Sheffield Hallam University

Faculty of Science, Technology and Arts

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Degree Course:	**Software Engineering**
Title Project:	**A companion app for the tabletop game Dungeons and Dragons that will connect old and new players**

Confidentiality Required?

NO

YES

Abstract

Being part of a group is the only way to play Dungeons and Dragons, although most people are able to play with their friends or families a lot of people are unable to do so for various reasons. Currently there is no app on the iOS app store or the Google play store that offers users a way to form groups and play together. The game isn't new player friendly, requires users to carry around physical paper sheets, and has a steep learning curve, all of which turn new players off from trying the game.

I plan to solve this by creating a cross platform (iOS, and android) mobile application that will allow players to form their own groups, create characters, and have guides to help new players understand the game mechanics. The application is targeted at both new players and existing veterans, as it will try and improve the current user experience.

User evaluations were done to assess the success of the application, and to see if it achieved the goal of aiding new players. All participants found that the application was easy to use and offered the correct functionality to be useful, however more work should be done before the app can be released.

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1. Intro

Dungeons and Dragons (which will be referred to as D&D from here on) is a table-top role playing game that involves 3+ players to be engaging in this social fantasy game. D&D is often played in person around a table where the players create characters, roll dice, check game guides, and take notes all while role playing a fantasy world.

D&D has had trouble transitioning into the modern gaming space as there are few tools that fully utilise the convenience and functionality of modern computing systems while incorporating the games systems. Often people have folders or notebooks with all of their game information that they bring with them each time they play a game. D&D is also notoriously difficult to get into, as new players are expected to spend money on game guides and essential manuals, which are typically large volumes of text explaining the core game functionality. D&D is a social game that you play with friends or family, however if you don't know anyone that wants to play then it can be challenging to find a group of people to play with in person.

The purpose of this application is to design a user friendly system that will help users shift from the old paper based system, to a mobile application that will have all of the functionality that is required to play the game. It should also provide useful game guides that will help new users to understand the game on a fundamental level, that would allow them to start playing right away. And finally it should have a system that allows users of the app to be able to form groups and find each other using their real world locations. This application will help new players pick up the game, and help streamline the game for verteran players.

The project will be referred to as the Dungeons Masters Handbook from here on.

1.1 Project Aims

- To explore the current state of Dungeons and Dragons.

- Research into any existing applications that are based around D&D to see what is currently out there, what can be improved and to see what isn't currently being done.
- To see how many new people would play D&D if it was more accessible to new players
- Define a development method and framework that will best suit a cross platform application
- To understand how to develop a cross platform mobile app
- To store user and game information in a secure backend system
- To manipulate and utilise location data
- To critically evaluate myself and understand how to improve

2. Investigation / Research

2.1 Operating systems

2.1.1 Available Operating systems

There are currently two major mobile operating systems; Android developed by Google, and iOS developed by Apple. There are other operating systems for mobile devices, but they have >0.1% market share around the world. In 2020 Android has 86.6% market share globally and iOS has 13.4% market share respectively. Android's market share is predicted to increase to 87.1% by 2023, and iOS is expected to fall to 12.9%. However in the UK iOS has a 49.9% market share, which shows that the UK is one of Apple's biggest consumers as almost half the amount of phones are running iOS. (Statista, 2020)

Year	2017	2018	2019	2020	2021	2022	2023
Android	85.1%	85.1%	86.6%	86.6%	86.9%	87.0%	87.1%
iOS	14.7%	14.9%	13.4%	13.4%	13.1%	13.0%	12.9%
Others	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
TOTAL	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Figure 2.1

There are other mobile operating systems such as Windows Phone, Symbian, Blackberry OS, and other smaller niche operating systems. Devices running these are typically used in industry fields, so developing for non-consumer operating systems isn't realistic for my project.

2.1.2 IOS

IOS is available for Apple iPhones and tablets, iOS 13 is the latest version and is only available on iPhone 7 and above. Development for iOS is done through xCode IDE which is only available on MacOS, and it uses the programming language of Objective-C.

Even though iOS has a lower market share than Android it has been shown that revenue sales on the App store far exceed the revenue on the Google Play Store, the reason for this could be

because the content quality and pricing strategy in Apples store consistently beats its competitors. *“iOS App Store 2018 revenue came to $46.6 billon, while Google Play revenue stood at $24.8 billion by this measure”*. (Iqbal, A., 2020)

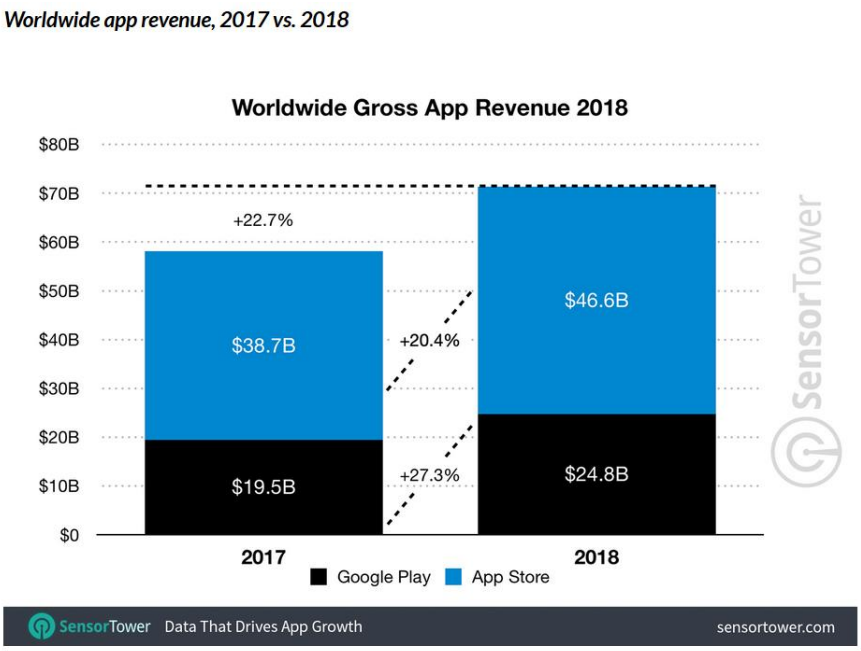


Figure 2.2

2.1.3 Android

Android is developed by Google using Java and was first released in September 2008. Development for Android is done using Android Studio, a free IDE that offers users the choice between Kotlin and Java development. Unlike xCode Android Studio can be downloaded on both macOS and Windows, because of this there are many more Apps in the Google Play Store compared to the App Store as developers aren’t restricted to one platform. However because of the quantity of apps on Android the quality of the apps also decline, this is why people are more likely to spend money on iOS apps as they know the quality will be of Apple standard.

There are many different versions of android that are run on devices, for example the Huawei line of phones run EMUI which is a custom UI over stock Android. As there are so many versions of Android developing for each version can be difficult as you have to tolerate the

different features and configurations. According to Google accommodating these different versions is doable as *“Android provides a dynamic app framework in which you can provide configuration-specific app resources in static files”*, (Android, 2020) this means that your app doesn’t have to be built differently for each phone, only XML layouts will differ.

In 2019 the most popular Android phone in the UK was the Samsung Galaxy S8 with 4.75 traffic share, and *figure 2.3* shows the top 10 Android phones. When developing my prototype app I will focus on full compatibility with Samsung devices at first.

Country	Rank	Phone model	Traffic Share
United Kingdom	1	Samsung Galaxy S8	4.75%
United Kingdom	2	Samsung Galaxy S9	3.80%
United Kingdom	3	Oppo R9s	2.59%
United Kingdom	4	Samsung Galaxy S7	2.54%
United Kingdom	5	Samsung Galaxy S7 Edge	1.80%
United Kingdom	6	Samsung Galaxy S9 Plus	1.45%
United Kingdom	7	Samsung Galaxy A5	1.34%
United Kingdom	8	Samsung Galaxy S8 Plus	1.17%
United Kingdom	9	Samsung Galaxy S6	1.14%
United Kingdom	10	Huawei P20 Pro	1.09%

Figure 2.3

2.2 Other Existing Apps

Android and iOS have different app stores which contain both cross platform and exclusive titles, I will investigate the top three cross platform apps as this is the market that I’m aiming for.

2.2.1 D&D Beyond

D&D Beyond is the official D&D app that is developed with the help of Wizards of the Coast, the creators of D&D. D&D Beyond is a free app however the app only provides the user

with minimal features and it is strongly recommended to purchase a membership to fully utilize the app.

The app doesn't require user authentication to view the marketplace, but it does require an account to purchase manuals and adventures. Accounts can be registered through their service, with a Google account, or with a Twitch account. As this app is supported by Wizards of the Coast they are able to sell the official adventures and game guides, as you can see in *Figures 2.4 and 2.5*, whereas most other apps can't offer this.

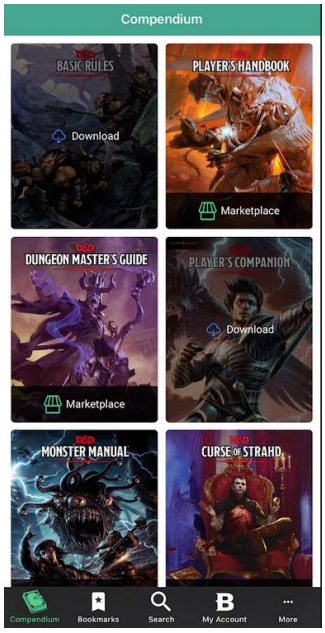


Figure 2.4

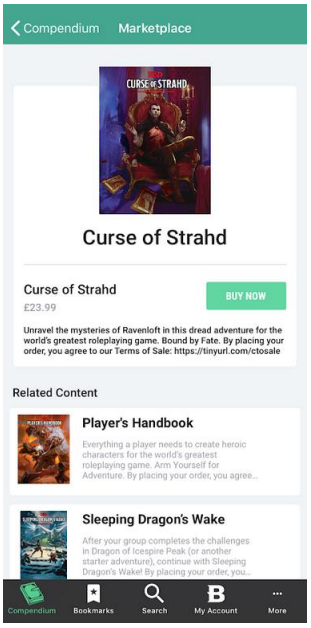


Figure 2.5

The app offers no way for the user to create or store character data, I think that this is a massive oversight as being able to have your characters with you is a big selling point for the D&D Beyond website. The final feature the app offers is being able to view items in the game, such as listing all of the spells and equipment.

This app currently has a rating of 2.6 on the Google Play Store with 4001 total reviews and a score of 2.5 on the App Store with 78 ratings, below are reviews from both stores:

Play Store:

1 star

“I'm giving the app 1 star for content only, because app usability is horrendous. Once you download the app, figuring out where your content is isn't very intuitive.” James Farias April 5 2020 (Google Play)

2 stars

“Very limited application. You can only access books that you've purchased & the search feature is not terribly useful. I should have access to certain information but when I go to search for it, it doesn't pull it up. Navigation is pretty terrible.” Ryan Paton, April 10 2020 (Google Play)

App Store:

1 star

“This app gives you access to digital books which you buy online and download to your mobile device, and access through the app. Yet, when I went in holiday to somewhere without phone signal or wifi, I could access none of my books, on iPad or iPhone” Mathew Wilcox, May 11 2020 (App Store)

3 stars

“The app itself is good, but only for reference of the books you own. Just like real life. My issue is that the main reason I use dndbeyond is for characters, which you can’t access through the app. If they implemented this I would quite happily change my review to a higher star rating.” Adam1909, Oct 26 2019 (App Store)

2.2.2 Complete reference for D&D 5

Complete reference for D&D 5 is developed by van Stein en Groentjes.The app's only function is to give the user an easy and convenient way of viewing game data, for example it lists all of the items and spells in the game, along the definitions as shown in *Figure 2.6 and 2.7*.

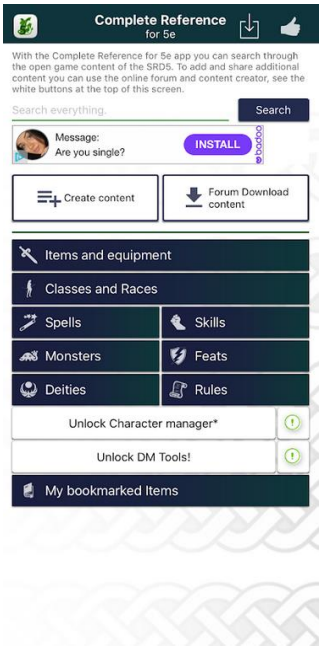


Figure 2.6

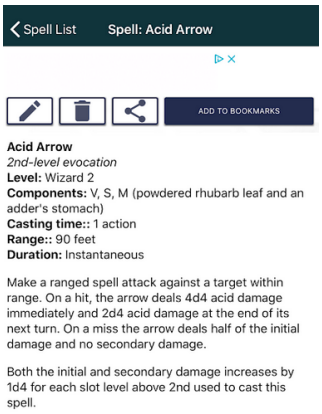


Figure 2.7

The app has no way of creating or storing character data, it's only functionality is to assist players with in game definitions and stats. This app is designed so people don't have to carry around the game manuals with them whenever they play.

This app has no user authentication as the user isn't saving or creating and data of their own. There are many ads that run on the app which could be an issue for some people, however as the app is free this is expected. The user interface for the app is very simple and offers no customisation or choice for the user.

2.2.3 Fight Club 5th Edition

Fight Club 5th Edition is an unofficial character building app developed by Lion's Den. The main function is to help users create characters, it does this by going step by step through each field and giving the user options to pick from, shown in *figure 2.8*. This is a very good method to help new users create characters as it gives an explanation and all the relevant information for each decision.

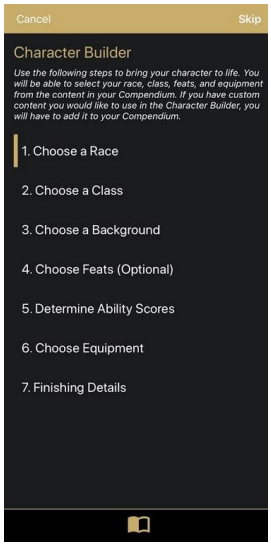


Figure 2.8

The app is very user friendly and has an easy to understand interface with consistent design patterns. All characters are then displayed on the home screen, where the user is able to select a character and view the stats in more detail, as shown in *figure 2.9*.

Figure 2.9

The other function the app offers is a “compendium” which similar to D&D beyond offers a list of items, races, classes, ect and explains in detail what each of these does. This is good as people often spend time searching through books to find a specific item or spell.

2.2.3 Comparison

	D&D Beyond	**Complete Reference for D&D 5**	**Fight Club 5th Edition**	**Dungeon Master's Handbook**
Free	Yes to download - but only offers 2 free guides the rest must be purchased	Yes with ads - premium version available	Yes with ads	Yes
User Authentication	Yes - required for any functionality	No - not needed	No - could be useful	Yes
Character Data	No	No	Yes	Yes
Game Information	Yes - But has to be paid for	Yes	Yes	Yes
Game Guides	Yes - Must be paid for	No	No	Yes
New Player Friendly	Yes	No	Yes	Yes
Requires Internet	Yes - unable to download purchased guides locally	No	No	Yes - only for first time authentication.
App Store Rating (iOS)	2.5 - 77 ratings	4.1 - 18 ratings	4.7 - 287 ratings	N/A

Play Store Rating (Android)	2.7 - 4,046 reviews	4.1 - 3,301 reviews	4.1 - 254 reviews	N/A

2.3 Architectures and frameworks

2.3.1 Ionic Framework

The Ionic framework is developed by Drifty. It was released in 2013 and built on top of AngularJS and Apache Cordova. The framework is an open source UI toolkit used to build high performance mobile and desktop apps using web technologies. The official Ionic documentation states that *"Ionic is focused mainly on the look and feel, and UI interaction of your app. That means we aren't a replacement for PhoneGap or your favorite Javascript framework"*, (Ionic Framework, 2016) so this framework will on be used for front end development.

I have decided to use the Ionic over other frameworks such as React Native, Flutter, and Xamarin, because this is my first time developing a cross platform app. Ionic has more documentation and better integration with other API's and services so development will have an easier learning curve.This framework also uses the Cordova plugin which allows it to use built in device features such as the camera and GPS, which will be used for my app.

2.3.2 AngularJS / React

Ionic is compatible with 2 other frameworks React and AngularJS. React is a javascript library used for building user interfaces, developed by Jordan Walke in May 2013. In 2019 the Ionic developers announced Ionic React, a framework that implemented standard react development patterns and the use of the react-dom library. (Lynch, M. 2019)

AngularJS is a platform for building mobile and desktop web applications, its a type-script based open-source web application developed by Google released in 2016. As AngularJS is developed by Google it has integration with other Google tools such as Google Maps. Angular is also *"an ideal technology for websites where the content should change dynamically based on user behavior and preferences."* (Harkushko. L, 2019) This applies to my project as the data being displayed will be dynamic as it'll change depending on the user interaction.

I have chosen to use AngularJS over React because I'm familiar with JavaScript, and Angular TypeScript is similar to JavaScript so the learning curve won't be as steep as using React. Also Ionic React is a new technology so there is a lot less documentation and resources online to

help with development, as opposed to Angular which has years of documentation and resources that I can access to help with development and learning.

2.3.3 Kotlin / Swift

The other choice for development would be to build my app using the native tools for both OS's, using Kotlin for Android and Swift for iOS. Kotlin was developed by JetBrains and in 2017 Google announced that "*Kotlin was becoming an official language to develop android apps"*. (Android Developer, 2020)

Swift was developed by Apple and released in June of 2014, it's a general purpose language made for iOS, macOS, and Apples other operating systems. According to Apple *"Swift is a successor to both the C and Objective-C languages."* (Swift - Apple Developer, 2020) which were used for iOS development in the past, but now most apps are made using Swift as it's faster and more powerful as it can fully utilize the LLVM compiler.

Developing a native app for both operating systems is a good idea if you want to maximise the performance and efficiency of your application, however as my app shouldn't be very resource intensive there would be little benefit to this approach. This would also substantially increase development time as I would first have to learn each IDE and language from scratch, so this isn't a viable option for me.

2.4 Backend

Backend systems handle the data management side of an application, they usually consist of a server, an application, and a database.

2.4.1 Firebase

Firebase is a service developed by Google and released in May 2012 and used to develop mobile apps. Firebase gives functionality such as databases, user authentication, analytic, messaging, and crash reporting. Firebase has native integration with Ionic as it's available from the official ionic integration documentation, so using it as part of my backend means that I won't have to build a database from scratch or manage the infrastructure as its *"Built on Google infrastructure that scales automatically, for even the largest apps."*. (Ionic Integrations, 2020)

Authentication

Firebase offers built in user authentication with easy to use SDKs. It has support for multiple authentication providers such as email and password, phone numbers, Google, Facebook, Twitter, and more. My app requires user authentication as each account will be linked to individual characters and group data, however developing a secure database myself will substantially increase development time.

I have decided to use Firebase as it has native integration with Ionic, and it is built on Google's infrastructure making it secure and scalable.

2.4.2 Local Storage

Storing data locally is where a database is created on the client side, instead of storing data through a server on an external database such as firebase. Ionic has a native local storage module called ionic storage, which uses a SQLite database. The SQLite database will be used to store characters created, and the guides, because the data will be stored directly on the users phones there will be a limit as to how many characters can be made as it may cause memory problems.

Not requiring an internet connection allows users to be able to access their data in any situation, for example if they wanted to play a game of DnD on a camping trip out in the woods then they would still be able to access their characters. However not all data can be stored locally, data that is changed based on external factors requires a connection to update, for example users would not be able to create or search for groups.

2.4.3 Google Maps API

The Google maps API allows developers to implement a Google Map into their project through the Google Console. The API allows developers to create customs maps with unique functions specific to their needs. This API also has native integration with the Ionic framework and should seamlessly work with iOS and Android.

I have decided to use the Google maps API over other map APIs such as TomTom, Mapbox, LocaionIQ, etc, because it has native integration with Ionic, it's the most popular API that users

will immediately recognise, and it has all of the features that I will need for my project such as custom marker placement and descriptions attached to the marker. According to Google they also have *"99% Coverage of the World: Build with reliable, comprehensive data for over 200 countries and territories"*, (Ionic Maps, 2020) so if my app was to get published to the app stores then anyone in the world would be able to use the map without problems.

2.5 Open Game License

2.5.1 What is an open Game License

The Open Game License (OGL) is a copyright license by Wizards of the Coast that allows developers to modify, copy, and distribute designs and mechanics for all of their tabletop role playing games. However they must share-alike copies and derivative works. *Figure 2.10* shows a list of activities that the OGL allows.

Activity	*OGL*
I want to design content using the fifth edition rules for D&D	X
I want to publish my original campaign world using fifth edition rules	X
I want to publish content using the Forgotten Realms	—
I want to print and sell my fifth edition D&D product on my own	X
I want to sell my product in the D&D online marketplace	—
I want my content rated by the largest network of D&D players	—
I want my content considered for additional publication by Wizards	—
I want my content considered for inclusion in digital games	—
I want my content considered for inclusion in Wizards marketing	—

Figure 2.10

2.5.2 Application towards my app

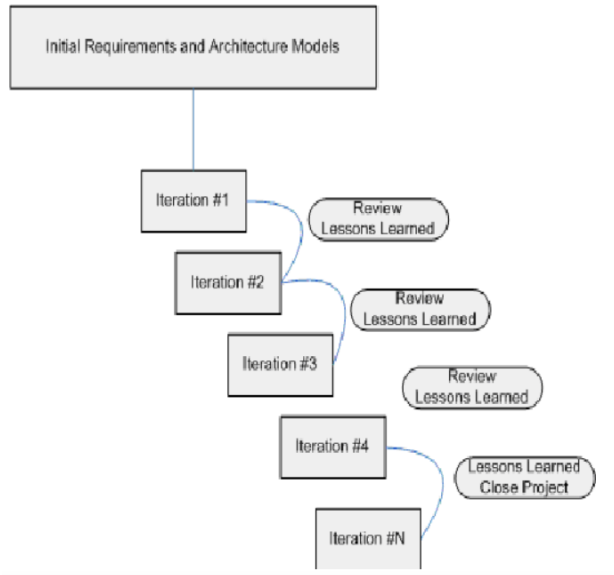
My app must follow the copyright laws as an infringement would result in the "*6 months and/or a £5,000 fine."* (Intellectual Property Office (2017) . I only intend to design content using the fifth edition rules for D&D so my app will be in compliance with the OGL, and shouldn't result in a copyright infringement.

2.6 Development Methodology

A software development methodology is the process of dividing development into phases to improve project management. The 2 approaches that I will be investigating for my project are agile, and waterfall methodologies.

2.6.1 Agile

Agile methodology is a model based on iterative development, where the requirements and the implementation are constantly changing and evolving. Agile development was created as a response to the inadequacies of traditional waterfall development. This method focuses more on collaboration between individuals rather than a complex planning strategy.



2.6.2 Waterfall

Waterfall methodology is a sequential development process, where each previous step is completed before moving on, this makes the implementation flow in a downward fashion similar to a waterfall. There are 5 phases for this model analysis, design, implementation, testing, and maintenance. You can see the downward flowing pattern in *figure 2.12*

Analysis

The analysis phase is where you go through the and decide on a complete list of requirements for the project. The requirements are typically defined as functional and non functional.

Functional requirements describe the users interaction with the system, and non functional requirements describe properties such as reliability, scalability, testability, and availability. Once these requirements have been decided they cannot be changed, without restarting the entire development cycle. (Bassil, Y. 2012)

Design

The design phase is where the developers design the systems, such as the user interface and algorithms, that were specified in the analysis phase. No code is written at this stage, it is designing how to implement the system requirements.

Implementation

This phase is where you take the designs and you realise them by developing the project. This is where the real code is written and the project gets built.

Testing

The testing phase is the process of checking that the software developed matches the specification and achieves what the project was set out to do. This is where any bugs can be found and fixed, and some definitions of the waterfall model have another implementation phase after testing to refine the project.

Maintenance

Maintenance phase is to modify and update the project to meet an ever changing and adapting software environment, I don't think that my project will go into the maintenance phase as it is unlikely to actually be released to the public.

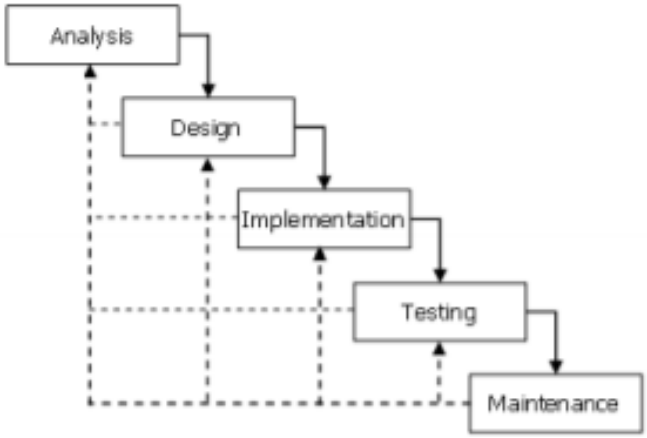


Figure 2.12

2.6.3 Chosen Methodology

I have chosen to use a waterfall methodology approach as the requirements and specification for my project won't change through the development cycle. Mike McCormick states in his Waterfall vs Agile Methodology paper that *"The waterfall model is suited for development of programs that are already stable. That is, their design doesn't need a major makeover."* (McCormick, M. 2012)

2.7 GDPR

The General Data Protection Regulation (GDPR) is a set of legal rules and regulations regarding the collection and use of personal data for people who reside within the EU. *"The GDPR entered into force in 2016 after passing European Parliament, and as of May 25, 2018, all organizations were required to be compliant.",* (Wolford, B. 2018) as my app is part of Sheffield Hallam it must comply with the GDPR rules and regulations.

