



Walkstars

A Health and Nutrition Game For Children/Teenagers

Ryan McDonnell

C12460362

Aneel Rahim

Table Of Contents

1. Project statement	5
1.1 Physical Activity.....	5
1.2 Nutrition.....	5
1.3 Personal Message	6
2. What research has been done and what are the outputs?	6
2.1 Background Research.....	6
2.2 Market Research	6
2.2.1 Market Research - Colours.....	7
2.3 Fitness Applications	7
2.3.1 MapMyRun.....	7
2.3.2 Fooducate	7
2.3.3 Myfitnesspal.....	7
2.3.4 Couch to 5K	8
2.4 The Obesity Epidemic.....	8
2.5 Video Games	9
2.6 Google Play and Android Gaming	10
2.6.1 Angry Birds.....	10
2.6.2 Pokemon Go.....	11
2.7 Alternative existing solutions to the problem you are solving	11
2.7.1 Fitness Courses.....	12
2.8 Technologies researched	12
2.8. 1 Android Studio IDE	13
2.8.2 Java Programming.....	13
2.8.3 Android Wear.....	13
2.8.4 Fitbit Charge 2	13
2.8.5 Sony Smart Watch.....	13
2.8.6 Sensors	14
2.8.7 Games Engine.....	14
2.9 Fitness Applications	15
2.9.1 MapMyRun.....	15

2.9.2 MyFitnessPal	15
2.10 Firebase.....	16
2.11 Other relevant research done	16
2.11.1Interviews	16
2.11.2 Physiotherapist	17
2.12 Research techniques	17
2.13 Resultant findings/requirements	17
2.13.1 Functional and Non-Functional Requirements	18
3. Analysis: Describe clearly what your solution will do	18
3.1 General Solution	18
3.2 Hardware Solution	18
3.3 Software Solution.....	18
4. Approach and Methodology	19
4.1 Methodology Overview	19
4.2 What is Scrum	19
4.2.1 Scrum Phases	19
4.3 Methodology Comparisons.....	20
4.3.1Waterfall Methodology Phases.....	21
4.3.2 Waterfall pro and cons.....	21
4.3.3 Comparison decision	21
4.4 Priority Phases.....	21
4.4.1 High Priority	21
4.4.2Middle Priority	22
4.4.3 Low Priority	22
5. Design.....	22
5.1 Design Overview	22
5.2 Use Case Diagram	23
5.3 Sequential Diagram.....	24
5.4 Technical architecture diagram:	25
5.5 Other design documents	26
5.5.1 Entity Relationship diagram	26
6. Prototyping and Development.....	27
6.1 Log in/Sign up prototype	27
6.2Home Screen.....	28

6.3 Minigame	28
7. Testing.....	29
7.1 Testing Overview.....	29
7.1.1 Tester's.....	29
7.2 Black Box Testing	29
7.3 White Box Testing	29
7.4 Unit testing.....	30
7.5 Integration Testing.....	30
7.6 System Testing	30
7.7 Testing Scripts	30
8. Issues and risks.....	31
8.1 Issues.....	31
8.2 Risks	31
9. Plan and future work	32
9.1 Project Plan Timeline	32
9.2 Key deliverables	32
10. Conclusions	33
10.1 Conclusion overview	33
10.2 Plausibility of proposed system	33
10.3 Summary of findings	33
10.3.1 Summary of Software	33
10.3.2 Summary of Hardware	34
10.3.3 Summary of Health and safety.....	34
10.4 Personal Development.....	34
10.4.1 Technologies Tested	34
11. Bibliography (research sources)	35

Table Of Figures

Figure 1. MyFitnessPal User interface	8
Figure 2. Popular video games played by American teenagers.....	10
Figure 3. Angry birds' graphical interface	11
Figure 4. Pokemon Go graphical interface.....	11
Figure 5. Wokamons Pedometer application	12
Figure 6. Sony smart watch.....	14
Figure 7. Floppy bird graphical interface	15

Figure 8. Mapmyrun map user interface	15
Figure 9. Firebase platform.....	16
Figure 10. Agile methodology approach.....	19
Figure 11. Scrum Methodology Phases.....	20
Figure 12. Waterfall methodology phases.....	20
Figure 13. Systems main function use case diagram	23
Figure 14. Sequential diagram for main functions of the system.....	24
Figure 15. Three Tier System Architecture	25
Figure 16. Walkstars ERD diagram.....	26
figure 17. Prototype for Log in/Sign up page.....	27
Figure 18. Prototype for the home graphical interface	28
Figure 19. Prototype for the mini game graphical interface	28
Figure 20. A Test Script example used in the development process of Walkstars	31

1. Project statement

Walkstars is a fitness application designed to teach the user the importance of an active lifestyle and a well balanced diet. The project's aim is to improve the user's fitness levels and knowledge of nutrition in a fun and competitive environment.

The application is designed to encourage physical activity by enticing the user to increase their daily step count. The pedometer sensor is used to track the amount of steps the user takes throughout the day. The application is also designed to teach the user a basic understanding of nutrition.

1.1 Physical Activity

Each user is given a Walkstar (Character) in which they look after i.e. feed and customize. The user can play various mini games with their Walkstar. The amount of energy their character will have in-game is determined by the amount of steps the user has taken throughout the day. The mini games allow for the user to collect Walkstar tokens (in-game currency). However, in each game the user will be playing against the clock. The more energy the Walkstar has, the quicker they can complete the game. The user can play against friends and share their results on social media i.e. creating a fun and competitive environment within the application.

1.2 Nutrition

The user is taught a basic understanding of nutrition when they choose what to feed their Walkstar. Walkstar token's collected within the mini games are used as currency allowing the user to buy a range of food items for their Walkstar. A booster system is implemented within the mini game to entice the user to feed their Walkstar a healthy diet. By choosing healthier food choices for the Walkstar, more booster is gained. However, healthier foods are more expensive than unhealthy foods therefore enticing the user to collect more tokens in the mini games. This has a knock-on effect as the energy the Walkstar has in the mini game determines how many Walkstar tokens the user can collect. This means that the user will want to walk more in order to increase their

character's energy levels. The idea is that the user will gradually learn over time that while unhealthy food's may cost less, healthier food's over the long haul are more beneficial and bring more rewards.

This report details how I went about my research, design and implementation of this project.

1.3 Personal Message

The idea for Walkstars came about when I was doing some independent research into the obesity epidemic in Ireland. Ireland is expected to become the most obese country in Europe by 2030 [1]. For this reason, I have based my final year project around coming up with an application to help combat the issue. I believe it is imperative that as a society, we teach the younger generation the importance of an active, healthy lifestyle. Prevention is better than cure, therefore, through targeting the younger generation it is hoped that it will reduce the number of children who develop obesity later in life.

The aim of this project is to teach children/teenagers the importance of an active lifestyle and a well balanced diet. The goal is to get the conversation started around the topic of childhood obesity and hopefully see some changes being made in the right direction.

2. What research has been done and what are the outputs?

2.1 Background Research

In this section of the report, the background research gathered into each section of the project is discussed. Since Walkstars is a fitness application directed towards a younger demographic, health and safety is amongst the most important topics researched.

Another critical area researched for the implementation of Walkstars is in the field of computer gaming and gaming software. Walkstars incentive for the user to get more active is largely based on how much energy the Walkstar has within the mini games. As the user can play and compete against friends, a fun and competitive environment is created within the application. It is important to understand which types of games teenager's play the most.

The research gathered in this section will help improve the design and implementation process of this project.

2.2 Market Research

The main demographic for this application will be children aged approximately eight to eighteen years of age. According to a study conducted by thinkhouse.ie [2], 96% of Irish 15-18 year olds own a smart phone. The study claims that 63% of those who participated preferred useful, helpful and productive applications. Of this 63%, over 37% said they prefer applications with a fun and entertaining environment.

Application's with a social aspect tend to rate higher with Irish teenagers. According to webwise.ie [3], the top five applications used amongst teenagers in Ireland are: Snapchat, Facebook, Youtube, instagram and messenger.

2.2.1 Market Research - Colours

As Walkstars is a fitness game with a demographic of children/teenagers aged 8 to 18 years of age, research into the colours this demographic are drawn to is a crucial aspect in designing a suitable user interface. empower-yourself-with-color-psychology.com [4] is a website that helps business's find and understand the type of colours that will attract a specific market. The website claims that blue is the colour generally favoured by most people independent of gender, age, country and culture. It also states colour preferences based on gender : Men prefer the colour blue to red, and orange to yellow while women prefer red to blue, and yellow to orange. However, both genders prefer blue, turquoise, green, red, yellow, black, white, gray and silver.

