HEALTHPET: HARNESSING THE POWER OF VIRTUAL PETS TO MOTIVATE EXERCISE AND PROMOTE ACTIVE LIFESTYLES

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ABSTRACT

In light of the recent pandemic and the increasingly online lifestyles of general people, the need to maintain an active lifestyle is becoming more important to consider as "more than a quarter of all adults [are] not getting enough physical activity. This puts more than 1·4 billion adults at risk of developing or exacerbating diseases linked to inactivity"[1]. HealthPet seeks to help tackle the issue by providing a place where users can earn and interact with virtual pets based on how active they are throughout the day. By using Unity and Firebase alongside native code, we are able to put together a package that provides a goal and incentive while also being able to preserve and maintain a user's progress on their path toward a healthier day.

KEYWORDS

Apple Watch Fitness, Pets, Exercise, Motivation

1. INTRODUCTION

The main problem that HealthPet is looking to help solve is the need to get more people to exercise. It is important to provide incentives that can get more people to live an active lifestyle, especially because "more than a quarter of all adults [are] not getting enough physical activity. This puts more than 1·4 billion adults at risk of developing or exacerbating diseases linked to inactivity" [1]. Without tools and experiences to make people want to be more active, many people will continue to live unhealthy lives that can affect them years down the line, especially in high-income countries as "prevalence was more than double in high-income countries than in low-income countries in 2016" [2].

Each of the methodologies covered in the prior section accomplishes different parts of the problem of getting users to live a healthier lifestyle. The first one covered the use of incentives to boost exercise but stops short of financial incentives alone. The second covered the virtual pet's connection to real-life activities but was limited by the uncertainty of whether the children were trying to keep the pet healthy or keep the researchers happy [3]. The final methodology covered the general aesthetics of virtual pets and how people respond to them but didn't have a tangible product to work with the fitness portion. HealthPet seeks to push harder on the use of virtual pets to provide a significant boost to the activity levels of its users.

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My method for solving this problem is to create a virtual pet app that could motivate people to exercise more. My solution solves some major problems because it could grab the attention of many people and encourage them to exercise for a reward [4]. In particular, the use of virtual pets is meant to target the younger demographic to contribute to instilling healthy habits earlier in life. This is because virtual pets as a medium are found to appeal more to the said demographic as "using a questionnaire-based measure, showed that younger virtual pet owners experienced higher values of companionship with their virtual pet than did older owners" [5].

For the first experiment, we set out to find out what pets and environments were the most popular to get a better sense of the end-user experience and preferred aesthetics depending on the demographic [6]. To conduct this experiment, a survey was sent out asking participants what a particular user likes or dislikes about the available pets and environments. The questions presented were made to gather information on factors such as preferences and prices among different age groups. The resulting data revealed some interesting findings, firstly that the panda and bamboo were the most popular among all demographics, which also indicates thematic pairs are preferred by users [15]. On the other hand, the chihuahua and forest were the least popular, possibly due to a lack of thematic connection and visual appeal. There were notable differences among age groups, namely that tigers were preferred by younger users while the great dane was preferred by older users.

In the second experiment, we measured the number of calories burned to gauge how much of an impact HealthPet can have on a user's daily life. The experiment consisted of multiple groups of people wearing Apple watches daily over the experiment period: those who use Healthpet and those who don't [7]. Another point is that we excluded people who are already active. After the experiment, we found that for every demographic, there is an appreciable increase in the number of calories burned among those who are actively using HealthPet than those who are not. Additionally, the 20-39 age group demonstrated a higher average calorie burn, while the 40+ age group had the lowest overall. With that being said, the impact of the HealthPet tended to be proportional to the effort put in.

2. CHALLENGES

In order to build the project, a few challenges have been identified as follows.

2.1. What the Visuals for the App should Look Like

There were many challenges while building the app such as what the visuals for the app should look like in the first place, particularly the animals that will be serving as the pets. We would need pets that have accurate animations and would be engaging to the users. We could use a low poly animal pack that has a wide variety of animals and backgrounds with different animations. This pack also had a modern aesthetic and could run on any mobile phone. By using these animations, we could bring the animals to life and make them more engaging for the users to interact with.

