additionally, when players encountered a "walk" wall, they walked significantly more than when they experienced a "wait" wall. Furthermore, shortening the duration of walking compared to waiting might make exer-walls even more attractive to players. Players also showed a slight increase in their average daily step count over the course of the weeklong study.

The results suggest that the exer-wall strategy has merits as a paywall option, and we recommend that more testing be done to see its complete effects when compared to the traditional paywall. More people playing the game with more time to record data would be

helpful for future research along with looking at how in-game purchases are effected by switching to exer-walls.

The goals of this MQP:

- Demonstrate that paywalls are frustrating to mobile gamers
- Design exer-walls, an alternative method to paywalls which encourages exercise
- Develop a mobile game to test the alternative method called “exer-walls”

Chapter 2 describes the background research. Chapter 3 encompasses the methodology of the study. Chapter 4 describes the experiment. Chapter 5 states the results of the study. Chapter 6 contains the conclusions and future works.

2 Background

This chapter provides background on Paywalls and their implementation in modern mobile games. The chapter also describes pedometers and their role in the Google Fit API along with details of the Libgdx game framework.

2.1 Paywalls

Paywalls are defined as “a system in which access to all or part of a website is restricted to paid subscribers” (Dictionary.com). Originally used in websites to prevent users from accessing certain pages for free, paywalls have become a staple of gaming. For our study, we redefine paywalls as “an arrangement in a game whereby users are restricted from content until they have paid for it with money, time, or effort”. Many mobile games, as well as a variety of other video games, have used paywalls in order to generate increased revenue. The rationale behind paywalls in games is that players are more likely to pay small amounts of money in the middle of a game than they are to pay large sums of money before acquiring the game. Modern paywalls can be broken down into four categories (Which Button is Jump, 2015):

1. Classic paywalls
2. The patience-wall
3. The pressure-wall
4. The adwall

The classic paywall: sometimes called downloadable content, it describes an in-game mechanism through which players make a purchase to acquire some form of content such as extra characters, new quests, or additional maps. The only way to get the new content behind a

classic paywall is to make the purchase; there is no other method of getting around the classic paywall.

Figure 1 *This image shows a paywall that players would experience. These paywalls target impatient players by allowing them to pay to bypass the time restrictions. (Dungeon Keeper, Mythic Entertainment, 2013)*

The patience-wall: forces players to wait a certain amount of time in order to complete an action or obtain a reward. These actions could range from rushing the building of an item as shown in Figure 1 to gaining another life. Patience walls typically have long wait timers that can be bypassed by making a small purchase, targeting players that are impatient enough to pay in order to get past the wall. Figure 1 demonstrates a paywall that a player may experience in a game. As Figure 1 shows, the game presents players with a tempting offer of removing wait timers, clearly targeted towards the impatient. A slight issue for developers is that if a player is patient enough, all of the game content can be accessed for free. Patient players do not pay for the game.

The pressure-wall: an evolution of the patience-wall with a social aspect included. These walls incorporate a competitive aspect into the game, allowing players who pay through walls to gain advantages over those who wish to wait. Games that incorporate pressure-walls make it very easy for players to see what their friends are doing and how they are progressing in comparison to them. These games may even notify players when their friends are close to

beating their scores. With pressure-walls, it is far more difficult to compete with other players without paying, forcing players that want to be better than their friends to pay. Pressure-walls target both impatient players and competitive players, increasing the number of players who pay for progression.

The adwall: makes players watch an advertisement before allowing them further progress in the game. While not a source of revenue on its own, adwalls are intended to promote other games made by the developers in order to increase the interest in the developer's other games.

2.2 Paywall Games

While researching mobile games that utilize paywalls, we found that it is a widely utilized monetization strategy, encompassing many varieties of mobile games. There are collectible card games such as *Hearthstone, Heroes of Warcraft* (Blizzard, 2014), puzzle games such as *Candy Crush* (King, 2012), strategy games such as *Game of War – Fire Ag*e (MZ, 2013), and even adaptations of classic games such as *Monopoly* (Hasbro, 2015).

Mobile Game	**Paywall implementations**
*Game of War – Fire Ag*e	Pressure-wall, Adwall
Candy Crush	Pressure-wall, Adwall
Monopoly	Patience-wall, Classic Paywall
Hearthstone, Heroes of Warcraft	Pressure-wall

Table 1 *Displays the paywall games researched and their different types of paywall implementations.*

Game of War is one of the most successful "free to play" games in the app-store. In 2015, the game was making $1.5 million per day through the use of pressure-walls (Watson). This game has players build a stronghold and an army in order to compete with other players. The building and upgrading of their stronghold and units takes time, ranging from a few minutes to

over a month. Those waiting periods can be bypassed through the use of in-game currency purchased with real money. Almost everything in the game can be done without paying, but players would then have to wait for everything. In order to have the same items or scores as other players, there is an unreasonably long waiting period. This situation is even worse for new players; all of the other players have so much, and it is impossible to catch up without spending money.

Candy Crush is a puzzle game that, in 2015, was making approximately $900,000 daily (Watson, N.D.). This game also utilizes pressure walls, constantly comparing player's scores on each level with the scores of their friends. Every time a player fails a level, a life is lost. In order to get back those lives, players have to either wait or pay. To compete with friends or to beat advanced levels, players are encouraged to spend money, otherwise they have to stop playing and try again later.

Hearthstone: Heroes of Warcraft is a collectible card game that utilizes the classic paywall model where players need to purchase digital cards to add to their collections. Given enough time, players can eventually earn enough in-game currency to purchase cards without real money, but this happens very slowly. In order to build a deck that can compete with other players, "booster packs" need to be purchased, which give players random cards, which they may or may not need. Hearthstone made over $10 million between 2014 and 2015 (Dotson, 2015).

The classic games such as *Monopoly* can operate on a system of play tokens. Each game requires one or more play tokens, depending on the number of players in the game. In order to get more of these tokens, players have to experience a form of paywall.

Most of these games are considered “free to play”, meaning that players are not required to spend money on the game in order to play it. In fact, only 1.35% of players spend any money on mobile games, and 62% of all mobile game revenue comes from only 0.13% of players (Takahashi, 2014).

2.3 Increase in Sedentary Lifestyles

According to a recent study, (Poladian, 2012) adult inactivity rates worldwide have been rapidly increasing. While playing video games is not the sole cause of this change, it is considered to be a factor. College students in particular are often inactive due to the demands of their studies and their participation in social activities. It has been shown that the activity levels that students exhibit during college years continue into their adult lives (Internicola, 2012). Physical inactivity contributes to obesity, high blood pressure, and the risk of cardiovascular disease.

2.4 Pedometers

Pedometers have become a widely integrated sensor in most modern phones. Even phones that do not have a dedicated sensor are still able to utilize accelerometers in order to count a user’s steps. These accelerometers measure acceleration forces, such as phone movement and gravity, in order to determine when steps are taken (Goodrich, 2013).

Recently, mobile games have been taking advantage of this sensor by incorporating it into the core gameplay. Games such as *Wokamon* (Noodum Co. 2014) and *Tep* (ZeaLab Products, 2015) have players care for their own digital pet, but players have to exercise in order to help their pet grow and stay healthy. Other games such as *Zombies Run* (Six to Start, 2012)

require players to run in order to gather supplies or dodge zombies. Applications such as *Pact* (Pact Team, 2013) have users sign a pact saying that they will exercise several times per week or they get charged a fee. *Pact* pays users who exercise, and is funded by the people who are penalized for not exercising. The pedometer readings in these games and applications encourage people to be healthy but also gives them a tangible goal in the games (Berkovsky, 2010). This method of goal setting has shown to be successful because it gives the players a sense of accomplishment both in the game and in real life.

2.5 Google Fit

Google Fit[1] is an Application Programming Interface (API) that provides programmers the tools necessary to utilize the sensors in Android devices for tracking fitness activities and diet. Applications can utilize the sensors API, recording API, history API, and sessions API in order to track the user's exercise. The sensors API detects changes in the sensors such as the accelerometer, the recording API saves the fitness data, the history API provides access to that data, and the sessions API allows saving of session metadata with the fitness data. All of this is supported in Android 2.3 and higher as a part of Google Play services.

2.6 Libgdx

Libgdx[2] is a Java game development framework. The framework allows for a Java application to be cross compiled for multiple different platforms including Windows, Android, Blackberry, iOS, and HTML5. All projects created with Libgdx begin by creating a Gradle project that has a base of at least Windows and Android application files. The framework makes it easier to focus on game programming by abstracting away complicated Opengl graphics

[1] https://developers.google.com/fit/android/
[2] https://libgdx.badlogicgames.com/

commands and instead provides a set of classes that can be extended to fit all types of games and applications.

One of the main advantages of developing android applications with Libgdx is that, since the application can be run on Microsoft Windows, the developer is able to quickly test during development without having to install the application on a real phone or an emulator. Use of this feature can help speed up development and make the application very portable across various platforms.

Libgdx is broadly supported and has numerous graphics API's that have been specifically written for it that function on all supported platforms. The features supported in these API's range from 2D skeletal animation to 3D particle editors. Although there are many tools that can be utilized when developing applications with Libgdx, it is not a traditional game engine. Developers that want to make games using Libgdx will only be able to do so in pure Java programming. The benefits of this compared to other larger game engines such as Unity[3] or Unreal Engine 4[4] is that the developer has full control over which parts of the framework to use. The developers also have the flexibility to add their own implementations of functionality to the Libgdx framework that makes the most sense for their games. We utilized Libgdx in developing our prototype.

[3] https://unity3d.com/
[4] https://www.unrealengine.com/

3 Methodology

There were three phases to our study: validating the problem, developing the game, and conducting the experiment. We started with evaluating the public's opinions of paywalls and how they felt about our idea of exer-walls. We then developed our game as a means of testing the implementation of exer-walls. Finally, we conducted a one week experiment in order to gather data about the impact of exer-walls.

3.1 Our Exer-Wall Idea

An exer-wall is an evolution on paywalls where a player is given the choice to exercise in order to continue, while also still having the option to pay to move past the wall. This new type of wall would be implemented with the goal of promoting a healthy and more active lifestyle for players. The exer-wall could give more freedom to players, too, since they can complete the exercise goal as quickly or as slowly as they want. The introduction of a physical aspect is intended to keep players invested in the game by provoking feelings of self-accomplishment via exercise, but also hopes to inspire players to exercise more in the future. Our implementation of exer-walls incorporated step counts as the exercise goals. Exercise is intended to replace the option for waiting, which will allow developers that adopt this new type of paywall to continue to use their original business plan providing an option to pay, but with added benefits to the player. These benefits may also help to retain players by reducing frustration with the paywalls, growing a game's player base and generating more revenue overall.

3.2 Pre-Survey

We started looking at the paywall problem by first surveying people to evaluate their frustration with paywalls. We also wanted to use this survey to gain more insight into whether our exer-wall implementation could be feasible and beneficial to the users. To develop the survey, we utilized WPI's survey creation, administration, and analysis site called Qualtrics[5]. Our goal was to get enough responses so that our result data would be statistically significant. In order to do this, we had to make sure our survey was concise so that users could quickly answer the questions and that each of the questions would generate meaningful data that could be further analyzed. The full list of survey questions can be found in Appendix A. This pre-survey covered three important topics: current physical activity, past experience with paywalls, and responses to proposals about our "exer-walls".

Our target demographic was college students because we had access to students for testing. We were interested in understanding the exercise habits of this demographic to help in calibrating the step goals of our exer-walls. We distributed the survey by emailing it to several email aliases at WPI. There was no incentives to completing the survey however we managed to receive 56 respondents. Of the 56 respondents, 68% were male, 28% female, and 4% preferred not to answer. The ages ranged from 18 to 51 with a median age of 20. 93% of our data was college students with the rest being WPI faculty. Our survey also notes that of the respondents, 51% are studying the field of Computer Science with a majority of the rest studying Engineering.

We found that respondents tend to live a fairly inactive lifestyle, with 31% exercising between zero and four hours per week. For many students, the only exercise that they do is walking to and from classes, far less than the suggested "sweet spot" of exercise, which is 450

[5] https://wpi.qualtrics.com/ControlPanel/

minutes per week (American Heart Association, 2014). Only 25% of students paid attention to their exercise.

Interviewees were also asked about how often they play games on their mobile devices. Seventy percent of responders use their phones for gaming, while 68% of the gamers said that they play games at least once per day. When asked about experiencing paywalls, 82% of people stated that they had played games with paywalls. A total of 20% of users attempt to avoid paywalls, and 68% are extremely unlikely to spend money on mobile games. Of those that experienced paywalls, 84% feel that paywalls negatively impact their opinions of mobile games.

When asked about exercising through paywalls, responses were generally positive. Those who would not spend money on mobile games indicated that they would exercise to get around walls, suggesting exercise times of up to an hour to avoid paying money, and exercise times of up to one half of the waiting time to avoid waiting. People were willing to put more effort into bypassing walls through exercise than through other methods such as payment.

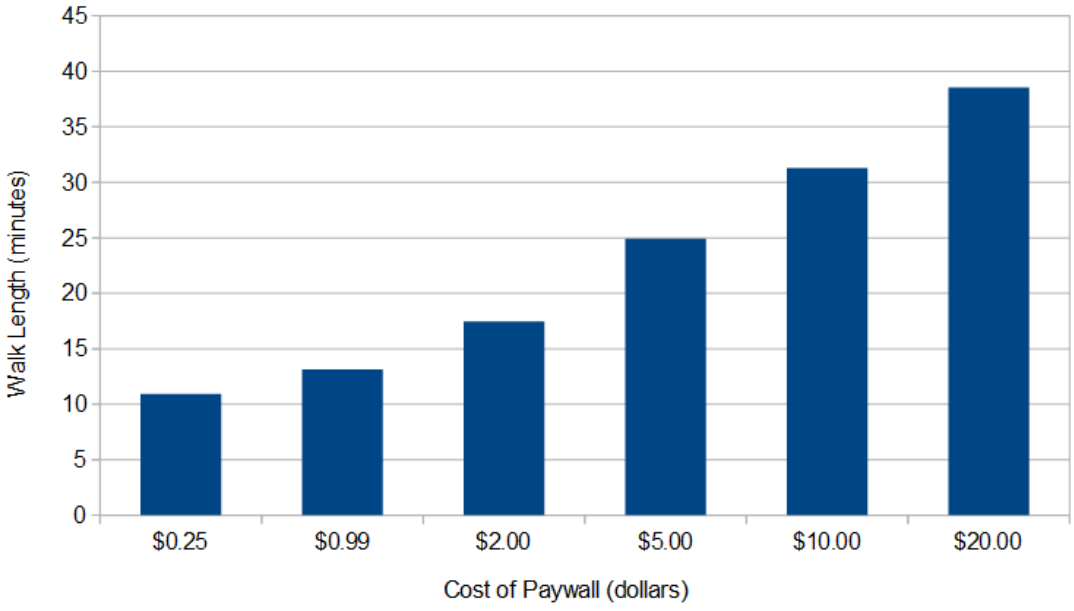

Figure 2 *This chart shows the user responses to the question "If you were playing a game and had to get through a wall for X dollars, how long would you instead walk to get through the wall?" The x-axis shows how much the wall would cost while the y-axis shows how long (on average) the users were willing to walk. A standard deviation of approximately 18 applies to each set of data.*

Figure 2 shows the average amount of time users would be willing to exercise to get through paywalls. The X-axis represents prices often used to purchase in-game currency in mobile games. The Y-axis represents how long users would walk to avoid paying that amount of money. As Figure 2 shows, users would be willing to exercise an average of ten to forty minutes, steadily increasing as the cost goes up, in order to avoid paying through paywalls.

3.3 Prototype

Given our goal of trying to understand users' interactions with paywalls and the feasibility of creating a new form of paywall, the exer-wall, we developed our own mobile game so that we could have full control over the code implementation. We specifically wanted the ability to insert exer-walls at various points in the game, as well as have control over parameters such as the steps required to get through the exer-walls. We also needed the ability to collect data on player choices. Our first step was to decide on which platform we would develop our game. Both Android and iOS have the capability of counting steps but we found that developing in Android would be easier for us to complete within our time-constraints given our previous knowledge from the advanced Mobile and Ubiquitous Computing course at WPI.

Developing a polished mobile game in only a few months was challenging. We investigated frameworks that could help speed up the development process. After looking at different frameworks such as Andengine[6], Unity, Cocos2D[7], and many more we decided that the Libgdx framework would suit our needs best. The reason for choosing Libgdx was that we had previous knowledge in the code base of the framework, so our development could be more

[6] http://www.andengine.org/
[7] http://www.cocos2d.org/

focused on creating content for the game rather than trying to understand the underlying workings of the framework.

We started brainstorming ideas for the mobile game making sure we could implement an exer-wall at some point during the gameplay. Our brainstorming led us to the idea of procedural content generation. Procedural content generation, algorithmically generating content in games, has many benefits when creating a mobile game such as assets reuse, built in replayability, and faster implementation. This allowed our game to be polished by experiment time with less time spent implementing the game content.

Our second decision was agreeing on the graphical style of the application. We chose to go with a minimalistic style because it would not only be faster for us to generate artwork using the Adobe Photoshop and Adobe Illustrator programs, but it would also work well with our procedural generation of images by having simple shapes to work with.

Our third decision was the setting of the game. We believed that choosing outer space as our setting would give us the opportunity to make an interesting game that procedurally generates different minimalistic looking planets. Using outer space also opened up a few different possibilities for where paywall blockades could be placed. A game involving flying around the galaxy to different planets can limit a player who wants to continue flying through paywall restrictions on fuel.

3.3.1 Pre-game Coding

Because our experiment needed to record information from players such as their daily steps and number of times the app was opened, we set up an online database that could receive post data from the users who participated in our study.

Next we designed a screen transition system that allowed button actions to animate the current screen into a new screen. This functionality was not built directly into Libgdx but was important to how our core game engine functionality worked.