Pre adolescent children prefer brighter primary to secondary colours such as red, yellow and blue while adolescents are more open to more complex and sophisticated colours due to their exposure to computer graphics. This information will be used to make Walkstars more aesthetic to the demographic it is aimed towards.

2.3 Fitness Applications

As Walkstars is fitness/gaming application, research into fitness and gaming applications popular among children and teenagers is crucial. This research is designed to give me a perspective and insight into what type of application's that rate high among the Walkstars demographic. Teen Vogue published an article in June 2015 listing the top seven fitness application's used by teenager's [5]. They include: Map My Run, Blogilates, Waterlogged, Fooducate and Get Better Sleep.

2.3.1 MapMyRun

Map My Run is a mobile application that allows the user to visualize over 70 million running routes. It tracks the user's activity and the user can share achievement's with their friends on social media. The concept of letting the user upload their achievements onto social media platforms is something that will be implemented into Walkstars.

2.3.2 Fooducate

Fooducate allows the user to scan barcodes of food items and retrieve nutritional information for that food. It will also suggest healthier alternatives. The application's aim is to get the user familiar with the foods they consume on a daily basis. Walkstars aims to incorporate this idea into its application. In Walkstars the user is given different food choices to select to feed their character. Healthier food choices give the Walkstar more energy booster in the mini games.

2.3.3 Myfitnesspal

Myfitnesspal is another fitness application researched when developing Walkstars . The Application is one of the leaders in the marketplace in the area of nutrition and health. It was estimating as having 75 million users in 2014 [6]. MyFitnessPal aids the user in their goal to gain, maintain or lose weight. Each user enters basic information on themselves (including gender, height, weight and level of activity) allowing for an algorithm to calculate the recommended amount of calories the user should consume per day. The application also allows the user to track their daily nutrient intake with the user updating a daily food dairy. The idea of having the user input information about themselves to determine their goal is something I am currently researching and hope to implement into my application.

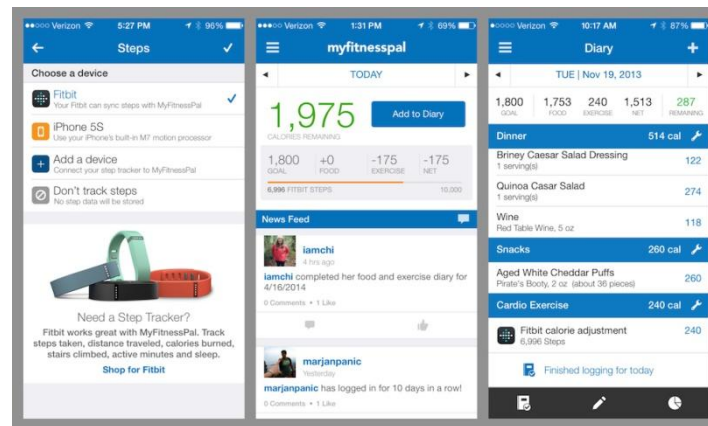


Figure 1. MyFitnessPal User interface

2.3.4 Couch to 5K

Couch to 5K is an application designed to get the user from 'couch' or sedentary to running five kilometres or 30 minutes in 90 days. Through the application the user is given a graduated training programme to follow. The plan is broken into nine weeks of activity. For example, week 1: the user has a five minute warm-up followed by an alternate 60 seconds of jogging with 90 seconds on walking totalling 20 minutes. In comparison during week 6: the user has a five minute warm up, followed by a half mile jog, quarter mile walk, three quarter mile jog, quarter mile walk followed by a half mile jog. The idea of implementing a gradual plan for the user is something that could work in Walkstars.

2.4 The Obesity Epidemic

Obesity and low physical activity levels are a growing problem in Ireland. The Children's Sport Participation and Physical Activity study (CSPPA) published in 2010 studied physical activity levels among 10-18 year olds in Ireland including a total of 5,397 children in their research. Results of this study found that only 19% of primary and 12% of post-primary school children met the physical activity recommendations these proportions have not improved since 2004. Girls were less likely than boys to meet the physical activity recommendations and the likelihood of meeting the physical activity recommendations decreased with increasing age. It also found that one in four children in their study were unfit, overweight or obese and had elevated blood pressure. [7]

Another study by Growing Up in Ireland, the National Longitudinal Study of Children in Ireland found that only one in four nine-year-olds met the recommendation of 60 minutes of moderate to vigorous physical exercise every day. [8]

Growing up in Ireland also examined other types of activities in which children participate in. It found that substantial amounts of time were spent playing video games, especially among boys. A total of 74% of boys and 54% of girls spent some time each day playing video games, with 30% of boys and 12% of girls spending one hour or more in front of a screen [8]. While this evidence may suggest that sedentary behaviour is increasing among children, Walkstars hopes to challenge the perceived normal of video/phone games and use them as a stimulant for increasing physical activity in children.

There is significant evidence that physical activity is one of the most important things that you can do for your health. There are many benefits of being physically active with evidence showing it improves well being, muscular and cardio respiratory health, bone density, weight management, cognitive function, ability to manage stress and it reduces risk of cardiovascular disease, stroke, colon and breast cancer, depression among others. [9]

The World Health Organization (WHO) now recognises physical inactivity as the fourth leading risk factor for global mortality and is estimated to be associated with one million deaths per year in the WHO European region [10]. In addition to the major health risks associated. There are also significant social and economic costs of inactivity. Inactive children have increased risk of lower self-esteem, higher anxiety and higher stress levels [11].

The estimated costs of physical inactivity are substantial. The WHO has estimated the cost to be about €150-300 per citizen per year in its regions countries [12].

Approximately 300,000 children were obese in Ireland in 2005 with a rising rate of 10,000 per year [13]. An Oxford survey suggests that children are not been given a proper education when it comes to nutrition [14]. The study reveals that nearly one out of five 11-16 year olds skipped breakfast before school. A study by Rampersaud et al. [15], says breakfast is the most important meal of the day. The article suggests that by skipping breakfast, you are zapping your body of energy and are at higher risk of over eating later on in the day. Eating breakfast before school has also been linked with improved cognitive function thus improving school grades. Showing, young people the beneficial aspects of breakfast and a well-balanced diet will be a key message in Walkstars.

Overall, there is an obvious issue created by the decreasing amount of daily activity performed amongst young people in Ireland today. The evidence suggests that the issue will continue to get worse unless something drastic is done to combat the epidemic head-on. Walkstars is committed to gathering as much information on the topic of childhood obesity and using this information to improve the functionality of the application.

2.5 Video Games

As Walkstars is to incorporate mini-games into its application, research was conducted into video games and the type of games user's in Walkstars demographic like to play. According a study by www.pewinternet.org, almost 97% of American teenagers aged 12-17 play computer, web, portable or console games. The website claims that 48% of teenagers use a mobile device to play their video games. Pewinternet also conducted a study on the type of games teenagers are most likely to play. The study claims that the top five video played amongst American teenagers are: Guitar hero, Halo 3, Madden NFL, Solitaire and Dance Dance Revolution. [16]

Each game differs in objective and play style. Guitar hero and Dance Dance Revolution both fall into the rhythm games category. The aim of both games is to stay with the music beat and match each note that appears on screen by hitting the corresponding button on the controller. Solitaire is a single player puzzle/card game that requires each card to be matched with its corresponding suite in order to win . Madden NFL is a sports game based on the National Football League in America. Halo 3 is a first person shooter that is popular among the computer and console online community.

It is interesting to see the differences between each game in the top five. However, each game has their similarities such as: a competitive environment, progressive score system, customization etc.



Figure 2. Popular video games played by American teenagers.

Based on this information, Walkstars hopes to incorporate some of these keys features into its mini-games. From the research conducted it appears teenagers play simple easy to learn games that have a competitive nature. Walkstars philosophy is that all users should be able to pick up the game for the first time and almost immediately understand how to use it. This would expand the potential target market.

2.6 Google Play and Android Gaming

Google play is a digital distribution service operated and developed by Google in 2008. It is the official marketplace for all android applications including games, books and videos. Applications on the marketplace can either be downloaded free of cost or at a price. Walkstars will be launched for android devices on Google play. Android was chosen for this project due to my familiarity with the system. Here are a few examples of popular android games that influenced the idea for Walkstars.

2.6.1 Angry Birds

Since Walkstars will allow the user to play various mini games, research into the android market and what makes a successful game was crucial.

Sitting on top of the Android most downloaded free applications for November 2016 is Angry Birds. The application was developed by Rovio Studios in 2009. The game allows for the user to sling angry birds across the screen with the goal of destroying all the pigs on the playing field. As the player progresses through the game, each level goes up in difficulty adding a competitive component to the application.