2.2. Finding out the Health Data Needed to be Collected

One of the most crucial points of difficulty came from finding out how and what kind of health data needed to be collected in the first place. This was in large part due to uncertainty over how to best interface with HealthKit in a Unity project considering the lack of built-in implementations. This means that in order to best address this issue we would need to write a custom plugin using swift code to serve as a bridge between the underlying data and the game.

This is also tied to difficulty in testing as an editor does not have access to such data, which means we would need to actively test with physical devices.

2.3. How to shape the Goals and Rewards

The final notable challenge to consider is how to shape the goals and rewards in such a way they cannot be abused while also helping the end user to stay motivated to stay active throughout the day. One of the main things we could do to address this is to give the player larger rewards if the goal they achieved is higher than the minimum value. The minimum value itself can exist to make sure people do not intentionally set too low of a goal to ensure that users are pursuing a level of activity that can be meaningful for a user's health. Of course, we should also have a way to keep track of when the last reward for a particular goal was given to ensure that there are no duplicate rewards for a given day. This can be done through the storage of timestamps in the backend database to serve as an enforced condition.

3. SOLUTION

The user first starts by login into the app, at which point they are then greeted by their pet and will be able to buy more items in the shop as they earn more points from exercising. The first major component that needed to be added was the authentication operations of the app to maintain and save user data. Of course, the central component HealthPet needed is the fitness component as it needs access to health data to function in the first place. Third, the shop component seeks to give the user goals and items to strive for to incentivize them to exercise. To achieve all of these goals, HealthPet was created using Unity as the base engine and Firebase as the database and authentication backend [8]. In addition to this, custom native iOS code was used so that the app can receive and use health data from the user's device.

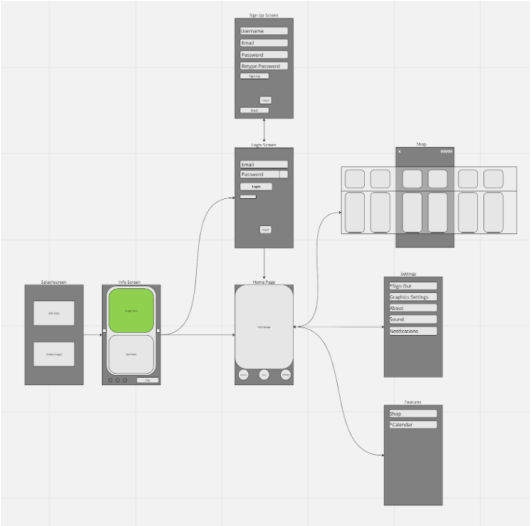

Figure 1. Overview of the solution

Login auth operation was necessary to identify the correct user that logged in and create accounts for new users. Firebase was used to upload all login information and store it for future logins.

Figure 2. Screenshot of the main page

```
public void SignUpAlt(string email, string password)
{
    auth.CreateUserWithEmailAndPasswordAsync(email, password).ContinueWith(task => {
    if (task.IsCanceled) {
        Debug.LogError("CreateUserWithEmailAndPasswordAsync was canceled.");
        return;
    }
    if (task.IsFaulted) {
        Debug.LogError("CreateUserWithEmailAndPasswordAsync encountered an error: " + task.Exception);
        return;
    }

    // Firebase user has been created.
    user = task.Result;
    // Debug.LogFormat("Firebase user created successfully: {0} ({1})",
    //     user.DisplayName, newUser.UserId);
    Debug.Log("User Created!");

    Debug.Log("Attempting to create new data!");
    // Do database thing here
    DocumentReference docRef = db.Collection("UserData").Document(user.UserId);
    Dictionary<string, object> initialData = new Dictionary<string, object>
    {
            { "Currency", 0 },
            { "Environment", "Original" },
            { "HealthData", new Dictionary<string, object>
                {
                    { "CaloriesBurned", 0 },
                    { "ExerciseMinutes", 0 },
                }
            },
            { "PetData", new Dictionary<string, object>
                {
                    { "Mood", "Neutral" },
                    { "PetAppearance", "GoldenRetriever" },
                }
            },
            { "Inventory", new Dictionary<string, object>
                {
                    { "Environments", new List<object>() { "Original" }},
                    { "Pets", new List<object>() { "GoldenRetriever" }}
                }
            }
    };
    docRef.SetAsync(initialData).ContinueWithOnMainThread(task => {
            Debug.Log("User's save data created!.");
    });

    });
}
```

```
1 reference
public IEnumerator Login(string email, string password)
{
    var loginTask = auth.SignInWithEmailAndPasswordAsync(email, password);
    // Wait until user is created
    Debug.Log("Waiting");
    yield return new WaitUntil(predicate: () => loginTask.IsCompleted);

    if (loginTask.Exception == null)
    {
        Debug.Log($"User logged in successfully!");
        user = loginTask.Result;
        SceneManager.LoadScene(SceneManager.GetActiveScene().buildIndex + 1);
    }
}
```