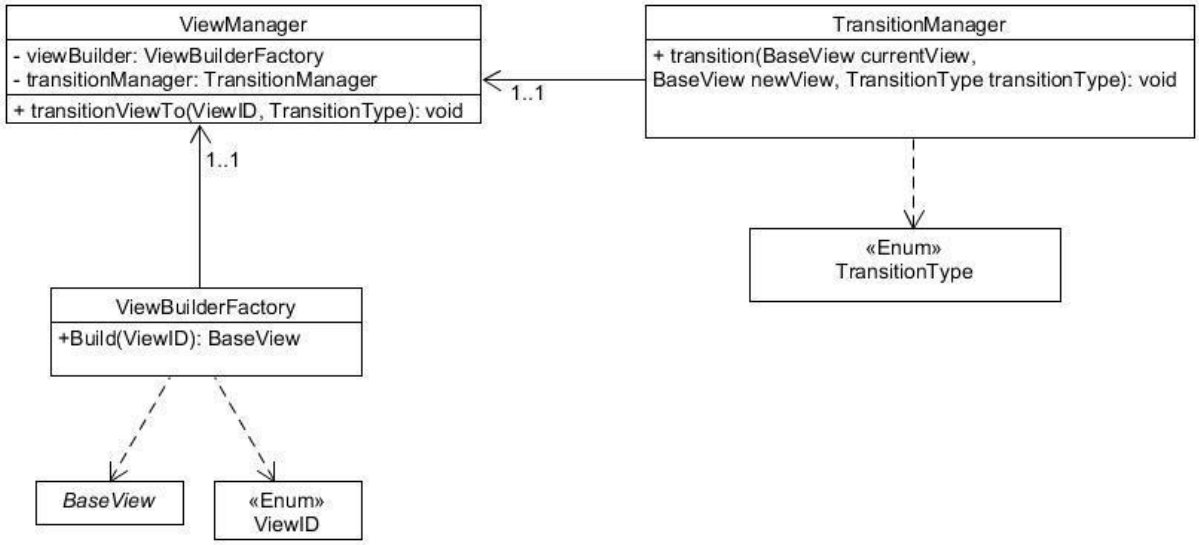

Figure 3 *This model is a class diagram displayed in UML which shows the setup of creating and transitioning between different views in the game.*

The Transition system seen in Figure 3 uses the Factory Builder design pattern that recognizes different views by their Enum IDs and handles them by using a view builder factory which creates the appropriate view to transition to.

Another major coding prerequisite was understanding Libgdx's asset loading system. At first we tried using the assetloader singleton that came with the Libgdx framework. This class allowed us to load and unload assets into textures (gltextures) that we could use later in our program. The asset loader worked well with few images, but problems arose when we began load many different images to be rendered on the screen at once. The problem was not so much that we had too many images but instead was a problem with the order textures were being drawn. For example, if we had two images that were both rendered one hundred times on the

screen, then we could have two scenarios. Scenario one would draw one hundred of the same texture and then one hundred of the other texture. This caused us to only have to make two opengl draw calls. In scenario two if we alternated drawing the images than at the opengl level we would swap the bind textures and make a new call resulting in two hundred draw calls. After understanding this functionality in Libgdx we decided to create asset sprite sheets which could be loaded into Libgdx as a single texture and then be broken down by specific asset atlas regions.

Figure 4 *A sprite-sheet created using the GDX texture packer which combines images into a single image to minimize in-game draw calls.*

An example sprite sheet is shown in Figure 4. This solution greatly sped up performance and enabled drawing many images on screen such as stars in the galaxy. Our understanding of how Opengl operates came from taking senior level computer graphics course at WPI (CS 4731)

where we worked with Opengl 4.0 which is very similar to the Opengl es which is the mobile version utilized by Libgdx.

3.3.2 Initial Game Design

The initial game design was the starting point which allowed us to decide that we wanted the game to take place in space and that we would be dealing with stars and planets. In the initial game, players play as a randomly generated character that was selected on the character creation screen show in Figure 5.

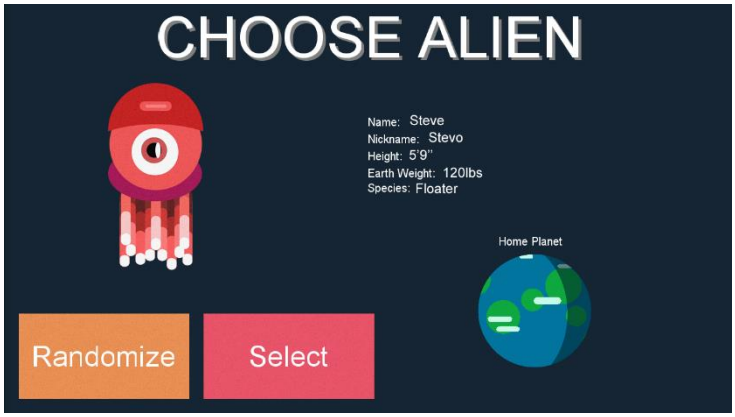

Figure 5 *Create Alien screen used in initial game concept. The screen allowed a user to randomly generate an alien to be used as the main character in the game.*

The goal in the initial version of the game was to climb the leaderboards by getting as many Mega crystals as possible. To get Mega crystals a player needs to convert their other currency, R, G, and B, crystals into Mega crystals. RGB crystals could be obtained through numerous different ways in the game. The main way was by having a character fly in their spaceship to a specific solar system. Each solar system had a random number of planets revolving around a sun that could then be flown to. Once at a planet the player had the ability to either mine, destroy or build an army on the planet as seen in Figure 6.

Figure 6 *Planet option screen used for deciding the fate of the current visited planet. Players would have 3 options when encountering a planet: mine the planet, destroy the planet, or build an army on the planet.*

Mining a planet gave players the ability to pump crystals out of the ground using an oil rig looking machine. Destroying a planet let the player shoot a laser at the planet which blew it up and gave the player crystals with the potential to earn a special capsule. These capsules could be opened later to receive a random amount of bonus RGB crystals. Finally building an army would let the player clone his/her character on the planet and over time this army of aliens would set out to capture new planets which could then be mined, destroyed, or armed with more aliens.

We started by designing this version of the game visually so that we would have an idea of how the game should look when we were to implement the functionality later on. Each of the screens for the game were drawn in Adobe Photoshop. We then implemented most of this version of the game adding in animations that were not depicted in the original drawings. The animations ranged from sprite animations to interpolating animations. Libgdx has some base code for creating animations but we leveraged our past knowledge from the senior level computer animation at WPI (CS 4732) to understand how to create certain animations such as the flying spaceship or the planet destroying laser beam. The code for this version was only at boilerplate level. This means that we implemented the functionality of navigating through all the different screens we had drawn up but did not necessarily complete the underlying functionality

that would be completed in the final version. The reason for this was so that we could quickly implement our idea to show to the focus group and also not waste time finishing a version of the game that would end up being different than the final version of the game.

3.4 Focus Group

After beginning development on our mobile application conducted a focus group with mobile game enthusiasts. Our goal for the project was to create a game that is interesting enough that paywall experiments with the game would not be skewed because people did not like the game, or that it was confusing or difficult to play.

We decided to present our initial game to subjects in a focus group and ask the group questions about it. To recruit subjects for the focus group, we reached out to friends who we knew were avid mobile game players. When emailing the potential candidates, we had them fill out a survey which allowed us to see when the best time would be to host the focus group so that we could have as many of the potential candidates make it. After settling on a date we rented out a room and met up with our focus group members. We also ordered pizza as an incentive for the members to attend the focus group.

We developed a set list of topics to discuss in order to get feedback on current ideas or implementations and to help spark discussion on new ideas. The list of discussion points we touched on during the focus group is as follows:

1. *Sound*: Is sound needed to have a successful game that could keep people entertained? Do different types of sounds in the game matter, such as background music or sound effects?
2. *Graphics*: Is the current artwork made for the game appealing for players?

3. *Storyline*: Will players need a storyline for the game to become interested or intrigued with the game? If so would players prefer that the storyline was integrated in the app through opening game cut scenes or would discussing them in the directions be sufficient?

4. *Currency*: Do you feel excited to get currency in the game? What makes currency valuable? Does a single currency work better in games or does having many different currencies which are used for different purposes work better?

5. *Planet Options*: The current game has 3 different options when flying to a planet, do these options seem balanced, equally interesting, and useful in the game?

6. *Character Customization*: Do players like the ability to create their own customized characters or is procedurally generated characters equally as appealing?

7. *Inventory Items*: What items would be interesting to see in the game that could add to the strategy of the game and also its overall entertainment?

8. *Login Bonus*: Would having some sort of reward for logging in be a good way to get players to keep coming back to the game every day?

9. *Rare Events*: Should there be extra content besides what normally occurs in the game to keep even the top time invested players interested in the game?

10. *Player Vs Player*: Is having the ability to play against friends more exciting than playing against an AI?

11. *Star Map Screen*: Should there be different types of stars in the game so that there is more meaning behind picking to fly to one over another?

12. *Graphic Map*: Would it be interesting to have a visual map of stars or planets that you have visited?

13. Name one thing you would like to see in the game.

14. *Pedometer incorporation*: Can you see yourself walking to get through exer-walls in the current game?

15. Where should paywalls be?

16. Would you play the game?

Topic	Before Focus Group	Feedback	Difficulty	Importance
Sound Effects	None	audio is important mostly sound effects	**Very High**	**Very High**
Meaningful Currency	RGB power and mega crystals	Planets give a specific Currency, has a specific purpose,	**Medium**	**Very High**
Collectibles	Currency	Hats or apparel for alien, "Pimping the ship", badges	**High**	**High**
Character	Simple pre drawn character	Modular alien where you can pick parts, drag and drop alien pieces, saving different randoms	**High**	**Medium**
Special/Rare events	None	Unique planets, other types of space structures, special stars, Black hole	**Very High**	**Medium**
Star Map	Scroll based map	Make map visually for planets owned	**Medium**	**Medium**
Story	None	Cut scene after character creation of some sort of text to set the scene for the game	**Medium**	**Medium**
Daily Bonus	None	Login bonus, steps taken bonus	**Low**	**Medium**
Player vs Computer/ Environment	Never ending resource farm	Boss battles, levels, end game?	**Very High**	**Medium**
Upgrades	Planet upgrades	Ship upgrades, character upgrades	**High**	**Low**
Player vs Player	Leaderboards	attack other players planets, steal resources,	**Very High**	**Low**
Ship	Simple pre-drawn ship	Different skins and colors for ship	**Medium**	**Low**
Background sound	None	good background music could be nice	**Medium**	**Low**
Easter eggs	None	Matt Damon level, John Cena, Star wars things	**Very High**	**Very Low**

Table 2 *denotes each focus group topic discussed with their ranked difficulty to implement and importance for the game. The table also shows what the original game had that fell under each topic and the specific feedback given by focus group members on each topic.*

The focus group lasted one hour and had its audio recorded so that we could go back and transcribe the discussion. The transcription can be found in Appendix B. To analyze the topics discussed, we went through each item and rated its potential difficulty to implement along with

perceived importance for the final version of the game. The rating scale was as follows: Very Low, Low, Medium, High, and Very High. This applied to both difficulty level and importance of implementation. These ratings can be seen in Table 2.

Of all the topics documented in the chart above, our final game design incorporated: Meaningful Currency, Story, Collectibles, Player vs Computer, Upgrades, and Special/Rare Events. By selecting these aspects of the game to focus on incorporating, we would be able to accomplish all topics with an importance level of “Very High”, “High”, and some of the “Medium” excluding sound effects which we did not have time to create. After selecting these topics, we changed the objective of our game while still keeping the overall theme of flying through space to procedurally generated planets. The reason for making this change was that there were several aspects of the original idea that would be difficult to implement properly and the idea left little room for us to accomplish adding in the extra topics that were discussed during the focus group. We went back to brainstorming a new direction for the objective of our game that could better incorporate the feedback from the focus group, but also still be manageable for us to complete within time constraints.

3.5 Mobile Game

After deciding on the improvements extracted from the focus group discussion, our game idea was finalized and programmed. The final game is called Laser Planets.

Storyline: In Laser Planets, the player is an alien traveling in his/her space ship through space. You have discovered something about the planets in this universe which is that they are alive, and can shoot laser beams. You decide that you want to build a team of the strongest planets in the galaxy and defeat anyone who stands in your way.

Figure 7 *Chose home planet screen allows players to randomly generate a home planet which can differ in color, eyes, and planet attributes such as their size and energy output.*

Planets:

Planets are entities in the game that are used to laser battle against other planets. Each player starts the game by selecting a procedurally generated home planet. Each planet has a set number of attributes which are: planet size, energy output, base color, and globe rank. Each of these attributes will depict how strong a planet is. The planet size and energy output are used in the mini-games which are discussed later during a laser battle. The base color is used for determining color wheel bonuses against enemy planets. The globe rank is a concise way of displaying to the player in a single number what tier or rank the planet is currently at. This number is used by the player when determining which enemy ranked planets it can potentially defeat in a laser battle. Planets also vary in appearance by their procedurally generated land and cloud masses in both color and size along with their eye designs.

Exploring:

In the game the player can explore stars by flying to them on the explore screen. Each star is a specific color. Red stars (red dwarfs) consist of a solar system with planets whose ranks range from 1-15, white stars (white dwarfs) 15-30, and blue stars (blue giants) 30-50. Each star

also has the potential to be rare which means that there is a high percent chance that planets in that star's solar system have rare eyes or are wearing a power-up hat.

Figure 8 *Explore screen is where players can select a star as they float by in order to fly to that specific stars solar system. Each time the player travels to a new star a fuel unit will be used.*

In order for the player to fly to a star he/she needs to use up a fuel unit. Fuel units allow the player to navigate their spaceship from star to star however when the player has no more fuel units he/she needs to replenish the units before being allowed to travel again.

Solar Systems:

Each solar system in the game is randomly generated with between one and six planets which revolve around the systems star. The planets display their rank and show their base color. When a planet is selected, the player is asked if he/she wants to fly to that planet. Flying to a planet allows the player to begin a laser battle using one of his/her own planets against the one they are visiting.

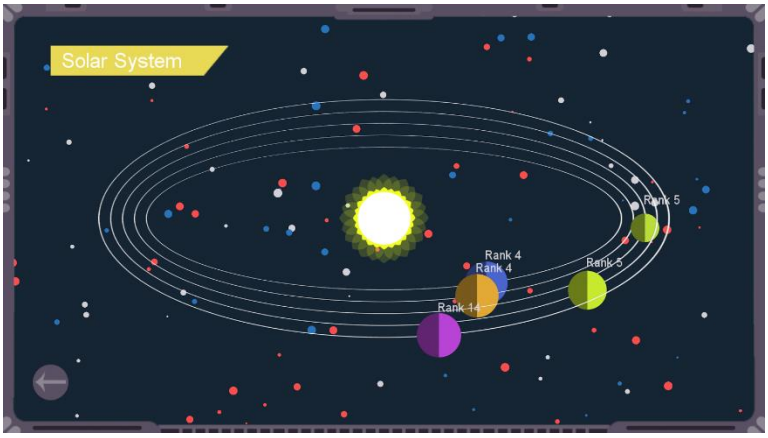

Figure 9 *Solar System screen shows a stars revolving planets each with their rank displaying above the planet. Selecting any of the planets will allow the player to fly to that specific planet and begin a laser battle.*

Laser Battle:

A laser battle consists of the player playing two mini-games which determines his/her planets resulting laser beam energy output. The first mini-game has the player press targets that pop up on the screen. The goal is to select only the targets that match the specific base color of the player's planet.

Figure 10 *Laser battle mini-game one has the player break targets that match their planets base color. Each target tapped will help add towards the planet's final energy output in the laser battle. Selecting any target that does not match the base color will deduct a point away from the total pressed.*

The second mini-game involves a power bar which slides between 0-100 percent power output. The goal is to time the power bar just right to receive the highest power output possible.

Figure 11 *Laser battle mini-game two has the player watch a power bar move between min and max with their goal of trying to stop the bar as close to max as possible. The bar moves more quickly the closer it gets to max making the task more challenging.*

Finally, the laser battle commences and the losing planet will become uninhabitable. If the player wins the battle he/she is given the choice between three options: absorb, take resources, or keep planet. Absorb allows the player planet to gain experience and rank up. Taking resources adds power crystals to the player's current amount. These crystals can later be used for buying items in the shop. Keeping a planet is an option that is shown if the user has an extra slot open in the inventory so that he/she can keep the defeated planet to expand their roster.

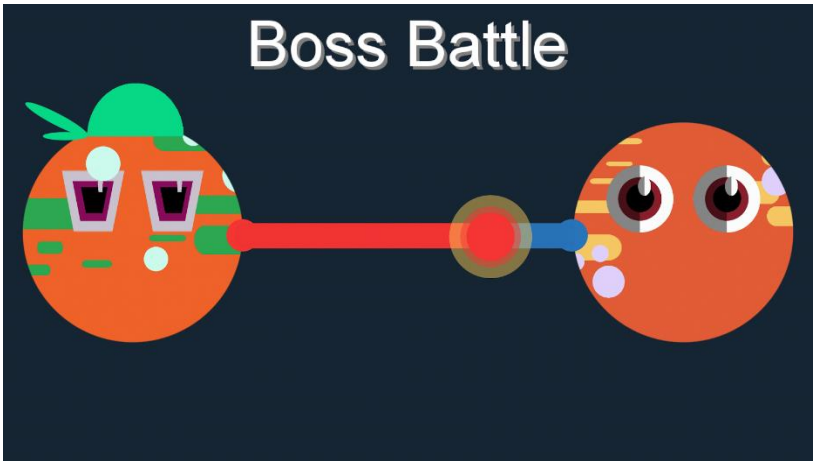

Figure 12 *Boss battle animation screen shows the laser battle animation with the winning laser beam eventually taking over the losing laser beam.*

Shop:

The shop allows the player to use their power crystals to purchase unique hats that cannot be found on planets normally in the galaxy. All hats have special power up abilities which can give a planet a bit of an advantage against enemy planets. Some power up effects increase the planet's strength if the planet is in a certain slot, making an enemy planet act as if it had a specific base color, or even having a small percent chance of a one hit knock out.