Figure 3. Angry birds' graphical interface

2.6.2 Pokemon Go

Pokemon Go is a location based augmented reality game available on android and IOS devices. It's initial release was on July 2016 and has since been downloaded over 500 million times [17]. Similar to Walkstars, on opening the application for the first time the user creates an avatar which is displayed on screen on a map based on the user's location. The application uses GPS systems to track the user's movements and the player can move around within their real world surroundings. The aim of the game is to catch as many Pokemon (Monster type character's) as possible. Pokemon are placed in real world locations which the player must go to in order to attain. A feature in the game that influenced the idea for Walkstars is the 'walk to hatch the egg' game. This is where the user is given an egg that contains a Pokemon. However in order to for the egg to hatch, the user must walk a certain amount of steps. The feature encourages the user to be active while playing the game. The foundation concept of Walkstars is that the user partakes in physical activity while playing a video game.



Figure 4. Pokemon Go graphical interface

2.7 Alternative existing solutions to the problem you are solving

There are many fitness applications in the android market place that use a step counter function to track the user's physical activity. For example the application 'Google Fit' is capable of: tracking daily activity, goal setting, easy to read statistics and integration with other fitness applications such as

MyfitnessPal. With 10-50 million downloads of 'Google Fit' between android and IOS devices to date, it is clear that there is a market for fitness application's out there [18].

However, Google Fit and similar applications are sophisticated and directed towards a more mature demographic in which the user already has some understanding of health and fitness. One of the unique aspects of Walkstars is that the application is targeting a younger demographic who are only developing their knowledge of health and fitness.

The likely closest competition to Walkstars is an application called Wokamons-Monster Walk Quest. The application has a similar aim to walkstars as it attempts to make walking fun for the user. This is achieved by letting player's grow and unlock different monsters based on the amount of steps they take. They can also unlock achievements and awards. The application has approximately 50,000 users to date [19].

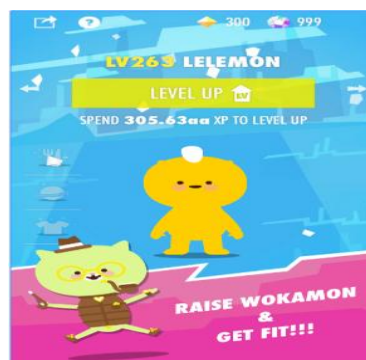


Figure 5. Wokamons Pedometer application

2.7.1 Fitness Courses

There are few health and fitness courses for teenagers in Ireland. A course run in University College Cork offers: educational talks on nutrition and healthy lifestyle, general fitness screening and a variety of age specific classes. Limiting factors of the course include the distance to travel to the location, cost of attending and time availability the course is run on. These are all factors that Walkstars hopes to overcome as it can be completed in any location, at any time for a nominal fee.

2.8 Technologies researched

The technologies that will be used in this project are as follows:

- Java programming
- Android wearable
- Bluetooth technology
- Android Integration and development
- Gaming
- Sensors
- Other Fitness applications
- GPS

2.8.1 Android Studio IDE

Android studio is a perfect integrated development environment (IDE) for this project as it includes all features needed to run this application. It is the official IDE for android development platform. Android studio includes a powerful code editor based on the IntelliJ IDEA technology featuring such technologies as advanced code refactoring and deep static code analysis. Some other features Android Studio offers are:

- Gradle based build support
- Rich layout editor with drag and drop features
- Support for building android wear apps

2.8.2 Java Programming

Java is a high-level programming language developed by Sun Microsystems in 1995. Java runs on a variety of platforms, such as Windows, Mac OS, and the various versions of UNIX. Java is the language used for android application development. It is a language I am very familiar with and one I have used on projects both in and outside of college. It supports a wide range of APIs in which will be used in this project.

Java allows for the easy integration of sensors. Sensors intended for this project include: Accelerometer, Step Counter, Step Detector. The main application will run on Kitkat 4.4 on android mobile devices as the application will work on 72% of devices.

2.8.3 Android Wear

Android wear smart watches come with an accelerometer installed which can be used to count the user's steps. For this reason, Walkstars will also have the capability of running on android wear. However, the functions on the android wear application are limited due to the size of the screen and processing power of the watch itself. Android wear can be programmed in Android Studio alongside the mobile application which means integration is improved. Integration is also improved due to the fact Android wear includes bluetooth and wifi connectivity.

2.8.4 Fitbit Charge 2

Fitbit is an activity tracker capable of tracking physical activity, calories burned and contains heart beat sensor. In their fourth quarter of 2015 they sold 8.2 million connected health and fitness devices [20]. The Fitbit Charge is reasonably priced and includes a range of useful features. Basic features include: Steps, Calories and distance. These features could create a range of different challenges to give to the user. Exercise features include: Pure pulse Heart rate and Cardio fitness level. This information would allow walkstars to build better custom programs for the user.

2.8.5 Sony Smart Watch

Sony Smart Watch is a line of wearable devices that can link up with android mobile devices. It can easily track a user's activity level as the watch includes an accelerometer and gyroscope sensor. The combination of the accelerometer and gyroscope enables precise calculation of the user's movement and direction. The smart watch also ships with GPS and compass sensors installed. The user can use the GPS to mark out a route in which they wish to walk. Connectivity includes Bluetooth, NFC and Wifi. Bluetooth makes connecting with android mobile devices easy. It is compatible with android mobile devices. [21]



Figure 6. Sony smart watch

2.8.6 Sensors

An accelerometer sensor reports the acceleration of the device along the three sensor axes. The measured acceleration includes both the physical acceleration (change of velocity) and the gravity. The measurement is reported in the x, y and z fields of `sensors_event_t.acceleration`.

All values are in SI units (m/s^2) and measure the acceleration of the device minus the force of gravity along the 3 sensor axes. [21]

The Accelerometer will be the main sensor used. It will be the underlying sensor to the `step_counter` and `step_detector`. From my research, I have found plenty of tutorials for implementing these sensors.

Other potential sensors include a heart beat sensor which would be a useful adjunct to this application, however due to the expense associated with a heart beat sensor it was not included in the initial design.

2.8.7 Games Engine

A game engine is a software framework designed to create and implement video games. LibGDX is an open-source game engine that uses Java programming language. For this reason, LibGDX integrates well with android mobile applications. It is highly recommended online for creating 2D games on android. It is free and has great performance reviews across devices [23]. LibGDX is a perfect candidate for Walkstars game engine as mini-games are a big factor to the applications unique selling point.

I have little experience in developing video games. However, I am currently following tutorials online teaching how to create games with Java for android. The most useful game I learned to recreate is floppy bird. This is the type and style of game that will be implemented in Walkstars.

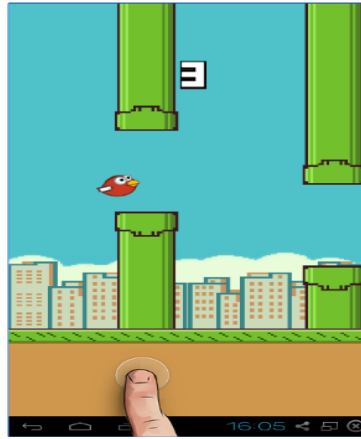


Figure 7. Flappy bird graphical interface

2.9 Fitness Applications

2.9.1 MapMyRun

MapMyRun uses GPS tracking and allows the user to visualise over 70 million running routes. One of the ideas for Walkstars is to implement a map function where the user can view their progress throughout the day.

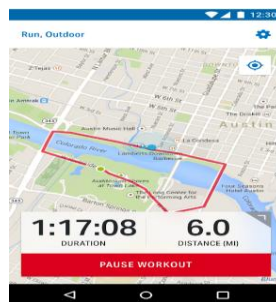


Figure 8. Mapmyrun map user interface

MapMyRUN's basic features include: following a pre-existing running course or creating your own course, analysis of performance including speed and calories burned, earn achievements based on running performance and share those achievements with friends on social media.

2.9.2 MyFitnessPal

MyFitnessPal gives users access the world's largest nutrition database with over five million foods [24]. The applications main features include:

- Exercise tracker: The application provides over 350 exercises and shows for each exercise how many calories are burnt.
- Calorie Counter: It helps the user keep track of how many calories they are consuming. The user can input into a food diary by typing in the name of the food or scanning the foods barcode. Information on the food is supplied along with healthy alternatives. A customised

plan is made for the user to suite their goals based on their inputted personal information i.e. weight, height etc.