2.7.1 How my app complies to the GDPR

As my app will be gathering personal data which is defined as *"any information that relates to an individual who can be directly or indirectly identified."* (Wolford, B. 2018) , this includes names, email addresses, and location data, all of which will be needed and stored with my app. To comply with the GDPR users of the app will be able to remove and wipe all of their data from the databases and servers whenever they want to.

As my app will be focused on UK users it will still have to comply with GDPR even after Brexit, as there will be a crossover period when the GDPR will come into force in the UK as well as the EU.

2.8 Research Questionnaire

As part of my research I created a questionnaire to ask other students questions related to D&D. I received 24 responses, and the results have affected the design decisions for the app.

2.8.1 Questions

The questions I've asked people are all related to the current state of the game. The questionnaire is split up into 3 sections, previous players, people who have never played before, and which apps and what platform people have used. I designed the questionnaire like this so I can get data for all the aspects of the game that will affect my design choices. There is a consent form explaining the purpose and use of the questionnaire, along with the ethical and legal considerations.

2.8.2 Results

From the results of the questionnaire I can see that 75% of responses have played D&D before, and from these 83% always play with the same people but 55% would be willing to play with new players. From this I know that there are people who are willing to join new groups so a feature such as Looking For Group would be useful.

66% of players stated that they use a physical character sheet, and 100% said they would be willing to move to a digital version, this supports my feature to store character data. 90% of people who use D&D apps said they have an Android phone and 50% said they would be willing to pay for a D&D app, from this data I could just make an Android app but as stated in section 2.1 iOS does have a large market share especially regarding the App Store.

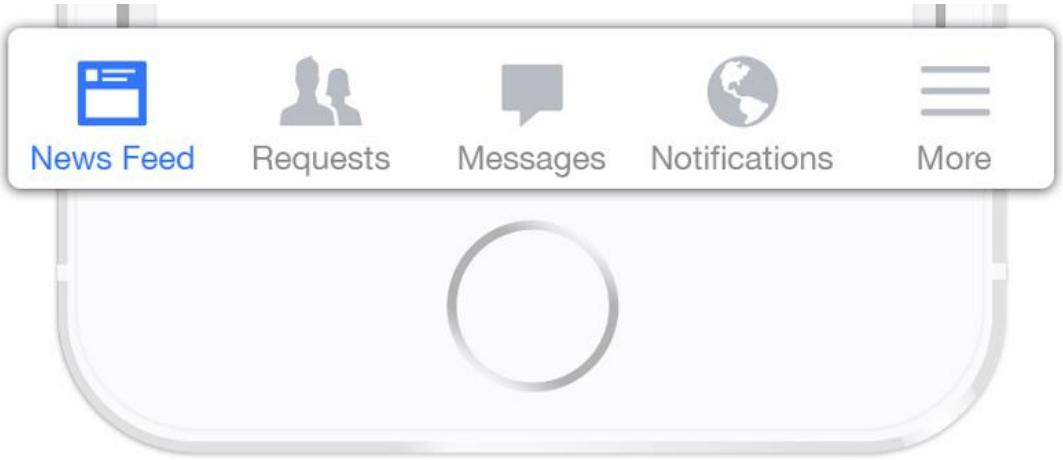
The results and a questionnaire can be found in the appendix.

3. Planning and Design

3.1 Design Patterns

3.1.1 Navigation

Navigation throughout apps can be done in many different ways, a typical method for mobile apps is with use of a tab bar, which is an array of links along the bottom of the screen that the users tap to navigate through. Tab bars are an easy way for the user to identify and to understand the structure of an application.*"Use a tab bar strictly for navigation. Tab bar buttons should not be used to perform actions."* (Apple 2020).



3.1.2 Seperate Pages

Within each page on the tab bar there will be further navigation to pages that are more specific, for example there will be a button on the home tab that will allow you to create a character, and this button will take the user to a different view but they will remain on the same tab. Having a tab and view based system gives the app a hierarchy structure.

3.2 Personas

3.2.1 Gavin Askew

Persona	
Name	Gavin Askew
Job title	Marketing assistant at Liverpool Football Club
User Type	Existing Player: **X** New Player:
Demographics	• 22 Years old • Lives alone in a flat in Liverpool • Has a degree in Business Marketing from DMU
Biography	Gavin is a young man who was raised in a small town outside of Leicestershire. After finishing highschool he went to De Montfort University where he studied business marketing, while still living at home and staying in touch with his childhood friends. Gavin has been playing Dungeons and Dragons with his group of high school friends for years. Having now moved away from his childhood friends he is looking for a new

	group of people to play with, but currently has no means of doing so. Gavin has tried many different ways of playing D&D, such as playing online with his old friends, joining random groups online, and going to different table-top stores looking for players.
Environment	With his current job, he has a basic understanding of computers but would not describe himself as technically competent. He has been looking for new ways to store his D&D materials.

3.2.1 Molly Harkins

Persona	
Name	Molly Harkins
Job title	Teacher at Virginia Primary School

User Type	Existing Player: New Player: **X**
Demographics	● 35 Years old ● Lives with her husband and 2 children in London ● Married with 2 daughters
Biography	Molly is a young woman who was raised in the heart of London and has lived her whole life there. She studied at University in Germany however, and she studied Education Studies as she has always wanted to be a primary school teacher. Molly has zero experience playing D&D however she knows what the game is, as her husband Mike plays it with his group of friends. Molly is thinking about trying the game with Mike and her children as a way of bonding and getting closer as a family.
Environment	Even though her job doesn't require technical skills, she is still quite knowledgeable about tech as she has an interest in the subject. She has wanted to get into D&D for a while now but has never had the opportunity.

3.3 Scenarios

Scenarios allow exploration and discussion of contexts, needs and requirements of a system. Scenarios do not explicitly describe the use of software or other technology; rather, they focus on what the users are trying to achieve, their motivations, their expectations, and the context in which activity currently happens.

Gavin Askew

Gavin's work schedule is pretty consistent throughout the week, because of this he plans personal activities around his work schedule. A typical work morning consists of Gavin sitting in meetings and managing his project work with his team.

After work Gavin uses the Dungeons Masters handbook and creates a group for his campaign. He logs into his account where he is able to see all of his previous characters that he has made, he starts creating some non playable characters for the campaign that he will be running. After finishing with the characters he creates a group and sets the party size to 6 players, and sets the location to a local gaming store in Liverpool.

After waiting a few days his party is full of 5 other people, and he can see the characters and a little bio for each person. They can now exchange contact information and set a date to meet and begin playing.

Molly Harkins

Molly spends most of her day teaching a class of 9 year old children. She spends her break and lunchtimes in the teachers office hanging out with her co-workers. On a few days of the week Molly holds the computer club where she and a few kids hang out to learn about computers and technology.

After work Molly comes home to her Husband and 2 children. She will spend the next part of the day doing errands and preparing dinner for the family. Afterwards she logs into the Dungeons Masters Handbook to create her character and look up the rules of the game, for her upcoming game with her husband and friends. She reads through the guides that explain how to create a

character and gives her some useful tips for creating a first character. She also reads about the rules for combat, and general gameplay.

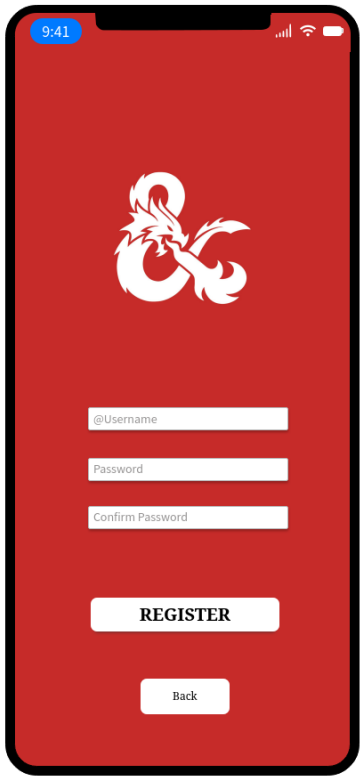
Now that she has a new character made and has a basic understanding of how the game will be played she is ready to join her husband's campaign.

3.4 Wireframes

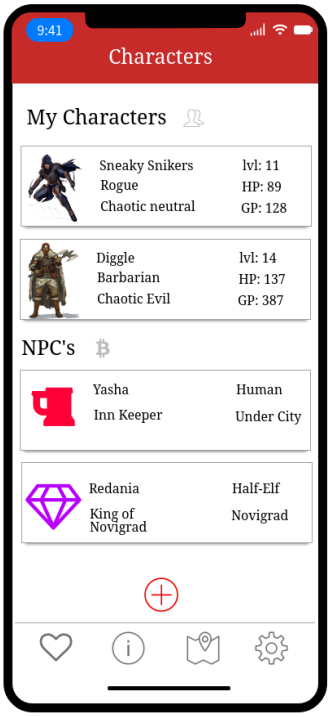
Wireframes are the design of the pages. I used WireframePro to make these designs.

Login page:

Register page:



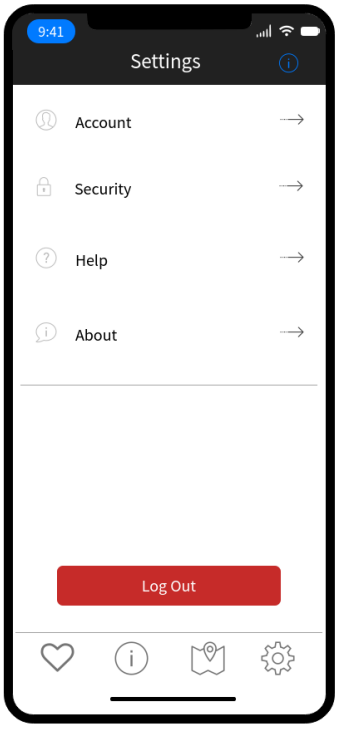
Home tab:



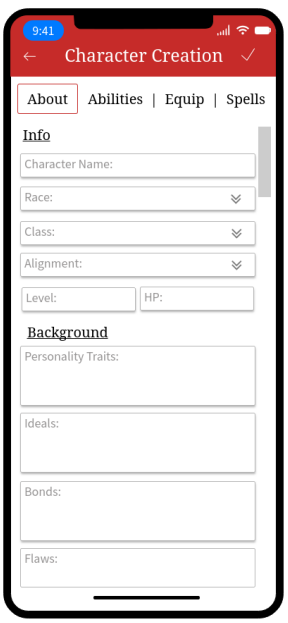
LFG tab:

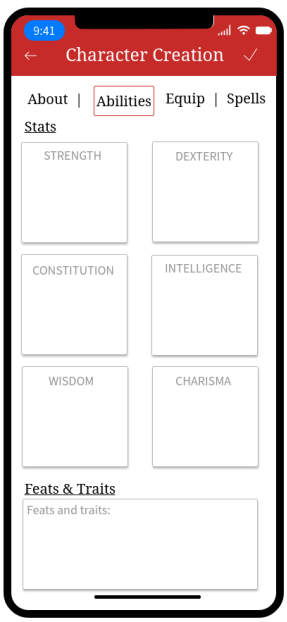
Guides tab:

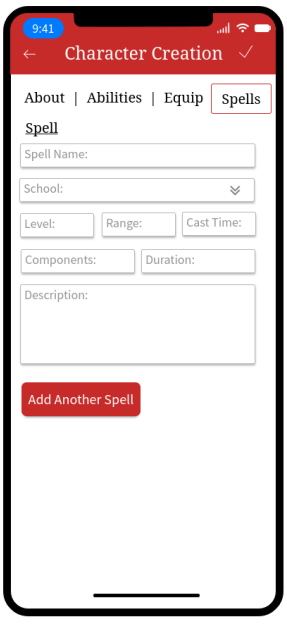
Settings tab:



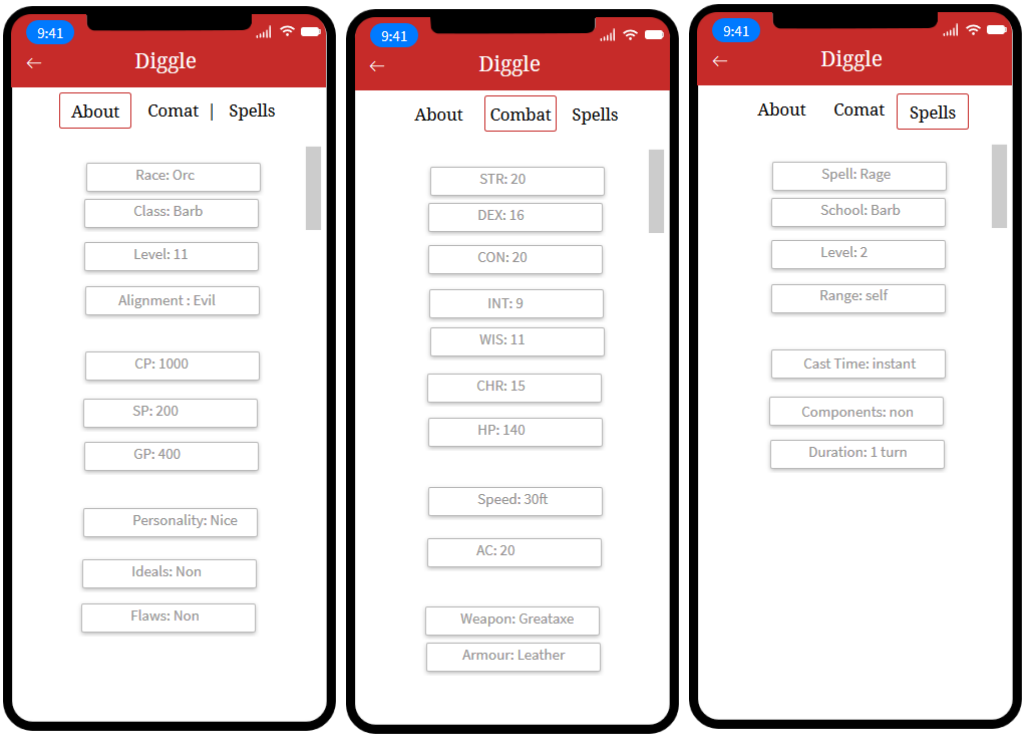
Character creation pages:



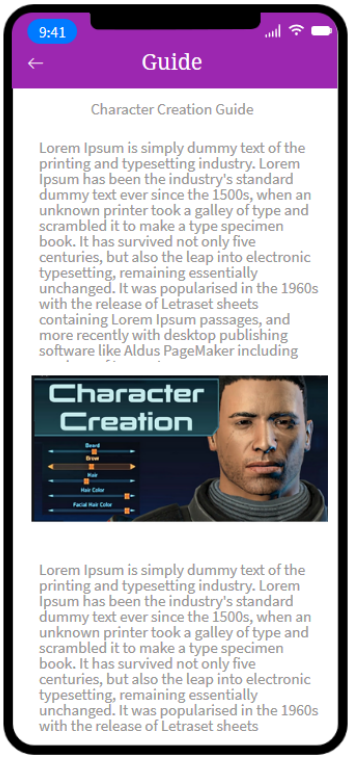




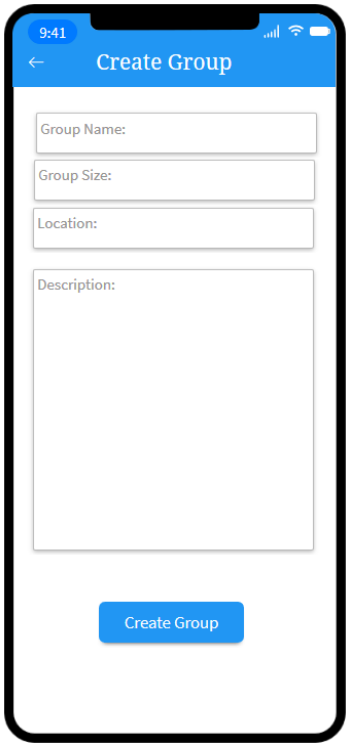
Character View Page:



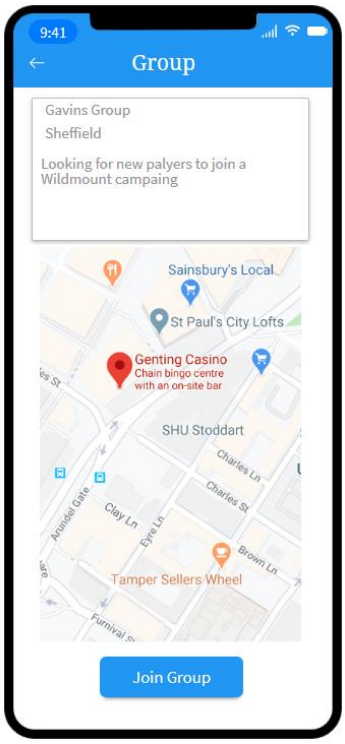
Guide View page:



Create Group page:

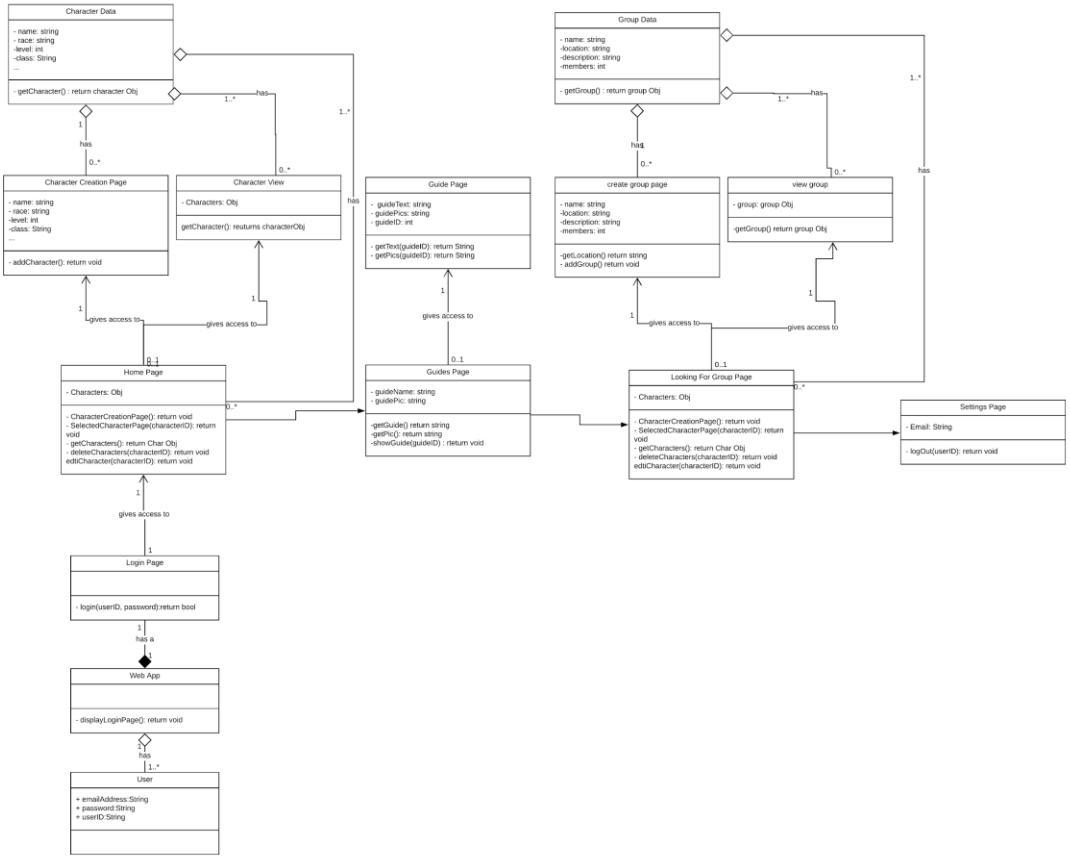


View Group page:



3.5 Class Diagram

https://www.lucidchart.com/invitations/accept/252e037c-ba2a-4a9e-8375-d818ac114b04



3.6 Architecture Overview

Users	Delivery Channels	Presentation Layer / UI	Application Services	Resources
New Players	Smart phone	Login page	Character data	Database
Existing Players	Tablet	Register page	Messaging between users	Google maps API
	PC / Laptop	Home Tab	Display of information	
		Character creation view		
		Selected character view		
		Guides Tab		
		Selected guide view		
		Looking for group tab		

		Search groups view Selected group view Settings tab		

Security, Big Data Analytics, Dev Ops, Cloud Management, Waterfall

4. Development

4.1 Project Management Tools

4.1.1 Github

Github is the world's leading version control tool, it allows you to create and define different development versions by backing up the project code files. I used the GitHub desktop app for my project as it has all the features used for Git such as pushing and pulling to repositories. *Figure 4.1* shows an example push using the GitHub desktop app.

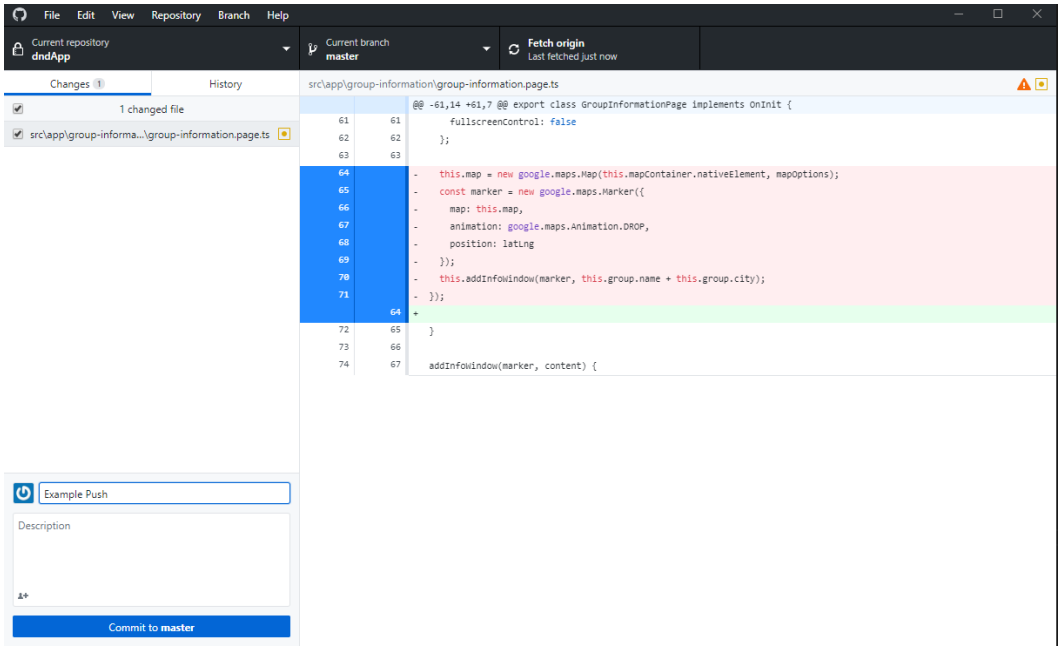


Figure 4.1

4.1.2 Trello

Trello is a web-based Kanban style list making application which is used to organise projects on a task by task basis. My trello board is set up to have every task required for the project on each card, and the completion progress as each list. This approach allowed me to easily keep track of what tasks needed to be done, and what tasks were currently being worked on. With a waterfall methodology I already know the requirements and the specification for the

project, so the tasks on the board don't have to be updated, or new ones created. *Figure 4.2* shows the layout of my Trello board.

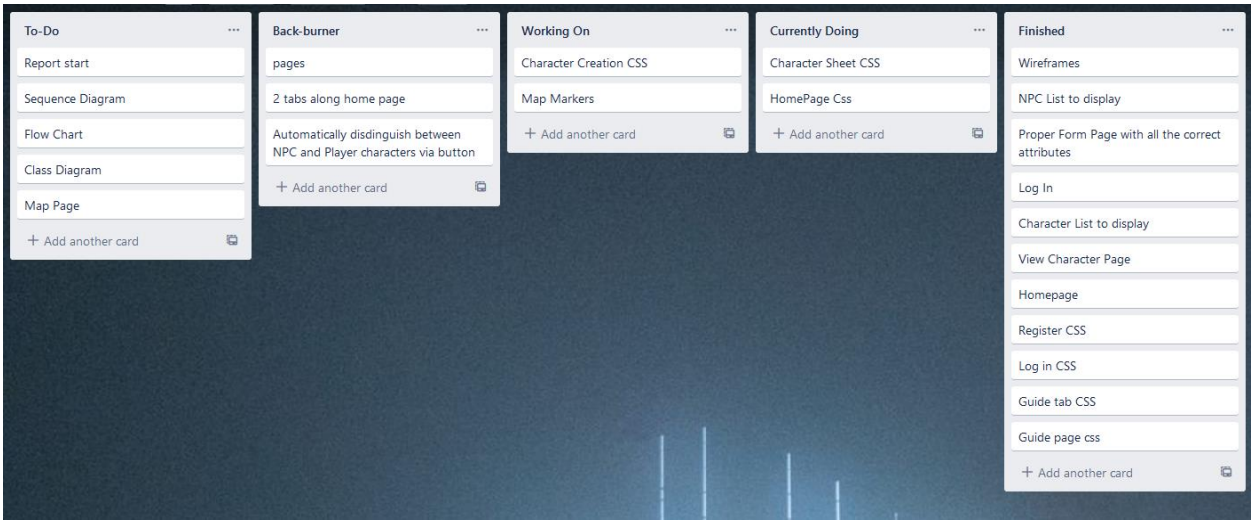


Figure 4.2

4.2 Getting started with Ionic

Ionic emulates native app user interface guidelines and uses native SDK's, this means that even though the app is a web app and can be run on a browser window, it will also be run natively on mobile platforms as it creates an Android APK and a xCode project.

