A HELPFUL PROGRAM TO ENCOURAGE THE USER TO ENGAGE IN PHYSICAL ACTIVITY USING FLUTTER, A REWARD SYSTEM USING FIREBASE AND HEALTHKIT API

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ABSTRACT

There is an increasing need to provide incentives for people to create healthier habits as the spread of COVID-19 caused many people since then to lead a more sedentary lifestyle. To get more people out and active, Runspiration seeks to incentivize people to move more through a gamified system that rewards people the more they move; users will be required to move at least 2km or more with the amount they can earn increasing the farther they are able to run. The application itself is created using a combination of Flutter and Firebase to handle and maintain user progress as they unlock and earn more coins and achievements to showcase to others. The use of randomness, as seen in the spinning wheel, also helps to increase the motivation of the user to do fitness. The primary challenge we had to overcome was the lack of a solid tool within Flutter for accumulating and using health data in a timely manner, requiring us to explore novel ways to access that information to use with the rest of the app. The application also used the health API from Apple to monitor the user's fitness status.

KEYWORDS

Flutter, HealthKit, Firebase, Running

1. INTRODUCTION

Covid 19 has been limiting people's ability and willingness to engage in physical activities, bringing potential health issues such as loss of muscle mass and fat accumulation, which suppressed muscle protein synthesis. The lack of physical activity can impact the body's insulin sensitivity, which can lead to issues with the cardiovascular system, peripheral circulation, and skeletal muscle oxidative function. However, by implementing the gamification ideology using Flutter, exercising can become interesting and therefore increase the user's motivation of doing so. A 12-week study found that the people in the "gamified" group reported 1661 daily steps compared to the baseline of 636. With their daily goal set and completed, it makes them not only more healthy, as jogging and running can optimally improve one's health and longevity, but also feel a sense of achievement and self-accomplishment.

The three methodologies that we covered discussed various approaches to the impact and effectiveness of fitness apps on improving user lifestyles.

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The first method by Gary Charness and Uri Gneezy, observed the effect of financial incentives on increasing user activity and motivation and found a tangible link to the amount of compensation affecting the overall gym attendance and subsequent health of participants. The main limitation of this study was that it was limited to the scope of money and so Runspiration explores new avenues beyond financial to improve user engagement.

Mary Gowin, Marshall Cheney, Shannon Gwin, and Taylor Franklin Wann found ways to identify what aspects of fitness apps were important to and contributed to the overall quality and improvement of college students' lives. They found that apps that are free and easy to use with gamified rewards were the most impactful according to student reports. Of course, the main limitation of this method is the lack of experimentation and so Runspiration seeks to expand on these factors through tangible testing through actual users.
Joseph Anna Sakitha, Raj K. Reshma, and Vijayan Sony also expand on the investigation of what makes a fitness app successful but expand further on the topic by covering what makes them a more attractive prospect compared to fitness centers. The main points that contributed were found to be the affordability and ease of access provided by the medium, but the quality of their findings is limited by the smaller sample size and sparse exploration of the field in general. Runspiration seeks to achieve the traits highlighted in this method with the added benefit of not being bogged down with excessive ads or bloat which the paper points to as a hindrance of many apps.

We propose an application that will promote an increase in the general activity of a user by rewarding them for their efforts in an app that treat distance walked as a game available on iOS and Android. Using data directly from the user's device, Runspiration will be able to present that day in the context of a series of rewards that the user can only receive by pursuing a fitness goal within the day. The number of points that a user will be able to earn will depend on the intensity of their progress as well so the higher the distance, the greater the reward! To prevent users from trying to cheat the system, we only permit the user to edit their goal once per day so that they must commit to the goal they set rather than setting it to a lower value later in the day should they not manage to reach the goal. There are also a series of achievements and borders that can either be bought with earned points or unlocked through other activity-related goals to further promote moving out of a person's comfort zone. The integrity of this kind is enforced by maintaining user progress in our database connection with the Firebase backend of our app. This cloud-based connection to user data also ensures users will be able to better safeguard their existing progress.

There were two experiments that were conducted to assess both the effectiveness and the impact of Runspiration on the activity and quality of life of its users. The first experiment compared the average running distance over a week between an experimental group that was actively using the app and a control group. The results showed that the app had a positive impact on promoting increased physical activity among those who typically do not lead an active lifestyle. However, further study will be necessary to determine the sustainability of this increase and the health benefits associated with it.