- Community: The community aspect consists of a forum where members can post questions or give tips and advice to other members and share recipes[25].

2.10 Firebase

Firebase is a development platform that provides tools to make high quality applications. Firebase makes user logins simple with the ability to log in with Facebook, Google, email etc. It allows the implementation of such features as Cloud messaging into your application with ease.

Firebase is definitely something I will be using with my project.



Figure 9. Firebase platform

2.11 Other relevant research done

2.11.1 Interviews

For an extra insight into the obesity problem in Ireland, I set up a number of interviews with teenagers and health professional's looking to learn more about the problem. As obesity is a sensitive issue, I asked my brother Ross who has overcome obesity for an interview.

Critical information gleaned from the interview includes:

- The lack of information that is provided in schools on health and nutrition.
- How increasing daily activity and improving diet helped with weight loss.
- How an unhealthy lifestyle can affect personal behaviours and mental health.
- How entertainment systems such as the playstation impacted on his fitness levels.
- What type of aid's he used to overcome the problem (MyFitnessPal).

2.11.2 Physiotherapist

To help with my understanding of the childhood obesity problem in Ireland, I am fortunate enough to be in frequent contact with physiotherapist Aoife McGovern. Ms McGovern has agreed to aid me throughout this project.

Together we researched guidelines on using steps as a measure of physical activity for children and adolescents. Unfortunately there are no step values based on health parameters such as blood pressure or BMI for children or adolescents at the time. However there has been research conducted into the average number of steps walked each day by children and adolescents and recommendations to achieve the recommended 60 minutes of moderate physical activity based on this. A study by Tudor-Locke et al. 2011 [26] established gender specific cut points for children based on pedometers readings. Values for boys are 1) <10,000; 2) 10000-12,499; 3)12,500-14,999 4) 15,000-17,4999 and 5) > 17,500 steps per day. The equivalent values for girls are 1) <7,000; 2) 7,000-9,499 3) 9,500- 11,999; 4) 12,000- 14,499 5) >14,500 steps per day. These cut points correspond with 1) sedentary, 2) low activity 3) somewhat active, 4) active 5) highly active. Walkstars offers a rewards based system for achieving higher levels of steps per day as it determines the amount of energy your character has for the mini game.

2.12 Research techniques

Since there are unfamiliar technologies such as game engine implementation in Walkstars .It is important to make a plan to ensure I better my understanding before implementation. Many of the technologies used have an abundance of accessible online material and tutorials. For implementation of sensors, the android developer website offers a library of how-to-guides

For firebase implementation, www.youtube.com offer's many video tutorials. The firebase website also includes how-to-guides for third party login.

To familiarise with general technologies, DIT library offers a wide range of Computer Science Books and access to an online library database in which you can view e-books and journals.

The most practical way for me to familiarise with these technologies is to practise with them. I have found that in my programming career, I learn best through trial and error.

2.13 Resultant findings/requirements

The following are the requirements necessary to provide a complete application

- Android Application development
- Java Programming for android and game engine
- Game engine integration
- Database integration
- Server side technology

2.13.1 Functional and Non-Functional Requirements

My research has provided me with the information needed to build a functional and non-functional requirements table for my project.

Functional	Non-Functional
Sign up and log in user	Usability
Step tracking	Security
GPS tracking	Data-integrity
Award tracking	Reliability
Administrative functions	Performance
Work in background	Environmental
Legal and Regulatory requirements	Manageability

3. Analysis: Describe clearly what your solution will do

3.1 General Solution

Walkstars aim is to teach young people the importance of a healthy lifestyle in a fun and active environment. The aim of the game is to go out walking so that you can support a healthy lifestyle for your avatar. A healthier avatar is better able to compete in the mini-games.

The user will be taught a basic understanding of nutrition. This will be done through the food choices the user makes for their avatar. The more walkstar tokens the user collects, the more healthy options they will be able afford. Though it may be basic nutrition, it is hoped the user will learn the basic advantages of eating healthy food and disadvantages of unhealthy food. Healthier foods come with benefits such as improved agility in the mini-games, while unhealthy foods will diminish the characters ability to perform.

There will be optional quizzes which the user can complete. They will unlock awards for their characters. The quizzes will be based on nutrition, hoping to further improve the players understanding.

3.2 Hardware Solution

The application uses multiple sensors such as: Accelerometer, Step counter, Step detector. The sensors can be found using the android studio libraries. For the most accurate readings the sensors will work together. Wearable devices may be implemented so that the user doesn't need to have their phone on them at all times. Bluetooth is used between mobile and wearable devices to ensure the data is kept consistent.

3.3 Software Solution

Third party gaming engine libGDX will be used to make the mini games. It is highly recommended online for developers with novice-intermediate levels of knowledge for game development. LibGDX also integrates with android studio really well.

For database, sqlite will be used due to my familiarity with it and how it integrates with android applications. Firebase is used for third party log ins.

4. Approach and Methodology

4.1 Methodology Overview

The methodology and approach that will be applied to this project is Scrum coming from the Agile movement. However since this is an individual assignment, it is not technically Scrum.

An Agile approach helps teams respond to unpredictability through incremental, iterative work cadences and empirical feedback. Agilest propose alternatives to waterfall, or traditional sequential development. [27]



Figure 10. Agile methodology approach

4.2 What is Scrum

Scrum is an agile framework for completing complex projects. Scrum was originally designed for software projects but works well with any complex scopes of work. Usually Scrum is split up into roles: Product owner, Scrum master and team. However, as this is an individual assignment, I will be doing all of the work.

4.2.1 Scrum Phases

- The product owner creates a backlog. This is prioritised with the highest priorities at the top.

- Next is the sprint planning, where a team will take some of the top priorities and split them up into small elements.
- In the spring stage, the team is given a fixed amount of time to complete the work.
- At the end of the sprint, the work should be potentially shippable.
- The sprint ends with a review. After this the next sprint begins.



Figure 11. Scrum Methodology Phases

4.3 Methodology Comparisons

There are a number of methodologies that could have been applied to this project. The Waterfall m Model is one I considered and researched. The Waterfall Model is a sequential design process which flows through the phases of conception, initiation, analysis, design, construction, implementation and maintenance.

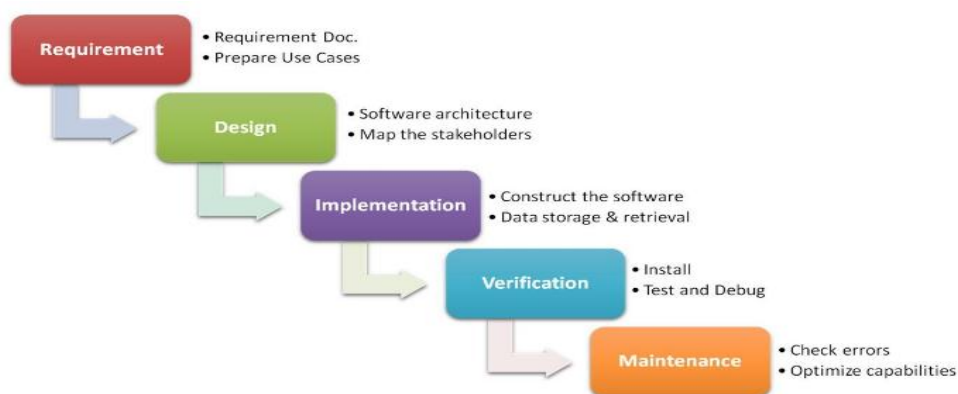


Figure 12. Waterfall methodology phases

4.3.1 Waterfall Methodology Phases

As can be seen in figure 12, the main phases for developing a project using the waterfall methodology are:

- Requirement gathering and analyses.
- System testing
- Implementation
- Integration and testing
- Deployment of system
- Maintenance

4.3.2 Waterfall pro and cons

Pros

Cons

Simple and easy to understand	High risk and uncertainty
Easy to manage. Rigid model	Not suitable for projects that will change a lot
Clearly defined phases	No working software until late into life cycle
Works well for small projects	Poor for long and ongoing projects
Phases are processed one at a time	Difficult to measure progress within stages

4.3.3 Comparison decision

From my research into the two methodologies Scrum and Waterfall, It was clear from very early on which one would be more suited. Scrum is an agile model meaning that the developer can revisit a phase after it has been completed. Since this is an individual project, agility in development is a requirement as errors will occur first time round. Waterfall is not suited for this type of project as it sequential and doesn't give as much room for handling errors.

4.4 Priority Phases

This section of the report will analyze features of the application to allow the creation of a priority wish list. This list allows for good time management as it ensures that the features with highest priority are completed.