Figure 13 *Shop screen displays the different hats that can be purchased using power crystals. These hats are unique as they cannot be found anywhere else in the game.*

Manage Planets:

The manage planet screen allows the player to see acquired planets. Here he/she can change the order of the planets, release a planet, and swap in and out different hats for the planets. If a planet becomes uninhabitable this is also where the player can go to select to heal his/her planet.

Figure 14 *Manage planets screen shows a players current planets and general information about each planet. This screen allows players to add/remove hats from planets, release a planet, change order of planet slots, and heal uninhabitable planets.*

Boss Battle:

Boss battles are similar to regular laser battles except the player goes up against one of Boss Jim's planets. Jim's planets have a higher percentage of being rare and having hats. Each time the player defeats one of Jim's planets, he/she will be given mega crystals which are used to determine where a player ranks on the leaderboard. Every time the player beats Jim, his next planet increases in globe rank making each new battle more and more difficult.

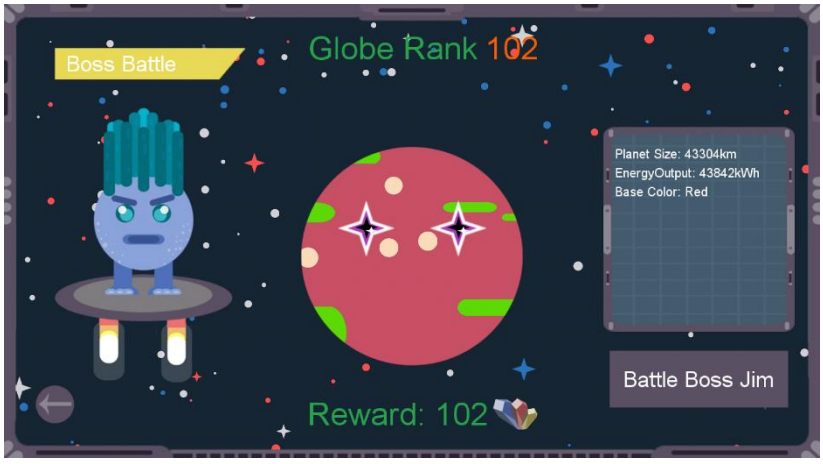

Figure 15 *Boss battle screen displays the current boss enemy planet that the player can face off against in a laser battle in order to win mega crystals. The mega crystal reward is directly related to the boss planet's globe rank.*

Leaderboard:

The leaderboard screen shows each of the players in the game and his/her current number of mega crystals. The more mega crystals a player has, the higher he/she will rank on the leaderboard.

Figure 16 *The leaderboard screen displays the current rankings of all the players playing Laser Planets. The leaderboard rank of a player is determined by his/her mega crystal count.*

The averaged game session length was predicted prior to the experiment to be around 2-3 minutes meaning that players were playing the game normally until they hit an exer-wall. The game was designed so that it could easily be played in short bursts seeing our initial research in which we found a study showing that most people use mobile apps and play mobile games in short time spans. The average mobile game session was 7.55 minutes as shown in Figure 17 (MarketingCharts 2015).

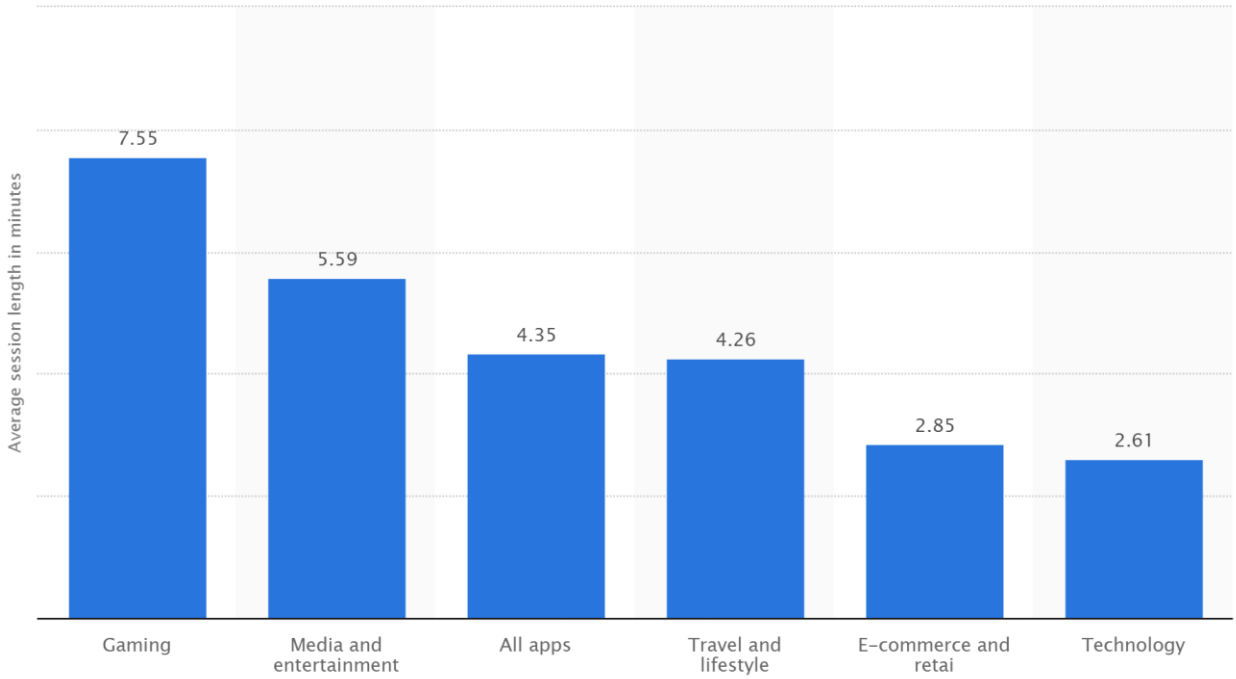

Figure 17 *Shows the average length of game sessions in different types of mobile applications. Games are shown to have 7.55 minute sessions on average which is the highest of all measured genre of apps but is still significantly lower compared to traditional video games. (MarketingCharts 2015)*

4 User Experiment with Exer-Walls

4.1 Paywall Implementation

In order to test if exer-walls are a good option compared to wait-walls, we selected places in the game to present the player with the exer-wall. For the purpose of the experiment, we did not use a paywall which allowed a player pay through the wall, instead focusing specifically on the walk compared to a wait option. In the game there were two different places where our exer-wall was implemented. The first location was in the explore screen. When a player runs out of fuel units, a new button appears on the screen that, when pressed, opens a popup telling the player what must be completed in order to continue.

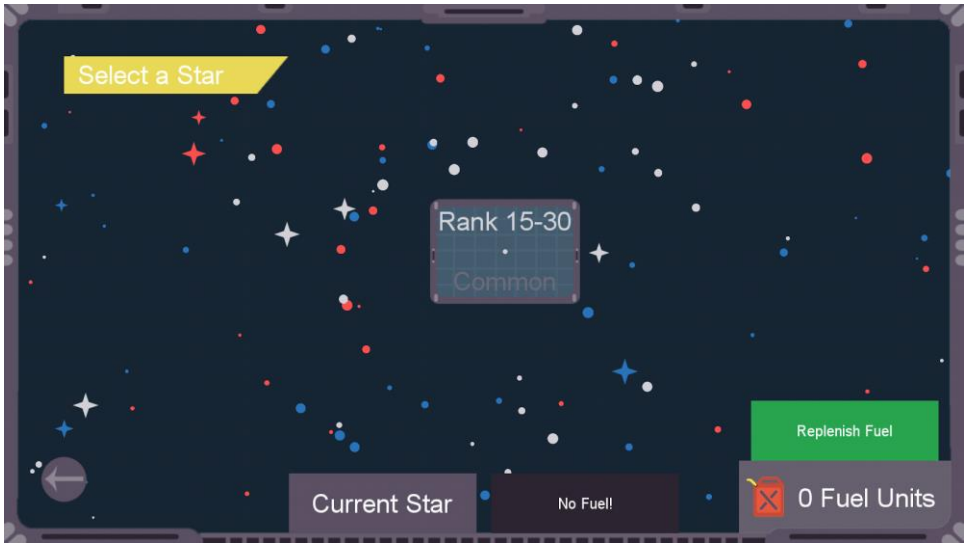

Figure 18 *Explore screen showing the replenish fuel button which appears when the player runs out of fuel units. When pressed the replenish fuel button will display an exer-wall to the player.*

One of three options would be randomly presented to the player. The first only shows the option to wait 20 minutes in order for their fuel units to replenish. The second option requires that players walk 300 steps in order to replenish the units. The third option allows a choice between walking the 300 steps and waiting for 20 minutes. These step counts and wait times

were selected based on the responses we received from our initial survey. On average we estimated 300 steps would take about 3-4 minutes to complete which is slightly lower than what the average person on the survey said they would be willing to walk when presented with a 20-minute wait option.

The second place where there was be an exer-wall in the game was when a planet became uninhabitable. If a player's planet lost a laser battle, then it needed to be healed on the manage planets screen in order for it to be ready to battle again. Pressing the heal button on an uninhabitable planet caused a pop up similar to the one for fuel units. The only difference was that instead of 300 steps and 20 minutes, the amounts would be 150 steps or 10 minutes. The steps and wait time for this wall were less because players were to encounter uninhabitable planets much more often in the game so we did not want to halt game progression too aggressively. These exer-walls allowed us to compare user behavior when looking at the two specific tasks of walking and waiting at a wall.

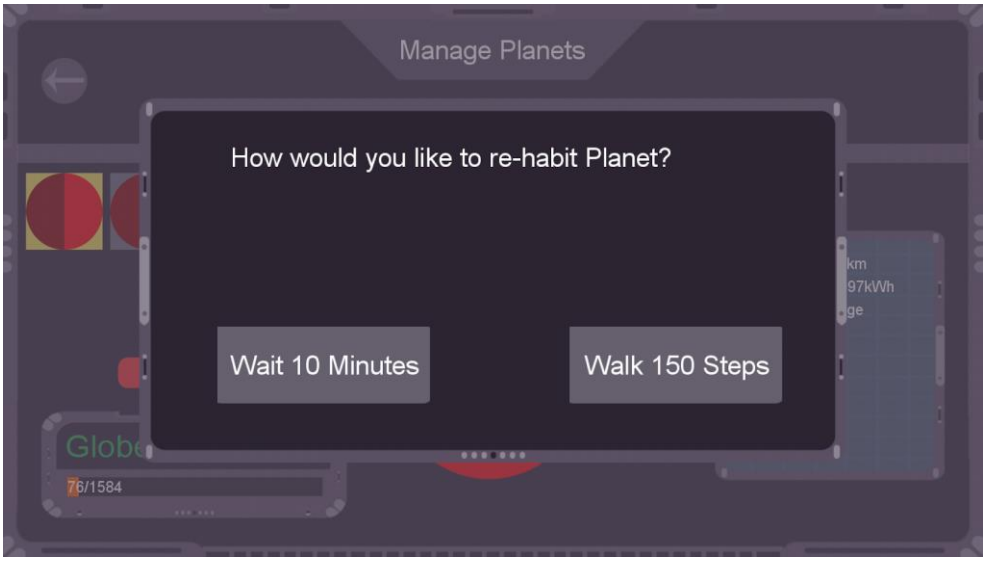

Figure 19 *Exer-wall popup shows options to the player which they must complete in order to either replenish fuel or heal a planet. Randomly the popup will only give the player the choice or walking or waiting while other times it will allow them to select either.*

4.2 Recording Data

The best way for our experiment to collect data about player's activity in the game was to have the game interface with a web server where we could store information on a database.

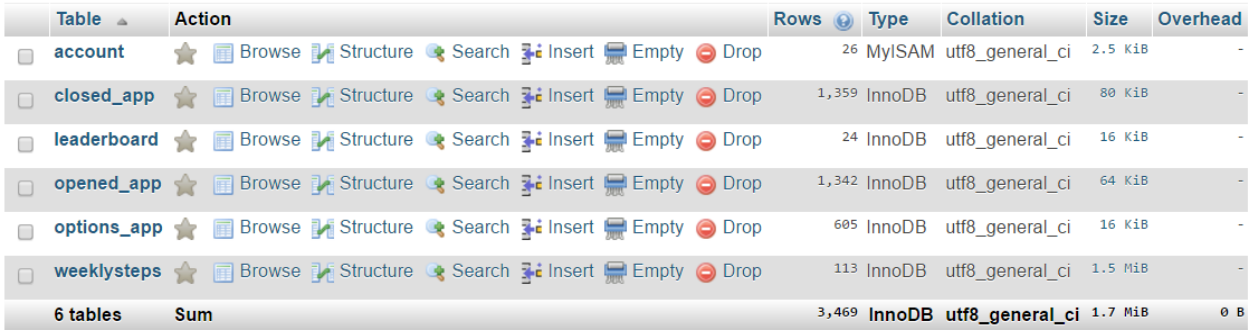

	Table	Action	Rows	Type	Collation	Size	Overhead
☐	account	Browse Structure Search Insert Empty Drop	26	MyISAM	utf8_general_ci	2.5 KiB	-
☐	closed_app	Browse Structure Search Insert Empty Drop	1,359	InnoDB	utf8_general_ci	80 KiB	-
☐	leaderboard	Browse Structure Search Insert Empty Drop	24	InnoDB	utf8_general_ci	16 KiB	-
☐	opened_app	Browse Structure Search Insert Empty Drop	1,342	InnoDB	utf8_general_ci	64 KiB	-
☐	options_app	Browse Structure Search Insert Empty Drop	605	InnoDB	utf8_general_ci	16 KiB	-
☐	weeklysteps	Browse Structure Search Insert Empty Drop	113	InnoDB	utf8_general_ci	1.5 MiB	-
	6 tables	Sum	3,469	InnoDB	utf8_general_ci	1.7 MiB	0 B

Figure 20 *MyPHPAdmin image showing each of the database tables created for collecting data in the experiment.*

Our database consisted of 6 tables: *account*, *closed_app*, *leaderboard*, *opened_app*, *options_app* and *weeklysteps* which are shown in Figure 20. The *account* table was only accessed when players first began using the application. The table was used for saving a player's username and Player ID. The table also verified the current username had not already been taken. The *leaderboard* table was used to record a player's number of Mega Crystals in the game. The Mega Crystals update the player's database entry each time they defeated a boss in the game. This table was also used on the leaderboard screen to populate the current list of players and their leaderboard rankings in order of highest Mega Crystals. That way players could see how they ranked against the other players in the game.

Opened_app and *closed_app* tables recorded each time the player opened and closed the application. The data was saved in the table using the username of the player and saved a timestamp of when the call was made. The *options_app* table had a similar purpose except it saved data entries each time a player made an exer-wall decision in the game. There were four different outcomes for an exer-wall in the experiment which were: walk, wait, choice walk, and

choice wait. The walk and wait options only gave the player a single choice of what they could do in order to complete the exer-wall. As explained earlier, this choice was randomly determined to be walk, wait or an option for the player to make the choice of walking and waiting. These decisions were saved into the database along with the player's username and a timestamp of when the action occurred.

Finally, the *weeklysteps* table was used for saving step information about the players in the experiment. To make sure that every player had their step information recorded by Google Fit, we asked the players in the directions, which can be found in Appendix C, to install the Google Fit app and to open it once so that google fit could begin storing step information. When the players open up the application, the splash screen asked them to connect their Gmail account to Google Fit as shown in Figure 21.

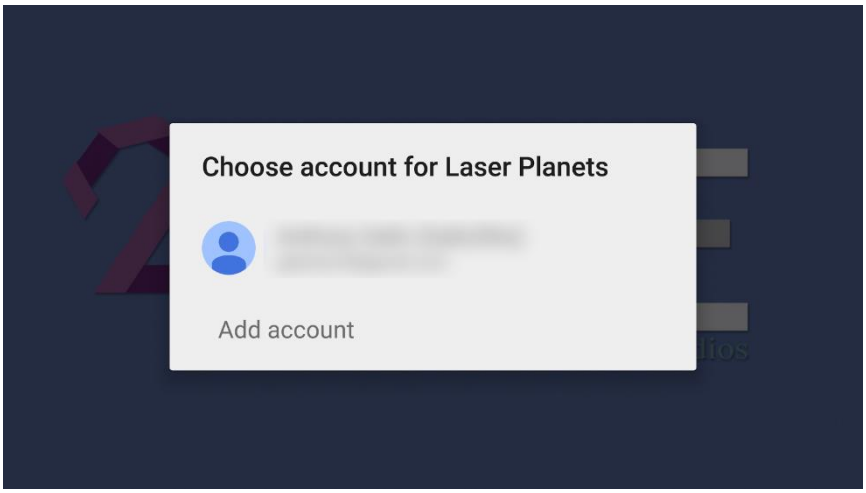

Figure 21 *Splash screen showing initial opening which will ask the player to link their Gmail account to Google Fitness and have them accept permissions to track activity.*

This allowed us during our experiment to keep track of player step activity recorded through their phone and other linked devices such as a smart watch, Fitbit, etc. Then by linking our app to Google Fit we retrieved past step information by using the History API. The History API allows a developer to specify a specific time period and interval to request steps from the fitness

database. For our experiment, we used the History API to retrieve the previous day's steps in 2 minute intervals. We then converted this information into an XML string to store each day of the player's step information in the database.