The second experiment focused on the user's sentiment, aka personal feelings when they use the app. This is accomplished through a feedback button in the app, which redirects the user to a Google form we designed that asks questions about their life quality before and after the use of Runspiration. We also asked the user's opinion regarding new features that they wished to add. With the user's feedback, we are able to clarify what we did well and need to improve on so that we can tweak our service to provide a better experience for the user.

2. CHALLENGES

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

2.1. How to Best Reward Users

One of the main challenges to consider is how to best reward users to maximize the health benefits they can get from using Runspiration. We designed a spinning wheel to randomize the reward so that it provides more motivation for the user to pursue more spins. Speaking of the spinning wheel, we thought about providing a "Thank you" option, which has a relatively high probability to be picked, but later lowered this down. The design motivation for this is that even for a random reward, it should still feel rewarding even if the user got a less valuable result. While the user may get motivated to get more spins when they rolled the "thank you" option, which means they get nothing, it's notable that if the probability for that is too high, it's very likely to discourage the user, since they worked hard but got nothing.

2.2. How to Go About Working with the Database

A notable challenge for Runspiration was how to go about working with the database in a way that was both functional and cost-effective. This is particularly relevant for us as the underlying backend database is firebase firestore, for which we are financially incentivized to minimize reads and writes as much as possible. To properly do this, we can identify which operations can be achieved via a local cache and perform those tasks in that manner before then initiating another read or write as a collective batch. This means we will be able to achieve multiple user data-related functions without having to initiate a read or write every single time.

2.3. How to Go About Obtaining Health Data

Another hurdle that has to be overcome is how to go about obtaining health data in the first place. The first part of this can be addressed by identifying what tools and APIs are available to us and how to best interface with them. Thankfully flutter has a health library that can communicate with Healthkit, but there are several other challenges to consider. One of the biggest hurdles comes from the fact that the data itself does not necessarily update in real-time, which means that measures such as estimates will need to be made to make up the difference until the true data eventually updates.

3. SOLUTION

Runspiration's main objective is to help users live a healthier lifestyle than they would otherwise. To achieve that goal, we set out to unify the following components:

1. Authentication

A. Before any user is able to start using Runspiration, they will be required to sign up for an account as this is what allows us to track and preserve their progress. By being able to attach user data to a unified database, we can keep their information safe and accessible.

2. Activity

A. Once the user has logged in, they can choose to start an activity by pressing the icon on the bottom left of the corner in the navigation bar. The user will be brought to the page to start a run,

while a man running on the road serves as a background image. Once the user clicked on the start button they will be directed to another page, in which there will be a timer recording their run time. The kilometers they run and calories they burn will also be available to the user by connecting the app with apple health API.

3. Achievements

A. Naturally, all of the activities the user participates in are in part due to the desire to unlock new achievements and earn rewards! This means that properly facilitating the collection and appearance of them is a major part of the Runspiration experience.

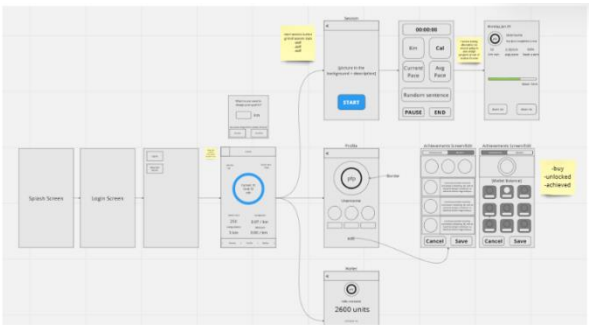

Figure 1. Overview of the solution

The first component of interest is the authentication aspect of the app. Before any user is able to start using Runspiration, they will be required to sign up for an account as this is what allows us to track and preserve their progress. By being able to attach user data to a unified database, we can keep their information safe and accessible. We will be doing this through Firebase which provides both the authentication services along with the databases to go along with it.