4.4.1 High Priority

-Health and safety guidelines. As the application involves the user's health, the correct precautions must be taking to ensure the application is safe for all users.

-Accurate pedometer implementation is of utmost importance as Walkstars is fundamentally a pedometer application.

-Secure User login. Each user will be categorized based on their personal information provided ie. weight and height so a secure login is vital.

-Mini games. A unique aspect of this application is the mini games. It gives users a reason to play and brings a social aspect to the app as users will play against friends. They will also be able to share achievements on social networking sites such as Facebook.

4.4.2 Middle Priority

-The integration of wearable devices. This is an important feature in the application but doesn't take away from the original use case if not completed.

-Visualisation of routes. This feature will allow users to select a route which they would like to take for their walk. This would be a beneficial feature to have, however implementation may be difficult.

-Statistics. The user should be able to view their work through various charts and tables.

-Design. Since the demographic is children and young adolescents, a suitable graphical interface is needed.

-Third party login. The user can login using third party applications such as Facebook and Google. Accessibility is the reason for this feature being added to the application.

4.4.3 Low Priority

-Character Customisation. The ability for the user to customise the appearance of their avatar isn't a key element for this application.

-Nutrition quiz's. The quiz's will add to the users overall learning objective however, they are not a core part of the application.

-Share to social media. User will be able to share their achievements on social networking platforms.

5. Design

5.1 Design Overview

This section will look at all aspects of design for this project. It will attempt to explain how all soft/hardware components will combine to bring a finalized product. Use case, class, sequential and critical path diagrams will be used to demonstrate how each function will work within the final product.

Tools used for design diagrams: creately

5.2 Use Case Diagram

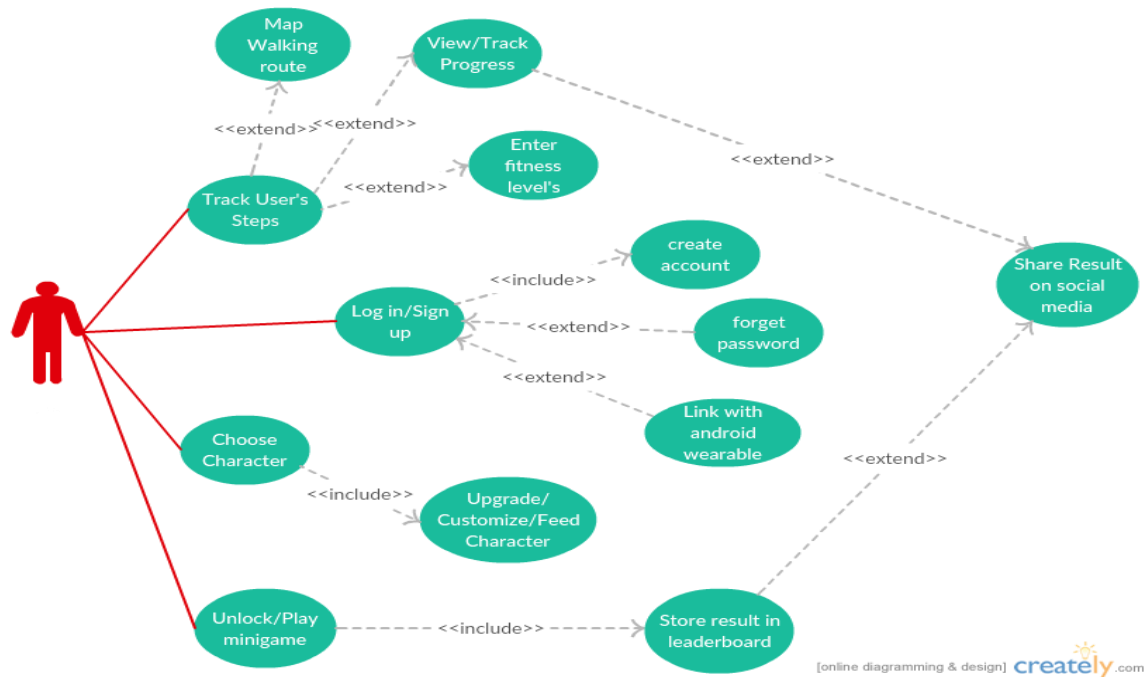


Figure 13. Systems main function use case diagram

Use case diagrams are used to describe a set of actions that the system should or can perform in collaboration with one or more external users of the system [28]. This is the main use case diagram as it showcases the level of functionality the user will be given in the final product. The main functionalities are: log in/sign up, track user's steps and choose avatar.

Log in/sign up - The log in/Sign up feature allows the user to create an account, retrieve account, log in and link devices. To create an account the user enters a valid email address and password. This is logged into the sqlite database. However, the user can surpass this by logging in with third party applications such as Facebook, Google and email. In this case, the user's details are stored in the firebase website application.

The link devices option allows the creation of a bluetooth connection between android mobile and gear devices.

Customise character- This feature allows the user to customize, feed and purchase boosters for their character. The currency is based on the amount of Walkstar tokens collected in the mini games.

Mini game - This feature allows the user to play a number of mini games. Once a mini game is completed the user will be shown their place on the leader board. They can also share their score on social media.

Step tracker - This feature counts the number of steps the user takes per day. The user will be given a recommended amount of steps to take.

5.3 Sequential Diagram

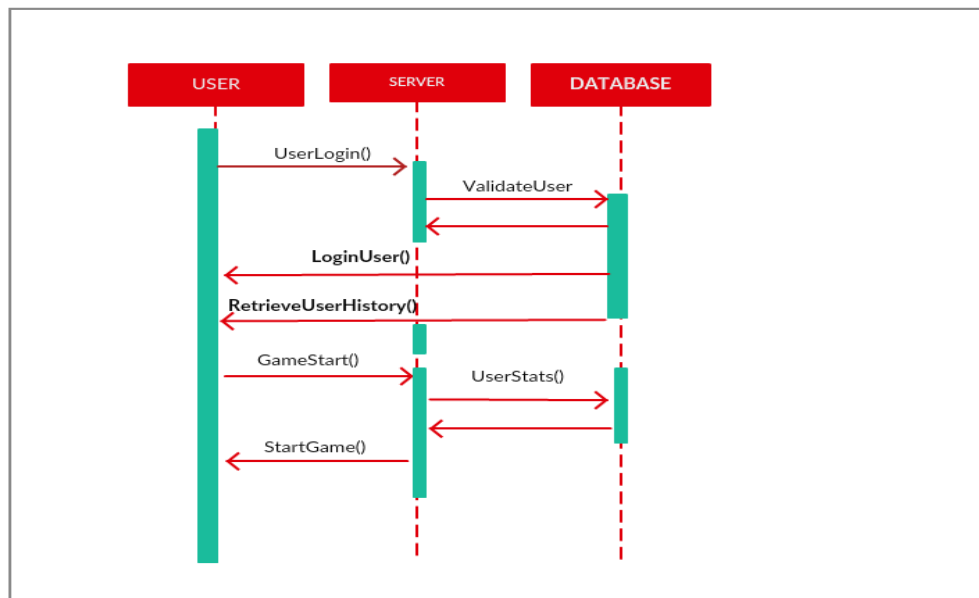


Figure 14. Sequential diagram for main functions of the system

Figure 14 shows the sequential diagram of two main functions of the application Walkstars. Sequential diagrams are used to show how objects interact with each other in the form of a message sequence chart. They are useful when testing as they show the expected result of the systems main functions. The two functions shown in this diagram are user login and play mini-game.

The user login requests the end user to enter in their username and password into the server. The server then validates these records against those stored in the applications database. If the records match, the user has successfully logged in.

The play mini-game function is called whenever the end user clicks on the minigame button. Once the server sees this request, it calls upon the user's records stored in the applications database. This will determine how much energy the user's character is given. Once this is completed, the server opens up the mini-game for the user.