4.3 Experiment Procedure

The experiment was conducted for one week from April 5th through April 12th, 2016. Potential participants were contacted through WPI email aliases which described what participants would need to do in our study. We held a raffle for the participants of the study for two $25 Amazon gift cards. There was also a $50 gift card to Best Buy for the player that was ranked first on the leaderboard at the end of the week. The experiment started with the interested people filling out our pre-survey. This survey gave us some initial information about the demographic, their exercise habits before installing our game, and also made sure that they had an Android phone to use while participating in the experiment. We ensured that the game would work on Android devices. Next, those that completed the survey were asked to fill out an IRB consent form for the experiment which can be found in Appendix C. Each person that signed the consent form was given the game as an APK file through email with a link to an instruction document. An APK file is a file that Android games get compiled into which when moved onto a phones storage and can be manually installed without having to go through the Google-Play Store. The instructions described how to install the APK file onto their Android phone and also included a short walkthrough of the game itself. The directions given to participants can be found in Appendix D.

We asked each of the participants to use the application at least once per day for a week so that we could record data about his/her behaviors in the game along with their daily step information extracted from the Google Fit History API. At the end of the week we had participants fill out a post-experiment survey which asked some closing questions about the game and exer-walls. The key questions were related to the frustration felt with the exer-walls and whether participants felt that they had increased their exercise over the course of the week. The full set of survey questions can be found in Appendix E.

5 Results

This section describes the data collected from the one week experiment. The experiment had users play our mobile game and encounter exer-walls throughout their playing. Data was collected from April 5th through April 12th, 2016. Participants daily step counts and in-game activity was recorded for this week.

5.1 User Demographic

We had 21 students from WPI as participants in the experiment. Of the 21 players only 5 were female with the rest answering male. The ages ranged from 18 to 31 with the median age being 21. Only one of the participants was not a student, the rest were studying Engineering or Computer Science.

5.2 Analyzing Data

After completing the experiment, the data collection was stopped and each of the database tables were downloaded into CSV files for analysis. This data was analyzed with different graphs that could display our results in a meaningful way. As mentioned earlier, the participant's previous days steps were saved the first time the app opened on any given day. This ended up causing issues for us when trying to collect a participant's step data if he/she did not open the app on consecutive days. Therefore when making comparisons against participant's daily steps, there were several days of missing data. Table 3 shows which dates we were able to collect step data for each of the participants. All underlined dates in parenthesis are days we have step data for even though the participants did not play the game on that particular day. Table 3 also shows the participants ages and genders which were recorded in the pre-survey of our study.

Participant Age	Participant Gender	Active Dates in April, 2016
21	Male	5/6/7/8/9/10/11/12
21	Female	(5)/6/(8)/(10)/11
31	Male	6/7/8/9/10/11/12
19	Female	7/8/9/10/11/12
21	Female	5/6/7/8/9/(11)
21	Male	5/6/7/(11)/12
20	Male	6/7/8/9/10/11
19	Male	(5)/6/7/8/(11)
22	Male	(5)/6/7/8/(11)
18	Male	5/6/7/8
22	Male	(10)/11/12
23	Female	6/7/(11)
22	Male	6/7/(9)
18	Female	7/8/(11)
19*	Male	6/7/8
21*	Male	5/6
22*	Male	5

Table 3 *Shows the participants and days for which we gathered step data. Due to our implementation, we could not gather data for days where the participants did not open the game, and some participants did not install or correctly set up the external application required to save step data. The dates in parenthesis have recorded step data, but no gameplay data. Users with asterisk next to their age did not fill out the post survey.*

Our pre-survey had 65 responses. Our target was to have more than 30 people participate in our study so we could make statistically significant claims from our results. Unfortunately not all of the pre-survey respondents participated in our study. The reason for this was that after completing the survey, potential participants needed to fill out a consent form before we could send them the game download. Many potential participants did not sign the consent form and were never given the game as a result. Of the 29 people who signed their consent forms, 21 of

those people installed and opened the game. After the week long experiment was finished, 13 participants completed the post-survey, found in Appendix F, which was emailed out to everyone who was participating. The post survey participants seemed to directly reflect the number of people played the game nearly every day.

There was 1,289 game sessions played between the 21 participants during the test week. The median game sessions per day for a player was 8 which gave us a significant amount of recorded data to analyze. In those game sessions, 78 hours 38 minutes and 5 seconds were spent playing the game. This averaged to about 3 minutes and 38 seconds per session, which corresponds to the prediction we made during development. When looking at total step data we did manage to collect from the week, we saw that our participants walked a combined 374,772 steps. This only amounted to 4,997 steps on average per day with a median of 5,391 which is half of the daily 10,000 recommended steps (Rettner, 2014). We did record during our pre-survey that 31% of participants only participate in 0-4 hours of physical activity per week and 40% from 5-10 hours. These answers show that the group of participants in the experiment are less physically active than recommended for a healthy lifestyle. If we were to have seen players favoring waiting over walking this could play a factor in that result

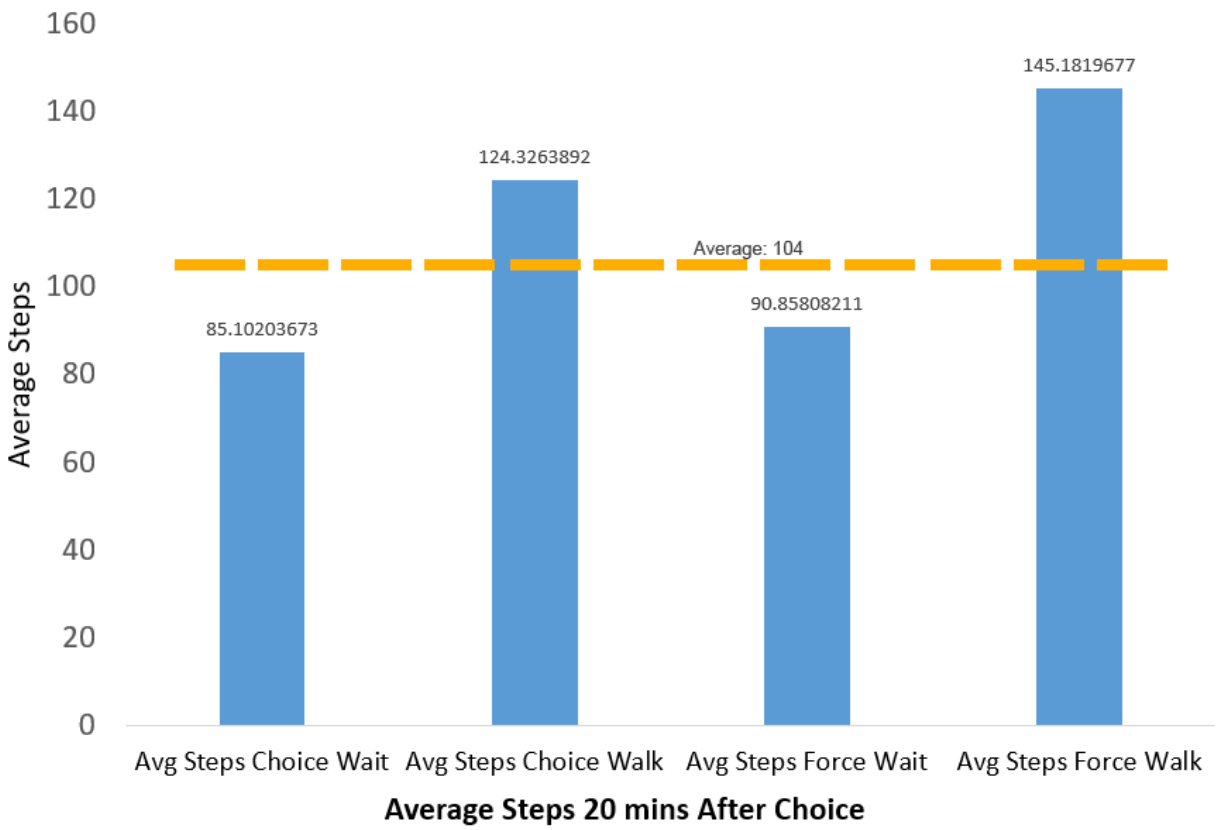

Figure 22 *Shows the average number of steps each player took 20 minutes after each exer-wall. This graph shows that player would take more steps on average when told to walk than when told to wait. They also walked more on average when they chose to walk than when they chose to wait. The orange line shows the average number of steps for a 20 minute time span given the player's average daily step count.*

Over the course of our study, the average step count per twenty-minute interval was approximately 104 steps. Figure 22 shows that the players who encountered or chose wait on the exer-walls walked less than the average step amount and those who encountered or chose walk, walked more than the average. When forced to walk we see that players saw the exer-wall as something they wanted to complete so they could get back to the game. However, our exer-walls were set at 150 steps and 300 steps but the average steps taken after participants were forced to walk was only 145 steps. Although this was still higher than the overall 20-minute average.

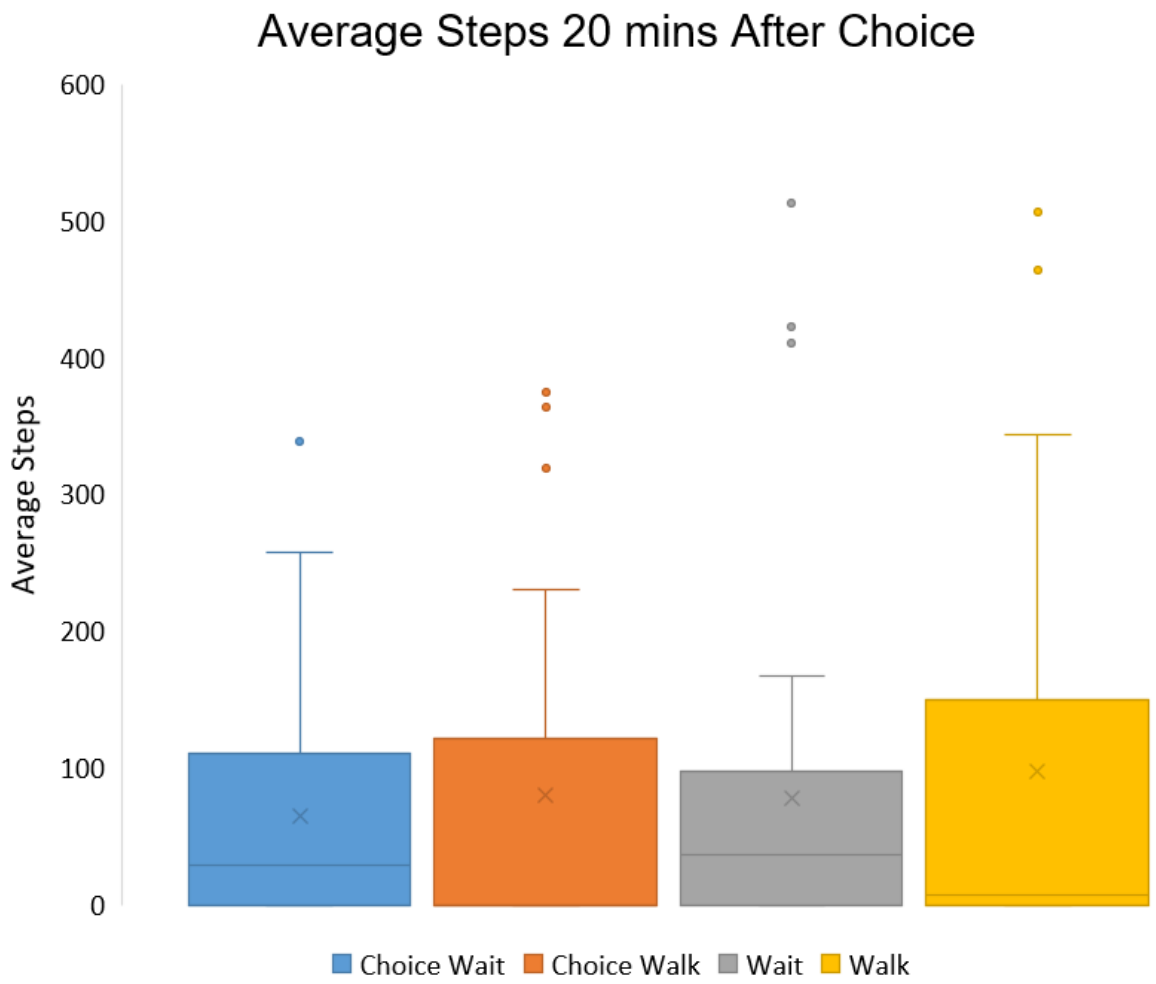

Figure 23 *Displays Figure 22 data as a box and whiskers graph. Each of the boxes shows that data was skewed after selecting an exer-wall option. The box and whisker plots show the lower extreme, lower quartile, median, upper quartile, and upper extreme along with some outlier values. Our plots have the same lower extreme and lower quartile for each graph which is 0.*

By looking at the results in Figure 23, we can see that our data plot may be too small to accurately see how a player's choice affects their step count. This was because out of our data we had many instances in which players walked zero steps for 20 minutes after selecting an option. The lower quartile for all four plots was 0. This was because each of the choices had people not walking any steps after making or being given one of the choices. The medians were 33.5 for choice wait, 0 for choice walk, 37 for force wait and 14 for force walk. The upper quartiles were 105, 110, 88 and 141 respectively. The highest observations for each were considered outliers and when looking at outliers off the graph at 1220 steps for choice walk, and 1178 and 828 steps

for force walk, we see that when given the choice or being forced to walk, there were some instances of players beginning a high level of physical activity. For a person to reach around 1200 steps in twenty minutes, it is very likely that he/she went for a run. Although we only saw this higher level of intensity behavior after the walk option, they were outliers to the rest of the data.

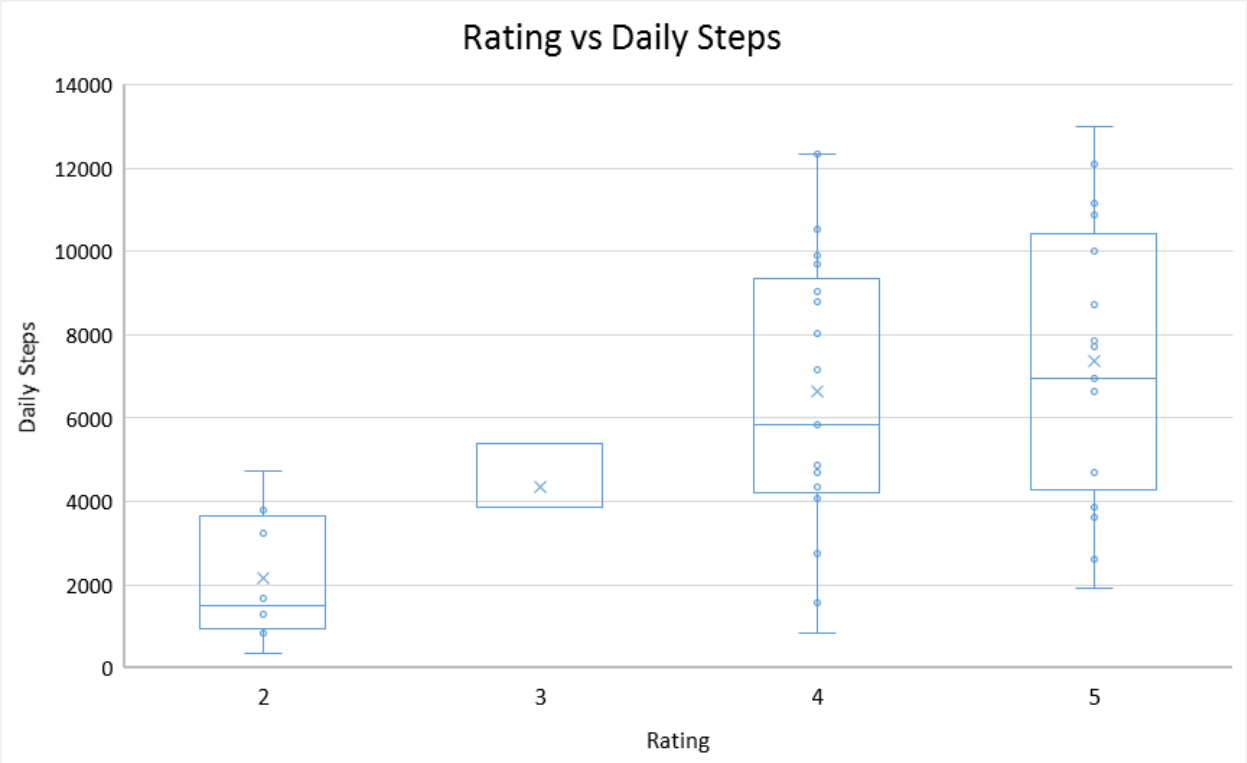

Figure 24 *Displays each player's step count (per day) relative to their rating of the game. This graph represents these data points in a box and whiskers plot. We can see that players who rated the game more highly, tended to have higher daily step counts.*

Players who were physically active with higher daily step counts generally liked the exer-wall game. In Figure 24 we have all players daily steps data plotted against how highly the player rated the game in the post survey. Players that gave the game a score of 2 and 3 (out of 5) generally had daily step totals below the daily step median of 5391. This may show that for some physically inactive players, the exer-wall concept of walking did not appeal to them. In the

future, it would be interesting to see if these players would have been players that would have paid to pass through the exer-wall. The higher end of the rating spectrum shows step counts evenly distributed above and below the median of the data meaning higher ratings did not directly affect daily steps. However, all of the players in our study that did have daily steps above the average generally liked the game. Further testing would need to be done on multiple different games to solidify our data correlations from Figure 24.