4.2.1 Installation

Installing Ionic is done through the Node.js CLI (Command Line Interface) by running the command :

```
$ npm install -g @ionic/cli
```

This will install the ionic CLI globally meaning that any packages can be used in any project on the machine. It isn't necessary to install Ionic globally but it makes creating different versions of the app easier as you don't need to keep installing packages to each project directory.

The project is initialised using this command in the CLI :

```
$ ionic start myApp tabs
```

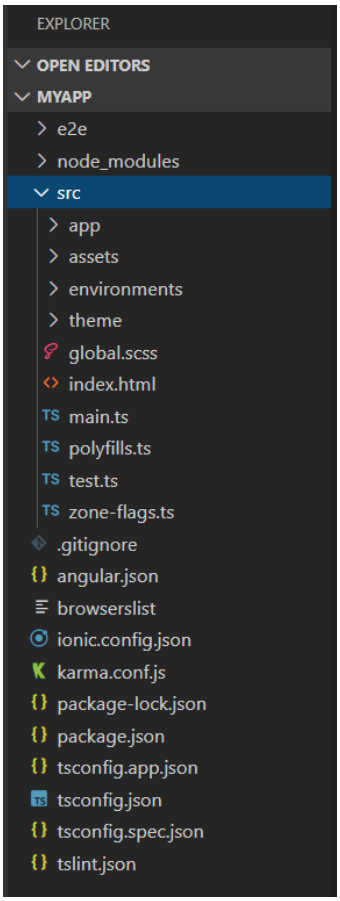
This creates a project called myApp with a default tabs template. There are many different templates that are available, to see these templates you can run the “ionic start --list” command in the CLI.

```
C:\Users\Arj>ionic start --list

Starters for @ionic/angular (--type=angular)

name         | description
-------------------------------------------------------------------------------
tabs         | A starting project with a simple tabbed interface
sidemenu     | A starting project with a side menu with navigation in the content area
blank        | A blank starter project
my-first-app | An example application that builds a camera with gallery
conference   | A kitchen-sink application that shows off all Ionic has to offer


Starters for @ionic/react (--type=react)

name       | description
-------------------------------------------------------------------------------
blank      | A blank starter project
sidemenu   | A starting project with a side menu with navigation in the content area
tabs       | A starting project with a simple tabbed interface
conference | A kitchen-sink application that shows off all Ionic has to offer


Starters for Ionic 2/3 (--type=ionic-angular)

name     | description
-------------------------------------------------------------------------------------------------------------------
tabs     | A starting project with a simple tabbed interface
sidemenu | A starting project with a side menu with navigation in the content area
blank    | A blank starter project
super    | A starting project complete with pre-built pages, providers and best practices for Ionic development.
tutorial | A tutorial based project that goes along with the Ionic documentation
aws      | AWS Mobile Hub Starter
```

When initialising an app the option to select a framework between Angular and React is shown. The Dungeon Master's Handbook was created using the Angular framework.

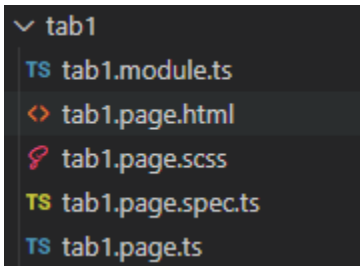
```
C:\Users\Arj\Desktop\Uni\report>ionic start myApp tabs

Pick a framework!

Please select the JavaScript framework to use for your new app. To bypass this prompt
next time, supply a value for the
--type option.

? Framework: (Use arrow keys)
> Angular | https://angular.io
  React   | https://reactjs.org
```

Opening the project folder in an IDE will show the files and folders that have been automatically installed for the Ionic and Angular Framework, as well as the node modules required to run the app on a web browser.



4.2.2 Angular 8

Each module has a TypeScript file as well as HTML files, Angular will be used in the TypeScript files to do all of the functional programming, and Ionic will be used on the HTML pages for the front end display.



4.2.3 IDE

An Integrated Development Environment (IDE) is a program that gives developers tools to write and sometimes build software. The basic function of an IDE is to have a code editor, build automation tools, and some sort of debugger. As I don't need any IDE specific tools I have chosen to use Visual Studio Code; it's a lightweight and fast code editor, with git integration, and many extensions that can be installed. My app can run through a nodeJS server, so I don't need any build tools in my IDE.

4.3 NodeJS Server

A NodeJS Server is used to install the packages and frameworks that are required, and also to host the project so it can be accessed on a web browser. Running the "ionic serve" command in the node CLI will run the project on a local port, this means that only devices connected to the same network are able to access the page.

```
C:\Users\Arj\Desktop\dndApp-master>ionic serve
> ng.cmd run app:serve --host=localhost --port=8100
[ng] i ﷽wds﷽: Project is running at http://localhost:8100/webpack-dev-server/
[ng] i ﷽wds﷽: webpack output is served from /
[ng] i ﷽wds﷽: 404s will fallback to //index.html
```

4.4 Backend Development

The backend of the project will be handled through the use of local storage, Firebase, and with the use of the Google maps API.

4.4.1 Local Storage

To use local storage the module must first be downloaded through the NodeJS CLI using the command:

```
ionic cordova plugin add cordova-sqlite-storage
```

Then the module is imported in app.module.ts. This is done so the storage module can be imported to specific modules in the system:

```
import { IonicStorageModule } from '@ionic/storage';
```

A database name and driver order also must be defined.

```
    IonicStorageModule.forRoot({
      name : 'characterDB',
      driverOrder: ['indexeddb', 'sqlite']
    }),
```

The database name is called characterDB and the order doesn't matter when running on a mobile device, however the order does affect testing on a browser as Chrome will use its own local storage if not pre defined.

Using the inspector view within a browser you can see the charactersDB stored, as well as a firebase database as shown in *figure 4.3*.

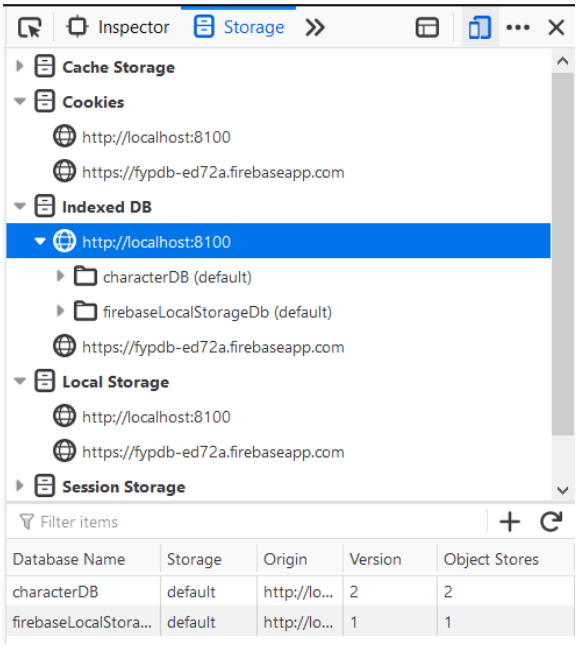


Figure 4.3

4.4.2 Firebase setup

Firebase is the database tool used to handle user authentication. To set up the database a project must be created on the firebase console website, this website contains all the tools that are needed to create and manage each table, and provides analytics to monitor the key events of the system.

After setting up the firebase console the firebase packages need to be installed through the NodeJS CLI with the command:

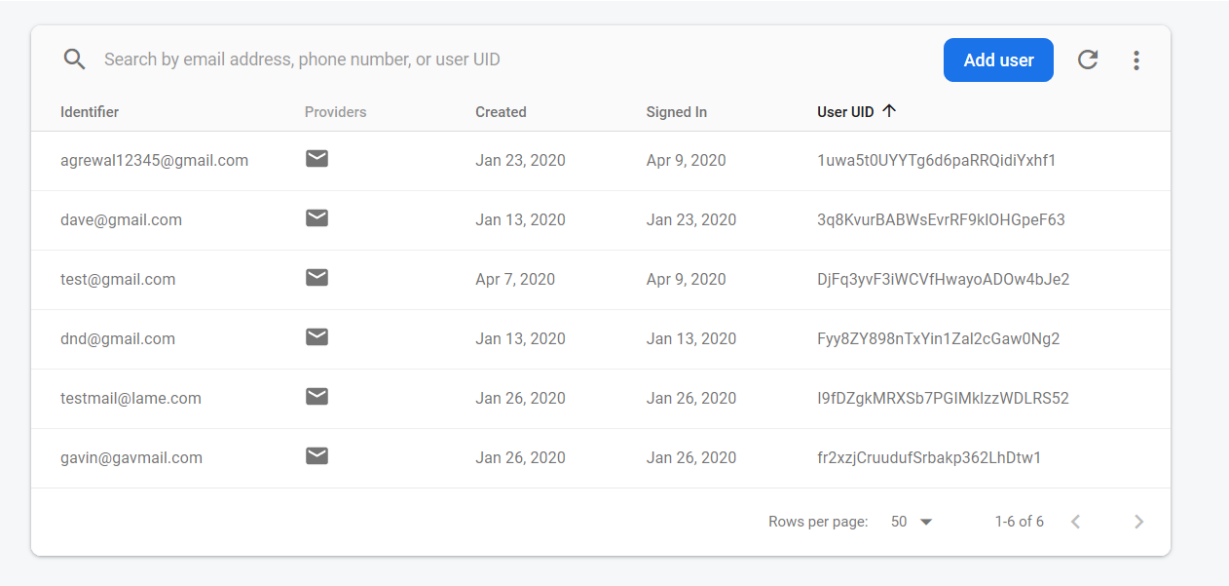
```
$ ionic cordova plugin add cordova-plugin-firebase
$ npm install @ionic-native/firebase
```

And then imported into the project:

```
import * as firebase from 'firebase';
```

4.4.3 User Authentication

The Dungeon Master Handbook uses the default authentication table which stores a user email, password, the creation date, last logged in date, and an automatically assigned unique user ID.



Through the firebase console you can also allow alternative sign in methods. You can see the full list of sign-in providers in *figure 4.4*

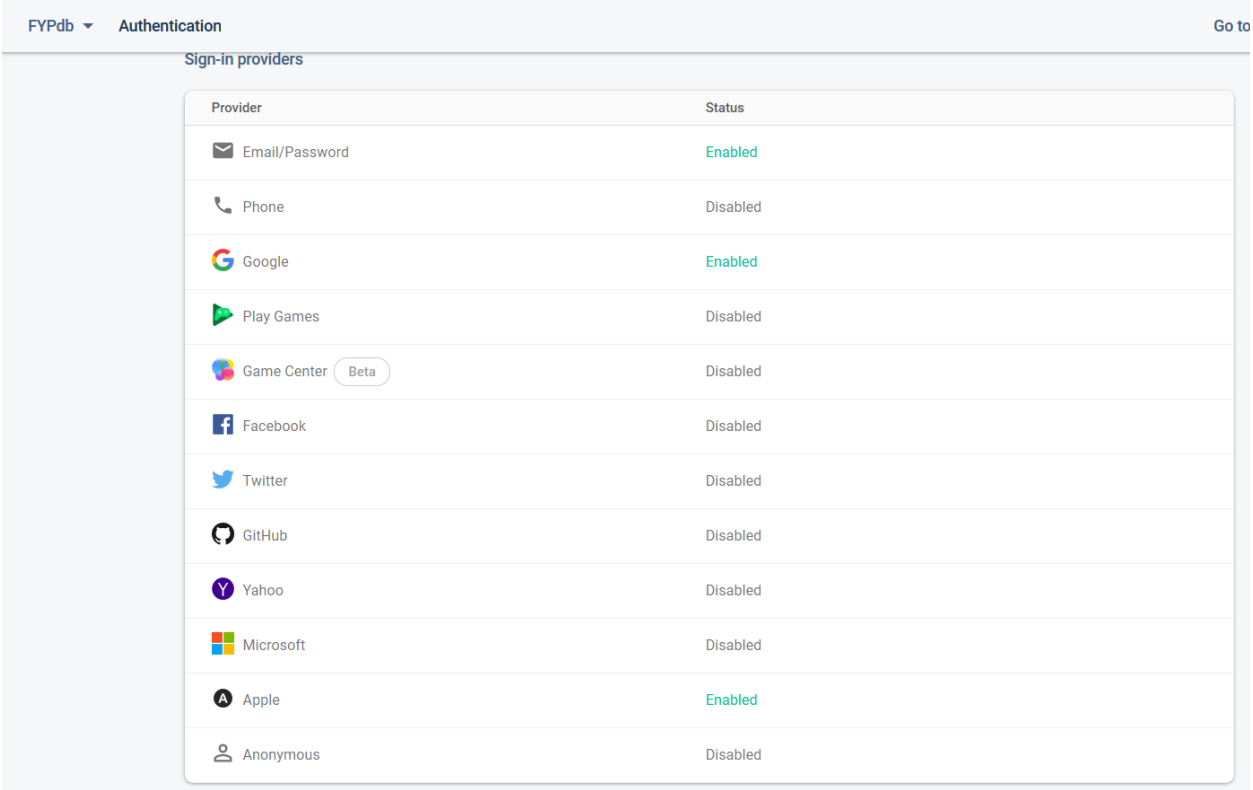
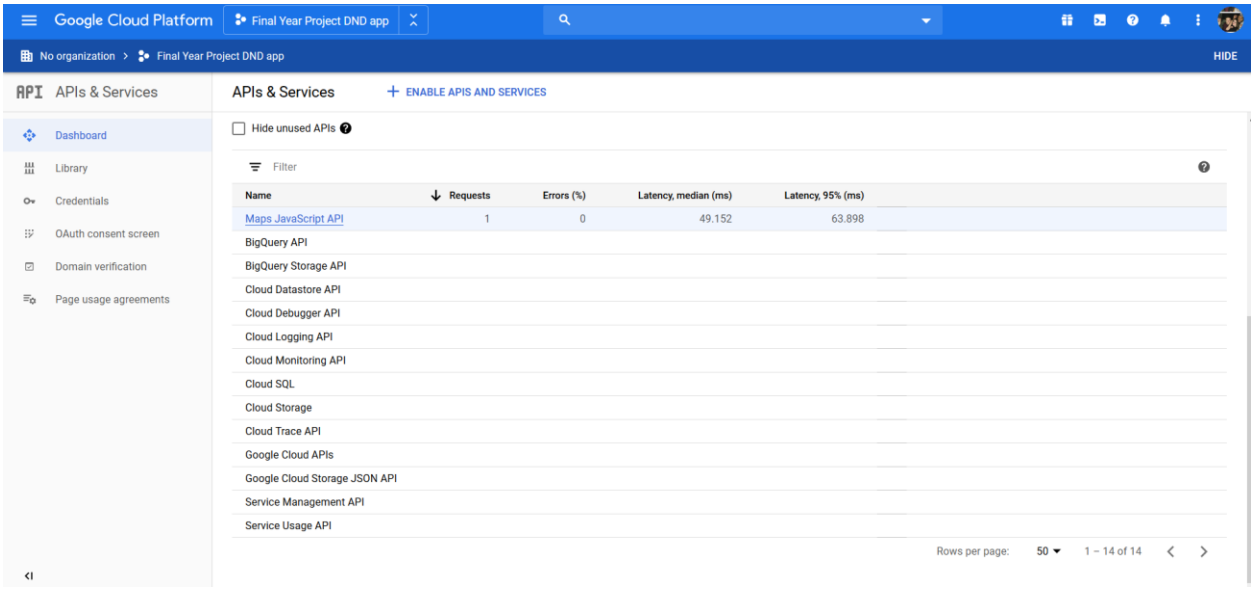


Figure 4.4

Users are able to sign in using a registered account, a google account, and an Apple account, this so that users can use accounts and services they already own. Google and Apple accounts are enabled as these are the devices that the app will be targeting. Game Center and Play Games could also be enabled, as these are mobile services, but for this stage of development it's not necessary.

4.4.4 Google Maps API

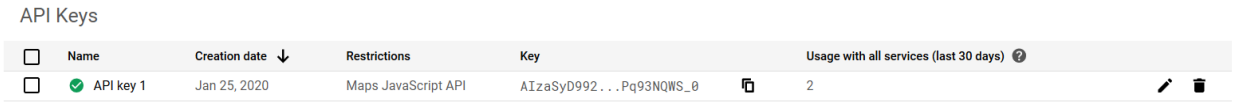
Google has plenty of services available through the Google Cloud Platform, and they have recently changed how they allow users to use their API's as it's now required to use the Google Cloud Platform. From this platform you can select which API service you need for your project, and from here you can view and track all of the analytics.



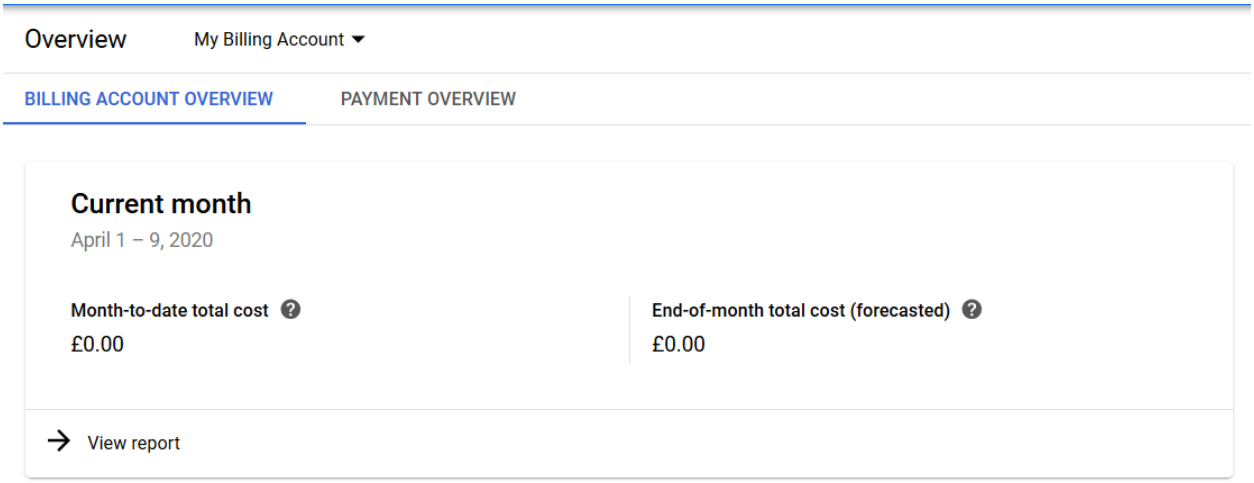
Once enabled you need the API key to allow your app to connect to it. This is done by adding the key provided by the Google cloud platform to a script tag that calls the google maps API, as you can see in *figure 4.5.*

```
<!--FOR GOOGLE MAPS-->
<script src="http://maps.google.com/maps/api/js?key=AIzaSyD992CGxc3e7z46w6vT1BYViPq93NQWS_0"></script>
```

Figure 4.5



With the new Google Cloud Platform you are now billed depending on the amount of traffic that you receive, however as I am the only user of my project the billing is £0 but this is something that could be important if I ever release my app.



4.4.5 Services

Services are modules that are only used for backend functionality. When generated they make 2 files, a service.spec.ts and a service.ts file. 4 services are made for the Dungeon Master's Handbook, authentication, character, guide, and group data service; each of these services have functions specific to it.

A service has to be imported by the page module that needs it. For example within the character service there is a function to create a character and it is called from characterSheet.ts, this is done so that the functions can be reused throughout the app without having to re-write them and also to reduce the load of a view.

Service import in characterSheet.ts:

```
import { CharacterService, Item } from '../services/character.service';
```

Initialising it inside the constructor of characterSheet.ts:

```
  constructor( public navCtrl: NavController,
      private characterService: CharacterService) {
                this.selectedView = "about";
              }
```

Calling service function within characterSheet.ts:

```
    this.characterService.addCharacter(this.newItem).then(item =>{
```

```
    ...
    });
```

Function definition in characterService:

```
  addCharacter(item: Item): Promise<any>{
    return this.storage.get(ITEMS_KEY).then((items: Item[]) => {
            ...
    });
```

4.5 Front End Development

With the backend set up the next step of development is to develop the front end, along with the functions and logic to make the app work.

4.5.1 Tabbed Views

The default tabbed template gives the project 3 tabs to work with, this is a good starting point but the design for my app required 4 tabs, a “home page”, “guides page”, “LFG page”, and the “settings page”. To implement these separate tabs the existing template is used and modified.

To create a new tab and to change the labels and icons of the existing tabs you have to go to the tabs.page.html, and use the <ion-tabs> and <ion-bar> tags to create the tabs that match the designs.

When creating a tab the location, path name, and icon need to be defined. The icon names return a default icon from the Ionic library. *Figure 4.6* shows the tab for the Home page.

```
<ion-tabs>
  <ion-tab-bar slot="bottom">
    <ion-tab-button tab="tab1">
      <ion-icon name="compass"></ion-icon>
      <ion-label>Home</ion-label>
```

```
    </ion-tab-button>
```

Figure 4.6

The routing of each tab is done in the tabs-routing-module.ts file and it works in a similar way to HTML paths as each path is defined with a name “tab 1/2/3/4”, and these names are linked to the actual path of the tab module within the project structure.

The tab routing module has to first be initialised in the app-routing-module.ts which will also contain the routes to every other page that aren’t the tabbed views. A path name must be defined for each module; for example I have called the tabs module “members” as only members who have logged in are able to see the tabbed view, the module loaded must also be specified.

With the tab routing connected the path for the home tab would be “localhost/members/tab1”, the users won't be able to see this path within the app itself but the pathing is displayed in the browser window and is useful for testing.

4.5.2 Creating Pages

Creating new Ionic pages is done by generating the module through the CLI, this will create the 6 files needed. The command to generate a new page is:

```
C:\Users\Arj\Desktop\dndApp-master>ionic generate page login
```

This specifies what to generate and the name of the page generated, there are many different types of modules that can be generated such as a component or a service. Specific options can be chosen during the generation such as skipping imports, *figure 4.7* shows some other example commands that can be run.

```
$ ionic generate
$ ionic generate page
$ ionic generate page contact
$ ionic generate component contact/form
$ ionic generate component login-form --change-detection=OnPush
$ ionic generate directive ripple --skip-import
$ ionic generate service api/user
```

Figure 4.7

The generated files are a routing-module.ts; needed to define the route page and the path, a module.ts file; used to initialise the module and includes the Ionic and Angular imports, a HTML and SCSS file; used for the front end views and the HTML page uses Ionic tags to display anything, and the SCSS file is used to style the page.

The final two files are a page.spec.ts file which is used to test the page to make sure it is able to run, and a page.ts file, that is used to write all of the logic and functions for the page. *Figure 4.8* shows the generated files layout in the project structure.

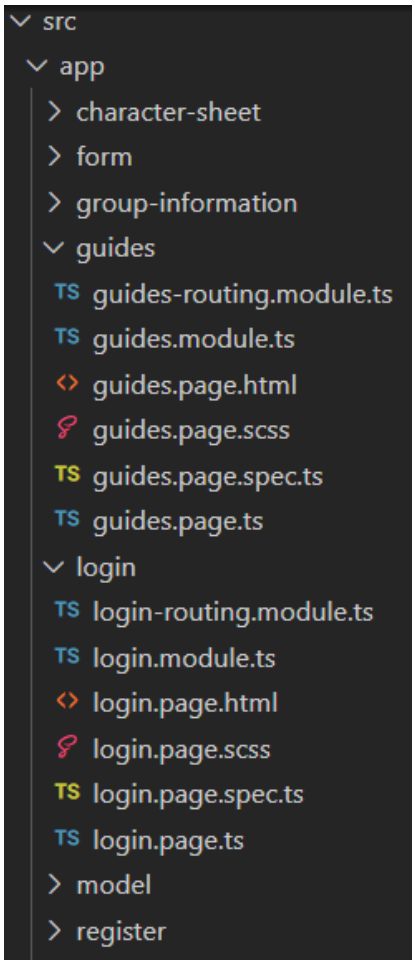


Figure 4.8

Once all the pages were created based on the designs that I made, I could start to implement the front end design choices, and the functionality to make the front end components work with each other and work how the design specifies.

4.5.3 Design

The design of each page has already been defined in my wireframes so all I had to do was to recreate these with Ionic. I tried to keep a consistent layout throughout each of the pages and views so that the user wouldn't get confused when navigating throughout the app, however as some of the pages require different data to be displayed the format of each of the individual pages had to look different.

Authentication pages

There are 2 authentication pages; the login page, and the register page. These pages are different from the other pages because the user will only be seeing it the first time they launch the app. I decided to make these pages very minimal and to only display the logo and some text boxes.

