

Dissertation

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Integer Factorisation App

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Acknowledgements

I would like to thank all those who have helped me in completing this project. In particular I would like to thank Janet Allison, my supervisor, who helped me throughout the project and was more than accommodating in allowing me to complete the project in a much shorter time frame than expected. Also I would like to thank Dr Adrian Moore who assisted and gave me advice and this has been very much appreciated. To my friends and family who have been very supportive over the last year and has helped me through some low points as well as celebrating the highs, I would like to thank you.

Abstract

Over the last few years technology has developed exponentially, and the current market focuses heavily on mobile application technologies. These applications range from mobile phone applications to tablet application as well as applications on other portable devices. Some of the main contributing factors to this expansion in the market include the ease of use, availability and flexibility of the devices among other factors.

Mobile technologies are becoming more important in everyday life; developers have created applications such as mobile banking apps which users find they are using on a daily basis. This can be summed up by Weiser in his paper 'Computing for the 21st Century' where he stated that "The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it." (Scientific American, 1991, pp. 66–75). With this taken into account there is an obvious market for developers to offer new products in the mobile application market.

The mobile application, 'Factoring 4 Adults', will include relevant learning material and user interaction intending to assist the user in developing their numeracy skills. The resources the developer will include in the application will be carefully selected and developed to ensure that the learning environment is suitable, achievable and challenging enough to allow for gradual development.

Through careful consideration of the current market and the learning experience of potential users the developer will be given a clearer understanding of the problem area and the solution. The developer has analysed and designed a number of concepts and various requirements to be included within the application, which in

turn has been translated through to solutions with a prototype having been created. The prototype has been evaluated and relevant recommendations will be made. The final product will be built based on requirements and experience from the prototype development.

Keywords: Mobile Application, Android, Content, Interactive.

1 Introduction

1.1 Introduction

It is well-known within education and industry that numeracy is a vital skill in order to have a skilled workforce and a successful economy. However it is well documented that the UK's adult population is lacking in numeracy skills. It has been stated by National Numeracy that "Nearly 17 million adults have numeracy skills roughly equivalent to those expected of children at primary school" (National Numeracy, 2011).

A large proportion of students within the UK fail to take up mathematics after GCSE level. The Royal Society suggests that "too many people in the UK are mathematically and scientifically illiterate" and this is due to "a persistent dearth of students taking up the subjects after GCSE" (Richard Vaughan, 2014).

The popularity of the smartphone has grown year on year and according to a recent report "Two thirds of people now own a smartphone, using it for nearly two hours every day" (Ofcom, 2015). Not only is there a heavy increase in the amount of smartphones but tablets are also increasing in popularity "Over half of UK households (54%) now have a tablet" (Ofcom, 2015). This establishes applications as a great medium in order to tackle the numeracy problem.

The application shall be free in order to be accessible to all of the population. The application will teach the user the basics of factorisation and prime numbers.

1.2 Problem Statement

The problem and solution can be summed up in the following problem statement:

“With increased globalisation and international competition, combined with the lack of numeracy skills within the UKs post GCSE population, there is a need for additional tools to secure the future of the UK population and its workforce with numeracy skills. A new simple to use application which users may access freely would be a fantastic tool for the young adults entering into the workforce”

1.3 Aims and Objectives

- Further discuss the current problem;
- Identify scope for success for a numeracy application for young adults;
- Identify and outline problems in existing solutions;
- Discuss and decide which operating system the application would be best run on
- Design and employ a simple design which can be operated by all users
- Test the finished application on a focus group to get reliable feedback on the functionality and layout of the application

1.4 Project Rationale

This project was undertaken for numerous reasons outlined below:

- The smartphone industry has experienced exponential growth in recent years. As a direct consequence of this, smartphones are more readily available for all ages.

- From the research carried out many adults lack numeracy skills of that expected, this application aims to change that. Tutorials, calculators and a quiz are intended to equip people with the knowledge needed.
- From investigation it seems that most apps are gradually becoming available to all platforms. Choosing Android as an application focuses on the likelihood that open source application development is the probable future in regards to cross platform compatibility.
- The project has resulted in the development of a prototype that has been launched.