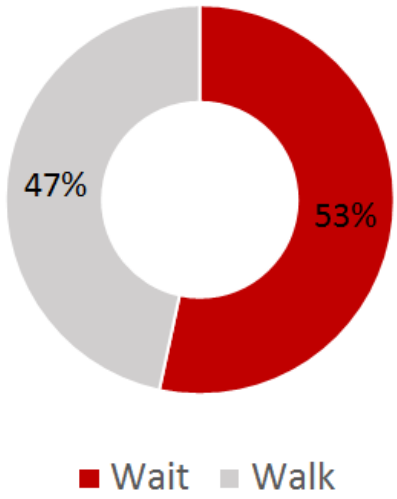

Figure 25 *This graph shows how often the choice to walk was made compared to the choice to wait. This only considers the times when players made the choice, not when they were forced into one of the options. Players preferred to wait more, but not by much.*

When looking at Figure 25 we can see that players chose to walk 47% or the time and chose to wait 53% of the time. These percentages being close suggest that players in the experiment did not have a strong preference of the choices. For waiting, people may have decided they did not want to get up and start walking or that they were in a situation where it would not really be feasible for them to walk. An example of this is if someone was playing the

game late at night, he/she might be playing right before going to sleep as shown in Figure 26. If they were presented with an option paywall at this time, we can see why waiting might be a better choice. If they were not planning on playing again until the morning, then they could benefit from sleeping by replenishing their fuel units and planets health in the game through the use of the "wait" option. On the other hand players may have noticed that the time it takes to walk the amount of steps would take less time than the wait time counterpart. For people that were already on the go, such as from walking from one class to another, the walk choice would be more convenient so they could get back in the game faster and be rewarded by being active.

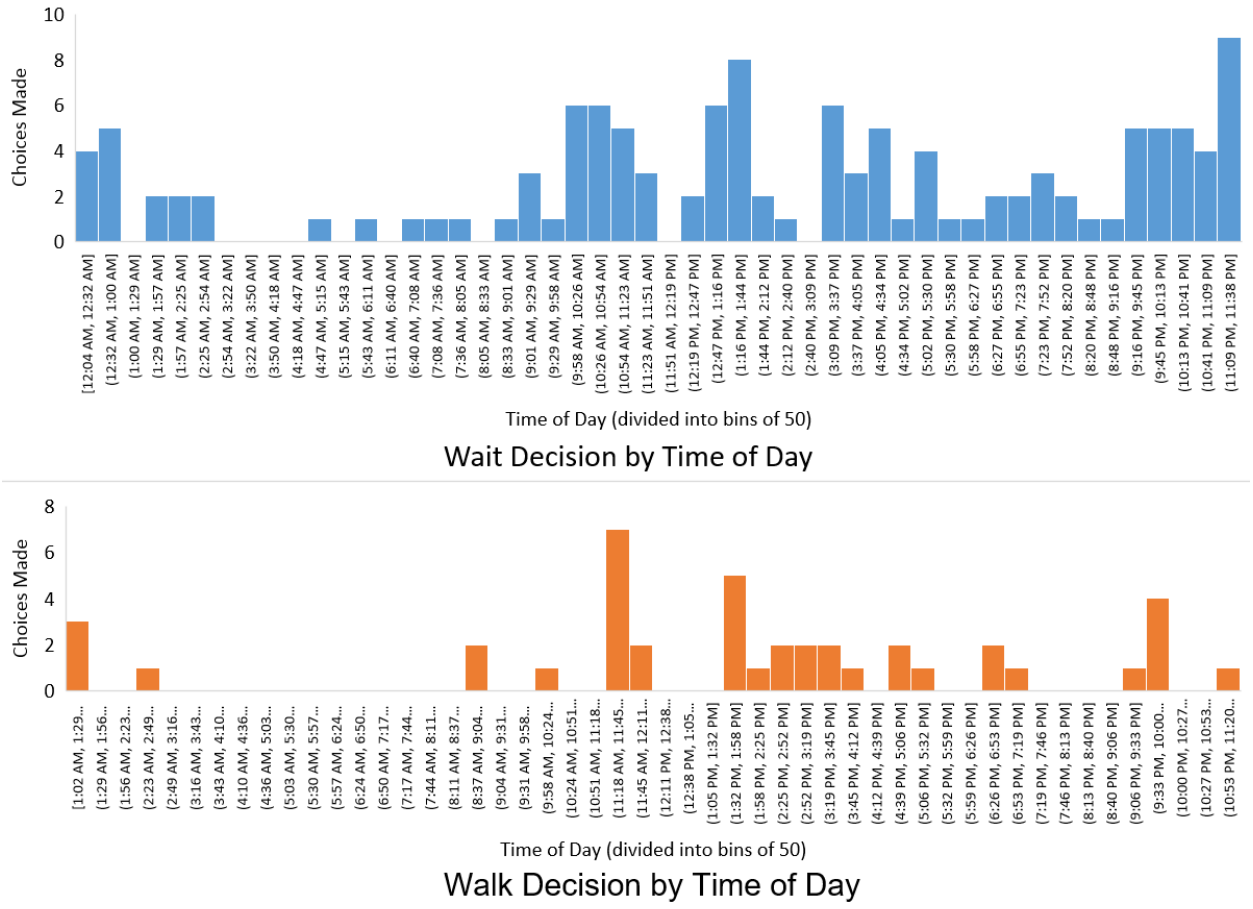

Figure 26 *Shows when players chose to walk vs when they chose to wait based on the timestamp of the exer-wall decision.*

Figure 26 analyzes whether or not players were preferring to select one option over another based on the specific time of day. The graphs have bars which display how many times a

player selected to either wait or walk in that specific time period. The graph split the day into 50 time periods because this way we could analyze the data where specific choices were being made throughout the day. From the graph, choosing to walk seemed to occur more often during the middle of the day. Choosing to wait seemed to occur evenly at any point in the day and was solely the choice of players who were playing the game very late or in the early morning. This can be attributed to the fact that whether or not the player wanted to, there is never really a time of day where they would not be able to wait through the wall. Walking on the other hand is different because people who are playing the game from a resting state, such as in bed, in a car, or public transport, might not have the option to get up and start being active. This means that players in a resting state who want to complete an exer-wall in the near future will choose to wait even if it takes longer than it would take to walk the given exer-wall steps simply because they are incapable of walking at the time. Having walking be a more limited task given the specific time of day, could actually work as an advantage for developers who could potentially see an increase in revenue from implementing exer-walls because people in certain situations will not be able to go for a walk.

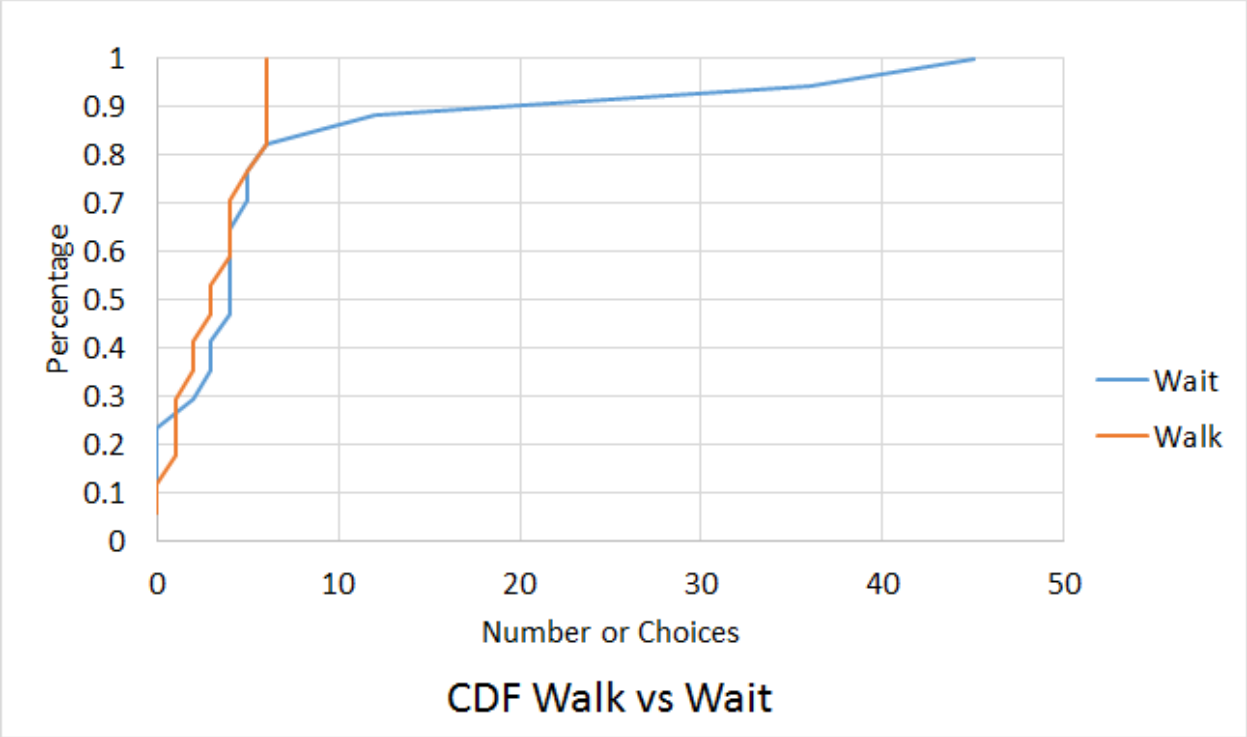

Figure 27 *This graph shows the cumulative distribution of walk and wait choices.*

Not all of the players chose walk and wait equally. We saw that some players were avid waiters while others avid walkers. Figure 27 shows that wait and walk choice numbers were similar seeing the lines are close together for a large percentage of the data however, because the blue wait line dramatically increases near the end we can see that some users went out of their way to wait significantly more than they chose to walk. The choice exer-wall allowed the players to tailor the paywall to what made more sense to them. Players almost equally choosing between walking and waiting helps to validate our claim of exer-wall feasibility since these choices could potentially be interchangeable.

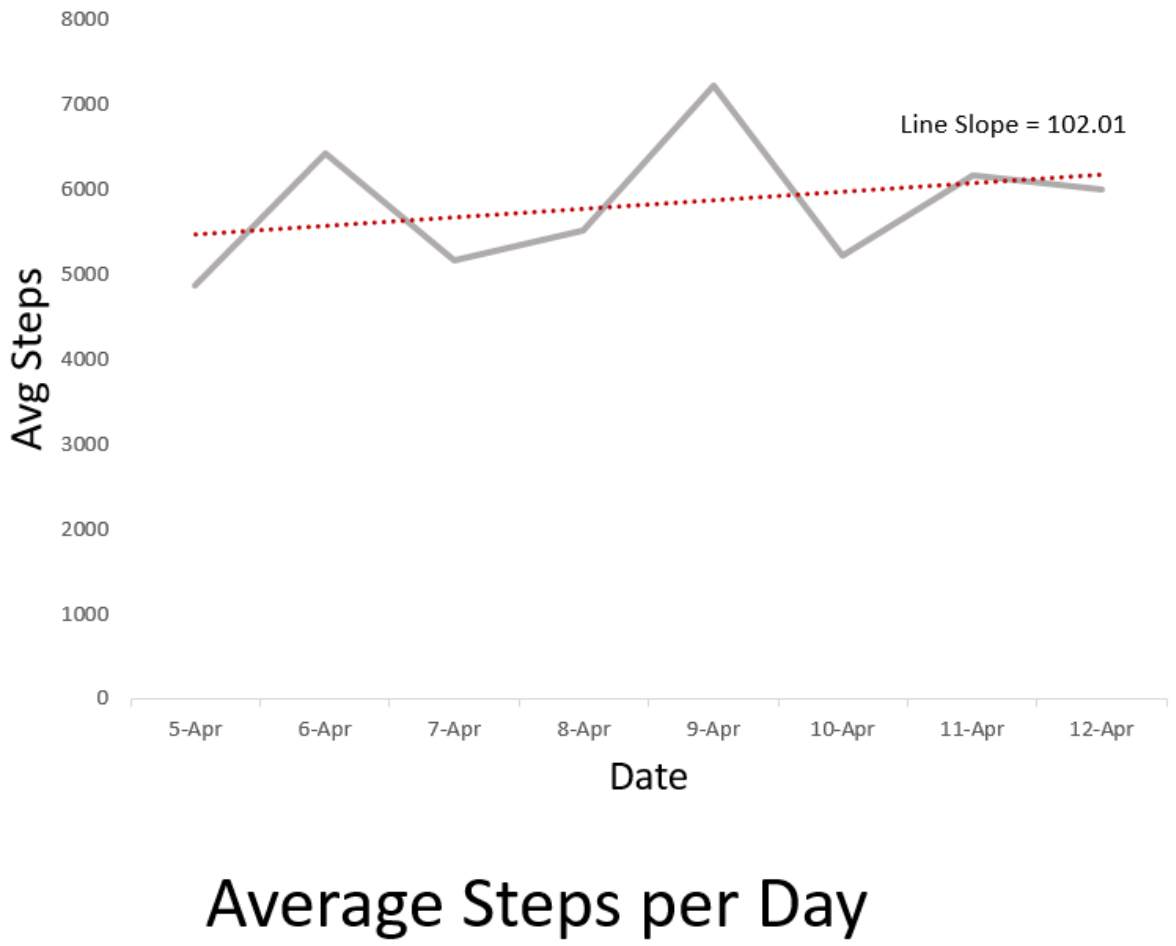

Figure 28 *This graph shows the average number of steps taken per day per players over the course of the week. The trend line is displayed, showing that players slightly increased their step count over the course of the study.*

In Figure 28, the average number of steps taken per day during our experiment is displayed. From analyzing the data it seems that the averages per day are not significantly different, however, we do note that the trend line for the average number of steps over the course of the week was positive. This positive trend is not significant enough for us to directly attribute a cause to the increase in step count to our game, but it could be one factor that contributed to the increase.

Average steps vary for people based on their weekly routine, weather, and specific day of the week. For us to better see any correlation between playing a game and an increase in average steps, we would need to have run the experiment for several weeks so that not only could we compare steps at a weekly level but also on a specific day of the week. If a player is very active on a Wednesday and we can see their activity on several Wednesdays over the course of several weeks, then we would have a better idea of whether or not having the app truly correlated with increase in steps.

Day	Temperature High/Low	Weather conditions	Average Steps
Tuesday, April 5	34/17 °F	Sunny	4868
Wednesday, April 6	38/18 °F	Sunny	6415
Thursday, April 7	52/38 °F	Light rain	5162
Friday, April 8	45/30 °F	Mostly cloudy	5508
Saturday, April 9	44/27 °F	Sunny	7227
Sunday, April 10	44/26 °F	Sunny	5222
Monday, April 11	55/37 °F	Cloudy	6170
Tuesday, April 12	53/33 °F	Light rain	5995

Table 4 *Shows the weather conditions and high/low temperature along with average steps for each of the days during which our experiment was conducted. These weather conditions may have played a role in players' daily steps on a particular day.*

When looking at the weather during our test week of April 5 through April 12 in Worcester, MA as shown in Table 4, we can see a varying range of weather conditions. As we see in Table 4, some days with reduced step counts coincided with poor weather conditions. Weather is a major reason why future studies on exer-walls will need to be conducted over a longer period of time so that data collected can reach its true average for daily steps counts and will make any correlation to increased step count stronger. For us to analyze this data in a different way, we can look at how many game sessions a player had in a single day and plot this versus their daily step count as show in Figure 29.

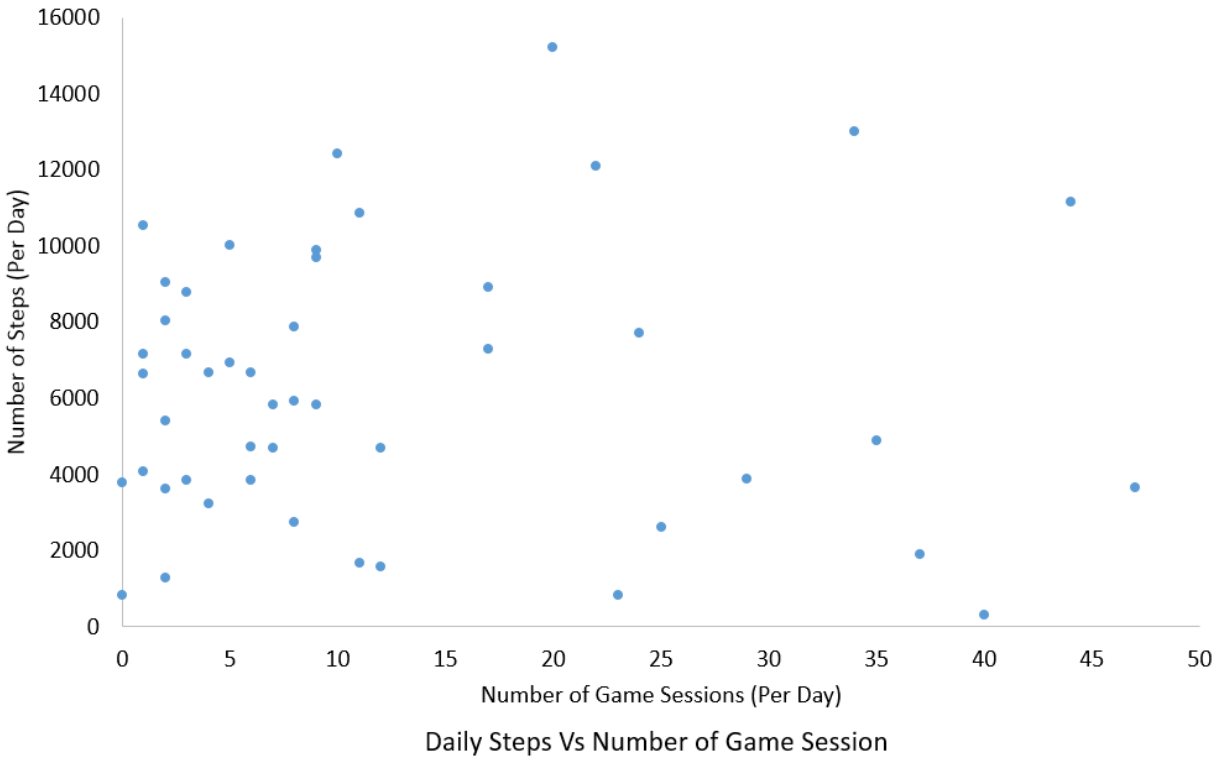

Figure 29 *This scatter chart shows player's daily step count compared to their game sessions. Each point represents one day of game use.*

Comparing daily steps to the number of game sessions per day can tell us more about how a player's overall engagement with the mobile game affected their step count. As we can see in Figure 29, most players on average opened the game between 0-15 times in a single day with daily step counts ranging evenly around the median.