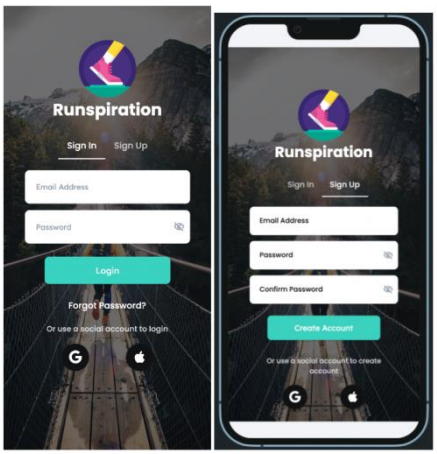

Figure 2. Screenshot of the main page

```dart
Future signin(email, password) async {
  try {
    //Attempt to sign in a user with provided email and password
    final accountLoginAttempt = await FirebaseAuth.instance
        .signInWithEmailAndPassword(email: email, password: password);
    //updateData();
    return accountLoginAttempt;
  } on FirebaseAuthException catch (error) {
    //Catch and log any errors that occur during the sign-in process
    print(error.message);
  }
}

Future<void> signup(userEmail, password) async {
  try {
    //Create a new user with the provided email and password
    final accountCreationAttempt = await FirebaseAuth.instance
        .createUserWithEmailAndPassword(email: userEmail, password: password);
    User? user = accountCreationAttempt.user;
    final docData = {
      "currency": 0,
      "spins": 0,
      "goal_for_running": 2,
      "progress_in_km": 0,
      "sessions": 0,
      "total_km": 0,
      "profile": "default.png",
      "lastOnline": Timestamp.now(),
      "lastEdit": DateTime.now().subtract(const Duration(hours: 24)),
      "lastReward": DateTime.now().subtract(const Duration(hours: 24)),
    };
    final achievements = {
      "active": ["empty", "empty", "empty"],
    };
    docData["achievements"] = achievements;
    final borders = {
      "active": "ID1",
      "unlocked": ["ID1"],
    };
    docData["borders"] = borders;
    FirebaseFirestore.instance
        .collection("user_data")
        .doc(user?.uid)
        .set(docData);

    //updateData();
  } on FirebaseAuthException catch (error) {
    //Catch and log any errors that occur during the sign-up process
    print(error.message);
  }
}
```

Figure 3. Screenshot of code 1

This snippet of code is covering the sign-in and sign-up functions for Runspiration. The sign-in function calls on Firebase with the entered credentials before allowing the user to go to the rest of the app. This is all done through asynchronous functions. An asynchronous function is used in order to enable the use of catch/try blocks, as well as allowing the main thread to execute. The sign-up function is in charge of setting up new users so they can properly interact with every feature. It also initializes a bunch of variables such as profile picture, session count (default to 0), currency, etc. which will allow the UI from future screens to show information properly even for a user who may not have done something related to that part of the app yet.

The next component of interest is the activity portion of the app! Once the user has logged in, they can choose to start an activity by pressing the icon on the bottom left of the corner of the navigation bar. The user will be brought to the page to start a run, while a man running on the road serves as a background image. Once the user clicked on the start button they will be directed to another page, in which there will be a timer recording their run time. The kilometers they run and calories they burn will also be available to the user by connecting the app with apple health API.