1.5 Requirements for application development

- A laptop computer which can access and run the development suite and emulation package for android applications.
- Download Android Studio for computer to use in the building of the android application
- An android device to connect to the computer to run and test the application on throughout the implementation stage of this project.

1.6 Dissertation Outline

The dissertation is organised as detailed below:

- Chapter 2 – This chapter focuses on analysis of the problems and an investigation of current solutions on the market; the advantages and disadvantages of these solutions will be discussed. The pros and cons of various different developmental platforms for writing the application on will also be discussed. Analysis of the market research.

- Chapter 3 – looks at the system requirements of the application to provide a solution, this will include research in the form of a questionnaire.
- Chapter 4 – discusses the design and layout of the application, with regards to user interface and the key functionalities of the application.
- Chapter 5 – Analyse the implementation of the prototype, and technical issues which arose from the creation of the application.
- Chapter 6 – Discuss the type of testing which was employed, in terms of the applications functionality and the users' ease of navigation through the app.
- Chapter 7 – General overview of the project, discuss recommendations that have come from focus group.

2.0 Analysis

2.1 Introduction

This chapter will take a closer look at the research surrounding the numeracy application. There will be a more in depth look at the problem, the growth of the smartphone industry and existing solutions.

2.2 The Problem

2.2.1 Numeracy skills lacking in adult population

National Numeracy estimate that as many as “4 in 5 adults have a low level of numeracy, below the level of GCSE grade C”, (National Numeracy, 2011). There is a high cost attached to this problem of poor numeracy skills; Economists from the Audit Office have estimated that there is a cost of “£20.2 billion per year equating to 1.3% of the UK’s GDP” (National Numeracy, 2014). These costs are borne by individuals, employers and the government.

2.2.2 UK pupils not pursuing maths post GCSE

According to Andrew Halls (Head Master of Kings College Maths School) “about 85% of students in England, Wales and Northern Ireland give up maths altogether after GCSE” (Andrew Halls, 2015). This presents a problem in itself as in order to keep the basic skills taught to students at GCSE one must maintain practice and even pursue to improve their numeracy.

Along with those who give up maths after obtaining at least a C grade at GCSE level many of the population fail to gain a maths GCSE. According to research conducted by the UK government “Of 244,231 young people (37%) who failed to achieve a C in their GCSE by age 16 in 2010: 93% failed to achieve a grade C by the time they were 18 in 2012; and 83% did not even take maths GCSE in their post-16 education” (Department for Education and The Rt Hon David Laws, 2013).