Some of the players who played the game more frequently had some of the highest step counts out of all the players while the other avid player's step counts were average or below average. We can split players into active and inactive groups respectively. The active group consisted of players who averaged more than 15 game sessions per day. Active players may have higher daily step counts because they were trying to accomplish all the exer-wall walking tasks. With the average game session having approximately 6 exer-wall occurrences, it would seem feasible that these engaged players would need to walk to continue playing because of not only

the choice walk options but also when they were forced to walk. The inactive addicted players, may have been choosing to wait instead of walk when given the option which allowed them to have a high game session count but a low step count.

Figure 29 shows that engagement in the game showed no correlation to their number of daily steps. There are two potential causes for this: first of all, players can encounter an exer-wall with "wait". Secondly, the exer-walls we incorporated into the game had significantly lower walk goals compared the player's average daily step counts, which ranged between 4000 and 8000 steps. If half of the encountered exer-walls were "walk", then players would be asked to walk an average of 1800 steps per day.

6 Conclusions

Mobile gaming is a multibillion dollar industry (Pearson, 2014). Most of this revenue is generated from paywalls in free to play games (Grubb, 2014). Paywalls are generally frustrating to players, and potential players tend to avoid games that incorporate them. We propose exer-walls as an alternative to traditional paywalls. Exer-walls replace the wait timers of traditional paywalls with a step goal but could also use other physical activities in the future.

We conducted a survey to validate our claims of frustrating paywalls and to see the public opinion on our exer-wall idea. Then we developed a mobile game that incorporated a form of exer-walls to determine whether or not exer-walls would be effective in increasing motivation for players to exercise and in reducing frustration of paywalls. Finally, we ran an experiment for one week that had twenty-one players use our game so we could analyze their daily step counts and record information about their game habits.

Through data collected from our seven day experiment, we conclude that exer-walls can motivate players to increase exercise. We saw that players who either chose to walk or were forced to walk increased their step count immediately after encountering the wall. We also saw that players who enjoyed the game more also had greater step counts. Finally, we saw an overall increase in the average daily step count among all participants of the study over the course of the week.

We also saw in our experiment that players chose to wait almost equally as much as they chose to walk. This result tells us that the walk and wait options could be interchangeable with developers current business models staying the same. This is because if walking has just as many caveats as waiting does, than some players will continue to spend money to pay through the

walls. The difference is with the exer-wall, players that do choose to complete the task will have the added benefit of being active.

Participants indicated in the initial survey they had frustration towards traditional paywalls, even going so far as to refuse to play games that include them. When encountering our exer-walls, participants stated in the post-survey that the sense of accomplishment from completing the step goals significantly reduced their frustration with the exer-walls.

6.1 Future Work

While our research shows that exer-walls have potential to be replacements for patience-walls, there is room for future research. To better validate our findings, we suggest that exer-walls be tested with greater numbers of players and for more extended periods of time. Only twenty-one participants were active in our study, and we only collected data for seven days. Neither the number of participants nor the duration of our study provided enough data to guarantee statistical significance. As mentioned earlier, a longer study would allow for comparison between several weeks which would lower the significance of weather, and allows for day of the week analysis. A longer study would also want to look into collecting step data from participants both before they were asked to play the game and also after they stopped playing the game. That way the study could look at what the average steps were for each of the participants before being affected by the game to see if there was a significant change. Recording step data after finishing the game experiment could show whether or not the game had affected the lifestyle of the participants into a more active and healthy one.

Another direction of study would be in implementing exer-walls alongside in-app purchases. We were unable to compare the effect that exer-walls would have on monetization. In order to be a viable replacement for paywalls, exer-walls would need to have little or no impact

on the business strategies of mobile game developers. From our study we believed that there was several factors that are introduced with exer-walls that would not only show a similar amount of paying players, but potentially show an increase in total players. This was because although walking was more rewarding for the players, there were more limiting factors on whether or not a player was capable of walking given the specific time of day and what they were doing when playing the game.

It would be interesting in future studies to see if a significant increase in exer-wall walking tasks cause a larger spike in engaged player's step counts, as they would not be able to play the game as much without completing the larger step goals. When a player hits an exer-wall in our game, there is a chance for a force wait or for the player to choose to wait. These hybrid walls that were used for testing do not allow us to see what happens to a player's step count if they were to solely have to walk to complete an exer-wall. Having a pure exer-wall implementation could potentially show the correlation we were looking for; that either by chance or preference inactive players would not have a wait-wall and would need to walk to continue to be playing the game frequently.

Our exer-walls had only two lengths: 10 minutes or 150 steps and 20 minutes or 300 steps. These two exer-walls only appeared in one location each. Future points of study could vary the number and variety of exer-walls. The reason for testing more variety or exer-wall amounts would be to see whether specific walk amounts were able to affect the player in a positive way more than others. Whether that positivity be though higher step counts, more engagement, or more in-game purchases, it would be important to see the differences so that developers could tailor their games towards specific positive goals accordingly.

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Appendix A - Initial Survey

Q1 Select your Gender
- ❍ Male
- ❍ Female
- ❍ Prefer not to answer

Q2 Enter your Age

Q3 Are you a student?
- ❍ Yes
- ❍ No

Q4 What field are you studying?
- ❍ Engineering
- ❍ Mathematics
- ❍ Science
- ❍ Arts and Humanities
- ❍ Business
- ❍ Health/Medicine
- ❍ Social sciences
- ❍ Computer science

Q5 How many hours per week do you participate in a form of physical activity?
- ❍ 0-4
- ❍ 5-10
- ❍ 10-15
- ❍ 15-20
- ❍ 20+

Q6 What sort of physical activity do you do? (check all that apply)
- ❑ Walking
- ❑ Running/jogging
- ❑ Gym
- ❑ Swimming
- ❑ Recreational sports (soccer, football, ultimate frisbee, etc.)
- ❑ Exercise games (WiiFit, Kinect Sports, etc)
- ❑ Other _____

Q7 How do you use your mobile phone? (check all that apply)
- ❑ Gaming
- ❑ Phone calls
- ❑ Text messages
- ❑ Web browsing
- ❑ Music
- ❑ Watch videos
- ❑ I don't own a smartphone
- ❑ Tracking exercise
- ❑ Other _____

Q8 What do you use to track exercise?
- ❍ External device (Fitbit, Nike+, etc)
- ❍ Pedometer app
- ❍ Other _____

Q9 How often do you play mobile games?
- ❍ 1-4 times per month
- ❍ 5-15 times per month
- ❍ 15-25 times per month
- ❍ Once daily
- ❍ 2-5 times per day
- ❍ 5+ times per day

Q10 Before continuing, it is important to define a word that will be used in the rest of the surveyPaywalls: A "roadblock" in a game that inhibits progress by making the gamer do some action (make a purchase, play an ad, wait for a timer to expire, etc) before continuing in the game

Q11 Have you played games that include paywalls?
- ❍ Yes
- ❍ No

Q12 The following games all include paywalls, please check ALL those that you have played
- ❑ Clash of Clans
- ❑ Puzzles and Dragons
- ❑ Candy Crush
- ❑ Farmville
- ❑ The Battle Cats
- ❑ Marvel Avengers Academy
- ❑ Other _____

Q13 How likely are you to spend money on a mobile game?

- ❍ Extremely likely
- ❍ Moderately likely
- ❍ Slightly likely
- ❍ Neither likely nor unlikely
- ❍ Slightly unlikely
- ❍ Moderately unlikely
- ❍ Extremely unlikely

Q14 If you encountered a paywall preventing play for X minutes, how much would you pay to continue immediately?

_____ 1 minute
_____ 10 minutes
_____ 30 minutes
_____ 1 hour
_____ 8 hours
_____ 24 hours

Q15 If you encountered a paywall preventing play that costs X dollars, how long would you wait to continue without paying?

_____ $0.25
_____ $0.99
_____ $2.00
_____ $5.00
_____ $10.00
_____ $20.00

Q16 If you encountered a paywall preventing play for X minutes, how long would you instead WALK to continue play?

_____ 1 minute
_____ 10 minutes
_____ 30 minutes
_____ 1 hour
_____ 8 hours
_____ 24 hours

Q17 If you encountered a paywall preventing play that costs X dollars, how long would you instead WALK to continue play?

_____ $0.25
_____ $0.99
_____ $2.00
_____ $5.00
_____ $10.00
_____ $20.00

Q18 How does the presence of paywalls affect your playing of a game?

- I refuse to play games with paywalls
- I try to avoid paywalls
- Paywalls don't bother me
- I enjoy paywalls

Appendix B – Focus Group Transcription

So, we are doing this focus group to get feedback on this game that we are doing. We are getting ideas on the implementation.

Right now, we have a lot of the game developed, but we have a ton of wiggle room to modify and change things. We wanted to have the focus group to get your reactions on where to go and what we have done so far. Let us know any ideas, reactions, and opinions that you have. All of your input will be accepted and helpful.

We wanted to start with what we have for the game so far. The background for the game is that it's a mobile game for android that takes place in space. You are an alien with a home planet, a name, and other features. Your goal is to get as many mega crystals as possible. The only thing with mega crystals is that the more you have the higher on the leaderboard you are. You start out on a home screen where you are flying through space. You can explore the universe, and check out the leaderboard. We will discuss the other options later. We will take you through a short run of exploring. You start on a screen with a bunch of stars. You can select one specific one to spend a fuel unit to fly to that star. You have a limited amount of fuel units that regenerate over time. When you fly to a specific system, there will be 1-6 planets revolving around the sun. You can select one of the planets where you have 3 options on the planet. You can destroy the planet or mine the planet for resources or you can clone yourself to build an army on the planet. The mining screen has an oil rig that you can pump in order to mine resources. You will gain all of the different currencies from mining. There are some upgrades which provide faster mining and auto mining so that you don't have to be there to gain resources. You can build your army to attack other planets without your input. And there is destroying the planet where you will gain some different currencies. There are capsules that can be get from destroying the planet which will give you a spin for a random selection of currencies. You can view the leaderboard to see mega crystals and scroll through all of the players and stats. You will be able to view the number of planets you have and the number you have destroyed as well as your character. The manage planet

screen contains all of the planets you have taken over so that you can visit all of your own planets to purchase upgrades. That is it for screens, do you have any questions or feedback on the gameplay you have seen?

First off, the game looks cool. Tell about the resources you get from destroying or mining. Is there incentive to do any one? Do you get more of one resource from a specific action?

When destroying the planet you get a decent sum of resources but you can't go back to get more.

If you are mining, you get a little bit of resources. That is an investment to slowly get more. If you build an army you don't get any resources immediately, but your army will go out and claim planets for you that you can mine on or destroy.

The advantage to destroy is like a quick cash inflow while mining you build up sustainability and armies help you get around the fuel unit restriction.

Really, it is a short term, midterm, and long term investment with different gains.

Any other questions on the screens or clarifications on things? We have specific things to talk about in a minute, but we want to make sure you understand the game first.

What do you use the resources for?

That is something that we don't have screens for yet. Pretty much, you need to spend resources to build, mine, or destroy planets. The more planets that you have, the more expensive more planets will be. This helps slow growth so that newer players can compete. Also, to get mega crystals, you have to trade up your resources into mega crystals. You need to balance your leaderboard position vs your resources. Now that you understand what is going on in the game, we would like to talk about sound. Is sound something that, in a mobile game, you guys find very important?

By sound, we mean both background music and sound effects.

Yeah, background music is important.

Personally, I don't really like too many sound effects. You know, like beeping every time you press a button. But definitely background music and sounds with important animations. Like cool explosion sounds.

So cinematic things, not so much clicking of buttons?

Right, clicking can get really obnoxious, especially when you are clicking a lot because you are good at the game. I think music is also something that is good for the title screen and overviews, but sound effects with actions are more important.

Quick question, does "Battle cats" have music throughout the gameplay?

Yeah, different sound tracks for what you are doing.

So when you destroy a planet, you would play an animation that has the planet blowing up, have some action music or something to help amplify the effect. It won't sound as flat as if you just have an explosion and silence.

The way I am visualizing this is that you have kind of like a star wars style clone music when building an army or something.

Alright, jumping to another topic, how do you guys feel about the graphics? The simple shapes art style?

I think it works not just from a practical point of view but also stylistically. It is a good theme. The only thing is that some of the buttons and things feel flat.

One thing that is hard to see on the projector is that buttons and many of the other shapes are animated and change colors when pushed. The stars actually move across the screen, but we can't really show that through still pictures, sorry.

So, storyline. We wanted to know how you feel about plot. Does it matter to you why you are going out to get the mega crystals? Would you want a cut scene or something?

Maybe a little cut scene after creation to allow people to know what's going on.
We don't want something that shows up often, just once when first starting the game is good. It doesn't have to be really compelling, it just needs to set the stage. I would look at how "Darkest Dungeon" does their animation, I think that it could help you get ideas. They shift one frame around to show things moving, but their way of doing it is very effective.

Okay, moving onto the next topic. The currency itself. Right now we have 5 different objects. Does it matter if the currency feels and looks rare? Does the currency need to look like money? What makes you feel interested in getting it?

Well, hats or something to dress up your character would be cool. Like, the more wealthy you are, the more wealthy you look (like a crown or something).

What if you had to go find the most interesting hats in the universe? Your leaderboard rank was based on whoever had the most hats.

I think that would add a bit more of an incentive to climb the leaderboard. Right now the goals feel a little arbitrary, as well as all of the different stages leading up to them. If each crystal had its own definite role, that might help negate that. Like if you had a reason to trade them around. Also, something like hats would help with the people who like to collect stuff and having the coolest had would be a neat system. You could tie your randomly generated system to the hat collection. Give hats a certain value and have its own ranking system. Let people be hat pioneers. There needs to be something to feel like you are progressing. You could also repurpose the mega crystals to upgrade the spaceship.

Actually, that is a good transition into our next topic. Does there need to be a customization option? With your ship type, hats (as you mentioned), something else in the world to find achievement in?

I like my choices. Buying stuff, pimping out my spaceship. Customization stuff. There needs to be something custom for the player to choose.

So would you rather have, instead of random alien creation, an alien that you can choose features of?

We actually have some images of aliens that our random generation can do. I can show them to you.
So with this randomization, there isn't really much variety for people to get? What if someone wants to do something totally ridiculous? It will be really hard for people to just keep randoming until something they like pops up.

Here, so we have this guy that is the basic alien. Then we can generate different types of eyes, facial features, and a few other features to look like other things. We can do pretty good things with randomization, but we wanted to know if it's something that we should keep working at, or if you would prefer a modular alien that you can build yourself.

Could you do a combination of both? Randomize until you get a few things you like, then change from there? Maybe even go back to previous randoms?
Could we like, choose a head and body, then random the rest? Or what about a drag and drop like spore where you can put things together however you want?
Well, it is definitely something that we can look into,
Yeah, people would be able to create a lot of cool and weird stuff.

So we want to move onto another topic. How do you feel about the options? You have destroy, mine, army… Do you have anything else you would want to do? Is there any option that is more interesting?

Is it assumed that all of the planets are lifeless?

Yes. We wanted to stay away from populated planets for simplicity's sake. It isn't something that we can't consider, however. What did you have in mind?

Well, I was thinking that you could build up your army with some friendly species or enslave the planet, or two players competing or allied on the same planet?
The thing I think when I see these options is the Total War games. Whenever you capture a settlement, you can burn down the city or occupy it. You could do something like that. Also, this is a really picky thing, but the words you use, you have two verbs, destroy and mine, then a noun in army. Also, the laser in the icon comes from the left, but you come in to destroy the planet from the right. One more thing, do you choose where your armies go?

No, your only control is to build the army. The army goes out on its own. What kind of control do you want?

Well, an idea that comes to mind is, well, do you get all of the currencies when you mine? Because you could make different planets give different currencies to add a strategic element to which planets you mine on. With this you could scan a planet to let players find planets find the currency that they need. Then there would be incentive to find specific planets.

What if the currency was tied to the color of the planet?

Yeah, that would be really good. You wouldn't need the scanning then because that is a dead giveaway. That does lead to an obvious problem with blue, though.

We have the ability for players to look over the planets that the army gathered while you were away, so that would let people screen the planets in a similar way to what you are talking about.
So, would you enjoy the game more if there is some sort of player vs player aspect? Besides the leaderboard aspect, of course.

I am just concerned with the challenge within the game. Am I just getting resources to feed into more destroying and mining?

Well, yeah. You are getting resources to get the mega crystals which is the score indicator. The more resources you have, the more mega crystals you can get. Having the most mega crystals means that you expanded out more than anyone else.

So the core gameplay loop is get resources to get more resources?

Right. So does that mean that you would rather have the game be less about who has the biggest empire but about ruining or even helping other people's chances of being the best by competing or forming alliance?

Yeah, the game feels very "farmy" which, isn't too interesting on its own, but it could use another end game, like the hats thing. Advancing to get cool stuff and competing with others would add another layer to what there is to accomplish. I do think that there is a decent of population of people who like to just farm stuff. The game Warframe, for example, is all about just getting cool armor and weapons. But then there are other games where you want to build your army and fight others.

Well, we wouldn't be able to have any "real-time" player vs player. Like, someone else can go to your planets to steal your stuff destroy your planet. Kind of like a back and forth thing behind the scenes.

What if you added like a scouting option? Like you have a scouting thing to find planets (like the army you have now) and an army that fights people, or even an AI boss battle.

So you are thinking a player vs computer environment that inhibits your expansion.

So all the players would be in the same universe? Like a local universe based on region? Because otherwise how would they interact with others?