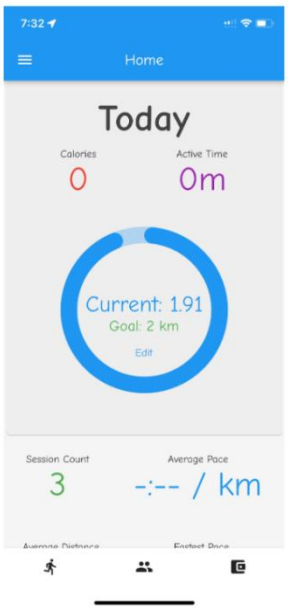

Figure 4. Screenshot of home page

```
// write a function that returns an int representing the total active calories burned today using the healthdatapoints list in singleton
int getCalories() {
  fetchData();
  double totalCalories = 0;
  for (var i = 0; i < _singleton.healthDataList.length; i++) {
    if (_singleton.healthDataList[i].type ==
        HealthDataType.ACTIVE_ENERGY_BURNED) {
      // print(_singleton.healthDataList[i].dateFrom);
      totalCalories +=
          double.parse(_singleton.healthDataList[i].value.toString());
    }
  }
  return totalCalories.toInt();
}

// write a function that returns an int representing the total distance walked today using the healthdatapoints list in singleton
double getDistance() {
  fetchData();
  double totalDistance = 0;
  for (var i = 0; i < _singleton.healthDataList.length; i++) {
    if (_singleton.healthDataList[i].type ==
        HealthDataType.DISTANCE_WALKING_RUNNING) {
      // print(_singleton.healthDataList[i]);
      totalDistance +=
          double.parse(_singleton.healthDataList[i].value.toString());
    }
  }
  return totalDistance;
}

// write a function that returns an int representing the total exercise time today using the healthdatapoints list in singleton
int getExerciseTime() {
  fetchData();
  double totalExerciseTime = 0;
  for (var i = 0; i < _singleton.healthDataList.length; i++) {
    if (_singleton.healthDataList[i].type == HealthDataType.EXERCISE_TIME) {
      // print(_singleton.healthDataList[i]);
      totalExerciseTime +=
          double.parse(_singleton.healthDataList[i].value.toString());
    }
  }
  return totalExerciseTime.toInt();
}
```

Figure 5. Screenshot of code 2

For the section of code highlighted above, the user will have already been asked to grant permissions for reading the health data each of these functions is looking to read; namely calories, distance, and exercise time. Each of these functions then follows the same pattern for acquiring data, which is to call the “fetchData()” function to query the device for current health data. This will cause the device to send and update the application’s singleton which will allow each function to then calculate the requested value before returning it to the caller.

The final component is the achievements segment! Naturally, all of the activities the user participates in are in part due to the desire to unlock new achievements and earn rewards! This means that properly facilitating the collection and appearance of them is a major part of the Runspiration experience.

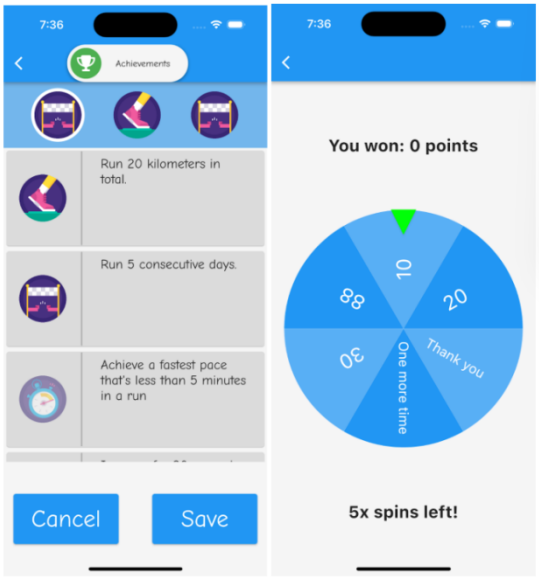

Figure 6. Screenshot of game

```
onFling: () {
  if (_singleton.userData!["spins"] > 0) {
    double rngResult = rng.nextDouble() * 100;
    int choice = 0;

    if (rngResult < 2.5) {
      choice = 5;
      winnings += 88;
    } else if (rngResult < 15) {
      choice = 4;
      winnings += 30;
    } else if (rngResult < 25) {
      choice = 2;
    } else if (rngResult < 45) {
      choice = 3;
      _singleton.userData!["spins"] += 1;
    } else if (rngResult < 70) {
      choice = 1;
      winnings += 20;
    } else {
      choice = 0;
      winnings += 10;
    }

    print("RNG: $rngResult, Choice: $choice");

    controller.add(choice);

    _singleton.userData!["spins"] -= 1;

    setState(() {});
  }
},
```

Figure 7. Screenshot of code 3

The following onFling() method includes the following:

First, it checks whether the user has any spins left, if not, it will reject the spin.

Second, it will randomly generate a number between 0 and 100, which will be stored in a variable named rngResult. Since the probability distribution for each number is even, we can decide it by setting up the numeric range. For example, if the number is smaller than 2.5, then the user will gain a winning of 88, which means that the probability that the user will have a winning of 88 is 2.5%. This distribution is assigned to all options using if-else conditional statements.

Third, once the spin animation is complete, it will get the result of the spin and subtract the user's spins by 1.

Lastly, in order to update the user's spins in real-time, we use the setState function to notify the rest of the UI to refresh themselves.

4. EXPERIMENT

4.1. Experiment 1

An important empirical detail that we wanted to test was to figure out the extent to which Runspiration played a role in the average distance traveled by users throughout their daily lives.