All of the elements on the page are created using Ionic tags, for example the entire page is wrapped in a <Ion-content> tag, and the input boxes for the email and password are defined as <ion-item> and <ion-input> tags. Similar to HTML tags you can add different attributes to each tag such as giving it a class, name, or style. Below you can see the definition of the password text box.

```
    <div class = "txtBx">
    <ion-item>
      <ion-input type="password" formControlName="password"
class="form-controll" required placeholder="Password" style ="color:
white;"></ion-input>
    </ion-item>
    </div>
```

Tab Views

All of the tabbed views, except for the settings tab, have the same layout using box items that the user can click on to navigate to the separate pages. Each tab has a different heading colour to clearly separate the functions of the app. The heading for the home tab is the same red (#c62b29) as the authentication pages, the guides tab is purple(#300066), the LFG tab is blue(#3880ff), and the settings tab is black(#222428). These colours are defined in the variables.scss file which contains global css for ionic components. Below is the definition for the “secondary” colour scheme.

```
  /** secondary **/
  --ion-color-secondary: #c62b29;
  --ion-color-secondary-rgb: 12, 209, 232;
  --ion-color-secondary-contrast: #ffffff;
  --ion-color-secondary-contrast-rgb: 255, 255, 255;
  --ion-color-secondary-shade: #0bb8cc;
  --ion-color-secondary-tint: #24d6ea;
```

The toolbars are then assigned to the matching colour scheme.

```
<ion-header>
  <ion-toolbar color = "secondary">
    <ion-title class  ="title">
      Characters
    </ion-title>
  </ion-toolbar>
</ion-header>
```

The other element on the tab views are the item boxes which are defined using <ion-item> tags, and the data they display is dynamically pulled from local storage. Looping through the character database in the TypeScript file displays the entire list of characters using only 1 ion-item tag. This method is also used to display the guides and groups.

```
    <ion-item-sliding class="container"  *ngFor="let item of items">
      <ion-item class="charList" (click)="goToCharSheet(item)">
        <ion-label>
          <h2>{{ item.name }} </h2> <p id="p2">Level: {{ item.level
}}</p><br>
          <p id="p1">{{ item.class }}</p>  <p id="p2">HP: {{ item.hp }}
</p><br>
          <p id="p1">{{ item.race }}</p>  <p id="p2">GP: {{ item.gp }}</p>
        </ion-label>
      </ion-item>
```

Character Pages

There are 2 character pages; create a character, and view a character. To create a character there is a button on the home tab that sends the user to the character creation page, and to view a character they can click on a character in the list. The characters ID is sent through the parameters and the data is pulled based on the ID.

```
    this.slug = this.activatedRoute.snapshot.paramMap.get('id');
```

Both of these pages have a similar layout but with different functionality. The way they are designed is to use a segmented page, this means that one page is split up into many different views that the user can select from a bar along the top. This is a common mobile design choice, as it allows the user to switch between segments without having to reload a page or pass any data.

This is implemented using <ion-segment> and <ion-segment-button> tags. A value is defined which refers to a div container. This was used to separate the different parts of character creation into entering your character info, stats, equipment, and spells. Displaying a selected character is done in the same way, but the information is pulled from the character database.

```
  <ion-content>
    <ion-segment [(ngModel)]="selectedView" color="secondary" style=
"font-family: 'Noto Serif';">
      <ion-segment-button value="about">
        <ion-label>About</ion-label>
      </ion-segment-button>
      <ion-segment-button value="abilities">
        <ion-label>Combat</ion-label>
      </ion-segment-button>
      <ion-segment-button value="spells">
        <ion-label>Spells</ion-label>
      </ion-segment-button>
    </ion-segment>
```

Guide pages

The guide page works in a similar way as the selected character, when the user selects a guide such as “role playing” they are navigated to a seperate page that pulls the text and pictures from local storage. The display of the guides uses <ion-item> tags with tags, and the div tags use the class from the SCSS file to make the guide as readable and user friendly as possible.

LFG Pages

To create a group the user clicks on the add button, here they are taken to the group from. A “get current location” button was implemented by using the geolocation module from Ionic, calling this premade function returns the users longitude and latitude coordinates which are then passed into the text boxes. When adding the group the data is added to the firebase database, where the LFG tab refreshes and pulls all of the groups from the database. *Figure 4.9* shows the firebase database with the group data.

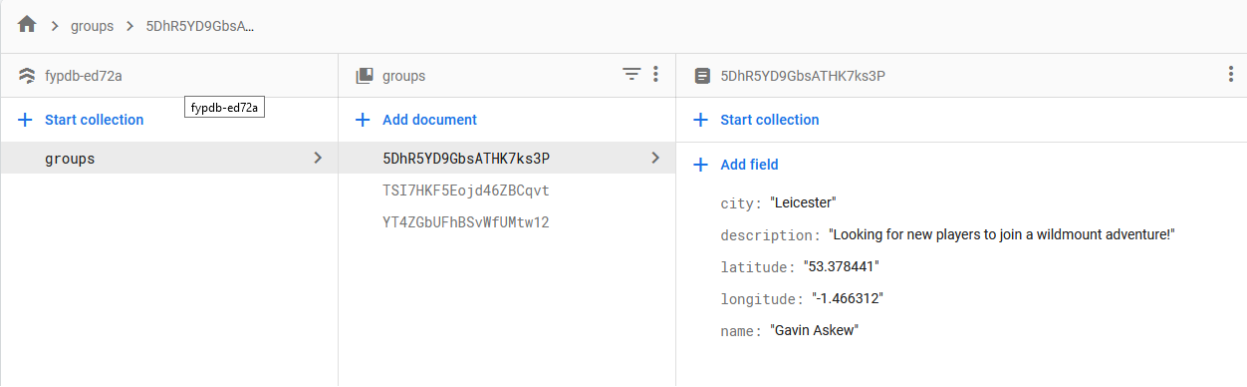


Figure 4.9

When clicking on a group item the user is taken to the selected group page, from here they are able to see the group information as well as the location on a Google map view. This was implemented by pulling the group data from the firebase database. The Google map is displayed by using a div with the scss “map id”, the css gives the map its size and location properties. The map is initialised in the backend using a Google Map object, and the marker pin is also retrieved from the database.

```
    this.map = new google.maps.Map(this.mapContainer.nativeElement,
mapOptions);
    const marker = new google.maps.Marker({
      map: this.map,
      animation: google.maps.Animation.DROP,
      position: latLng
    });
    this.addInfoWindow(marker, this.group.name + this.group.city);
  });
```

4.5.4 Functionality

Linking front end elements with backend functionality is done by calling the functions from the modules TypeScript file. An example of this is to call the function goToHomePage through a click action on an ion-button. The call is made on the front end HTML file, and the function definition is in the TypeScript file.

Function call:

```
<ion-back-button (click)="goToHomePage()"></ion-back-button>
```

Function Definition:

```
goToHomePage(): void{
  this.navCtrl.navigateForward('/members');
}
```

4.6 Building to devices

Building my project to run natively on Android and iOS requires a APK file for Android and a xCode project for iOS. Ionic has built in commands that you run through the CLI that will automatically create these files for you.

4.6.1 Android APK / xCode project

To create either of the native projects cordova must be installed globally to the machine through NodeJS, and this is done by running the command:

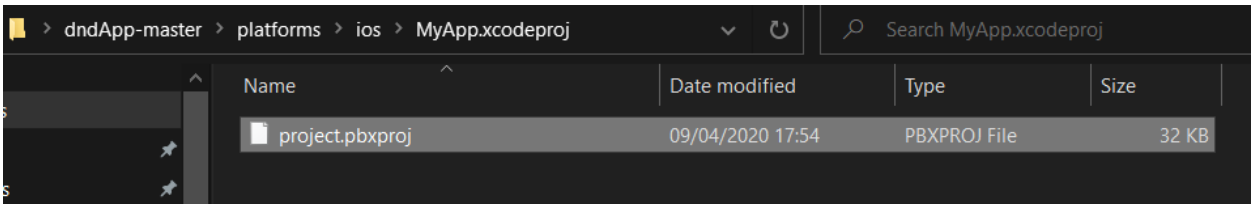
```
C:\Users\Arj\Desktop\dndApp-master>npm i -g cordova
```

Running the command “Ionic cordova platform add ios | android” will generate the projects as shown for iOS in *figure 4.10*.

```
C:\Users\Arj\Desktop\dndApp-master>ionic cordova platform add ios
> cordova.cmd platform add ios

You have been opted out of telemetry. To change this, run: cordova telemetry on.
Using cordova-fetch for cordova-ios@^5.0.0
Adding ios project...
> ionic cordova resources ios --force
> cordova-res.cmd ios
[cordova-res] Generated 50 resources for ios
[cordova-res] Wrote to config.xml

C:\Users\Arj\Desktop\dndApp-master>S
```

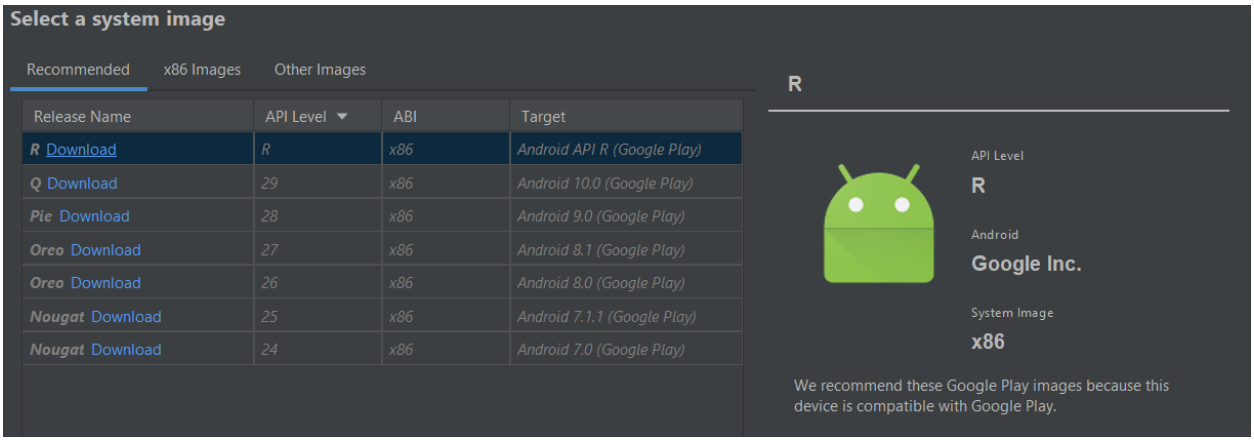
Figure 4.10

Once it's finished running a platform folder will be added to the project directory containing the new files.



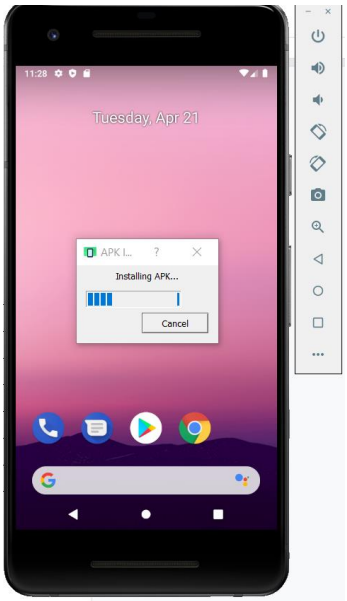
4.6.2 Android Studio

With the android APK file the project can now run on Android devices, this can be done either with a physical device or through an emulator. I don't own an Android device so I have used an emulated device to test my app. There are many different ways to emulate an android device; the option that I have chosen is to use the built in emulator in Android Studio. The version of Android can be selected and changed to allow testing for different device configurations.



Running an Android emulator depends on the processor that you have, as my test machine has an Intel CPU I had to enable virtualization in the BIOS settings. If my machine was running an AMD CPU then I would have to enable VT-x virtualisation, however not every AMD chip supports this technology.

Once the emulator is running drag and drop the APK file from the file directory onto the emulator and the app will be installed.



4.6.3 Mac OS Catalina Virtual Machine

I also don't have access to a machine running the latest version of Mac OS (Catalina), either through the University or personally, so I decided to use a virtual machine(VM) running Mac OS to be able to build my device on iOS.

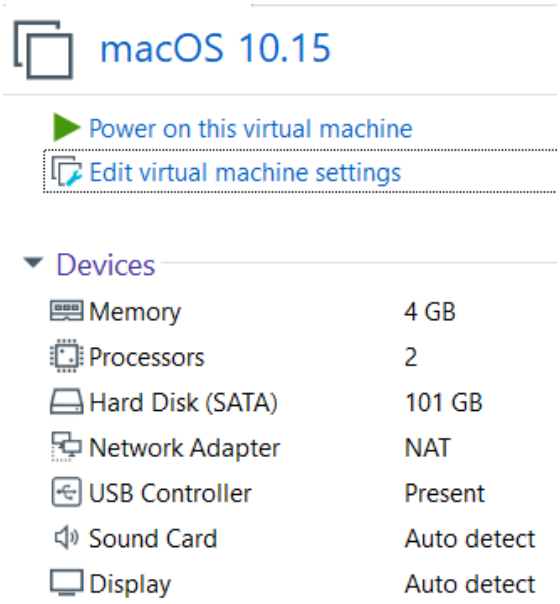
VMWare Workstation Pro has the best performance compared to other virtual machines and has native integration with VMWare tools, which allows the VM to run at a native 1080p resolution, and allows more than 3mb of video memory. This bottle neck of 3mb of video memory is the reason that I decided against using Virtual Box even though it is a free software whereas VMWare requires a purchase after the initial 1 month trial.

After installing VMWare Workstation Pro a copy of MacOS Catalina is required which can be acquired online, however this report does not support any illegal means of obtaining software. The other way to aquire a copy of Mac OS Catalina is by using an existing machine that is running Catalina and creating a ISO file. This is done by running a series of commands in the Mac terminal, as shown in *figure 4.11*.

```
# Create a DMG Disk Image
hdiutil create -o /tmp/Catalina -size 8500m -volname Catalina -layout SPUD -fs HFS+J

# Mount it to your macOS
hdiutil attach /tmp/Catalina.dmg -noverify -mountpoint /Volumes/Catalina

# Create macOS Catalina Installer
sudo /Applications/Install\ macOS\ Catalina.app/Contents/Resources/createinstallmedia --volume
/Volumes/Catalina --nointeraction

# Unmount Catalina Disk
hdiutil detach /volumes/Install\ macOS\ Catalina

# Convert the dmg file to a iso file
hdiutil convert /tmp/Catalina.dmg -format UDTO -o ~/Desktop/Catalina.cdr

# Rename and Move to Desktop
mv ~/Desktop/Catalina.cdr ~/Desktop/Catalina.iso
```

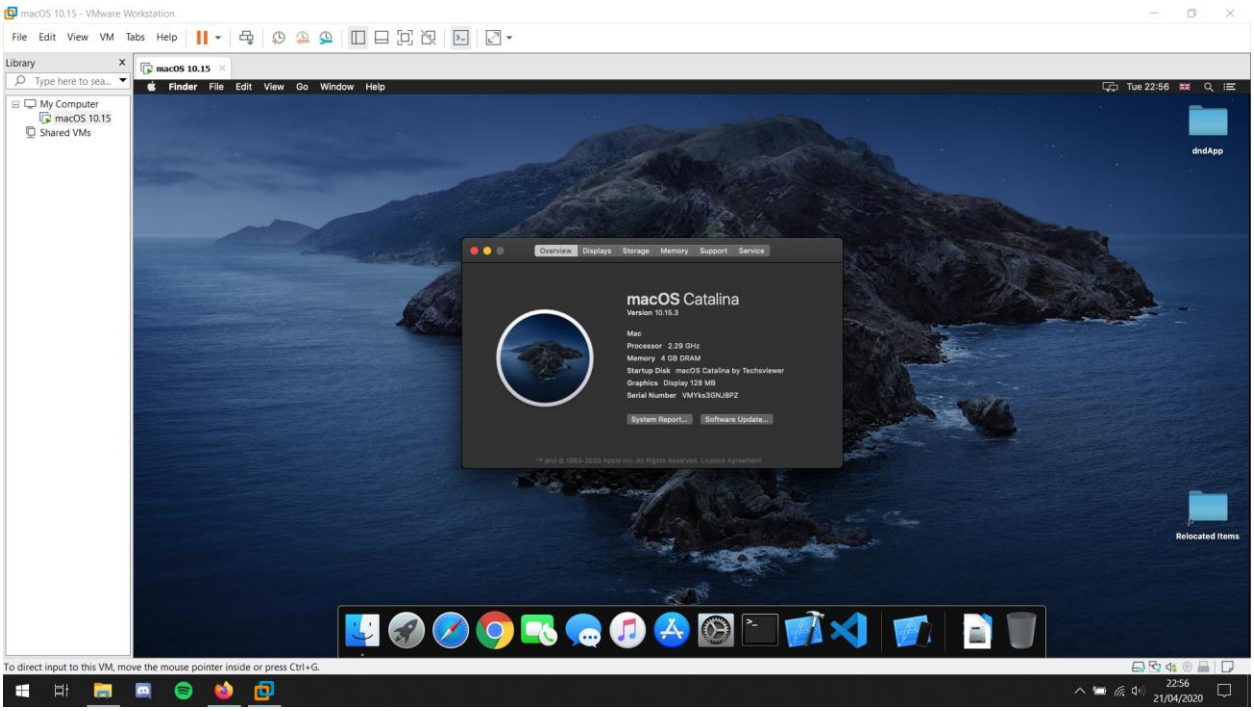
Figure 4.11

WIth the ISO file the VM can be initialised. To set up the VM there are many settings that have to be fine tuned depending on the machine running the VM as it's hardware dependent. The amount of CPU cores that the VM can use, the amount of RAM given, the size of the hard disk, and other settings such as a CD drive are all able to be configured.



After the settings have been configured the VM can be launched, it will reboot a few times and after a few minutes the default Catalina setup screen is displayed where an account can be created.

Once the VM is running VMWare Tools can be installed, as stated above this will improve the overall performance of the VM and allow a larger video memory size to be used by the machine. More video memory will allow the graphics and animations to run more smoothly, making the system feel more responsive and faster, however this isn't necessary for building to iOS, but it does help with testing.



4.6.4 xCode

The Mac VM must be running the latest version of Catalina, which can be done by applying any updates required, as this will give support for xCode 11. Xcode 11 is required to build to devices running iOS 13 and above. After xCode 11 is downloaded through the app store, the project file can be downloaded from the repository on GitHub or through a USB device if needed.

Once in xCode you will have to sign the app with a unique name, the name I chose was arjDnDFyp. As I own an iPhone 11 I was able to run my app natively on my device, by connecting my phone to the computer the VM will ask if you want this device to be recognised by the host machine (Windows) or by the guest (Mac OS), show in *figure 4.12*, this is also another feature that is only applicable with VMWare. After connecting my phone to the VM I installed the app onto the device through xCode by using the build tools along the top.

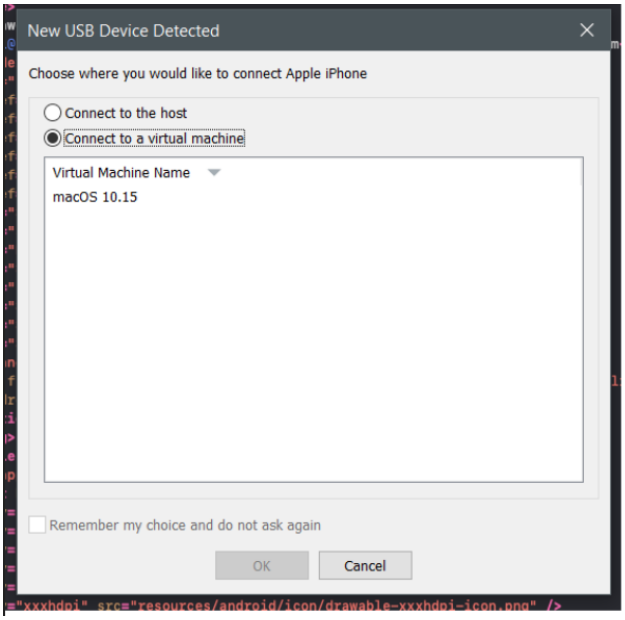
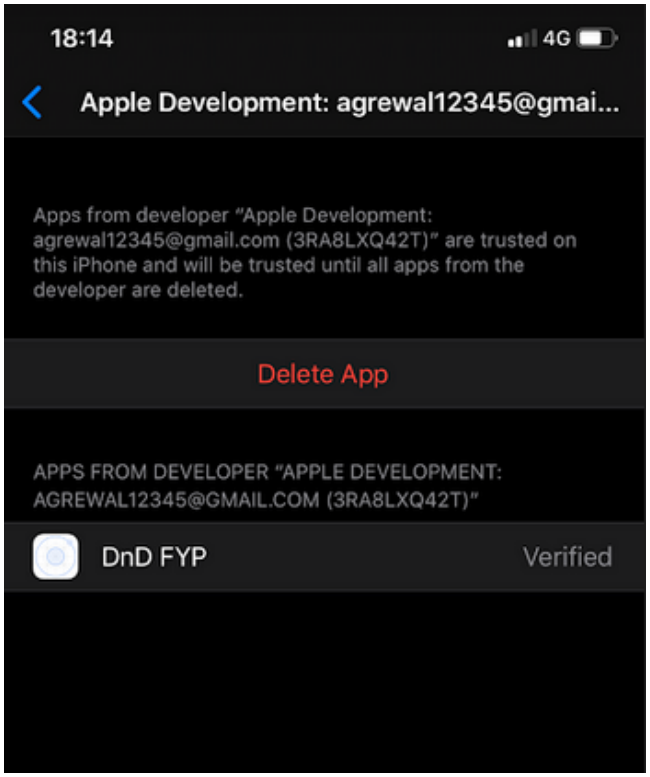


Figure 4.12

Once the application is added to a device you will have to trust the developer for it to be able to be run. This is done through the “trust” page on the settings app.



5. Testing

I'll use 3 forms of testing for my app; a user interface evaluation where 2 other people will evaluate the design and usability of the app, manual unit testing where I go through each feature of the app and test the functionality, and finally to try the app in a live game.

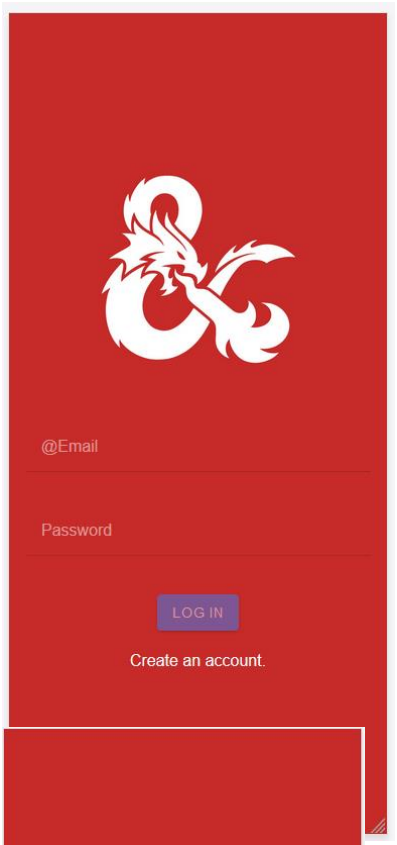
5.1 Manual Unit Testing

5.1.1 What is manual unit testing

Manual unit testing involves going through and testing the functionality of the system, without focussing on the usability or design. I have chosen to do manual unit testing instead of automated unit testing as true user input is required as there are no automated responses or services.

5.1.2 Test results

Register an account



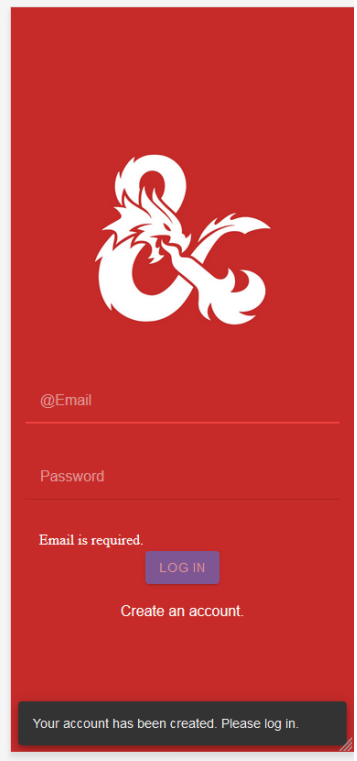
To register a character you have to click on the register button. This sends you to the register page.

← Create account button

The user must enter a valid email address and a valid password. The email must contain a “@” symbol for it to be considered valid. The email cannot already be registered to the system.

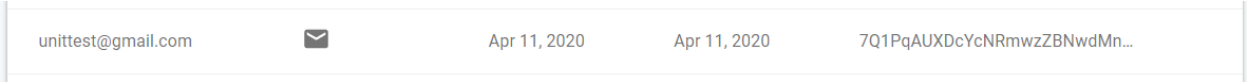
This approach does not check to see if the email exists, for example the user could enter a gmail that they haven't created, or enter an email such as “a@a.a”.

← Error messages for user



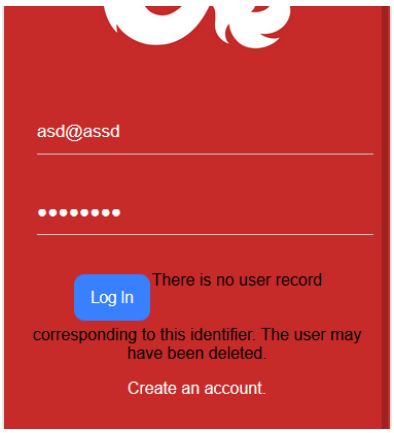
Once the account is registered the user is navigated back to the login screen, and a toast message appears at the bottom confirming the registration.