5.4 Technical architecture diagram:

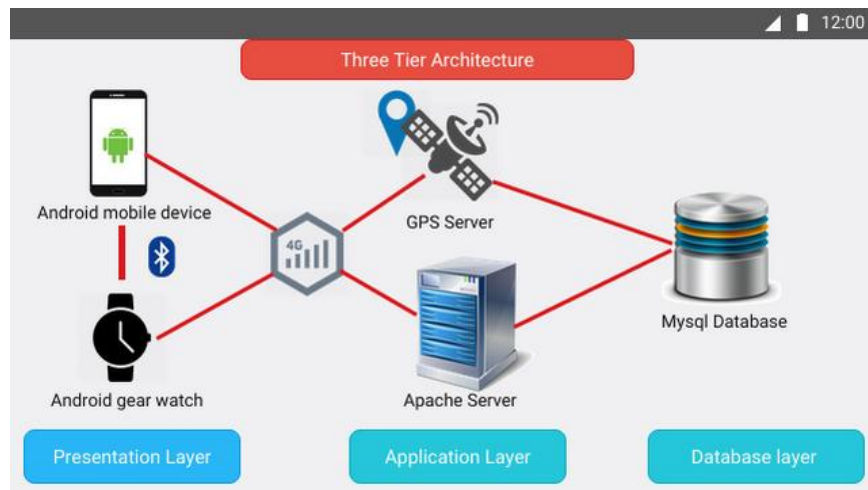


Figure 15. Three Tier System Architecture

Figure 15 looks at the technical architecture of the system. The architecture has three tiers: the presentation, application and database.

The presentation tier holds the end devices of the system, i.e. Android mobile and gear. The two devices are linked together via bluetooth technology. The presentation tier communicates with the application tier via mobile internet.

The application tier holds the servers in which the presentation and database tier communicate with. The two servers are: Google maps and firebase. GPS server provides information routes which the user can use for their walks. Firebase is a tool that enables the user to log in using third party applications such as Facebook and Google. The user's information is stored within the Firebase database.

The database layer stores information about the application such as user details and scores. The two database systems used in this application are sqlite and firebase. Sqlite is an local database that integrates well with android applications. It will store the majority of information. The firebase database stores information on third party logins and cloud communications.

5.5 Other design documents

5.5.1 Entity Relationship diagram

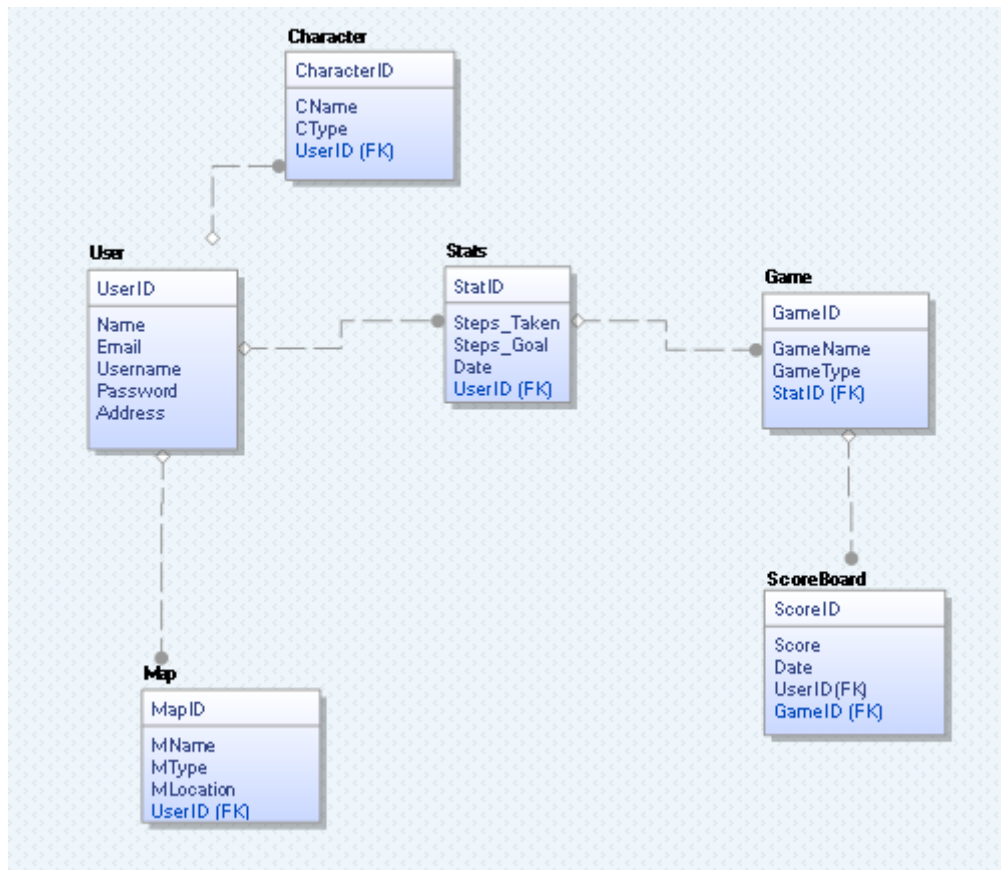


Figure 16. Walkstars ERD diagram

Figure 16 shows the Entity Relationship Diagram (ERD) diagram designed for the Walkstars application. An ERD diagram shows the relationship between each entity in a database.

Walkstars database has six entities in total: User, Character, Map, Statistics, Game and Scoreboard. The User to Character relationship is one to one because each user can only choose one character. User to Map relationship is one to many as the each user can make multiple walking routes. User to statistics is one to one as each user has only one set of statistics. Statistics to Game relationship is one to one as the game only pulls information on the user on a daily basis. Game to Scoreboard relationship is one to one as each game can only store one result.

This ERD for the system is only preliminary as entities may increase as development continues.

6. Prototyping and Development

In this section of the report, all aspects of prototyping and development for this project will be discussed. Prototyping is an important role in the development of a project as it allows for the developer and shareholders to visualise the application before any implementation is complete.

A prototype is a draft version of a product that allows you to explore your ideas and show the intention behind a feature or the overall design concept to users before investing time and money into development. A prototype can be anything from paper drawings (low-fidelity) to something that allows click-through of a few pieces of content to a fully functioning site (high-fidelity).

Tools used in Prototyping : Creativity, FluidUI, MockingBot

6.1 Log in/Sign up prototype

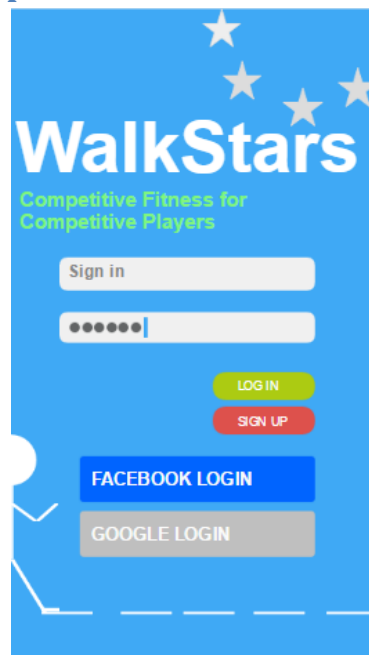


figure 17. Prototype for Log in/Sign up page

The first page the user will see when they open the application is the log in page. The page will allow the user to: create an account, login and sign up with Walkstars, Facebook and Google accounts. Firebase database is used for Facebook and Google logins. The idea of third party login was to make the application more accessible to everyone.

6.2 Home Screen



Figure 18. Prototype for the home graphical interface

The main page of the application is the home screen. This is where the user will interact the most. The home screen has the user's character in the foreground and their step's progress bar in the background. This screen will be animated so that the character moves around and there are moving parts in the background. Options can be found on the side of the screen. They include: customize character, feed character, purchase boosters and play mini games.

6.3 Minigame

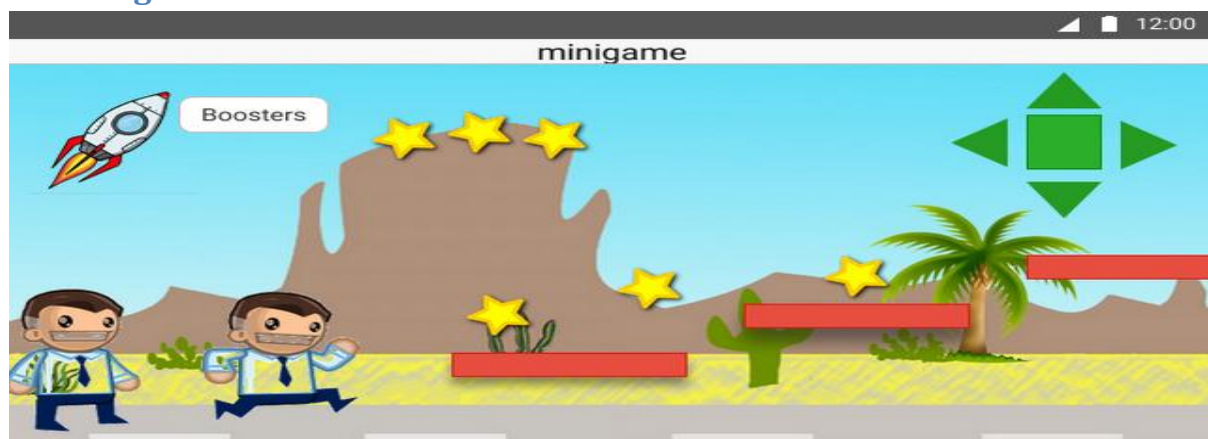


Figure 19. Prototype for the mini game graphical interface

Figure 19 shows the type of mini game's in the application. The goal of the game is to collect as many Walkstar tokens as possible. The character will always be moving forward and will be competing for the best time to finish each game. The character's energy bar will be based on how well they have been fed throughout the day. This will have an impact on how fast the character can move and how high they can jump. The reason for this is to teach the user the importance of a healthy diet.