We will compare the average amount of running distance over the course of a week. Participants will be chosen out of people who are not normally very active in the first place. Our definition of someone who is not very active is someone who burned less than 200 active calories on average per day within the last 30 days. Participants will be randomly split into two groups. The control group will be instructed to go about their day as normal, but they will not be using Runspiration. The other group will all be using Runspiration. Once the distance data for every day is collected, we can then compare them to see if there is a notable difference.

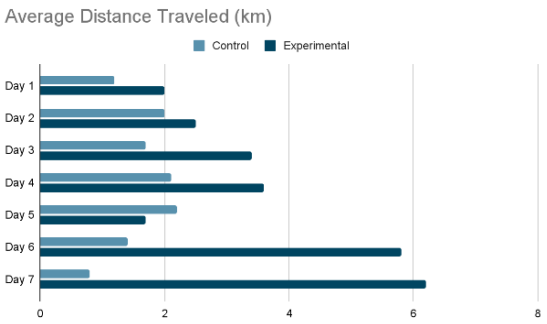

Figure 8. Average Distance Trabeled (km)

The experiment designed to compare the average running distance over a week between two groups of typically inactive individuals yielded compelling results. The experimental group, who used the Runspiration app, demonstrated a significantly higher level of activity compared to the control group who did not use the app. It's important to note that the selection criteria ensured a homogeneous baseline activity level among the participants, which strengthens the validity of the results. The data suggest that Runspiration has a positive impact on promoting increased physical activity in individuals who otherwise lead a sedentary lifestyle. However, further studies might be required to analyze the sustainability of this increase in activity over longer periods and the potential for associated health benefits. Overall, the experiment provides promising evidence for the effectiveness of Runspiration in enhancing physical activity in a sedentary population.

4.2. Experiment 2

Another potential concern we will want to address is the general user sentiment for those who are using Runspiration. This is important to gather information for as it gives a better picture of what strengths of the app we want to emphasize and what parts will need improvement.

We designed a special area in the app, which the user can access by clicking the link there.

https://forms.gle/c7kJL2pfy8RqwQ6v9

The form will ask for advice & comments, including the user's subjective view regards to if Runspiration helped improve their life quality. The form also includes optional questions for the user to provide feedback. These questions include:

If you think that your life quality improved because of Runspiration, what part of the app do you think helped you the most?

If you think that your life quality did NOT improve after using Runspiration, what part of the app do you think we need to improve on?

What particular features would you like to see added?

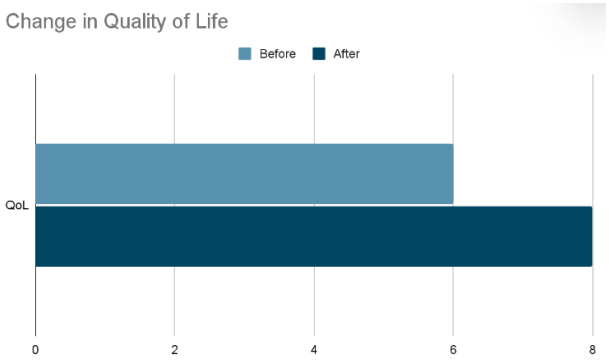

Figure 9. Change in Quality of Life

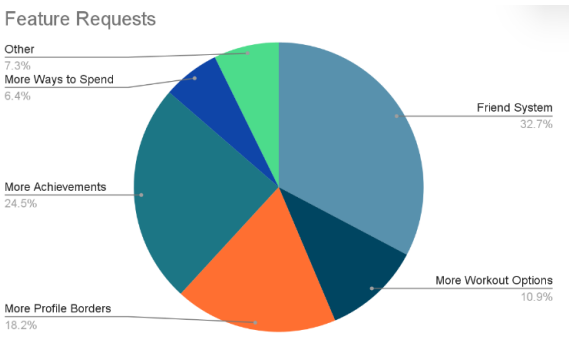

Figure 10. Feature Requests

This experiment sought to understand Runspiration's impact on users' perceived quality of life (QoL) and collect feedback for future improvements. The results show a significant increase in the QoL ratings, from an average of 6 before using Runspiration to 8 after the usage period, suggesting that the app has a positive influence on users' well-being.

The feedback collected via the in-app form provided valuable insights into the users' preferences. The most frequently requested features were a social interaction component, such as a friends system, and enhanced personalization features in addition to the current profile borders and achievements. These requests suggest that users value community engagement and personalization in their fitness journey. This feedback can be crucial in future iterations of the app, potentially leading to increased user satisfaction and retention.