Figure 3. Screenshot of code 1

This code helps users to create new accounts that have no progress and logs you into the app when email and password are entered correctly. The second part of the code checks if you entered the email or password correctly and logs you in once authentication is complete. Then the login manager places you on the home screen.

The fitness component is one of the more central elements that needs to function for HealthPet as rewards a player can earn are directly tied to this data. To accomplish this, we use Apple's HealthKit API to query for the relevant information [9]. One particular implementation detail that also needed to be considered was the asynchronous nature of these queries which meant that there

needed to be callback functionality so that the app will properly respond once the app finished its search.

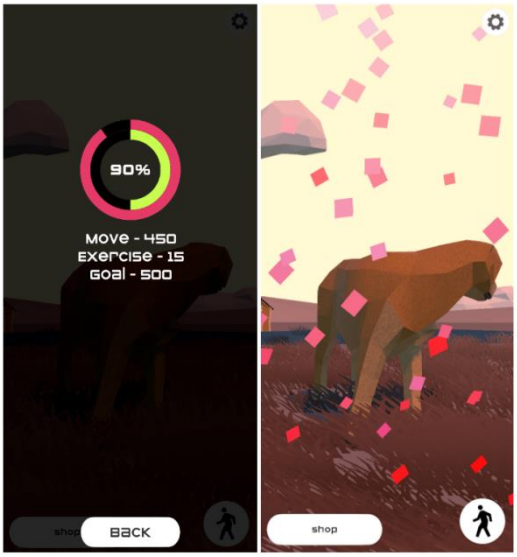

Figure 4. Screenshot of exercise

```
@objc public func getCurrentMoveRingValue() -> Double {
    guard let sampleType = HKSampleType.quantityType(forIdentifier: .activeEnergyBurned) else { return 0 }
    let startDate = Calendar.current.startOfDay(for: Date())
    let predicate = HKQuery.predicateForSamples(withStart: startDate, end: Date(), options: .strictEndDate)
    let query = HKStatisticsQuery(quantityType: sampleType, quantitySamplePredicate: predicate, options: .cumulativeSum) { _, result, _
        if let sum = result?.sumQuantity() {
            self.moveRingValue = sum.doubleValue(for: HKUnit.jouleUnit(with: .kilo)) * 0.239
            print("Move ring value: \(self.moveRingValue)")
        }
    }
    healthStore.execute(query)
    return moveRingValue
}

@objc public func getCurrentExerciseRingValue() -> Double {
    guard let sampleType = HKSampleType.quantityType(forIdentifier: .appleExerciseTime) else { return 0 }
    let startDate = Calendar.current.startOfDay(for: Date())
    let predicate = HKQuery.predicateForSamples(withStart: startDate, end: Date(), options: .strictEndDate)
    let query = HKStatisticsQuery(quantityType: sampleType, quantitySamplePredicate: predicate, options: .cumulativeSum) { _, result, _
        if let sum = result?.sumQuantity() {
            self.exerciseRingValue = sum.doubleValue(for: HKUnit.minute())
            print("Exercise ring value: \(self.exerciseRingValue)")
        }
    }
    healthStore.execute(query)
    return exerciseRingValue
}
```