7. Testing

7.1 Testing Overview

This section will look at the different methods and techniques that will be used in testing this application. The main techniques are white and black box testing. This section will go into the two in more detail. The two are perfect for this project as there are a lot of moving parts that have to integrate with each other. For example, a mini game will only be unlocked once the user has taken a certain amount of steps. The application has to ensure that the user cannot access them before hand and that when they open the mini game, it is a smooth transition.

7.1.1 Tester's

There will be three kinds of users testing this system: novice, intermediate and advanced. Each kind will be split up into categories' based on attributes such as: type of user, age, accessibility.

Since the application involves health and safety, I am hoping to get a number of professionals who work in the field to test the application. This will ensure that the application is suited to the demographic and is safe for all users.

Teenagers will be brought in to test since they are the key demographic. It is hoped the sample group will include teenagers with a normal body mass index and teenagers with an overweight or obese body mass index.

Even though the demographic is directed towards teenagers, the application will be made suitable for all ages. A random number of the population would be helpful because they are unbiased and may bring a different perspective.

7.2 Black Box Testing

Black box testing, also known as Behavioral Testing, is a software testing method in which the internal structure/ design/ implementation of the item being tested is not known [29]. The approach is designed to find errors such as interface, performance or termination errors etc. Using the recent example of the smooth transition to the mini game, if the user has completed the target number of steps and the mini game doesn't open. This is the type of error Black Box Testing should reveal.

7.3 White Box Testing

This method is basically the opposite of Black Box Testing in that the user is aware of the coding structure. The approach is designed to reveal errors within the internal structure of the source code. 'White-box testing usually involves tracing possible execution paths through the code and working out what input values would force the execution of those paths' [30]. An example of this in

Walkstars would be with testing the algorithm that calculates the number of steps the user should take. With White Box Testog, a tester would input any number of values to ensure the system is working properly. If a flaw is found, the code is analyzed thoroughly and the issue is resolved. This testing will go on until no flaws can be found and the system performance is secure.

7.4 Unit testing

This method breaks the project down into units and each unit is tested individually. This type of testing is good for bringing out the smaller errors which can be overlooked if the system is tested as a whole. For example, Walkstars's ability to count steps will be tested separately from the user log in system.

7.5 Integration Testing

As already mentioned, there are a lot of different functions within the application. Integration testing is used to ensure that all functions work with each other smoothly. An example in Walkstars is the integration between mobile and wearable devices. Each device must be up-to-date with each other; otherwise the data will be incorrect.

7.6 System Testing

In system testing the behaviour of whole system/product is tested as defined by the scope of the development project or product [31]. System testing is the last monitor before release to the market. It is therefore important to go through it in-depth. It is carried out by specialist and independent testers.

7.7 Testing Scripts

A test script is a document that records a set of instructions needed to perform a successful test on system functions. The following is an example of a test script used in development for this application.

Project Name: WalkStars					
Test Name: User Login		Test Version:2.0.1		Test Date:26/11/2016	
Test ID	Test Condition	Expected Results	Procedure	Pass/Fail	Defect ID
1234	User logs in using wrong password	Message is toasted: Username or Password incorrect	1. User opens application 2. User misspells password	Pass	NULL

1235	User Logs in using correct username and password	User is directed to main application page	1. User opens application 2. User inputs username and password	Pass	NULL
1236	User logs out and logs back in	User is directed back to login page. User is directed to main application page	1. User logs out of application 2. User log into application	Fail	1

Figure 20. A Test Script example used in the development process of Walkstars

8. Issues and risks

8.1 Issues

The main issue with this project is that it involves people's health. The demographic for the application is teenagers. For the reason, there is a responsibility to research and fact check each piece of information carefully to ensure that nothing makes the application unsafe to use. This issue can be tackled in a number of ways. 1) Make sure all resources are reliable and backed up with concrete evidence. 2) Have a health professional look over the research collected. 3) Have the health professional test any functions of the application that involve the user's health. With these methods for tackling the issue in place, I am confident the application will be accessible to all types of user with the guarantee that it is safe to use.

I believe the addition of the wearable device will also add a great amount of safety. The user will be given guidelines, based on their weight, age, height and physical activity level.

Another issue with this project is the accelerometer sensor as it not the ideal sensor to be used for counting steps. There is the option of using the step_counter sensor built into the android libraries. However, this sensor can only be ordered to wake up on a number of android phones. This is due to the amount of power consumption the sensor uses. For this reason, some phone developer's choose for it not to be accessible. The two options are: 1) Program the accelerometer so that it counts steps as accurately as possible. 2) Use the step_counter function and limit the amount of devices the application can work on. Android studio has plenty of tutorial's on sensors and how to implement for the most accurate readings.

8.2 Risks

The main risk with this project is my lack of knowledge programming computer games. This will be my first attempt at creating any type of computer game. However, through my research into computers games when designing this application I am confident Walkstars will deliver high quality mini games from within the application. As it is the main risks of the project, it is a high priority and will be one of the first features to be coded.

Other issues I see arising is the data-link between mobile and wearable devices. Both devices need to have the same amount of pedometer accuracy; otherwise the data won't match up.

9. Plan and future work

9.1 Project Plan Timeline

December
<ul style="list-style-type: none">-All research gathered will be placed into a library and categorised.-Finalise design-Begin coding the layout and main function's of the application-Update Project Plan diary
January
<ul style="list-style-type: none">-All high priority functions coded.-Resume coding medium priorities.-Planning User manual-Update diary
February
<ul style="list-style-type: none">-Testing and maintenance a commences-All coding finalised.-User Manual started-Update diary
March
<ul style="list-style-type: none">-Coding 100% finished-Update and complete User Manual-Continued System Testing
April
<ul style="list-style-type: none">-Last changes made-Everything completed-Demo Project at Project fair-Reflective diary

9.2 Key deliverables

The key deliverables that will need to be made in order to successfully complete this project are:

- Library of research on the topic of physical activity in children and adolescents.
- Create secure and accessible user log in system.
- Design the layout for the application (mobile and wearable devices).

- Design quality user interface.
- Design mini games.
- Program two high quality mini games.
- Link mobile and wearable devices using bluetooth. Send data between the two.
- Program a working and highly accurate pedometer.
- System link up to various social media accounts.
- Complete system testing and implementation.
- All functions of the system integrate with each other.

10. Conclusions

10.1 Conclusion overview

The final section of the report summarizes and concludes on the findings made in the research, design, approach, testing and implementation of this project.

10.2 Plausibility of proposed system

Research into all areas to do with this project has ensured that the project is plausible. The background research into childhood physical activity levels and obesity has made it clear that there is a need for an application like Walkstars. Research into the fields of videos games, fitness and nutrition applications have provided the information and functions needed to make Walkstars attractive to its demographic. The hardware research concludes there is an abundance of different ways in which this application could be completed. Each aspect of design and approach has been looked into and a good risk management system has been put in place. The testing approach will bring a high grade application to the market. A lot of thought was put into the project plan to ensure this application will be completed on time. With confidence in research, design, approach, testing, implementation and maintenance, an all round, fully developed application will be ready by launch date.

10.3 Summary of findings

The research into technology, design, approach, implementation, testing and maintenance has proved that the requirements gathered are perfect for the completion of this project. This section summarises and concludes the software and hardware decision's made throughout the project.

10.3.1 Summary of Software

Android is the preferred platform for this application as I have two years experience using android software . Android studio was chosen as the IDE was already set up on my computer and I have experience using it. Android offers an array of libraries making ease of the implementation of certain features such as Google Maps. Java programming language was fitting as it is the main language

used for android programming and is one I am familiar with. The operating system needed to run this application is kitkat 4.4 and higher. The implementation of the sensors is the reason for this as they don't run on older phones.

LibGDX games engine was chosen as it is written in java and integrates well with android studios. The game engine is also highly regarded online and is recommended for developers with little game development experience. LibGDX website also offers a library of tutorials and how to guides. All this together makes LibGDX a perfect candidate for this project.