However, further investigation into why these features are highly requested may provide deeper insights into user behavior and preferences, ultimately informing more user-centered design strategies.

5. RELATED WORK

Gary Charness and Uri Gneezy addressed the problem of increasing physical activity among people by running a financial incentives program meant to get people who do not normally attend the gym to start forming a habit of doing so. They conducted this program by splitting participants into three groups. While all of them were handed motivational pamphlets, two of the groups received $25 dollars to attend the gym once a week with one of those groups getting an additional $100 to attend eight more times within the next 4 weeks. Their result is that groups that received monetary incentives, especially the 3rd group that received high incentives, attended the gym more often. In another study, they focussed on paying participants $75 to measure their biometric data, with an additional $50 per session for two follow-up measurement sessions. The difference between the groups this time was that the control did not need to do anything while each subsequent group was increasingly required to attend the gym to receive the promised compensation. They found "a significant and persistent increase in attendance rates for people in the third group, and this increase is again entirely driven by people who had not been regular gym attendees (at least once per week)". [6] These results show the effectiveness of incentives to drive healthy habits but are limited since the only form of incentive explored is money. Runspiration seeks to expand on user motivations through the use of achievements, gamification, in-game currency, and cosmetic designs.

Mary Gowin, Marshall Cheney, Shannon Gwin, and Taylor Franklin Wann investigated health and fitness app use in college students. They discovered that college students use apps to meet different goals that improve their life quality, such as exercising and revising eating habits. As a result, the participants reported that the ideal app they expect should be free, easy to use, and provide a source of motivation in terms of visual cues, or in-game rewards.

While the interviewees did report that fitness apps help develop their exercise routine and eating habits, the limitations with regards to this research are that it's only in the form of interviews and lacks experiments, which involves the use of control groups and scientific results. However, with Runspiration, it'll be possible to truly compare the two groups of people — one that downloaded and used the app, and the other that did not. Therefore gaining scientific data that helps prove the opinion that fitness apps help improve life quality.

Joseph Anna Sakitha, Raj K. Reshma, and Vijayan Sony seek to identify "the effectiveness of fitness apps in terms of various factors like time, cost and accessibility. Also, it digs into the reasons why these apps are preferred over fitness centers." [9] They carried out this investigation via random sampling and found that the main factor contributing to the effectiveness of a fitness app is the convenience of access both for "choosing the app initially and also for achieving their fitness goal". [9] The majority of participants also liked how fitness apps save more of their time by being more affordable than fitness centers, which ties into the financial incentives discussed in the first methodology covered. There are, however, some important limitations as their solutions are dependent on a relatively small sample size in a limited geographical area and the fact that the topic overall is a relatively unexplored area of research, both of which may negatively affect the accuracy of the findings. Our app seeks to address the details that contribute to a useful fitness application through a free model that allows anyone to participate and begin interacting with and earning rewards for their efforts.

6. CONCLUSIONS

Some limitations and improvements in regards to the project include:

1. UI design could be optimized.

User interface design is a constantly evolving part of user experience. Runspiration focussed primarily on having functional UI as part of its emphasis on feature implementation. As we close out on more and more required features, more work needs to be put into both building assets through the use of graphical tools like Figma for the existing screens and adjusting how they are sized and aligned to create a more cohesive and immersive experience for the end user.

2. More user interaction could be added (e.g. Friend system)

We can achieve this by adding a chat or friend system so that users can communicate with each other and form bonds, which increases user motivation. Implementing a ranking system and distributing rewards based on that may help increase the motivation of exercising as well. Both of these would be implemented through the app's interaction with the Firebase backend and with the addition of cloud functions to ensure data integrity.

3. Richer and more beautiful cosmetics could be added.

Cosmetics is one of the cornerstones of our incentives system for getting more users to live an active lifestyle. Therefore, a consistent requirement with eventual updates and fixes would be the introduction of more such rewards to allow users to better represent themselves and showcase the accomplishments that they make with one another.

Runspiration provides a resolution to the current increasing health risk regards to modern people. The implementation of in-game currency, cosmetics, use of Apple's health API, achievements, etc. helps increase users' motivation to exercise and pursue a better and healthier lifestyle.

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