← Confirmation message



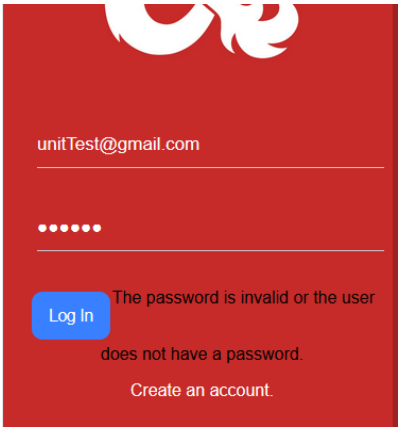
We can then check the firebase database to see that the account was created successfully.

Log in



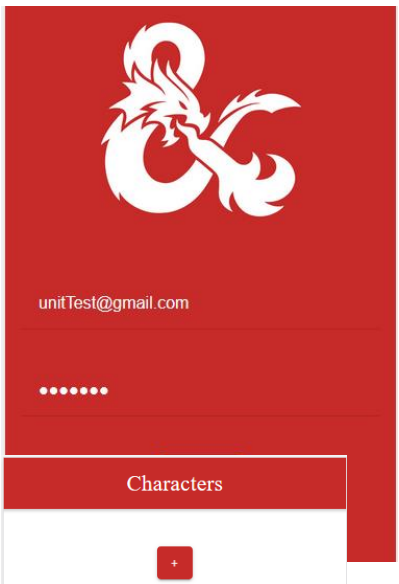
If the user enters an email that isn't registered, they will be shown an error message telling them this.

← Error messages for user



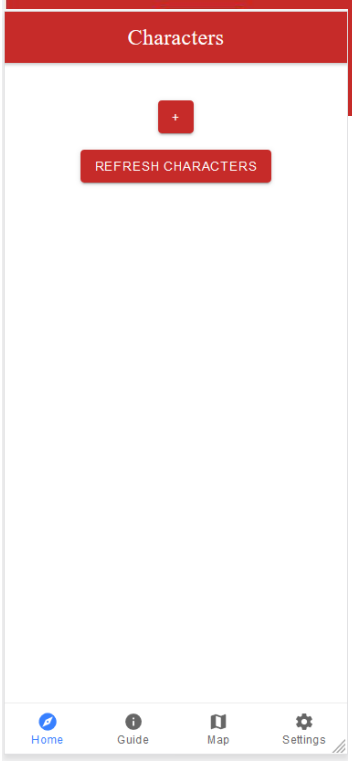
If the user enters a registered email with an incorrect password, then they are again shown an error message.

← Error messages for user



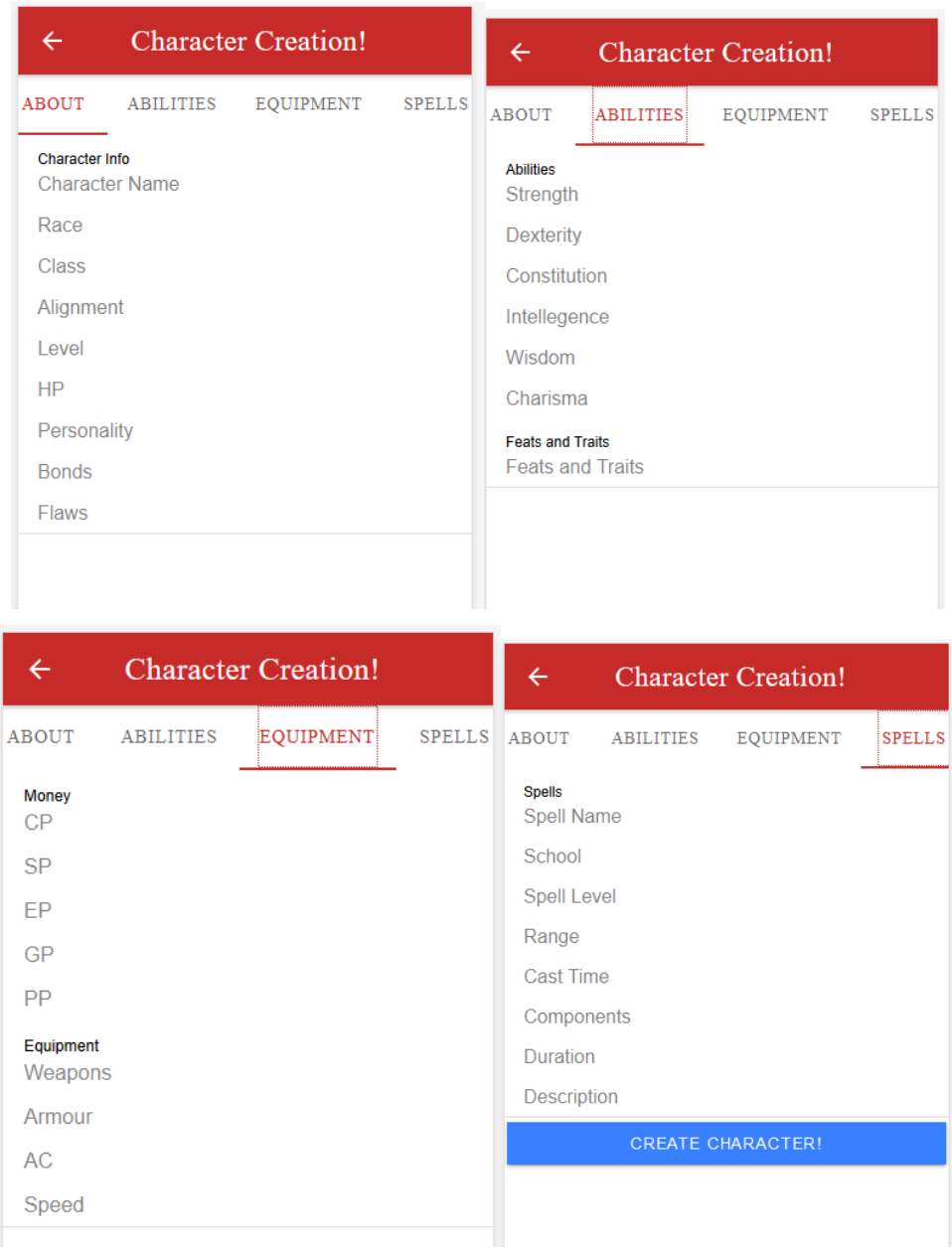
To log in the user must enter a valid email and password, in the same way as the registration form. If everything is correct they are able to log in and are sent to the home page.

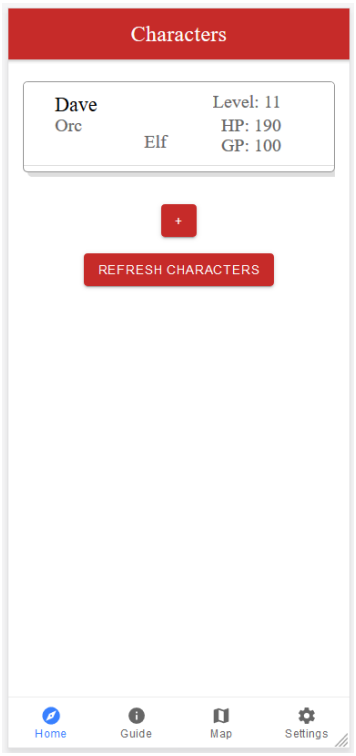
Create a character



To create a character the user has to first click on the + labeled button from the home page, this should take them to the character creation page.

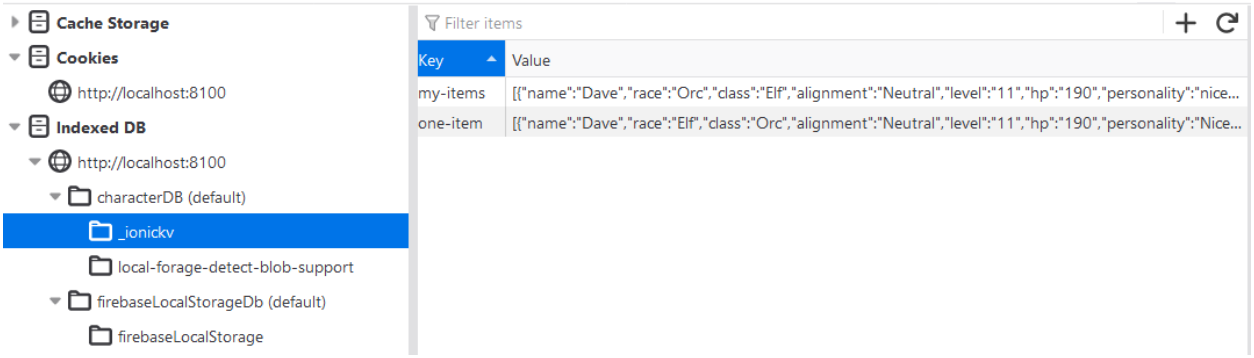
The user then has to fill in each field with the correct input type. However if they don’t enter something for all fields then the character won't be created.





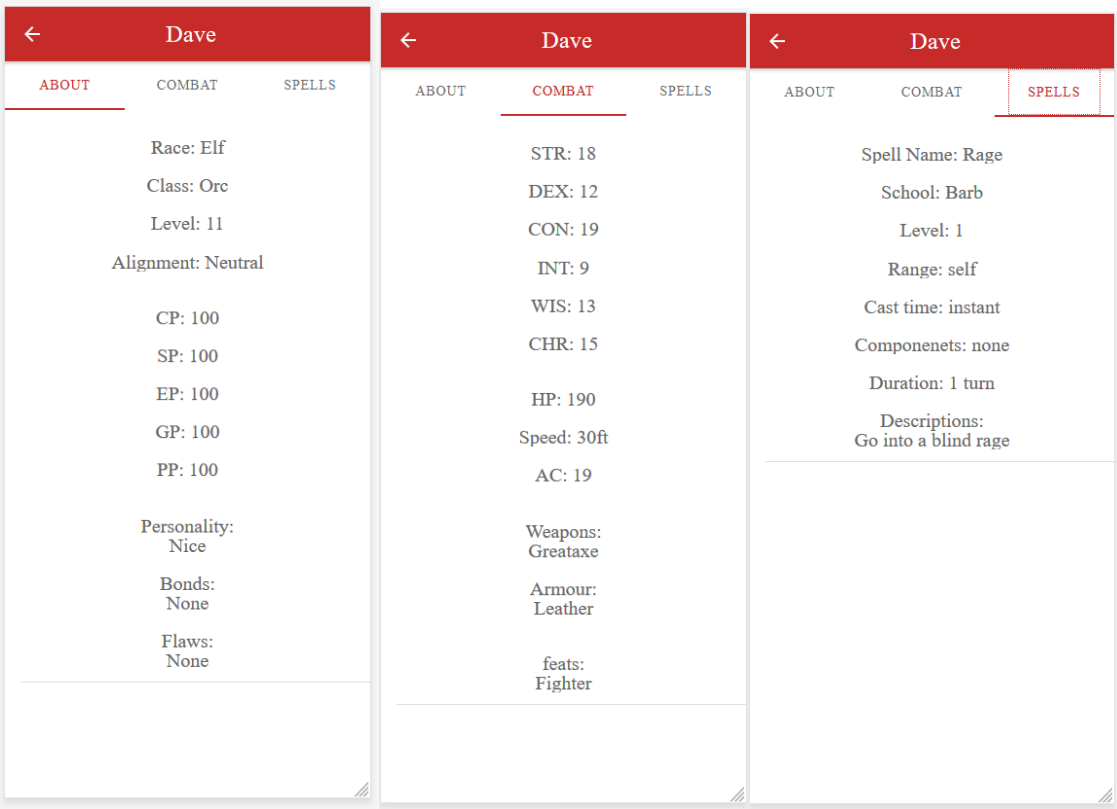
Once the character has been created, the user is able to view them on the home screen.

We can also check local storage on the browser to see that the character has been added to the database. All the characters are stored with the key my-items, and a selected characters info is stored with the key one-item which dynamically changes.

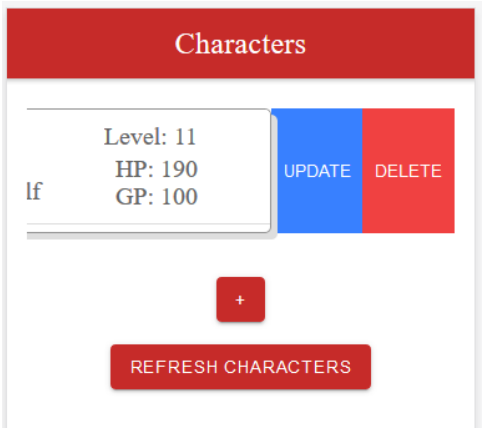


View a character

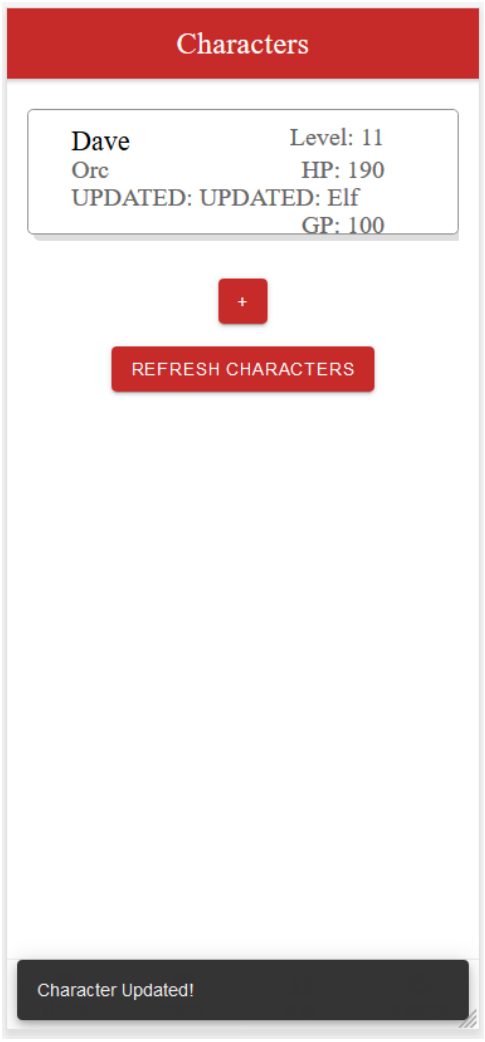
To view the data of a selected character the user clicks on one from the list and is taken to this view. From here the data is pulled from the database and displayed.



Edit a character



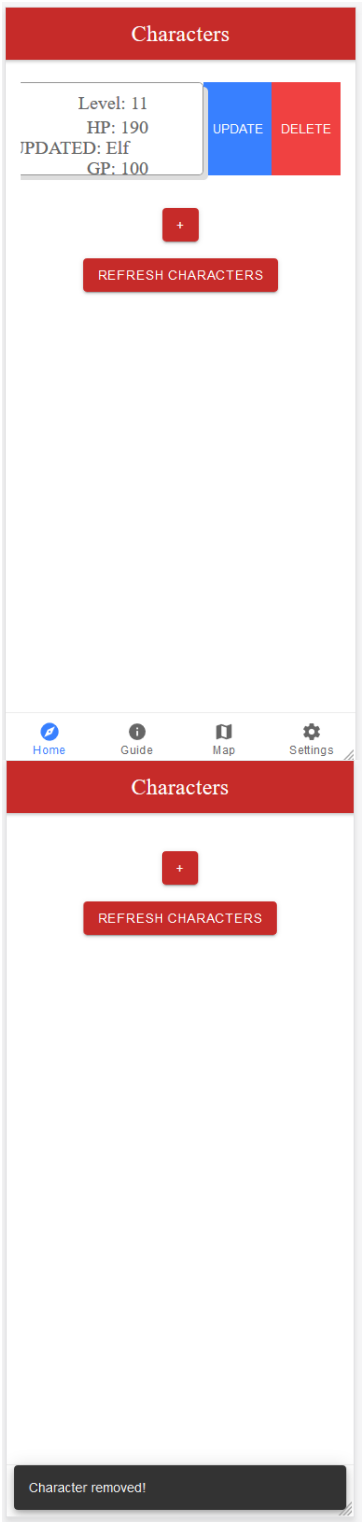
To update a character the user has to swipe on whichever character they want to update, and select the update button.



The update button only changes the “race” field to a predefined updated message. This should be changed to send the user to a form where they can change all of the character information.

The user is also shown a toast message confirming the update has been completed.

Delete a character



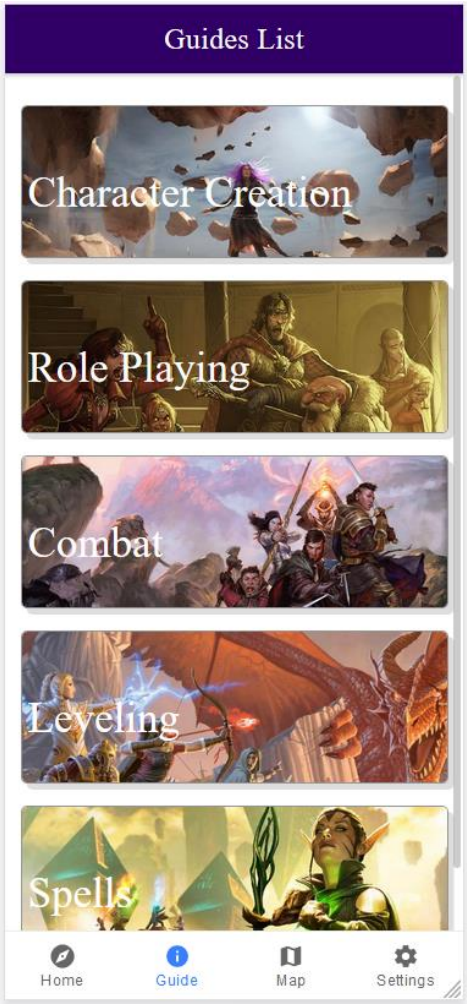
The user must swipe on a character and select the delete button.

The character has been removed from the list, and again a toast message is shown at the bottom of the screen informing the user of the deletion.

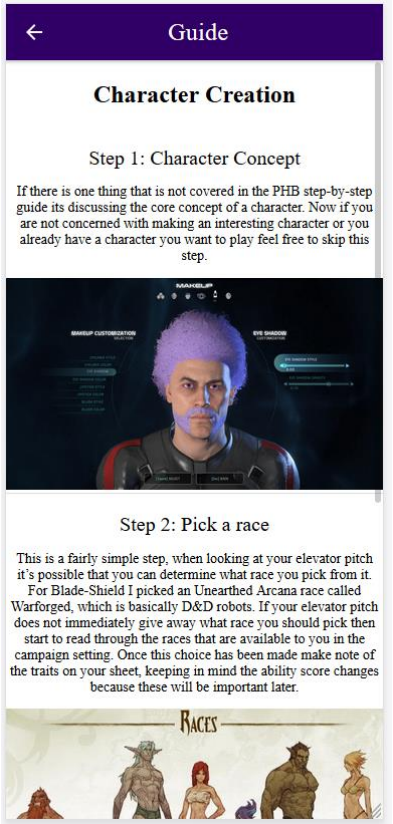
We can also see in the database that the character has been deleted.

Key	Value
my-items	[]

View a guide

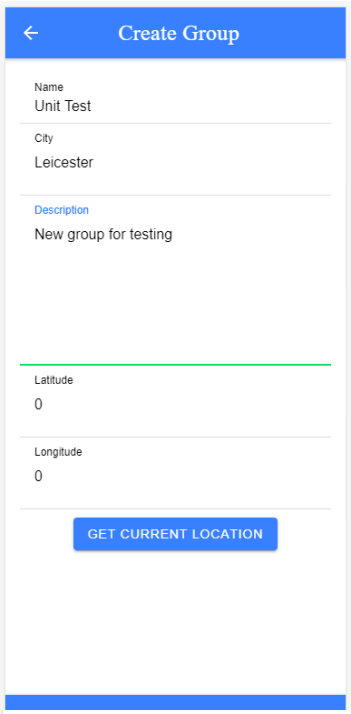


To view a guide the user must navigate to the Guide tab from here they can see all of the guides, which are pulled from the local database. We can see that the correct guide names and pictures are being displayed.

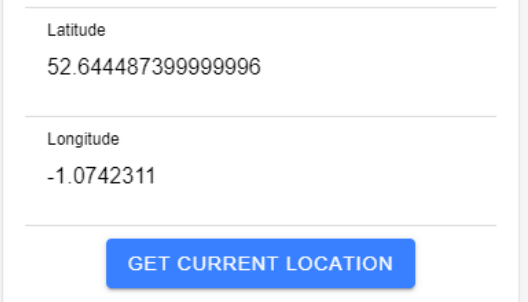


Once a guide has been selected the text and images for that guide are pulled and displayed. The correct information is being displayed. Clicking on the back button in the top left will take the user back to the guides tab.

Create a group

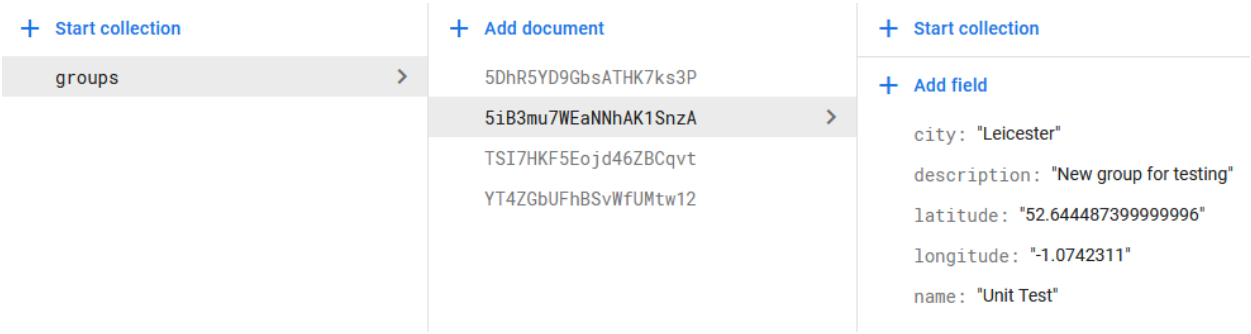


To create a group the user clicks on the plus button along the bottom, this will take them to the group from.

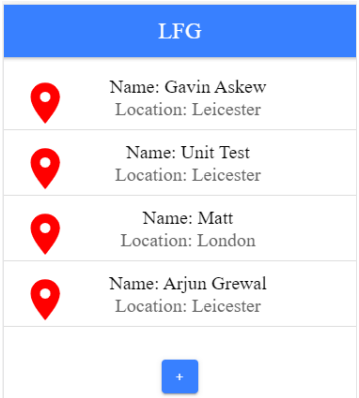


Clicking on the “get current location” button automatically adds their longitude and latitude coordinates.

Once added we can check the firebase database to see it's been added.



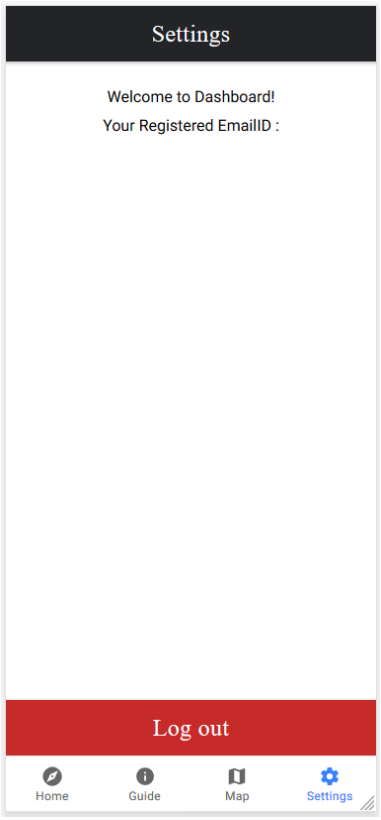
View a group



To view a group the user must navigate to the LFG tab and from here they will see a list of all available groups that are being pulled from the firebase database.

The correct data is being pulled from the database, and the google map is being displayed with the correct attributes. We can also see that the marker has been placed on the correct location on the map.

Log out



To log out the user goes to the settings tab and clicks on the log out button. The user will be redirected to the login page, and any user data stored should be deleted.

5.2 UI Evaluation

User interface evaluation is done by getting people to perform pre written tasks, these tasks will be timed and the feedback recorded. The tasks written should include the use of the main functions of the app, and the feedback is aimed towards how usable and friendly the user interface is and not about how the functions themselves work. *"The goal of user interface evaluation is to make products and services more usable, easy to learn, and intuitive for the user."*

I will also have the users fill out a SUS form that will give feedback on the UI elements that you can find in the appendix.