Figure 5. Screenshot of code 2

This particular set of functions looks to get the data for the Apple Watch move ring and exercise ring for the current day [10]. Each one establishes the time range that they want to get the ring data from before then conducting a health store query. Once the information is obtained, the necessary conversion calculations such as the move ring value being converted to kilocalories are made before returning those values to the callers within Unity. There are also other variants of these functions that take in date as input so that we can query for what the user did on other days. These functions in particular are the ones most in need of callbacks as they are only practically able to be called once or a few times as opposed to these current functions which can simply sit in the update loop.

The shop panel is used to buy different pets and backgrounds with currency earned from completing goals. After you purchase something, it will automatically get put onto the home screen.

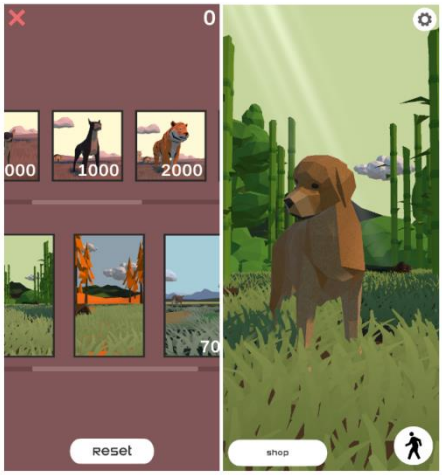

Figure 6. Screenshot of main screen

```
public void PurchaseItem(string itemID, int cost, int type)
{
    if (Convert.ToInt32(MainManager.Instance.databaseManager.currentUserData["Currency"]) >= cost)
    {
        Debug.Log("User has enough money!");
        DocumentReference docRef = db.Collection("UserData").Document(MainManager.Instance.authManager.user.UserId);

        if (type == 0)
        {
            unlockedPets.Add(itemID);
        }
        else if (type == 1)
        {
            unlockedEnvironments.Add(itemID);
        }

        Dictionary<string, object> updateData = new Dictionary<string, object>
        {
                { "Currency", Convert.ToInt32(MainManager.Instance.databaseManager.currentUserData["Currency"]) - cost },
                { "Inventory", new Dictionary<string, object>
                    {
                        { "Environments", unlockedEnvironments},
                        { "Pets", unlockedPets}
                    }
                }
        };
        docRef.UpdateAsync(updateData);
    }
    else
    {
        Debug.Log("User does not have enough money! ");
    }
}
```

Figure 7. Screenshot of code 3

This snippet pictured above is one that focuses on the act of purchasing an item. It takes in an itemID along with its respective cost and purchase type before determining whether or not the user has enough money to conduct the purchase [14]. If they do, then the cost is deducted from their balance before the item in question is credited to both the local inventory and the online copy kept on the database.

4. EXPERIMENT

4.1. Experiment 1

One particular detail we would want to address is how invested users are in their respective pets in ways such as interaction and appearance. This is because the collection of these pets is the main fitness motivator so strengthening this aspect would be important for HealthPet's mission.

The main means of data collection for this experiment is through the use of surveys for the general user. The purpose of this survey is to get a better sense of what a user likes or dislikes about certain aspects related to the pets or environments that can be collected. Some specific points to consider are the general popularity of each animal or environment as well as the reason why a user chose to buy them over the others. It would also be important to gather the motivation

for why a user would not choose to get a specific animal or environment, particularly in regard to price and preference.