Sqlite and firebase are used as the database for the system as they are light weight and integrate well with android.

10.3.2 Summary of Hardware

The Android mobile device is an obvious choice for this project as it has the capability of running each feature. Android devices have multiple sensors built in. They include an accelerometer, gyroscope and compass.

Android wearable activity watches are optional for use in this application. As with the mobile devices, android wear come equipt with all sensors mentioned above. The addition of android wear means the user doesn't need to have their phone on them at all times in order for their steps to be recorded.

10.3.3 Summary of Health and safety

Due to the nature of this application, it was critical to find out the safe amount of activity you can give to a general audience. The user will also be prompted a message whenever they start up the application stating that they should consult a doctor before engaging in any physical activity if they have a history of heart or lung issues, severe infections or fever, severe illness of any kind or are unwell at present.

Since one of the aims of the application is to teach the user about nutrition. Ever piece of information used in the application must be approved by a health care specialist. However, the level of nutrition learning will be kept very basic. Information will only be pulled from reliable resources such as: safefood.eu and worldhealth.net.

10.4 Personal Development

Personal development through the in depth research made into each developmental stage of this project. An example of personal development made was in the research into game engines and technologies. Since this is the first time I will attempt to implement a game engine on android, research into the field of video game software and technologies was a crucial part in improving my understanding of the systems. The research has given me the confidence to create and implement a mini game into Walkstars. Confidence in my ability to tackle the task on hand improved along with my risk management techniques. The following is a summary of the areas in which I gained the most personal development.

10.4.1 Technologies Tested

The following is a summary of the technologies that have been tested so far:

- Java programming
- Android programming
- Sensors
- Android mobile and wearable devices
- Game engines (libGDX)
- GPS technology

Other non-technical areas of personal development include:

- Time management (Project implementation timeline)
- Communication (Working with tutor)
- Organization (Making project plan)
- Research analysis

Now that a summary of the main features and requirements is completed along with an in depth look into the design and approach, implementation of the application can now be started.

Words: 9,351

11. Bibliography (research sources)

1. Trends in adult body-mass index in 200 countries from 1975 to 2014: a pooled analysis of 1698 population-based measurement studies with 19.2 million participants *The Lancet* , Volume 387 , Issue 10026 , p1377 – 1396.

2. thinkhouse.ie. (2014). *Irish Mobile Youth Report 2014*. Available: <http://www.thinkhouse.ie/downloads/mobilereport/Full-Report-Thinkhouse-Mobile-Youth-Survey.pdf>. Last accessed 27th Nov 2016.

3. *5 Apps and Social Networks Teens Love*. Available: <https://www.webwise.ie/parents/5-apps-and-websites-teens-love/>. Last accessed 27th Nov 2016.

4. *Color Psychology to Empower and Inspire You*. Available: <http://www.empower-yourself-with-color-psychology.com/>. Last accessed 28th Nov 2016.

5. Pennell, J. (2015). *7 Feel-Good Apps That'll Improve Your Life*. Available: <http://www.teenvogue.com/story/health-fitness-apps>. Last accessed 27th Nov 2016.

6. (2014). *Announcing 75 Million MyFitnessPal Users!*. Available: <http://blog.myfitnesspal.com/announcing-75-million-myfitnesspal-users/>. Last accessed 27th Nov 2016

7. Woods, C.B., Tannehill D., Quinlan, A., Moyna, N. and Walsh, J. (2010). The Children's Sport Participation and Physical Activity Study (CSPPA). Research Report No 1. School of Health and Human Performance, Dublin City University and The Irish Sports Council, Dublin, Ireland.
8. Williams, J., Greene, S., Doyle E., Harris E., Layte, R., McCoy, S., McCrory, C., Murray, A., Nixon, E., O'Dowd, T., O'Moore M., Quail, A., Smyth, E., Swords, L., Thornton M. (2009) Growing Up in Ireland – national longitudinal study of children: The Lives of 9-year olds. Dublin: The Stationery Office.
9. Warburton, D.E.R., Nicol, C.W., Bredin S.S.D. (2006). Health benefits of physical activity: the evidence. *Canadian Medical Association Journal*. 174 (6), p801-809.
10. World Health Organisation. (updated 2016). *Physical Activity Factsheet*. Available: <http://www.who.int/mediacentre/factsheets/fs385/en/>. Last accessed 27th Nov 2016.
11. *Get Ireland Active! The National Physical Activity Plan for Ireland*. Available: <http://www.getirelandactive.ie/Professionals/National-PA-Plan.pdf>. Last accessed 27th Nov 2016.
12. World Health Organization. (2006) Physical activity and health in Europe: evidence for action.
13. Department of Health. (2005). Report of the National Taskforce on Obesity: Obesity – the policy challenges.
14. Brown, R and Ogden, J. (2004). Children's eating attitudes and behaviour: a study of the modelling and control theories of parental influence. *Oxford Journal* . 19 (3), p261-271.
15. Rampersaud, G.C., Pereira, M.A., Girard, B.L., Adams, J. and Metz, J.D . (2005). Breakfast Habits, Nutritional Status, Body Weight, and Academic Performance in Children and Adolescents. *Journal of American Dietetic Association*. 105 (5), p743-760.
16. Lenhart, A., Kahne, J., Middaugh, E., MacGill, A., Evans, C., and Vitak, J. (2008). *Teens, Video Games and Civics*. Available: <http://www.pewinternet.org/2008/09/16/teens-video-games-and-civics/>. Last accessed 28th Nov 2016
17. Smith, C. (2016). *75 Pokemon Go Statistics (November 2016)*. Available: <http://expandedramblings.com/index.php/pokemon-go-statistics/>. Last accessed 28th Nov 2016.
18. (2016). *Google Fit - Fitness Tracking*. Available: <https://play.google.com/store/apps/details?id=com.google.android.apps.fitness>. Last accessed 28th Nov 2016.
19. (2016). *Wokamon - Monster Walk Quest*. Available: <https://play.google.com/store/apps/details?id=com.wokamon.android&hl=en>. Last accessed 28th Nov 2016.
20. Fitbit, inc. (2016). *Fitbit Reports \$712M Q415 and \$1.86B FY15 Revenue; Guides to \$2.4 to \$2.5B Revenue in FY16*. Available: <https://investor.fitbit.com/press/press-releases/press-release->

details/2016/Fitbit-Reports-712M-Q415-and-186B-FY15-Revenue-Guides-to-24-to-25B-Revenue-in-FY16/default.aspx. Last accessed 28th Nov 2016.

21. Eiseinreich, D. (2012). *Programmable watches*. Available:

<http://www.slideshare.net/rhu6ar6/programmable-watches>. Last accessed 28th Nov 2016.

22. android.com. *Sensor Types*. Available: <https://source.android.com/devices/sensors/sensor-types.html>. Last accessed 28th Nov 2016.

23. slant.co (2016). *What are the best 2D game engines for Android?*. Available:

<https://www.slant.co/topics/1476/~2d-game-engines-for-android>. Last accessed 28th Nov 2016.

24. myfitnesspal. *Lose weight with MyFitnessPal*. Available: <https://www.myfitnesspal.com/>. Last accessed 28th Nov 2016.

25. Gear & Tech. (2016). *MyFitnessPal Review: Pros & Cons Of Top Fitness App*. Available:

<http://www.builtlean.com/2013/09/19/myfitnesspal-review/>. Last accessed 28th Nov 2016.

26. Tudor-Locke, C., Craig, C.L., Beets, M.W., Belton, S., Cardon, G.M., Duncan, S., Hatano, Y., Lubans, D.R., Olds, T.S., Raustorp, A., Rowe, D.A., Spence J.C., Tanaka, S., and Blair S.N.. (2011). How many steps/day are enough? for children and adolescents. *International Journal of Behavioral Nutrition and Physical Activity*. 8 (78)

27. (2008). *The Agile Movement*. Available: <http://agilemethodology.org/>. Last accessed 28th Nov 2016.

28. (2016). *UML Use Case Diagrams*. Available: <http://www.uml-diagrams.org/use-case-diagrams.html>. Last accessed 28th Nov 2016.

29. *Black Box Testing*. Available: <http://softwaretestingfundamentals.com/black-box-testing/>. Last accessed 28th Nov 2016.

30. *DEFINITION white box (white box testing)*. Available:

<http://searchsoftwarequality.techtarget.com/definition/white-box>. Last accessed 28th Nov 2016.

31. *What is system testing*. Available: <http://istqbexamcertification.com/what-is-system-testing/>. Last accessed 28th Nov 2016.