5.2.1 UI Evaluation Plan

Purpose

- Can the user perform all tests on both platforms
- Does the user prefer one platform over the other
- How usable is the system
- What parts of the UI can or should be changed

Sessions

- Session will take 15-45 minutes

- Participants will sign a consent form
- Complete all tasks on both platforms
- Complete the SUS from
- Users provide verbal feedback, that is recorded by the moderator

Scenarios

Both iOS and Android will use the same scenario:

- Register a new account
- Log in with new account
- Create a new character
- View new character
- Edit character
- Delete character
- View a guide
- Join a group
- Log out

Subjective Metrics

- SUS questionnaire
- Likert scale

5.2.2 Results

	Hamza	**Ashgar**
Test 1: Register a new account	Very simple to do, buttons and actions all clearly labeled. Time: 01:12	Easy to do, fields are validated well. After registration you should be automatically logged with a created account. Time: 00:48
Test 2: Log in with new	Again easy to do, and forms are validated well with error messages.	Should have been automatically logged in when the account was created, but this works fine.

account	Time: 00:32	Time 00:44
Test 3: Create a new character	Fields need to be better validated, and should give the user more of an idea as to what each stat means, as a new player he isn't sure what races or classes are available in the game. Time: 03:12	Looks fine, hard to tell which fields are for text and which fields are for numbers. Doesn't save character unless all fields are entered correctly. Time: 02:46
Test 4: View created character	Have to click on the refresh button for new characters to appear, it should be automatic instead. Character view looks nice. Time: 00:34	Character list should be automatically updated. Time: 00:20
Test 5: Update the characters information	Update button is in a nice spot having to swipe on the character, but it has no functionality yet. Time: 00:23	Update button doesn't work as intended. Time: 00:13
Test 6: Delete Character	Button is coloured correctly, and indicated what it does. Works as intended. Time: 00:13	There could be some form of sensible deletion, such as a confirmation box. Time: 00:07
Test 7: View a guide	Simple navigation with clearly labeled guides.	Easy to find and read, text size could be adjustable for users with visual difficulties.

	Time: 00:08	Time: 00:09
Test 8 : Join a group	Groups are also easy to see and view, could add a search to the groups list to narrow search. Also maybe a range limit on the location. Time: 00:21	Nice and simple, should show the current members in a group, and offer some way for users to interact with each other. Time: 00:37
Test 9: Log out	Very simple to do. Time: 00:04	Easy button location, again could ask for log out confirmation. Time: 00:05
Android App: The above tests were all completed on a iOS device	The Android version looks and feels just as good as the iOS version. I like the consistency between the two versions. Characters should be carried over and linked with your account instead of only stored locally, so that logging in with a different device will still have my characters available.	The Android version feels a little slower than the iOS version, but the functionality seems to work fine. Characters should be tied to account and not just the device, so I can log in on multiple devices and sync all of my data.

From these results I know there are a variety of redesigns that can be carried out, I will go into further detail into this in section 6.5 Future Improvements.

5.3 Play Testing

I planned to do a play test of my app where I would gather a few of my friends, install the app on their personal devices, and play a game of D&D. The reason for this test would be to see how the app works in a real world situation with a group of both new and returning players.

It would also have been a good way to measure how well the app works on a variety of Android and iOS devices.

Due to the global pandemic caused by the COVID-19 virus our government has ordered social distancing for the entire country. During this unfortunate time I am unable to gather 5 of my friends to play a game of D&D using the Dungeon Master's Handbook app as we are unable to meet in person, I also had to self-isolate during the planned time making it impossible to do.

6. Evaluation

In this section I will talk about how successful and unsuccessful the different aspects of my project were. I will discuss the application itself, if it met the project aims, any unachieved goals, future improvements, and a critical evaluation of myself and the project.

6.1 Design

The design phase of this project was very important as many key decisions were made here. Deciding on what design patterns to use really helped with the development of the app, as choosing a tab based view was easy to implement and gave the entire app a logical structure to develop, and also for the user friendliness.

Making personas and scenarios gave me an idea of the type of potential users of the app. Having these helped shape my design of the wireframes as I realised that not everyone using the app would be as familiar with technology or with D&D, so I decided to design my app to be as simple and user friendly as possible.

The wireframes I designed were crucial to the development as it gave a clear structured path of what needed to be made. The wireframe designs we're based on the research into the other apps, and what other non D&D apps look like.

Drawing a class diagram, and making the architecture overview was a key choice. The class diagram helped with understanding the data side of the backend, and helped me understand how all of the componentes will interact with each other. The architecture overview was needed so that I know what the entire architecture of the app will be, and know what will be needed for development.

6.2 Development

The development stage of the project was definitely the most time consuming yet interesting phase. Creating a cross platform app using Ionic was something completely new to me, however there are plenty of tutorials and documentation online that helped ease me into it.

Ionic is also quite similar to HTML, it is a web app after all, so there was some familiarity with it. Using Angular TypeScript didn't have quite a steep learning curve as I previously thought as it is very similar to JavaScript, a language I have years of experience with.

The decision to use Angular over React was a good choice as Ionic-React is a new technology there isn't as much community support compared to Angular which has been supported by Ionic for years.

The backend proved to be quite challenging to develop as using local storage on a web browser was quite buggy. Whenever I made a change to the code the app was automatically rebuilt using nodeJS, however refreshing the app on the web browser caused the storage and various visual elements to break, so everytime a change was made I had to close the web window and reopen it. Implementing Firebase and the Google maps API proved to be quite straight forward as they both had simple integration with Ionic, it was simply a case of importing the modules and using the predefined methods from the documentation.

Developing the front end was quite easy as it used HTML and SCSS elements, both of these I have used in the past. Also I had detailed wireframes so I already knew what each page was going to contain. Ionic has many tools that made the front end development go smoothly as there wasn't much styling needed on my part, as all of the animations and colours are pre defined.

Building both iOS and Android projects was perhaps the most difficult part of development. This was because I used a lot of different technologies and they all had to be compatible with the version of Ionic and the latest versions of iOS and Android. Also having to set up a virtual machine and an emulator just to test the app proved to be very difficult, as there were many hardware issues that appeared.

6.3 Project Aims

I think over the course of development the project aims have remained the same, this is in part due to the waterfall methodology that I used. The project aims are defined in section 1.1 of this report.

Explore the current state of Dungeons and Dragons

I think I was successful in this aim through my research into existing apps and sending out a questionnaire.

Research into any existing applications that are based around D&D to see what is currently out there, what can be improved, and to see what isn't currently being done

Having researched into the 3 most popular cross platform D&D apps on the App store and the Google Play store I think that I have achieved this aim, as I have made design decisions based on this research

See how many new people would play D&D if it was more accessible to new players

With the results from my questionnaire I think this aim was met successfully, however there could have been a larger response size.

Define a development method and framework that will best suit a cross platform application

Having researched into the existing cross platform frameworks I decided to use Ionic, because of this I think that this aim was met.

Understand how to develop a cross platform mobile app

My app can be successfully built to both iOS and Android using the ionic cordova commands. I now understand that an xCode project and an android APK must be created to run the apps on the mobile devices.

Store user and game information in a secure backend system

With the use of firebase authentication user info is stored in a secure backend, and the groups created are also stored in the firebase database.

Manipulate and utilise location data

The final aim was to use location data and I believe I was successful in meeting this aim, as my app can get the users current location and display it on a Google Map.

6.4 Unachieved goals

Due to time constraints and lack of knowledge there are unachieved goals within the project. These are all core features that should be implemented but that I was unable to do so, however with more time and research I would be able to add these features.

6.4.1 Joining Groups

Currently users are only able to create and view groups, there is no way for a user to join a group. This is one of the main features of the app I was unable to implement, because this is the first time using a firebase database so I couldn't find a proper solution with my limited knowledge.

6.4.2 Update Character Info

Character information changes a lot when playing a D&D game and currently there is no way for a user to edit this data, however the backend functionality is there. I was unable to implement this due to time constraints as the update feature only changes the race for now, but this can be modified to include other data but a new view would need to be added.

6.5 Future Improvements

Future improvements are the features that need to be done before the project is finished, ideas that other people have recommended to add, and enhancements that can be made after release.

6.5.1 Necessary Improvements

There are 2 necessary improvements that need to be made, these are the unachieved goals that I've talked about above. These haven't been implemented due to lack of time, and not fully understanding how to manipulate data stored in a firebase database. Below is a list of the necessary improvements:

1. Users should be able to join groups that are made
2. Characters information should be able to be updated

6.5.2 Recommended improvements

From the UI evaluation there are recommendations and improvements that could be implemented to the app, these are not critical improvements they would only improve usability.

One improvement would be to automatically log the user in after registration and for the user to remain logged in when the app is closed. Another suggestion was to have the characters tied to the account instead of just the device, this would make it so users could switch between devices and still have their data with them.

6.5.3 Potential Improvements

Potential improvements are improvements that can be worked on in the long term, even after the app has been released. A potential improvement could be to allow users to share characters, this would make it so everyone in your group could see the character you have. Another improvement would be to allow the creation of non playable characters, these would only be characters for the story of the game and not characters that the players have made.

6.6 Critical Reflection

During the development cycle for the Dungeon Master's Handbook I've learned a lot about software engineering tools, project management, and the importance of research. Ionic was the main software tool that I had to learn for this project, and I think that with the amount of documentation and all the videos available online my knowledge of the framework has greatly grown. I was always looking things up and checking the documentation during development whenever errors would arise and most of the time there would always be a solution or guidance.

I learned a lot about different frameworks, libraries, and APIs as every technology that I used for this project was a first time for me. Using Angular was a great way to improve my Java skills, and helped with other modules for this year as I could apply what I did in my project for other assignments.

During the project there were many things that went well. One aspect of the project that I think went really well was the research and investigation phase, as looking into existing products to figure out what already exists was very beneficial to the overall design of my app. Making a

questionnaire and getting all of the responses also helped tremendously with the design decisions of the app, as the results proved that my app has a reason to exist.

There are aspects of the project that I know went poorly and can be improved upon for the next project. The main problem I have is with time management, at the beginning of the project cycle I was meeting the timeline set out in my action plan, however after Christmas my time management became worse in part due to other assignments. Because of this some features were never implemented, and other features can be improved.

6.7 Conclusion

Overall I think that my project was a success and not just in terms of meeting the requirements, which I believe I did, I think that it was a success because I've learned many different tools and techniques that helped me improve as a software engineer. I can take these new skills and apply them to any future project that I will be part of. Even though there were aspects of the project that went poorly and can be improved upon, mainly my time management skills, I can take these lessons and learn from them to become a better developer.

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9. Appendix

9.1 Appendix A - Project Specification

PROJECT SPECIFICATION - Project (Technical Computing) 2019/20

Student:	Arjun Grewal
Date:	11/10/2019
Supervisor:	Abayomi Otebolaku
Degree Course:	Software Engineering
Title of project:	A companion app for the tabletop game Dungeons and Dragons that will connect old and new players.

9.1.1 Elaboration

Elaboration

Dungeons and Dragons can be a very difficult game to get into if you're interested in it, because it requires you to learn a lot of rules and characters before you can start playing the game. You also need to find a group of around five people to play with which can be equally as difficult as learning how to play. Currently it is very inconvenient for new players to join the game, and existing players might want a new modern way to play the game.
The purpose of my mobile application is to make it easier and more user friendly for new

players to learn about and start a game, also to allow people to search for games around them and to be able to message these people to form groups to play in. The app will provide users with ways to create and store characters and game stories, this will help existing players move to a modern way of playing.

9.1.2 Project Aims

Project Aims

- To explore the current state of Dungeons and Dragons
- Research into any existing applications that are based around DnD to see what is currently out there, what can be improved, and to see what isn't currently being done
- To see how many new people would play DnD if it was easier to get into
- To see how many people want to play but can't because they have no one to play the game with
- Decide which method and framework would be best suited for my cross platform mobile app
- Understand how to develop a cross platform application
- To develop my project while using the agile methodology
- Develop for iOS, something I've not done before
- To be able to securely store information of users, and any game data into a database
- To learn how to use location data and how to manipulate a map of your area
- To critically evaluate myself and see if I would approach the project in the same way if I were to do it again

9.1.3 Project Deliverables

Project Deliverables

I am going to be producing a cross platform mobile application. I will be using android studio to develop the app and I will use a framework that supports both iOS and Android. Also, I will create a database that will store the details of user's accounts, characters, and any games that they have created. As well as any documentation I will deliver the final APK file, and the project folders.

9.1.4 Action Plan

Action Plan

Tasks	Date
Finish project specification. The project spec should be completed and signed	25/10/19
Research into current mobile development options and IDEs	02/11/19
Create questionnaires or surveys for my research into the game	06/11/19
Using my research questions ask: • Current players of Dungeons and Dragons about the game • People who have never played about the game • people who want to play the game but currently don't have a group, about the game	22/11/19
Research into existing Dungeons and Dragons applications on both android and iOS	24/11/19
Investigate different cross platform frameworks and methods	26/11/19
Research into different user interface designs for mobile	26/11/19
Research which database type would be best suitable for my project	26/11/19
Set up version control such as a GitHub	26/11/19
Design phase for the application	05/12/19
Develop a prototype, with main functions implemented	31/12/19
Test the prototype myself, and get other people to test it and give feedback regarding the functionality of the app	10/01/20
Continue development of the app working more on the UI, and take the testing results into consideration and making changes where needed	04/02/20
Test the app myself again, and also get other people to test the app to	12/02/20

find any bugs and to give feedback on the interface	
Make any final changes to the app based on the results of the testing	01/03/20
Finish writing the report	22/04/20
Submit project	23/04/20

9.1.5 BSC Code of Conduct

BCS Code of Conduct

I confirm that I have successfully completed the BCS code of conduct on-line test with a mark of 70% or above. This is a condition of completing the Project (Technical Computing) module.

Signature:

9.1.6 Publication of Work

Publication of Work

I confirm that I understand the "Guidance on Publication Procedures" as described on the Bb site for the module.

Signature:

9.1.7 GDPR

GDPR

I confirm that I will use the "Participant Information Sheet" as a basis for any survey, questionnaire or participant testing materials. This form is available on the Bb site for the module. **Signature:**   

9.2 Appendix B - Research Ethics Checklist

General Details

Name of student	Arjun Grewal
SHU email address	b6025753@my.shu.ac.uk
Course or qualification (student)	Software Engineering
Name of supervisor	Abayomi Otebolaku
email address	ao5734@exchange.shu.ac.uk
Title of proposed research	Your experience with the tabletop game Dungeons and Dragons
Proposed start date	02/11/2019
Proposed end date	19/12/2019
Brief outline of research to include, rationale & aims (250-500 words).	The research that I will include is focussed on gathering player data about the tabletop game Dungeons and Dragons. The research will not be about the players themselves, but about features and characteristics of the game itself. The reason I need to do this research is so that I can discover what current players think about the game and to see what new players would want to get involved in the game. Only with this research will I be able to develop an application that will be useful for people who are interested in the game.

Where data is collected from individuals, outline the nature of data, details of anonymisation, storage and disposal procedures if required (250-500 words).	The data that I will be collecting will come from people completing surveys and questionnaires. The questions that I will be asking will be written by me, but there will be no personal or irrelevant questions on the questionnaires. The nature of the data is to see where the current state of Dungeons and Dragons lies, to see what people who are actively playing the game think about it and how the systems that are currently in place work, but also how it can be improved upon. Also I will be asking people who have never played the game what questions about it, and what could cause them to try to get into playing the game. The data that I'll collect will come from people but since people are not the focus of the data, everyone who participates will be left anonymous as the actual persons details aren't relevant to the information that I am looking to collect. Also at any point if someone wants their data to be removed from the research I will comply and remove them. The storage of the research will be done either on paper or electronically through google forms. The data will be disposed of once it has been finished with. I will not be handling any sensitive or private information regarding any person, all the information that I will collect will be relevant to the game Dungeons and Dragons.

1. Health Related Research Involving the NHS or Social Care / Community Care or the Criminal Justice Service or with research participants unable to provide informed consent

Question	**Yes/No**
1. Does the research involve? • Patients recruited because of their past or present use of the NHS or Social Care • Relatives/carers of patients recruited because of their past or present use of the NHS or Social Care • Access to data, organs or other bodily material of past or present NHS patients • Foetal material and IVF involving NHS patients • The recently dead in NHS premises • Prisoners or others within the criminal justice system recruited for health-related research* • Police, court officials, prisoners or others within the criminal justice system*	**N**

• Participants who are unable to provide informed consent due to their incapacity even if the project is not health related	
2. Is this a research project as opposed to service evaluation or audit? For NHS definitions please see the following website http://www.hra.nhs.uk/documents/2013/09/defining-research.pdf	**N**

2. Research with Human Participants

Question	**Yes/No**
Does the research involve human participants? This includes surveys, questionnaires, observing behaviour etc.	Y
Question	**Yes/No**
• Note If YES, then please answer questions 2 to 10 If NO, please go to Section 3	N
• Will any of the participants be vulnerable? Note: Vulnerable' people include children and young people, people with learning disabilities, people who may be limited by age or sickness, etc. See definition on website	N
• Are drugs, placebos or other substances (e.g. food substances, vitamins) to be administered to the study participants or will the study involve invasive, intrusive or potentially harmful procedures of any kind?	N
• Will tissue samples (including blood) be obtained from participants?	N
• Is pain or more than mild discomfort likely to result from the study?	N
• Will the study involve prolonged or repetitive testing?	N
• Is there any reasonable and foreseeable risk of physical or emotional harm to any of the participants? Note: Harm may be caused by distressing or intrusive interview questions, uncomfortable procedures involving the participant, invasion of privacy, topics relating to highly personal information, topics relating to illegal activity, etc.	N
• Will anyone be taking part without giving their informed consent?	N
• Is it covert research? Note: 'Covert research' refers to research that is conducted without the knowledge of participants.	N

• Will the research output allow identification of any individual who has not given their express consent to be identified?	**N**

3. Research in Organisations

Question	**Yes/No**
• Will the research involve working with/within an organisation (e.g. school, business, charity, museum, government department, international agency, etc.)?	N
• If you answered YES to question 1, do you have granted access to conduct the research? If YES, students please show evidence to your supervisor. PI should retain safely.	
• If you answered NO to question 2, is it because: • you have not yet asked • you have asked and not yet received an answer • you have asked and been refused access. Note: You will only be able to start the research when you have been granted access.	

4. Research with Products and Artefacts

Question	**Yes/No**
1. Will the research involve working with copyrighted documents, films, broadcasts, photographs, artworks, designs, products, programmes, databases, networks, processes, existing datasets or secure data?	Y
2. If you answered YES to question 1, are the materials you intend to use in the public domain? Notes: 'In the public domain' does not mean the same thing as 'publicly accessible'. • Information which is 'in the public domain' is no longer protected by copyright (i.e. copyright has either expired or been waived) and can be used without permission. • Information which is 'publicly accessible' (e.g. TV broadcasts, websites, artworks, newspapers) is available for anyone to consult/view. It is still protected	Y

by copyright even if there is no copyright notice. In UK law, copyright protection is automatic and does not require a copyright statement, although it is always good practice to provide one. It is necessary to check the terms and conditions of use to find out exactly how the material may be reused etc. If you answered YES to question 1, be aware that you may need to consider other ethics codes. For example, when conducting Internet research, consult the code of the Association of Internet Researchers; for educational research, consult the Code of Ethics of the British Educational Research Association.	
3. If you answered NO to question 2, do you have explicit permission to use these materials as data? If YES, please show evidence to your supervisor.	
4. If you answered NO to question 3, is it because: A. you have not yet asked permission B. you have asked and not yet received and answer C. you have asked and been refused access. Note: You will only be able to start the research when you have been granted permission to use the specified material.	**A/B/C**

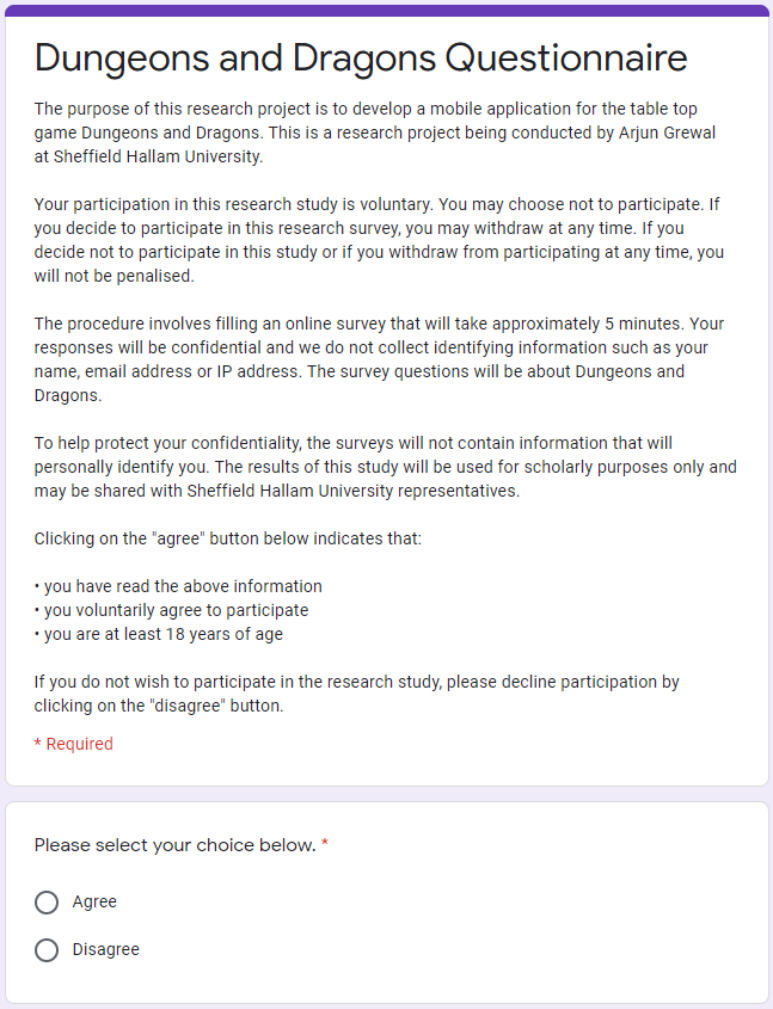
Adherence to SHU policy and procedures

Personal statement
I can confirm that: − I have read the Sheffield Hallam University Research Ethics Policy and Procedures − I agree to abide by its principles.
Student
Name: Arjun Grewal Date: 23/10/2019
Signature: 
Supervisor or other person giving ethical sign-off
I can confirm that completion of this form has not identified the need for ethical approval by the FREC or an NHS, Social Care or other external REC. The research will not commence until any approvals required under Sections 3 & 4 have been received.

Name: Dr Abayomi(Yomi) Otebolaku	Date: 24/10/2019
Signature: 	

9.2 Appendix C - Questionnaire and Results

Questions



Dungeons and Dragons Questionnaire

The purpose of this research project is to develop a mobile application for the table top game Dungeons and Dragons. This is a research project being conducted by Arjun Grewal at Sheffield Hallam University.

Your participation in this research study is voluntary. You may choose not to participate. If you decide to participate in this research survey, you may withdraw at any time. If you decide not to participate in this study or if you withdraw from participating at any time, you will not be penalised.

The procedure involves filling an online survey that will take approximately 5 minutes. Your responses will be confidential and we do not collect identifying information such as your name, email address or IP address. The survey questions will be about Dungeons and Dragons.

To help protect your confidentiality, the surveys will not contain information that will personally identify you. The results of this study will be used for scholarly purposes only and may be shared with Sheffield Hallam University representatives.

Clicking on the "agree" button below indicates that:

• you have read the above information
• you voluntarily agree to participate
• you are at least 18 years of age

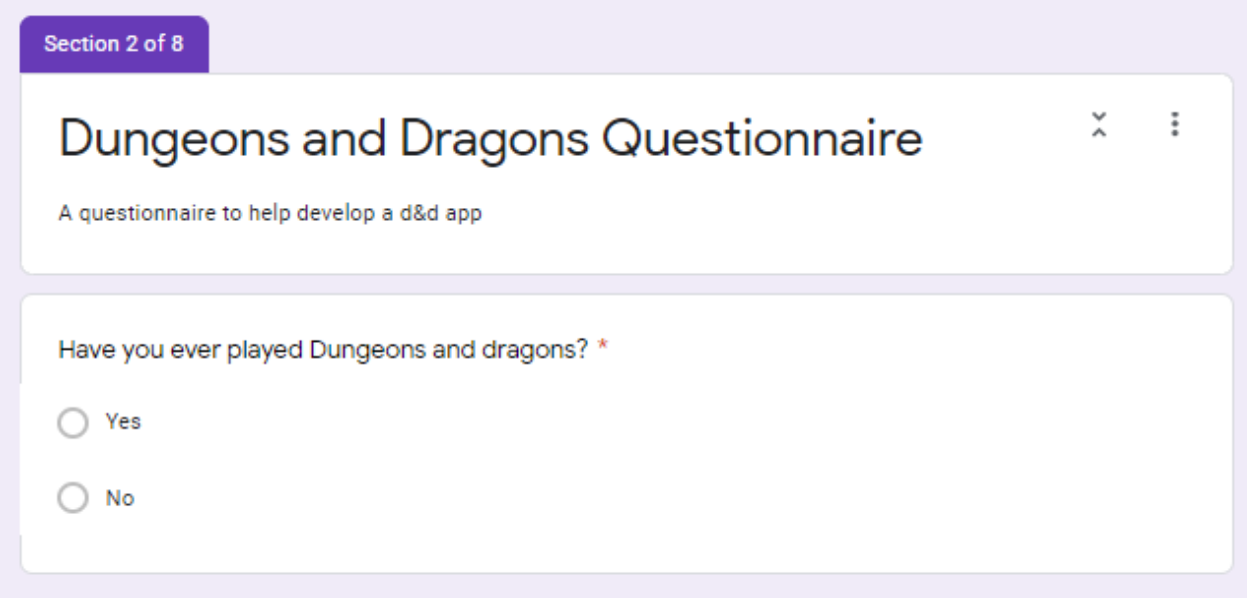
If you do not wish to participate in the research study, please decline participation by clicking on the "disagree" button.