What about a player vs player for just resources so you wouldn't have to worry about territories?

From a development standpoint, I feel like going for something like a player vs player where you just gain or lose resources without too much interaction would be the easier option.

Or maybe everyone has their own local universe to do their own things and they enter into a larger universe to player with other people.

The thing is, all of this game sends information to a database. Every planet you have is sent to and saved there. We could randomly grab other's planets from there for you to fly to. Or we could provide a search option so that you can get to another player's planet by their username. With this, we could have a whole universe that we don't necessarily need to map out completely. We could also let the player interact with the computer on their own. Does that sound interesting?

In that case, how would the player vs player and player vs environment interact with each other? Like if you wanted to invade someone's planet outside of your own local system, would you have to beat a boss to get there first? Do the two systems run in parallel or do you have separate instances?

That is certainly something that we will have to think about. But, going back to the territory thing, we have the screen that shows you which planets you have in list form, would you like to see a map that shows you your territory compared to other player's territory? We could even show some unclaimed territory so you can see where you will be expanding to.

That would be a really cool way to see how you are advancing, especially if you can compare it to other people. It would allow for comparisons even better than if it were just numbers.
Wouldn't the goal of the game shift dramatically? You could have it be a territory fight. It almost helps incentivize progression beyond the mega crystal thing.

What about rare events on planets? Like each random planet looks similar to other random planets, but would it be worth making special planets where they look very different from the rest of them? Like specially shaped or something?

I want to see different shapes and silly ones.
Just a note, I hope that there is consistency when you click on planets between the system and the planet view. Consistency is important.

Right, that is important.

So, there are a few different types of stars. Is that something that you would want to encounter during your exploration? Like red stars and white dwarfs?
I don't think it would matter. Besides, the dying stars wouldn't even have planets.

It would be a little too much detail that has so little effect. Different colors or binary star systems is kinda cool, but it is icing on the cake not something that is really important to add. Nobody will really be too sad that they aren't there.

Would you guys want a daily login bonus? To give incentive to play?

Oh yeah, definitely.

Puzzles and Dragons has a login bonus that keeps me coming back every day.

Can you think of something you could get that would help keep you logging in every day?

Well, I heard that you were doing something with a pedometer…maybe you can tie that to the login bonus. The more steps you have at the end of the day, the more bonus you get. Personally, and I don't really play these games so I might not be the right one to ask, that alone might keep people coming back. If you have a different kind of incentive, then that might de-incentivize the whole walking piece.

The number of steps you have at the end of the day could give you currency. It shouldn't be linear because that could make people who don't exercise fall super fall behind people like us, who run a lot. Maybe with a hard cap or something. Like someone working in an office would get much less reward than someone who works in the field.

What if the daily bonus could be a unique resource? Like a special kind of capsule that you can only get by logging in?

We could do that. But we have almost run out of time, so we have two more questions to ask. Would you want to play this game? Is it something that you are interested in?

(4 yeses)

Yeah, I definitely would. Especially with the stuff that we have been talking about, with more incentive to play more.

Alright, one last thing: if you could think of one crazy idea that may be impossible to implement, but would ensure that you play every day, what would you add to the game? Take a minute to think…

Well, I would love some cats…

What about some sort of teaching game? Like Duolingo, I could get some of my French vocab done in your game. Daily login bonus is a new word in a different language.

I like the idea of very specific Easter eggs. Like Matt Damon…

What about individual star systems from well-known science fiction stories. Like an homage to Tattooine or the Death Star. It'll have a short little cut scene so you don't miss it.

Alright, well we are all out of time, so we will have to call it here. Thanks for coming.

Appendix C - Consent Form

Informed Consent Agreement for Participation in a Research Study

Investigator: Philipp Baumann, Anthony Gallo

Contact Information: phbaumann@wpi.edu; argallo@wpi.edu

Title of Research Study: Fitness in Mobile Gaming

Sponsor: None

You are being asked to participate in a research study. Before you agree, you must be fully informed about the purpose of the study, the procedures to be followed, and any benefits, risks, or discomfort that you may experience as a result of your participation. This form presents information about the study so that you may make a fully informed decision regarding your participation.

The purpose of the study is to determine the effects of integrating a pedometer tracking mechanism as an alternative means of avoiding waiting times in games for mobile devices.

Volunteers will be provided a download for our mobile game. They will be asked to play the game for a period of one week, after which we will stop collecting data from the game. Participants will be free to uninstall or keep the game after the study. Once all participants have downloaded the game, we will be collecting data on the usage of the game and from pedometers on the user's phones. We ask that users keep their phones on them as much as possible, and that they log into the game at least once per day.

We will not be providing benefits for participants of this study.

We do not foresee any risks or discomfort to participants.

We will keep records on the participant's daily number of steps as recorded by the phone. This information will be sent to a database, accessible only by investigators. We will also keep record of the times at which game was played, the times during which the participant has actively walked, and how many times the choice (between walking and waiting) was made. The data recorded will not be traceable back to any individual user. Users will be asked to provide an email, but that is only for validation purposes.

We will also be issuing surveys both before and after the experiment.

Records of your participation in this study will be held confidential so far as permitted by law. However, the study investigators, the sponsor or it's designee and, under certain circumstances, the Worcester Polytechnic Institute Institutional Review Board (WPI IRB) will be able to inspect and have access to confidential data that identify you by name. Any publication or presentation of the data will not identify you. The data collected will be represented in the final MQP report. We do not foresee any injury to participants of this experiment. If you are injured, we can not provide any compensation or treatment for the injury.

You do not give up any of your legal rights by signing this statement.

Participants will be entered into a raffle for a gift card prize. There will be two prizes available: a $50 Best Buy gift card, a $25 Amazon gift card. Participants will not be able to win more than one prize.

For more information about this research or about the rights of research participants, or in the case of research-related injury, please contact:

Investigator Philipp Baumann: phbaumann@wpi.edu

Investigator Anthony Gallo: argallo@wpi.edu

IRB Chair Professor Kent Rissmiller; kjr@wpi.edu; 508-831-5019

University Compliance Officer Jon Barteslon; jonb@wpi.edu; 508-831-5725

Your participation in this research is voluntary. Your refusal to participate will not result in any penalty to you or any loss of benefits to which you may otherwise be entitled. You may decide to stop participating in the research at any time without penalty or loss of other benefits. The project investigators retain the right to cancel or postpone the experimental procedures at any time they see fit.

By signing below, you acknowledge that you have been informed about and consent to be a participant in the study described above. Make sure that your questions are answered to your satisfaction before signing. You are entitled to retain a copy of this consent agreement.

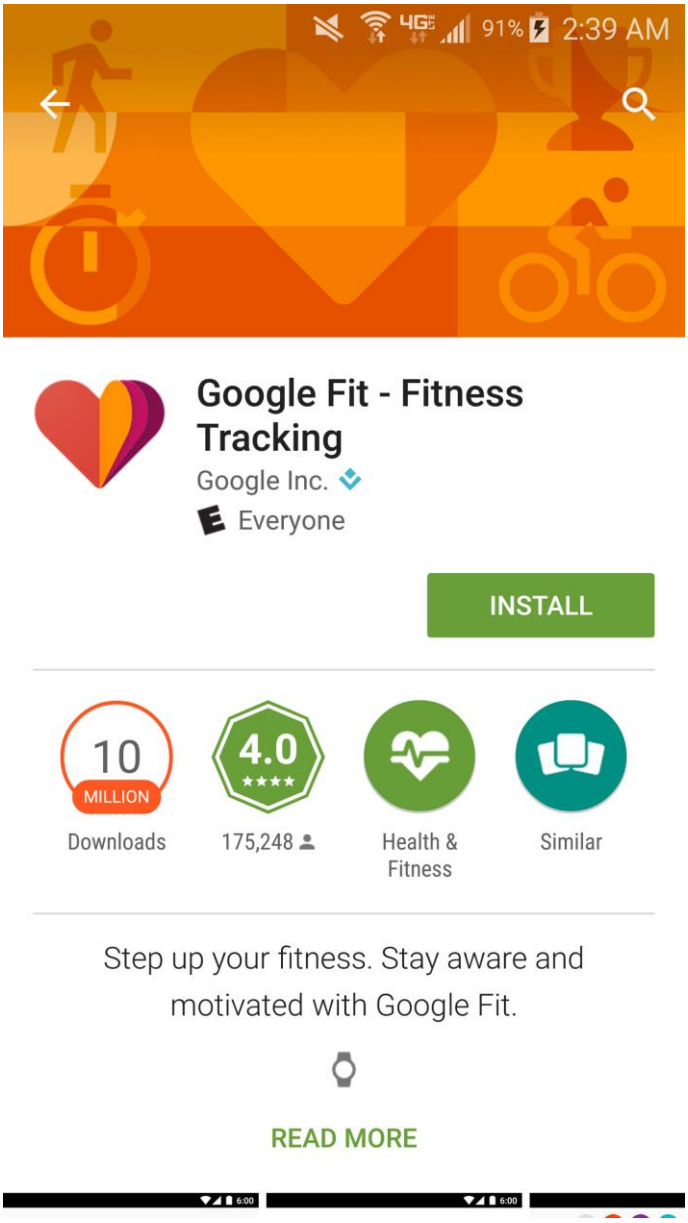
Date:_____ Study Participant Signature _____

Date:_____ Signature of Person who explained this study _____

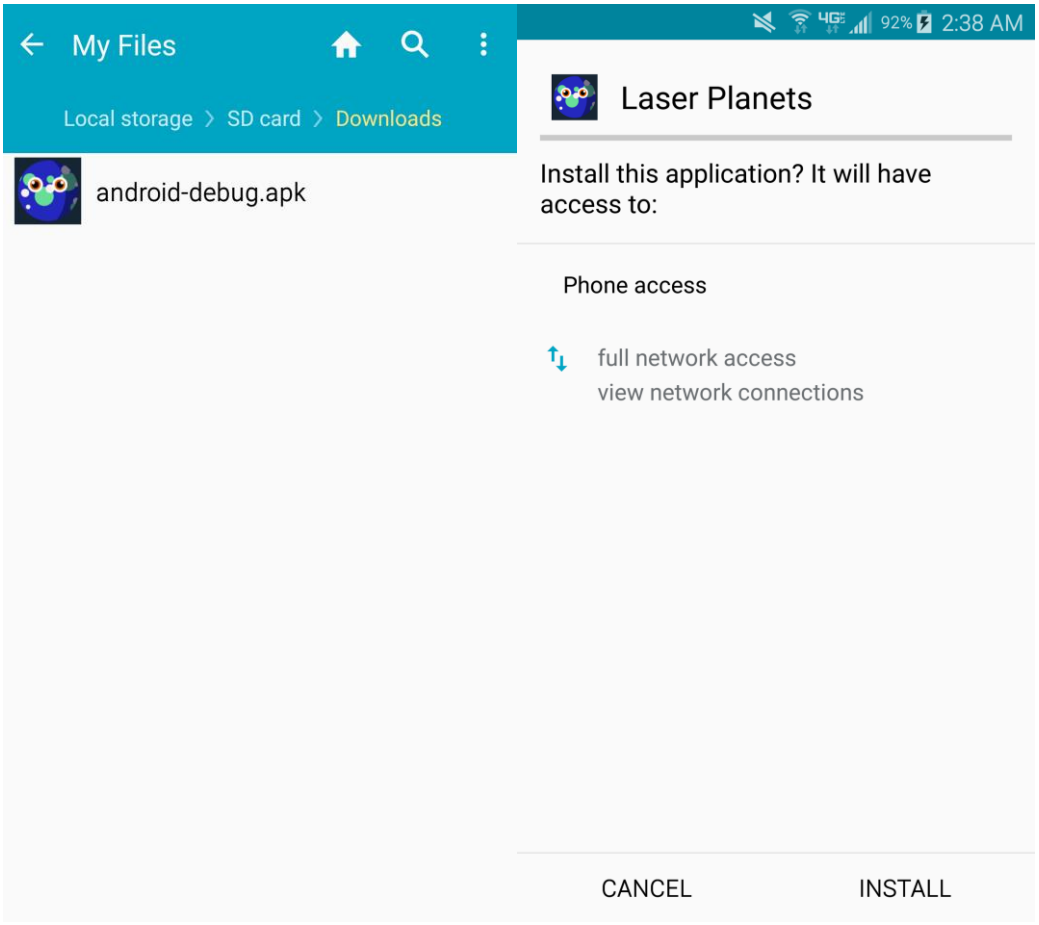
Appendix D – Laser Planets Instruction Guide

Installation

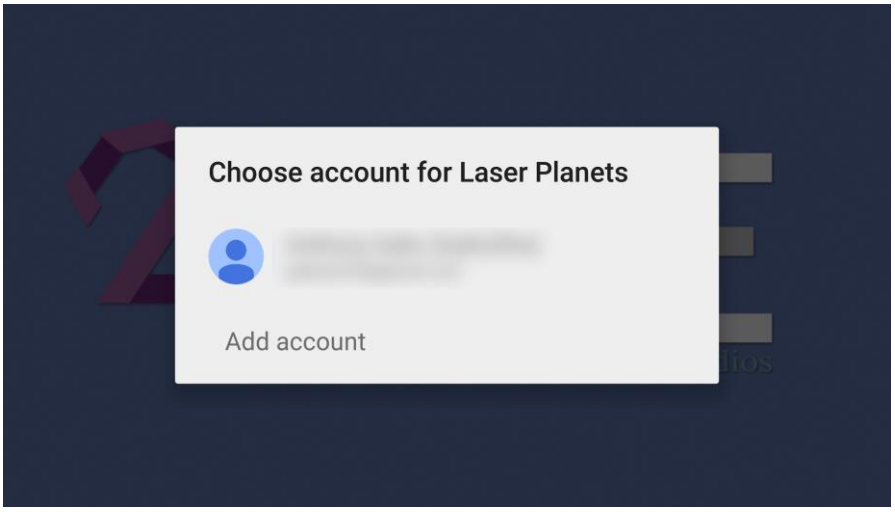
1. Install the google fit app from the android market and make sure to open it once before installing the game.



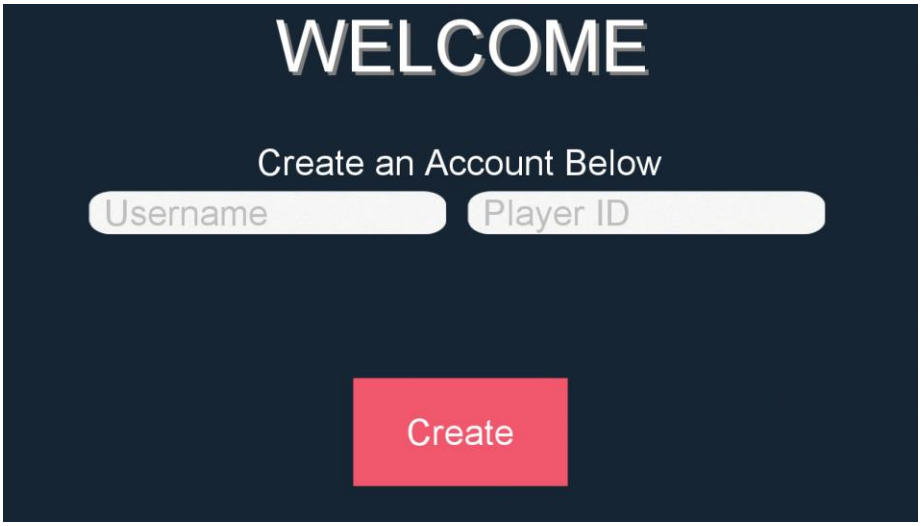
2. Copy android-debug.apk file from email over to your android phone



3. Locate the .apk file on your phone and press install.
4. Open up the app and link your gmail with google fit



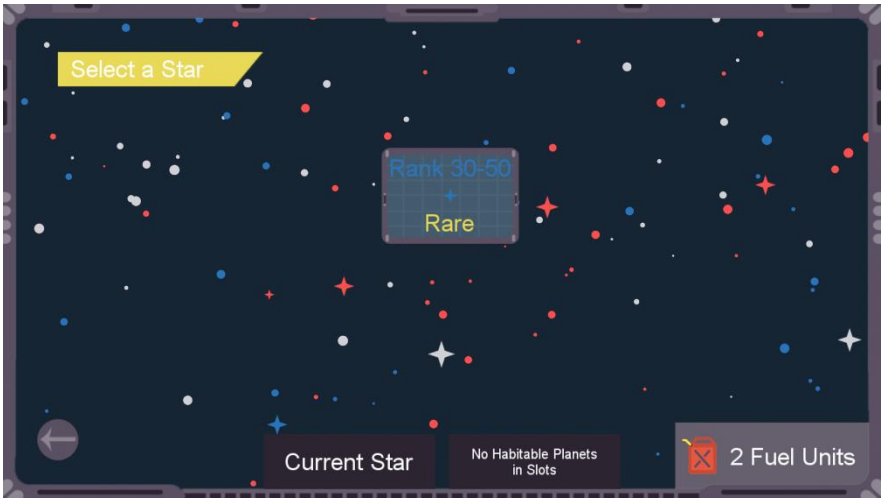
5. Create a username and enter your player id from the survey. If you do not remember your ID, please email phbaumann@wpi.edu to request it.



Choose Home Planet

- Use the randomize button to generate different home planets
- Each planet has three stats - Planet Size, Energy Output, and Base Color
- All three are important to building a big and strong planet so choose wisely!

Base Color Matchup



Base colors get extra stat boosts against certain other base colors. Using the color wheel we can see which colors get a boost over others:

Each color gets a major boost against the color left adjacent to it

Example green gets a stat boost against blue, blue against violet, violet against red etc

Use this knowledge to your advantage to give you the best chance at beating tough boss planets.