The survey used to gather the data from below: https://forms.gle/sBdqbV2vHqvaUMsCA

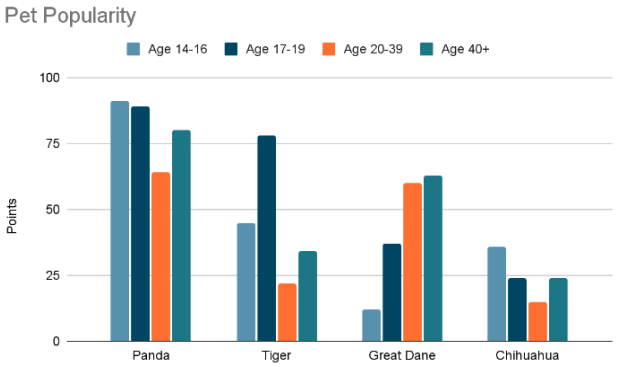

Figure 8. Pet Popularity

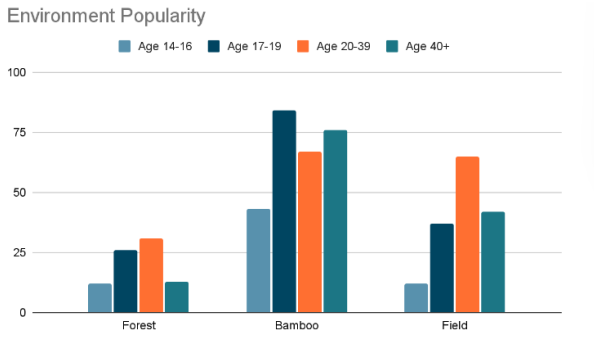

Figure 9. Environment Popularity

One notable detail is that both the panda and the bamboo environment were the most popular across all demographics. The fact that these two are thematically related reinforces the idea that there should be more pet and environment pairs as people would have two things they would need to unlock to get what they want, which given the popularity users are willing to put in the effort to do so. On the other hand, the chihuahua and forest are generally the least popular items from each category. This can be in large part due to the fact that there are no thematic pairs to match them with while also not standing out as much visually. For some animals, there is a significant divide in preference depending on the demographic. For the tiger, it is generally preferred by younger users (ages 14-16 & 17-19) with a tally of 123 votes compared to 56 votes among the older groups. Meanwhile, the Great Dane has the opposite profile with a vote count of 49 among younger users and 123 from the older groups. An important takeaway from this is that predators or other animals that are perceived as “cool” are generally preferred by younger audiences, whereas older people are less likely to be swayed by such details.

4.2. Experiment 2

The other point to consider is how much of an impact the usage of HealthPet has on the average activity of a user in their daily lives. Knowing how much of an effect it has can help gauge where the app needs to improve.

For this experiment, users will be using an Apple Watch daily over the experiment period so that activity data related to them can be collected. There will be a control group of people that are a mixture of people who use HealthPet and those who do not. There will also be two other groups, with one being made up of people who do not use HealthPet and the other who does. Activity metrics will be measured in terms of activity rings and exercise rings. Another important point is that we excluded people who are already active, which is to say they workout on average an hour or more per day.