* Required

Please select your choice below. *

Agree

Disagree


Section 2 of 8
Dungeons and Dragons Questionnaire
A questionnaire to help develop a d&d app
Have you ever played Dungeons and dragons? *
Yes
No

Section 3 of 8

Previous Player

Questions for people who have played before

How often do you play D&D? *

- Daily
- Weekly
- Monthly
- Yearly
- Rarely

How active are you in the D&D community? e.g forums/subreddits *

	1	2	3	4	5	
Not Active						Very Active

How well do you know the game rules? *

	1	2	3	4	5	
Don't know any of the rules						Know all of the rules

How likely are you to use a D&D app *

	1	2	3	4	5	
Not very likely	○	○	○	○	○	Very likely

Do you always play with the same people? *

- ○ Yes
- ○ No

Would you play D&D with strangers? *

- ○ Yes
- ○ No

Do you typically play as the DM or PC? *

- ○ DM
- ○ PC
- ○ Either

Do you use a physical or digital character sheets? *

- [ ] Physical
- [ ] Digital

Do you use any mobile apps when playing D&D *

- ( ) Yes
- ( ) No

Section 4 of 8

Never Played

Question for people who have never played D&D before

Why not? *

- Interested but haven't had the chance to play
- Don't know anyone who plays
- Don't know what it is
- Don't enjoy table top games
- Not interested
- Other...

How familiar are you with D&D? *

	1	2	3	4	5	
Never heard of it	○	○	○	○	○	Very familiar

How likely are you to start playing D&D *

	1	2	3	4	5	
Not very likely	○	○	○	○	○	Very likely

Do you know anyone who plays? *

- Yes
- No

Section 5 of 8

Apps

OS?

What OS is your phone? *

- iOS
- Android

Section 6 of 8

iOS Apps

Description (optional)

What App do you use? *

- D&D Beyond
- Fight Club 5th Edition
- Complete Reference for D&D 5
- Spellbooks
- Real sheet collection
- Other...

How useful is the app? *

	1	2	3	4	5	
Not very useful						Very useful

What feature would you like in a D&D app? *

Short answer text

Would you pay for a D&D app? *

- ○ Yes
- ○ No

Section 7 of 8

Android Apps

Description (optional)

What app do you use? *

- [ ] D&D Beyond
- [ ] Spell List D&D 5th Edition
- [ ] 5e Character
- [ ] Fifth edition character sheet
- [ ] Monsters and generators for D&D
- [ ] Other...

How useful is the app? *

	1	2	3	4	5	
Not very useful	○	○	○	○	○	Very useful

What feature would you like in a D&D app? *

Short answer text

Would you pay for a D&D app? *

- Yes
- No

Section 8 of 8

No Apps

Description (optional)

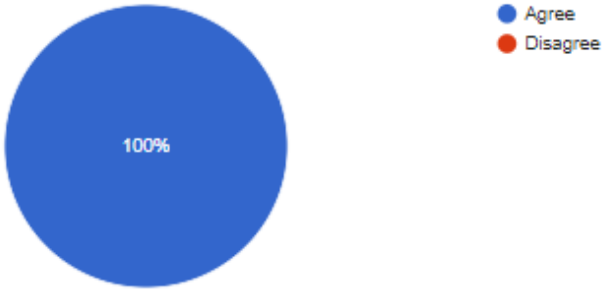
What would make you get a D&D app? *

Short answer text

Results

Please select your choice below.

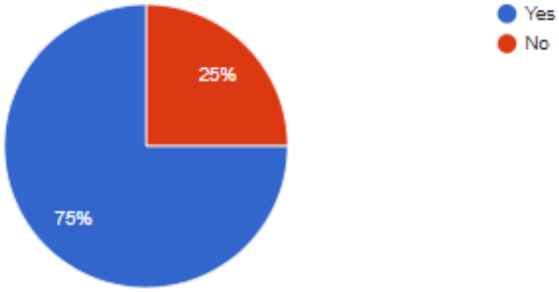
24 responses



Dungeons and Dragons Questionnaire

Have you ever played Dungeons and dragons?

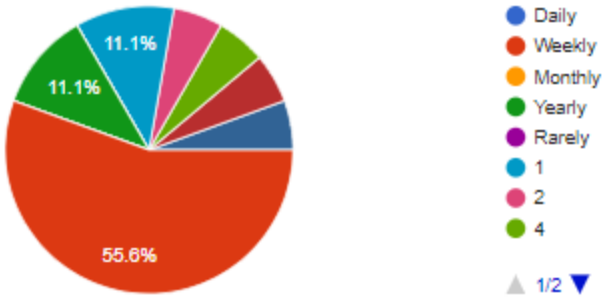
24 responses



Previous Player

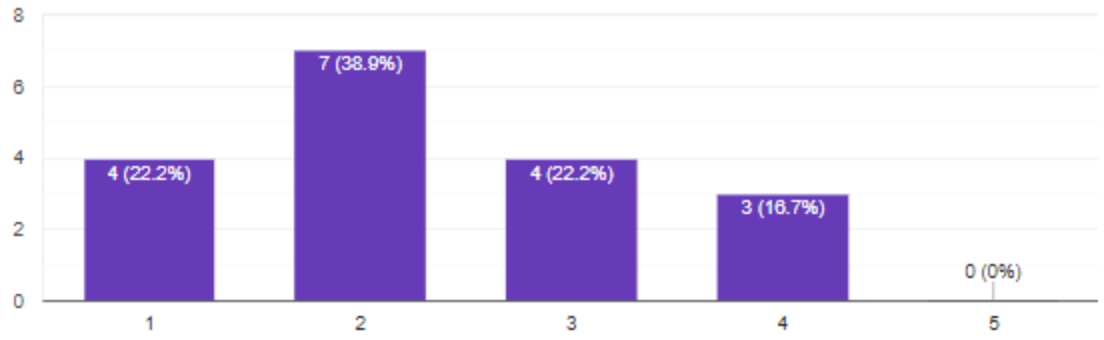
How often do you play D&D?

18 responses



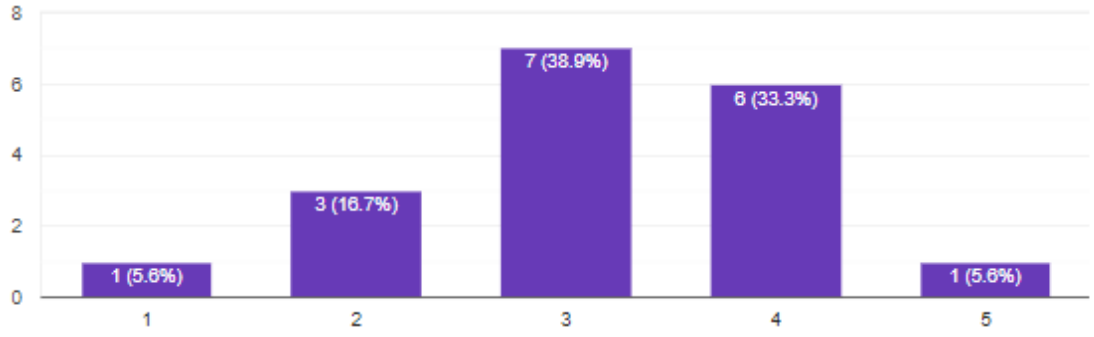
How active are you in the D&D community? e.g forums/subreddits

18 responses



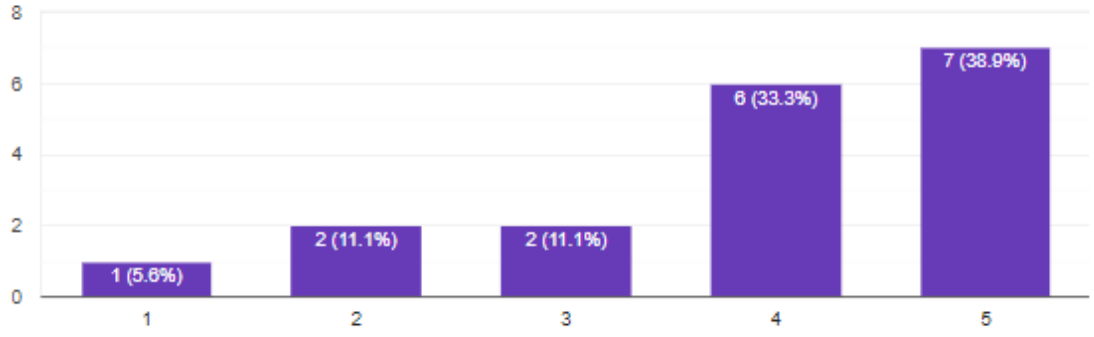
How well do you know the game rules?

18 responses



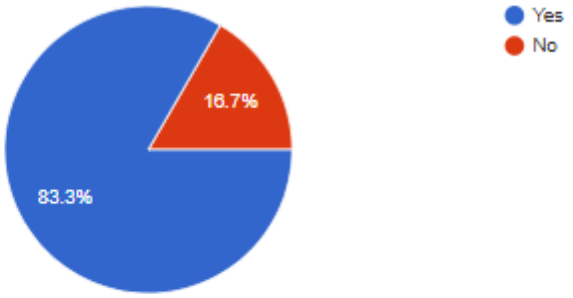
How likely are you to use a D&D app

18 responses



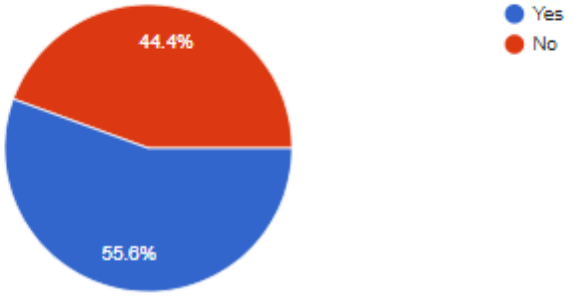
Do you always play with the same people?

18 responses



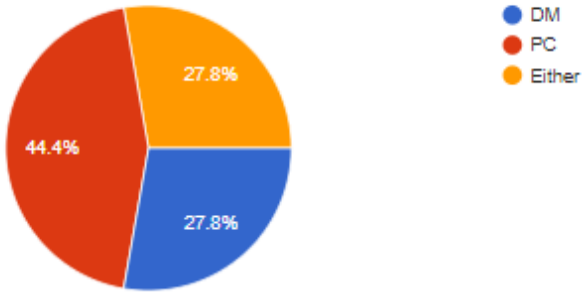
Would you play D&D with strangers?

18 responses



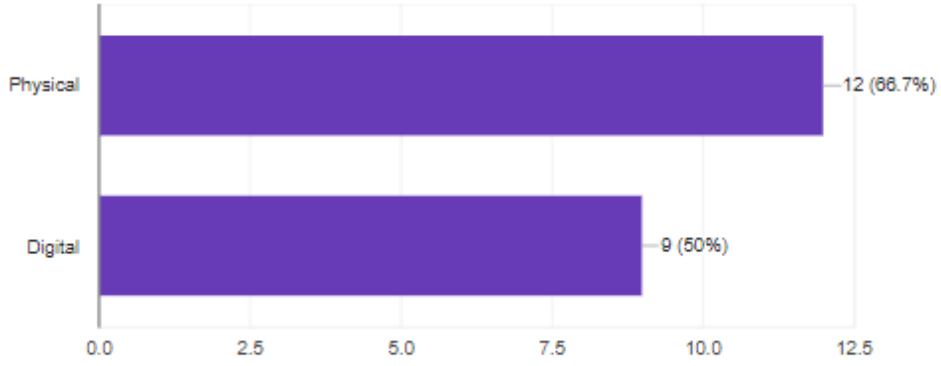
Do you typically play as the DM or PC?

18 responses



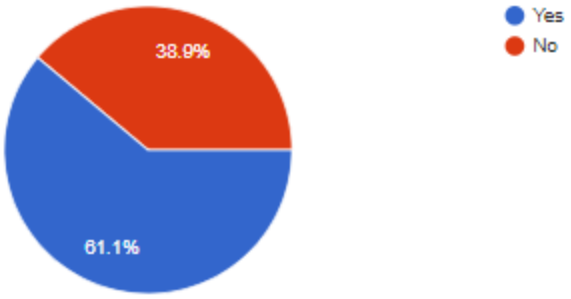
Do you use a physical or digital character sheets?

18 responses



Do you use any mobile apps when playing D&D

18 responses



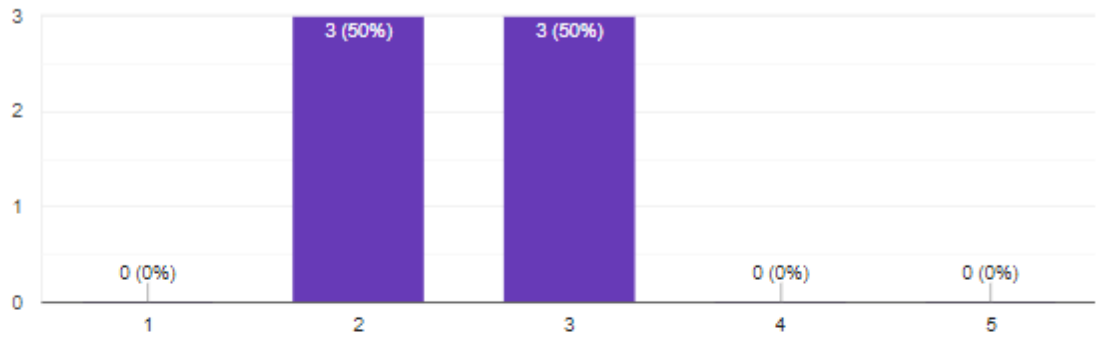
Never Played

Why not?

6 responses

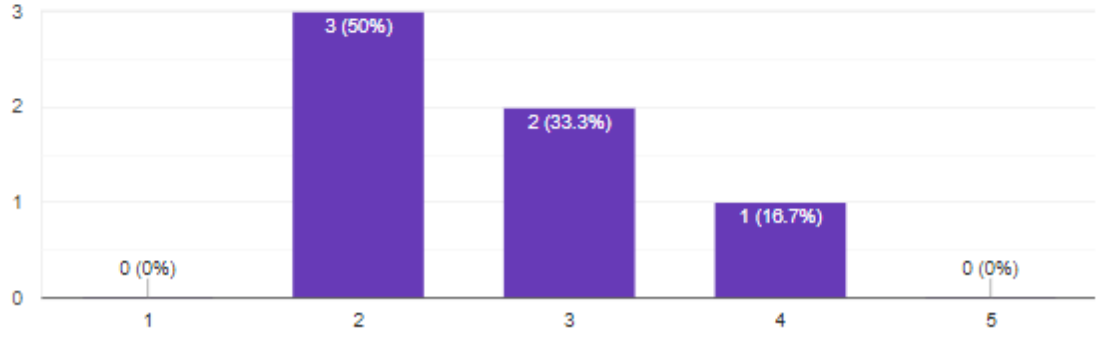
How familiar are you with D&D?

6 responses



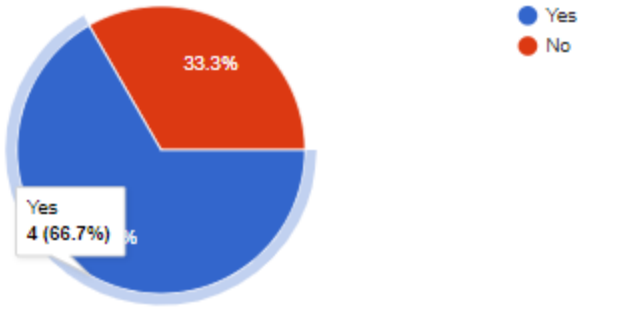
How likely are you to start playing D&D

6 responses



Do you know anyone who plays?

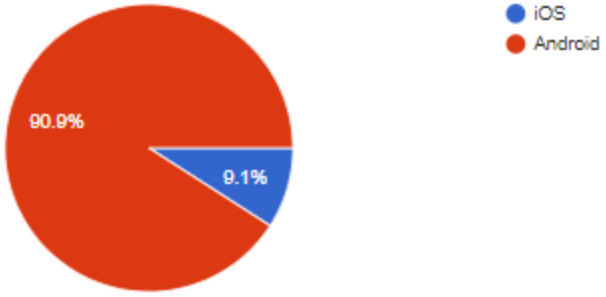
6 responses



Apps

What OS is your phone?

11 responses



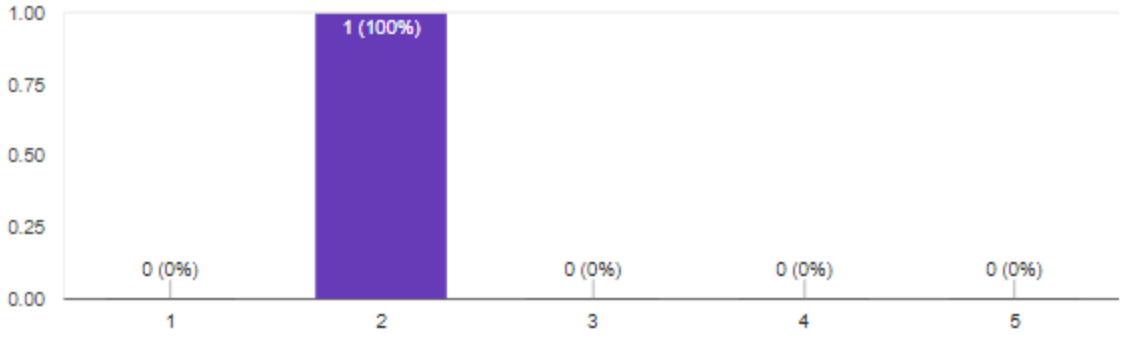
iOS Apps

What App do you use?

1 response

How useful is the app?

1 response



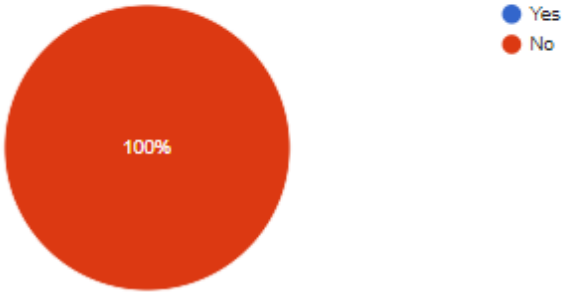
What feature would you like in a D&D app?

1 response

To store DM information

Would you pay for a D&D app?

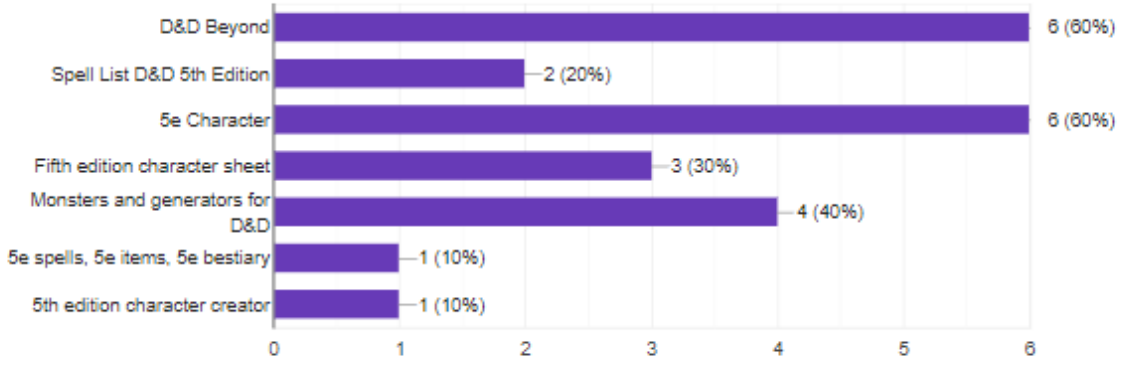
1 response



Android Apps

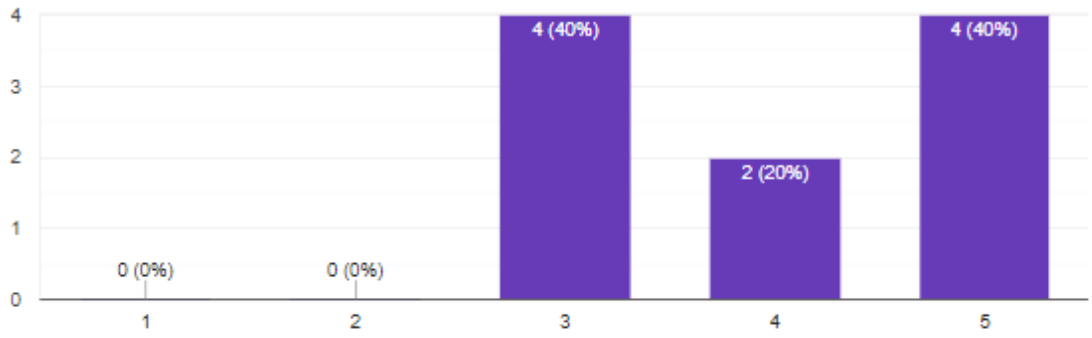
What app do you use?

10 responses



How useful is the app?

10 responses



What feature would you like in a D&D app?

10 responses

List of Spells

Homebrew Stuff

Ability to create characters and view items

Simple easy to use character creation

Quick Start Feature that gives a reccomended character sheet to save time for people that dont want to spend it or just want a one off game.

dungeon generator

Rules alongside character sheets

Character sheet generator that only generates the stats etc that don't change during play so that it can be printed off and used on paper easily, have spells, items,characters etc in one app instead of multiple apps

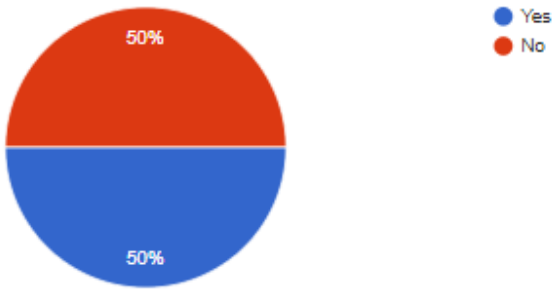
Character sheet generator that only generates the stats etc that don't change during play so that it can be printed off and used on paper easily, have spells, items,characters etc in one app instead of multiple apps

Different ablities for characters

i don't know

Would you pay for a D&D app?

10 responses



No Apps

What would make you get a D&D app?

3 responses

Maybe an all-in-one app with built-in character sheets, dice simulator, list of spells and their descriptions, weapon list, armour list etc.

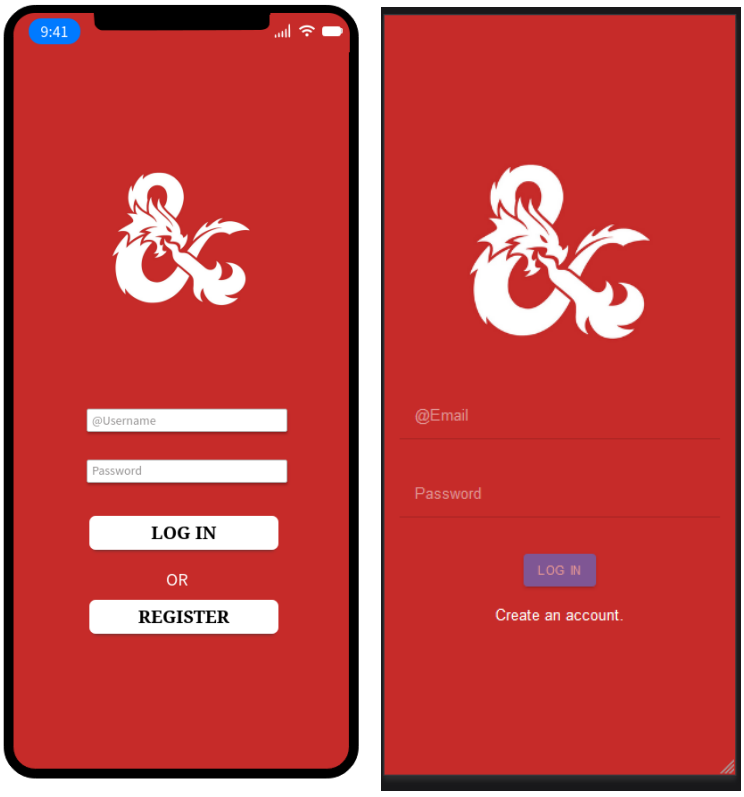
Make it more useful than using my paper notes

Something that lets you make and store homebrew monsters.