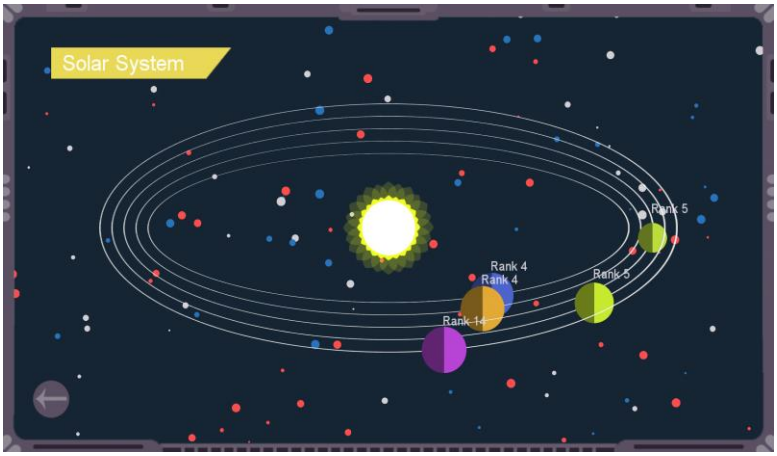
The Secondary Color Wheel

Explore Screen

- 3 Types of stars - Red Dwarfs, White Suns, Blue Giants
- The color of the star determines the globe rank of the planets in that system
- Some stars are rare and have a chance for containing rare planets
- The fly to star button will fly to the currently selected star but caution, doing so will use up a fuel unit.
- When fuel units reach zero you will be able to select to replenish fuel by either waiting or walking
- Flying to Current Star will not use up a fuel unit and will bring the player back to its most recent star

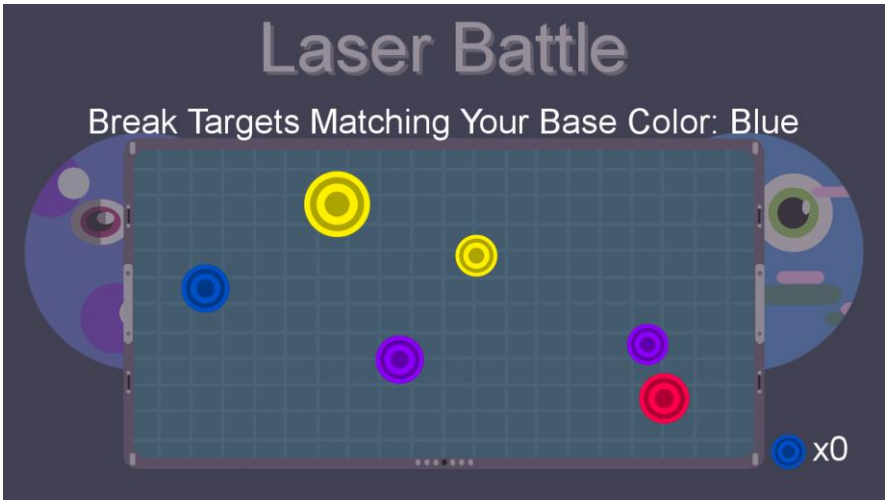
Solar System

- Solar systems will contain planets revolving around their star
- The planets will show their levels and when clicked on the player will fly to that specific planet



Laser Battle

- When battling another planet, you will first need to try to tap all of the targets matching that of your planets base color.
- Tapping colors that are not your base color will decrease your target count
- Next you will need to time the power bar so that you can get it as close to max as possible

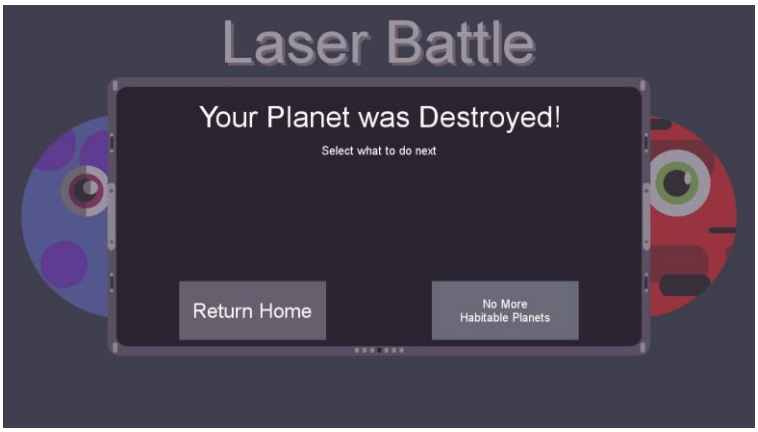


Winning a Laser Battle

- You will be given three options when winning a battle.
- Absorb planet - Will add xp to your planet allowing it to rank up and get stronger
- Take Resources - Will give the user power crystals which can be used to buy items
- Keep Planet - if one of the 4 planet slots are open the user can keep the planet they just beat in battle

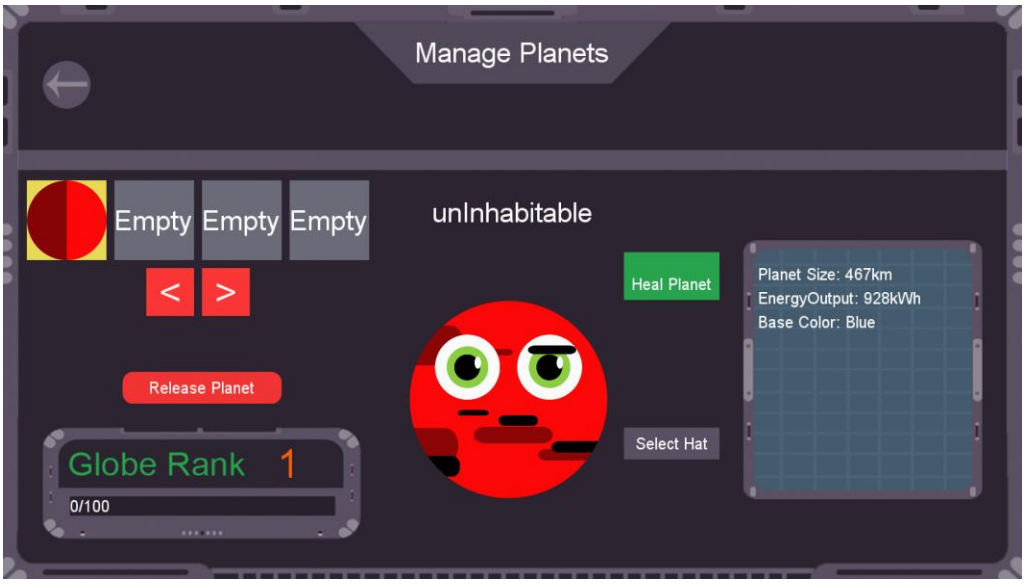
Losing a Laser Battle

- If the player has more habitable planets left in their slots, than they can rematch the current planet otherwise they will have to return to the main menu



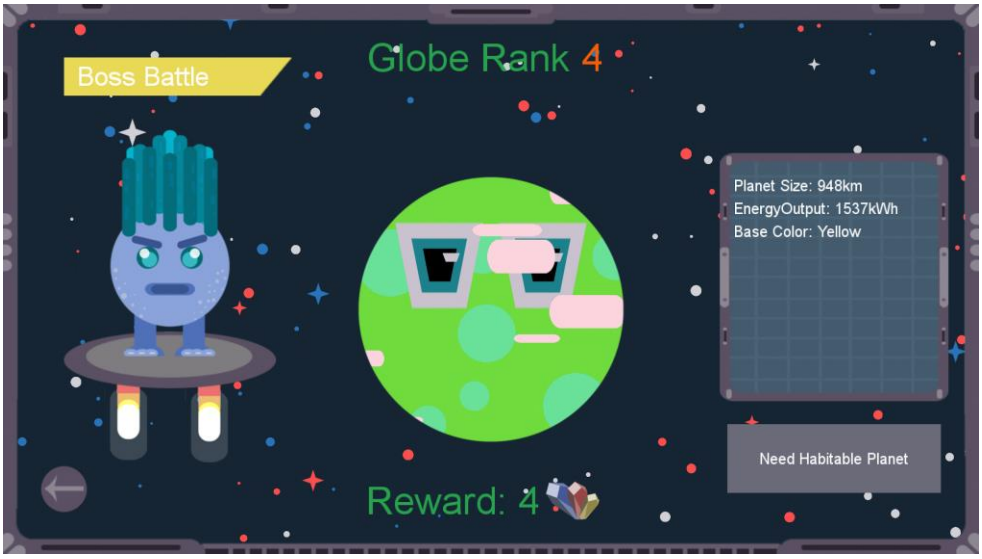
Manage Planets

- This screen lets you see your current planets, reorder their lineup, heal them if they've become uninhabitable, add/remove hats from a planet, and release planets
- Note: You cannot go exploring planets without having at least one planet habitable so make sure to keep healing up your planets!



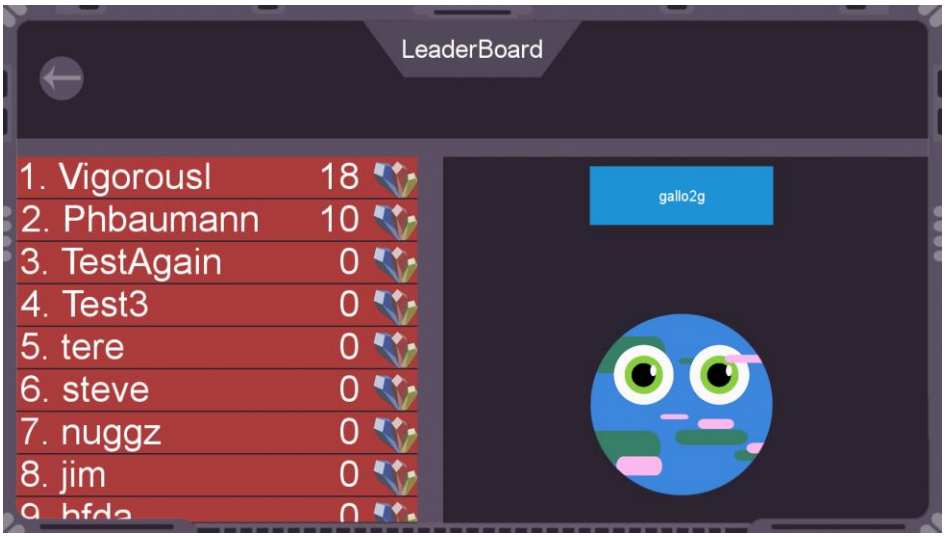
Boss Battle

- Boss battles work the same way as regular battles except for each win you will receive mega crystals which determine your rank on the leaderboard
- Boss Planets are known to be rare so winning will allow you to keep them to keep building your lineup



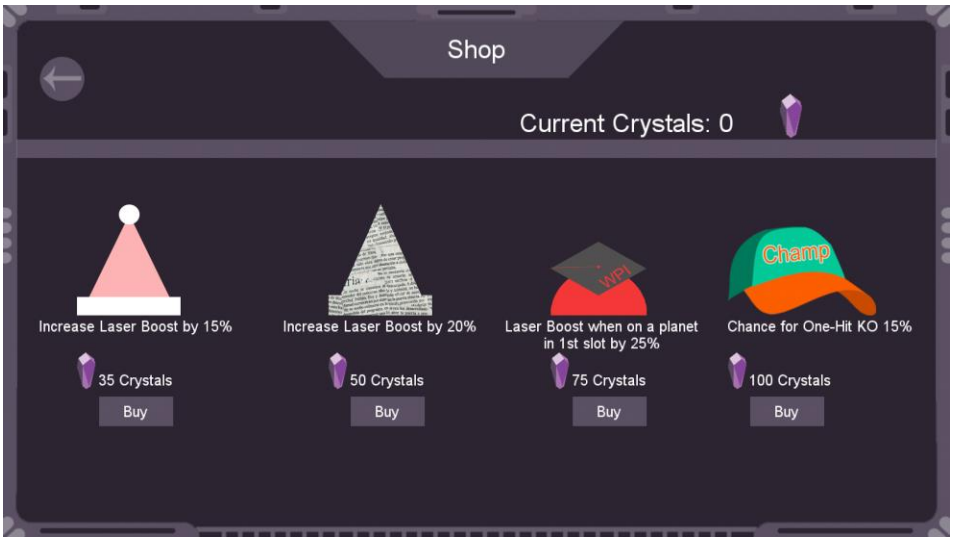
LeaderBoard

- Shows the current leaderboard base on each player's mega crystals



Shop

- The shop allows you to buy special hats by using mega crystals.



Strategy - The main objective of the game is to build a strong planet team that can face as many boss planets as possible. Boss planets will increase in rank after defeating each previous boss planet. To level up your planets explore the solar systems finding planets that are evenly matched with your planet. Hats are used in the game as item buffs for your planet. Hats have many different buff effects so finding as many as you can in the galaxy will help you to strengthen your planets.

Disclaimers:

The game may have minor bugs, if you find anything game-breaking, please email phbaumann@wpi.edu or argallo@wpi.edu and we will do our best to fix it.

We cannot restore any lost save files.

We will be drawing the raffle for participants at the end of our 1 week study. Any users that are found using exploits or outright cheating to get ahead in the game will be disqualified from receiving prizes.

Appendix E – Pre-Experiment Survey

Pre-Survey

Q1 Do you use an Android mobile device?
- ❍ Yes
- ❍ No

Q2 What is your email address?This is required for entrance into the gift card raffle and for directions for the study.

Q3 Select your Gender
- ❍ Male
- ❍ Female
- ❍ Prefer not to answer

Q4 Enter your Age

Q5 Are you a student?
- ❍ Yes
- ❍ No

Q6 What field are you studying?
- ❍ Engineering
- ❍ Mathematics
- ❍ Science
- ❍ Arts and Humanities
- ❍ Business
- ❍ Health/Medicine
- ❍ Social sciences
- ❍ Computer science
- ❍ Other _____

Q7 How many hours per week do you participate in a form of physical activity?
- ❍ 0-4
- ❍ 5-10
- ❍ 10-15
- ❍ 15-20
- ❍ 20+

Q8 What sort of physical activity do you do? (check all that apply)
- ❑ Walking
- ❑ Running/jogging
- ❑ Gym
- ❑ Swimming
- ❑ Recreational sports (soccer, football, ultimate frisbee, etc.)
- ❑ Exercise games (WiiFit, Kinect Sports, etc)
- ❑ Other _____

Q9 How do you use your mobile phone? (check all that apply)
- ❑ Gaming
- ❑ Phone calls
- ❑ Text messages
- ❑ Web browsing
- ❑ Music
- ❑ Watch videos
- ❑ Social Media
- ❑ Tracking exercise
- ❑ Other _____

Q10 How often do you play mobile games?
- ❍ 1-4 times per month
- ❍ 5-15 times per month
- ❍ 15-25 times per month
- ❍ Once daily
- ❍ 2-5 times per day
- ❍ 5+ times per day

Q11 Have you played games that include paywalls?Paywalls: A "roadblock" in a game that inhibits progress by making the gamer do some action (make a purchase, play an ad, wait for a timer to expire, etc) before continuing in the game
- ❍ Yes
- ❍ No

Q12 How do you feel about paywalls in games?
- ❍ Like a great deal
- ❍ Like somewhat
- ❍ Neither like nor dislike
- ❍ Dislike somewhat
- ❍ Dislike a great deal

Q13 Please save this number to be used as your ID later ${e://Field/ID}

Appendix F – Post-Experiment Survey

Post-Survey

Q1 Please enter the username that you used for the game

Q2 How often did you play the game?

- ❍ 7+ times a day
- ❍ 4-6 times a day
- ❍ 2-3 times a day
- ❍ Daily
- ❍ 4-6 times a week
- ❍ 2-3 times a week
- ❍ Once a week
- ❍ Never

Q3 Please rate the game with the following conditions(Note: the walls were where you were given the opportunity to walk or wait to heal planets or restore fuel)

	1 Star	2 Stars	3 Stars	4 Stars	5 Stars
The game as you played it	❍	❍	❍	❍	❍
As if you had to wait at every wall	❍	❍	❍	❍	❍
As if you had to walk at every wall	❍	❍	❍	❍	❍
As if you had the walk/wait choice at every wall	❍	❍	❍	❍	❍

Q4 The option of walking gave you a feeling of control over your playing

- ❍ Strongly agree
- ❍ Somewhat agree
- ❍ Neither agree nor disagree
- ❍ Somewhat disagree
- ❍ Strongly disagree

Q5 The walk/wait walls made you want to stop playing the game
- ❍ Strongly agree
- ❍ Somewhat agree
- ❍ Neither agree nor disagree
- ❍ Somewhat disagree
- ❍ Strongly disagree

Q6 The "walk" option frustrated you
- ❍ Strongly agree
- ❍ Somewhat agree
- ❍ Neither agree nor disagree
- ❍ Somewhat disagree
- ❍ Strongly disagree

Q7 The "wait" option frustrated you
- ❍ Strongly agree
- ❍ Somewhat agree
- ❍ Neither agree nor disagree
- ❍ Somewhat disagree
- ❍ Strongly disagree

Q8 You felt like you increased your daily step count because of the game
- ❍ Strongly agree
- ❍ Somewhat agree
- ❍ Neither agree nor disagree
- ❍ Somewhat disagree
- ❍ Strongly disagree

Q9 Completing the walking goals gave you a feeling of accomplishment
- ❍ Strongly agree
- ❍ Somewhat agree
- ❍ Neither agree nor disagree
- ❍ Somewhat disagree
- ❍ Strongly disagree

Q10 Being forced to walk frustrated you
- ❍ Strongly agree
- ❍ Somewhat agree
- ❍ Neither agree nor disagree
- ❍ Somewhat disagree
- ❍ Strongly disagree

Q11 Being forced to wait frustrated you

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

Q12 Would you like to see more mobile games incorporate in other types of walls besides the usual waiting an certain amount of time i.e. walking some amount of steps

- Yes
- Maybe
- No

Q13 Thank you for your participation. We will be emailing you if you win a gift card.