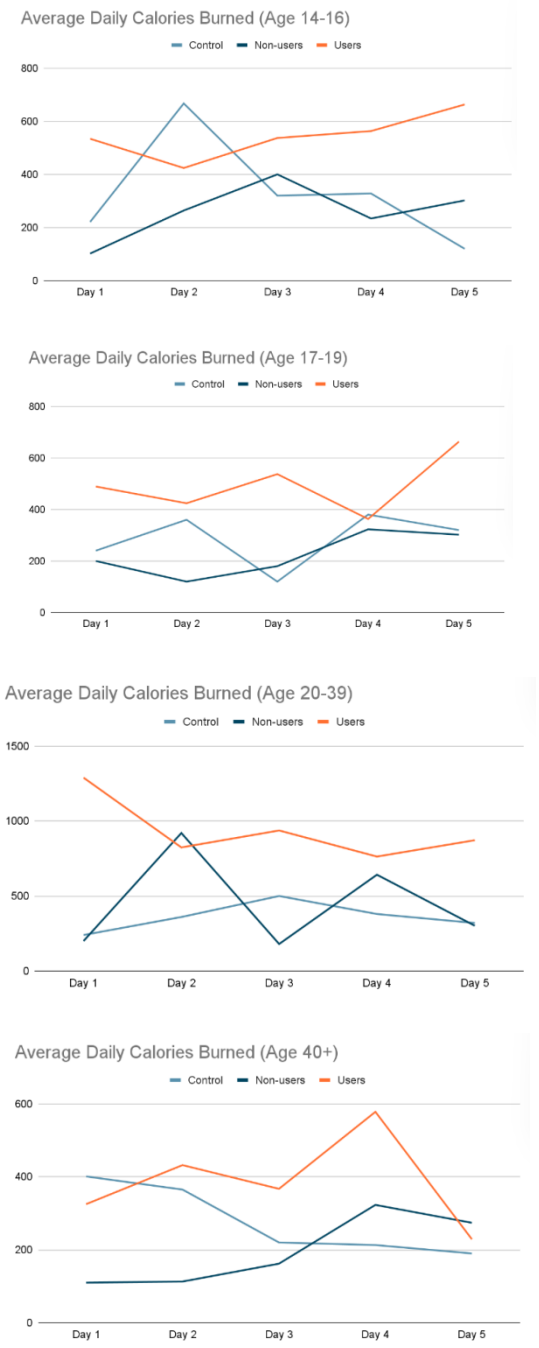

Figure 10. Average Daily Calories Burned

The most important takeaway from the data is that for every demographic, there is an appreciable increase in the number of calories burned among those who are actively using HealthPet than those who are not. It is important to note, however, that this could be more of a correlation than causation as the people using the app could simply be more health conscious in general, but this uncertainty is largely accounted for by filtering out people who are already active from all of our test groups and not telling participants of each group the existence of the others. Another notable observation is that the 20-39 age group has a significantly higher amount of average calories burned, whereas the group aged 40+ has the lowest overall averages. That being said, we can see that regardless of the average calories burned, the impact of HealthPet tends to be generally proportional to match.

5. RELATED WORK

Gary Charness and Uri Gneezy addressed the general topic of giving people incentives to exercise to see if it has a noticeable impact on the habits and motivations of the people in question. It is important to note that their experiments were “entirely driven by people who did not previously attend the gym on a regular basis” [2]. For all students involved, their gym fees were waived so as not to affect experiment results. In the first study, the control group was given a motivational pamphlet talking about the benefits of exercise while the other group was “told that they would receive $25 to visit the gym at least once during the following week and then to return to the lab to answer questions” [2]. Once they returned, half were offered an additional $100 if they attended the gym another eight times in the next four weeks. Every one of the students in said group completed the experiment. This shows that there is a tangible difference and benefit from people being given an incentive to live a more active lifestyle, although it is limited to the scope of financial rewards. Our method seeks to build on the same idea through the use of collectible pets, which have the benefit of gamifying the process along with social drives should it be executed correctly.

Sun Joo (Grace) Ahn and Kyle Johnsen address the general topic of giving children incentives to consume more fruits and vegetables by giving them each a virtual pet that reflects the health of the child [11]. If the child reached the targeted amount of F&V consumption, the dog was healthier, more responsive, and was able to learn tricks more quicker. However, children that failed to reach the targeted amount of F&V consumption had dogs that were unhealthy and unresponsive. Some of these study’s limitations were that the children had to complete the assignments that were given to them by the researchers, so we don’t know for sure if the children ate more F&V to keep the dog healthy or to keep the researchers happy. My project doesn’t force the users to stay active but it advises them to.

Chaolan Lin and Travis Faas address the general topic of which type of pet graphic design grabs the most attention and will keep the users the longest [12]. They used a survey to question people about their demographic, playing habits, and personal relationships with the animals. This solution isn't very effective because there weren't any working apps for the people to try out. My project actually has multiple different types of pets and environments for users to try out.

6. CONCLUSIONS

One of the limitations of HealthPet is that direct interaction with the pet is relatively limited. Adding more ways to interact such as pets reacting more to the user hitting their goals and [13] becoming healthier in response. Another aspect that needs to be expanded is a notification system that can effectively send out reminders and notices for users to ensure they keep tabs on their pets

and goals. A longer-term aesthetic goal would also be the addition of more animations and custom cosmetics for specific animals.

To continue promoting users to live a healthier lifestyle we can continue to build out the feature set of HealthPet to give people more ways to earn and interact with their pets to stay more motivated to live a healthier life.

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