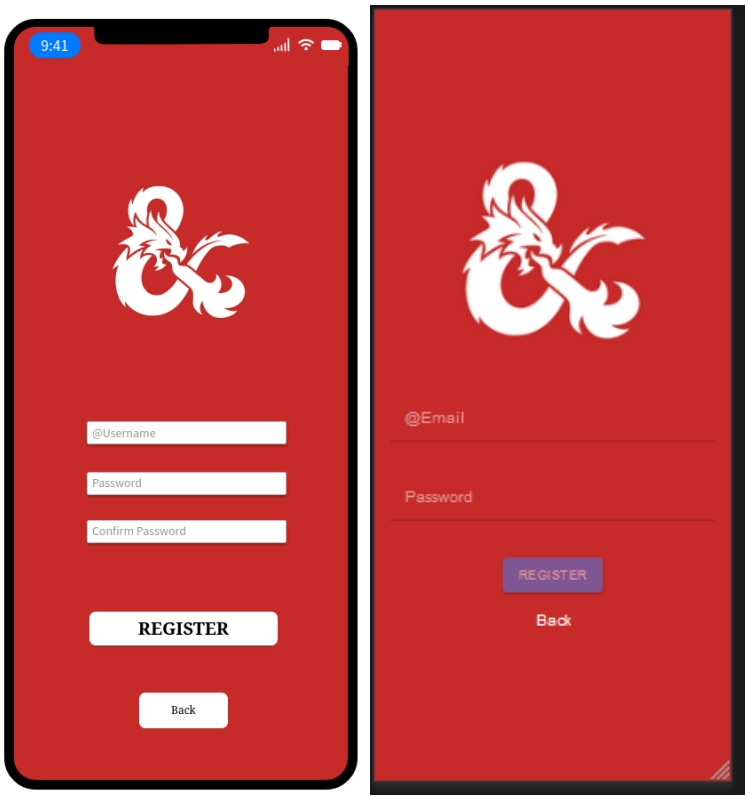
9.4 Appendix D - Application Screenshots (Wireframes and Implementation)

Design on the left, implementation on the right.

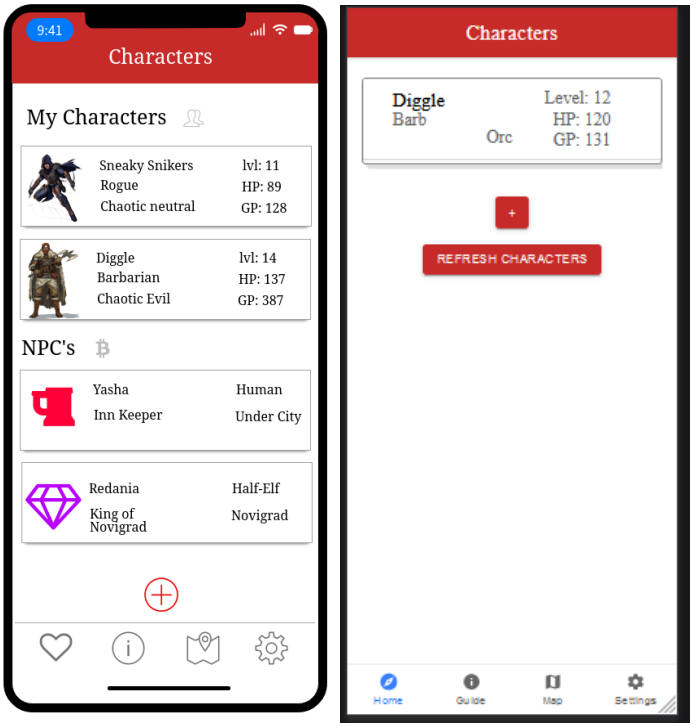
Login page:



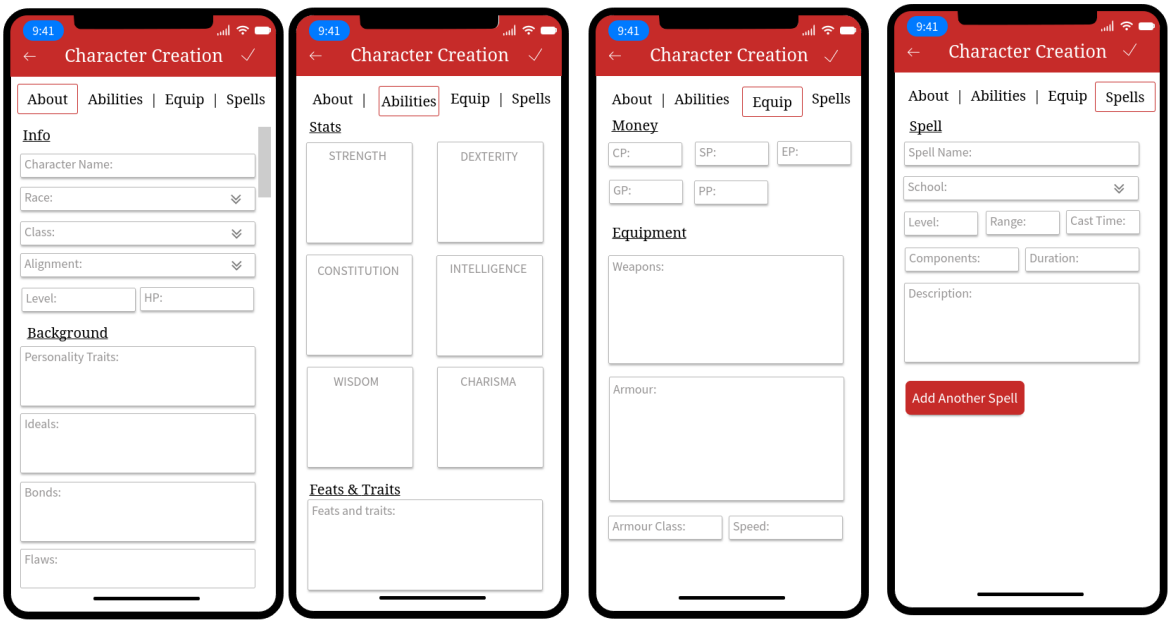
Register Page:

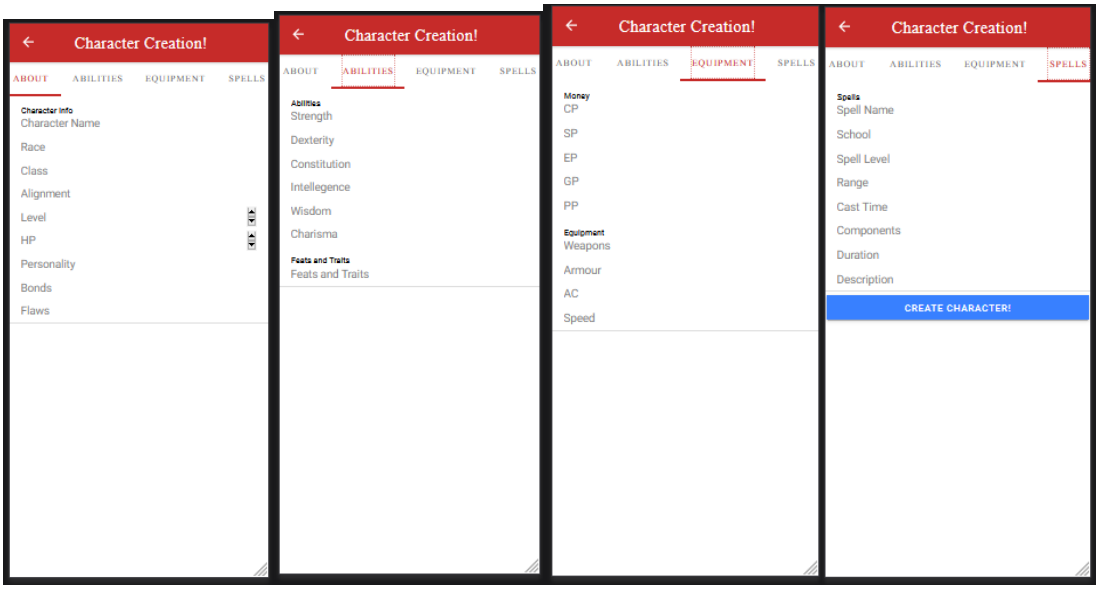


Home Page:

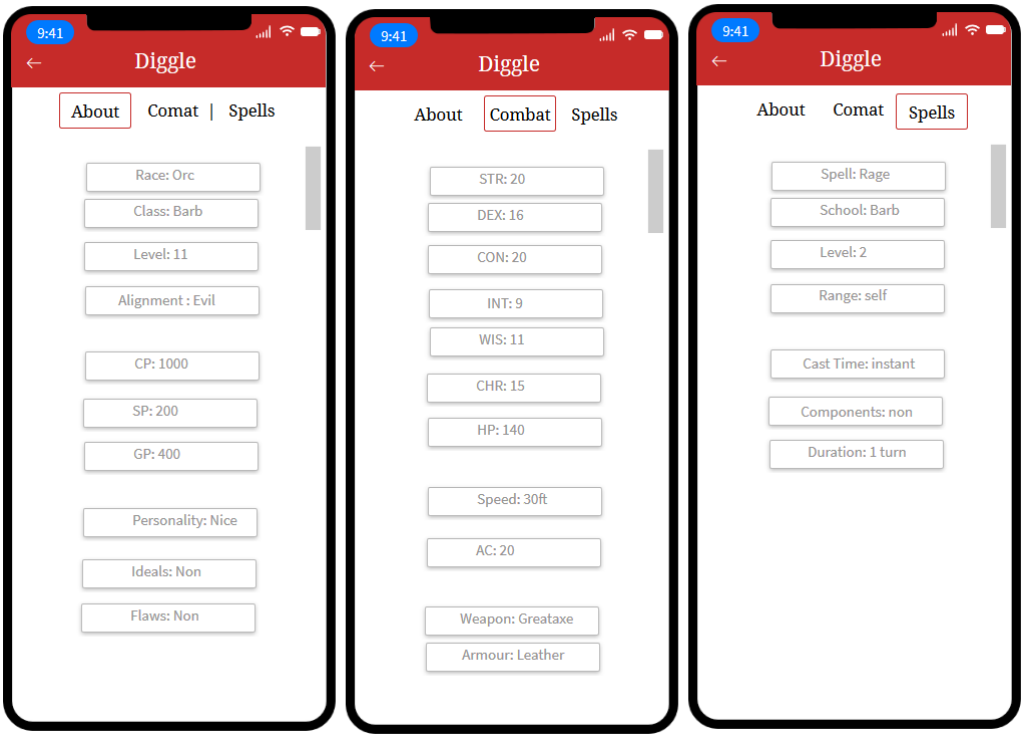


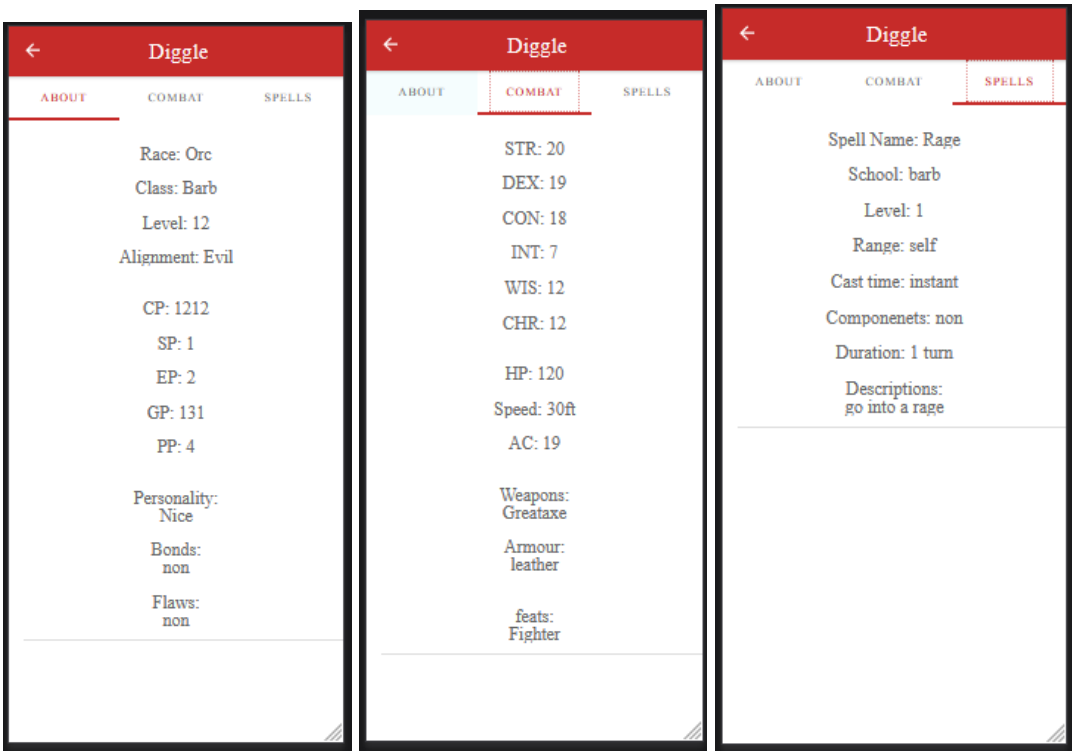
Character Creation Page:



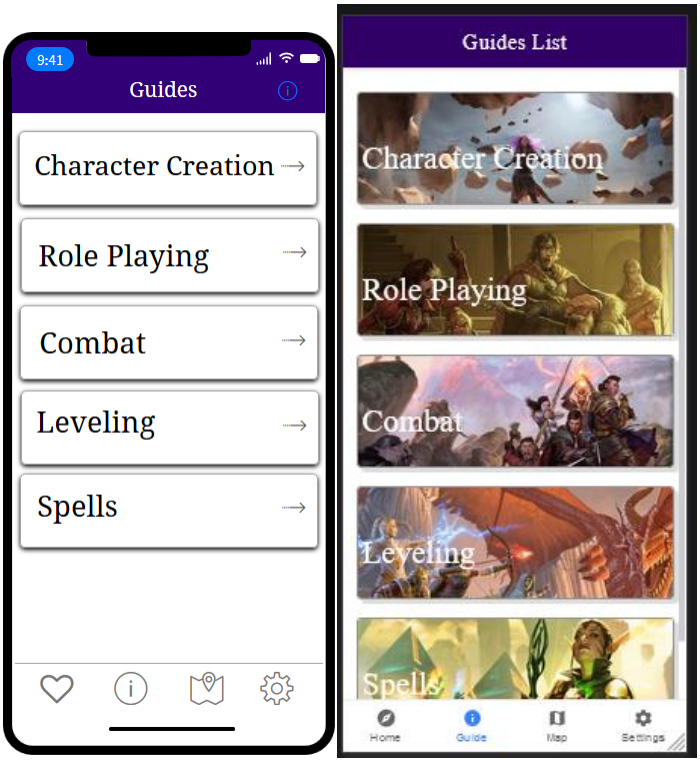


Character View Page:

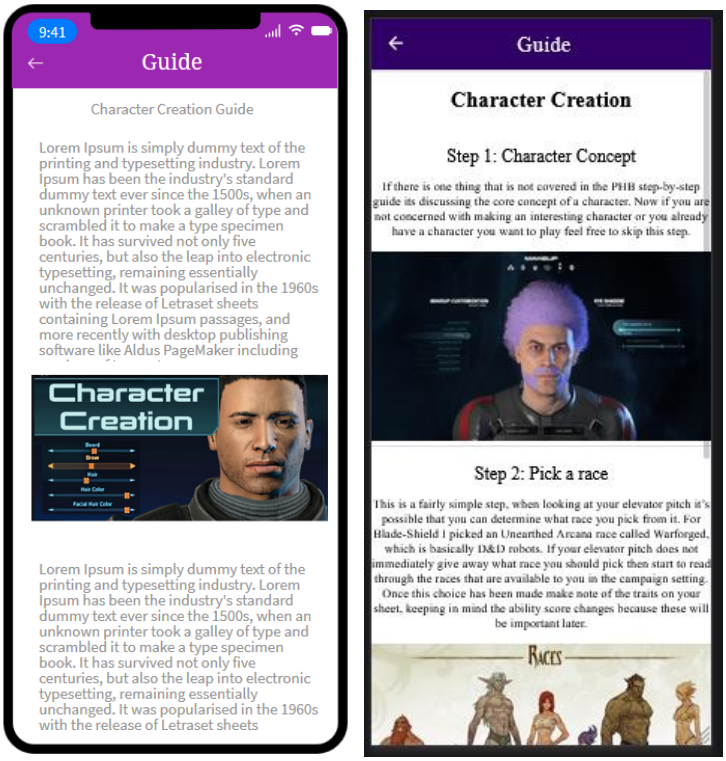




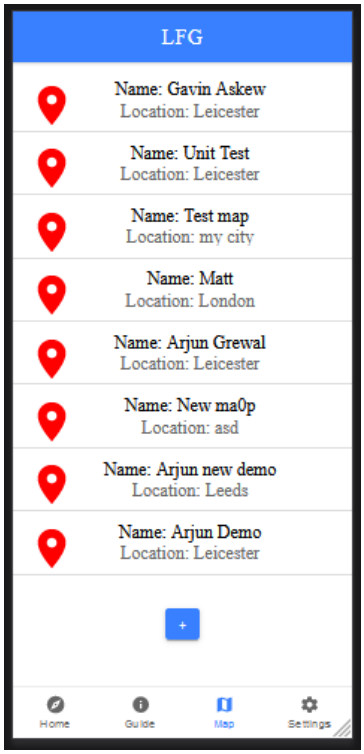
Guide List Page:



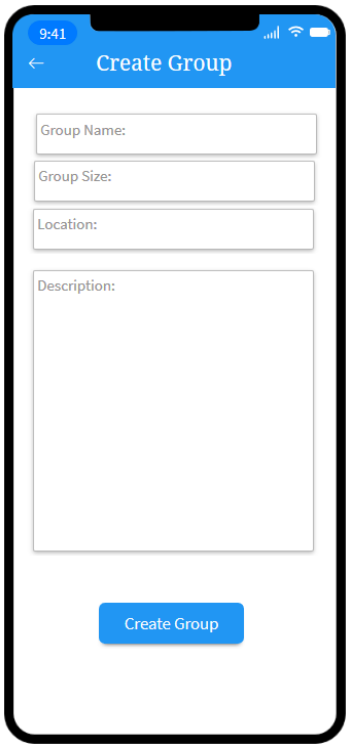
Guide Page:

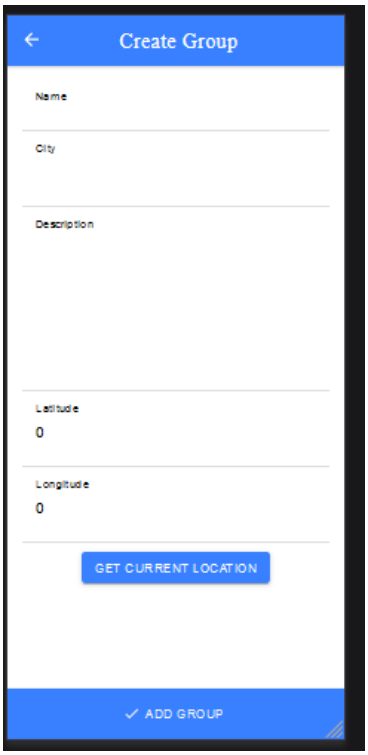


LFG Page:

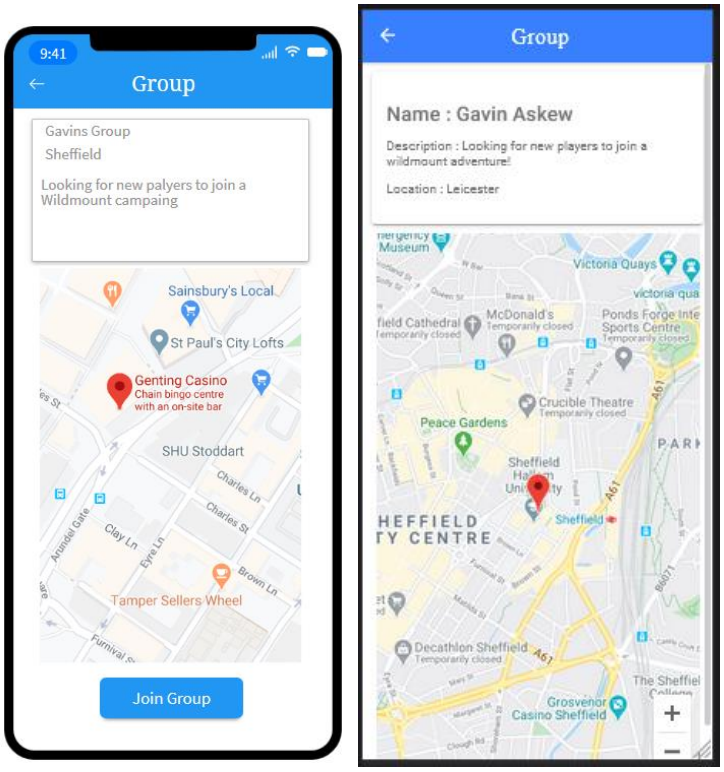


Create Group Page:

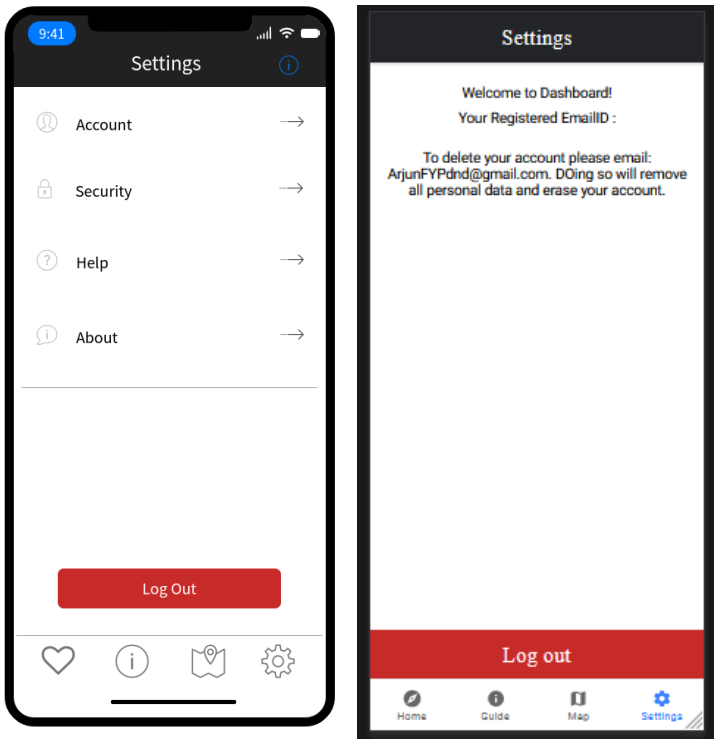




Group Page:



Settings Page:



9.4 Appendix E - SUS Consent Forms Forms

Please answer the questions below and then sign the form.

I agree to participating in this research project: (Yes/No)
(Please circle)

I agree to text quotations from me being included in publications and presentations anonymously:
(please circle) (Yes/No)

Name:	Muhammad Hamza Mahmood	**Contact number/email:**	07411170701
Signature:	Hamza	**Date:**	16/03/20
Researcher signature:	agreed	Date:	16/03/2020

Details of who to contact if you have any concerns or if adverse effects occur after the study are given below.

You should contact the Data Protection Officer if: · you have a query about how your data is used by the University · you would like to report a data security breach (e.g. if you think your personal data has been lost or disclosed inappropriately) · you would like to complain about how the University has used your personal data DPO@shu.ac.uk	**You should contact the Head of Research Ethics (Professor Ann Macaskill) if** · you have concerns with how the research was undertaken or how you were treated a.macaskill@shu.ac.uk
Postal address: Sheffield Hallam University, Howard Street, Sheffield S1 1WBT Telephone: 0114 225 5555	

SUS Usability Scale

Questions	Rating
I think that I would like to use this system frequently.	Disagree
I found the system unnecessarily complex.	Strongly Disagree
I thought the system was easy to use.	Strongly Agree
I think that I would need the support of a technical person to be able to use this system.	Strongly Disagree
I found the various functions in this system were well integrated.	Somewhat agree
I thought there was too much inconsistency in this system.	Strongly Disagree
I would imagine that most people would learn to use this system very quickly.	Strongly Agree
I found the system very cumbersome to use.	Disagree
I felt very confident using the system.	Agree
I needed to learn a lot of things before I could get going with this system.	Strongly Disagree

Please answer the questions below and then sign the form.

I agree to participating in this research project: (Yes/No)
(Please circle)

I agree to text quotations from me being included in publications and presentations anonymously:
(please circle) (Yes/No)

Name:	Asghar Mahmood	**Contact number/email:**	07849984977
Signature:		**Date:**	16/03/2020
Researcher signature:		Date:	16/03/2020

Details of who to contact if you have any concerns or if adverse effects occur after the study are given below.

You should contact the Data Protection Officer if:	**You should contact the Head of Research Ethics (Professor Ann Macaskill) if**
· you have a query about how your data is used by the University · you would like to report a data security breach (e.g. if you think your personal data has been lost or disclosed inappropriately) · you would like to complain about how the University has used your personal data DPO@shu.ac.uk	· you have concerns with how the research was undertaken or how you were treated a.macaskill@shu.ac.uk

SUS Usability Scale

Questions	**Rating**
I think that I would like to use this system frequently.	Agree
I found the system unnecessarily complex.	Strongly Disagree
I thought the system was easy to use.	Strongly Agree

I think that I would need the support of a technical person to be able to use this system.	Strongly Disagree
I found the various functions in this system were well integrated.	Somewhat agree
I thought there was too much inconsistency in this system.	Strongly Disagree
I would imagine that most people would learn to use this system very quickly.	Agree
I found the system very cumbersome to use.	StronglyDisagree
I felt very confident using the system.	Agree
I needed to learn a lot of things before I could get going with this system.	Strongly Disagree