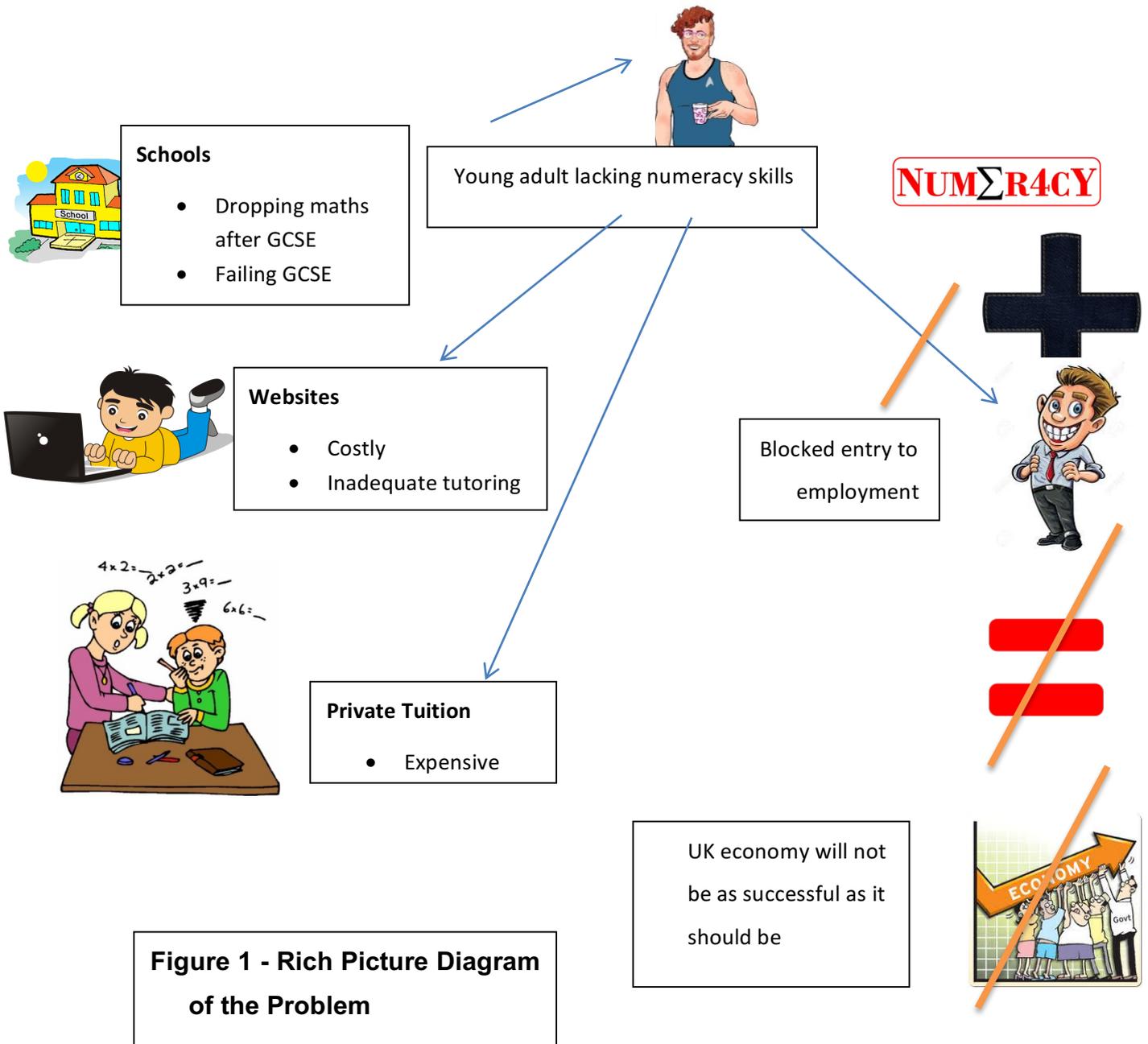
2.2.3 Existing solutions are not issue free

There are a range of courses available to those wishing to brush up on their mathematical skills in order to bring them to an adequate level. These can be provided by private/home tutors. However tuition comes at a heavy cost, tuition to GCSE level ranges from £17.75 - £26.00 per hour (Personal Tutors, 2015) and therefore is only available to those who are financially well off.

Other courses include GCSE foundation maths revision classes' which are run at technical colleges such as the Northern Regional College. However these classes still come at a cost and are dependent on the student being free to attend these classes as well as provide their own transport to and from the technical colleges.

Another solution available is mathematics tutoring websites providing adults with a well-developed and user-friendly environment to both learn basic numeracy and brush up existing numeracy skills. These environments provide the user with a good platform to learn and revise numeracy. Sadly not all of such websites offer the user with adequate tutoring and many are not free. City College offers online courses costing £34.00 per course (hotcourses.com, 2015). Even though this is significantly lower than private/home tuition these courses may be deemed as being too expensive.

On the following page a Rich Picture Diagram of the Problem can be seen.



The above rich picture diagram summarises graphically the problem and all the different stakeholders.

2.3 Proposed Solution

The proposed solution to the problem which has been presented and discussed in the previous section is a new Numeracy application which shall be free and easy to use for the user enhancing their numeracy skill set. The solution is based around the below points:

- Target Audience;
- Cost;
- Content;
- Smartphone popularity;
- Competitive analysis.

2.3.1 Targeted Audience

The target audience is simply young adults. The problem and solution to this lack of numeracy skills in the UK is firmly centred on young adults and their long term interest in the application is essential. The other three groups identified as targets are; teachers at school who can influence young adults to indulge in the use of the application, young unemployed adults whose job search may be affected by their lack of numeracy skills, and a government careers service who deal with young adults searching for work, who may lack in numeracy skills and therefore they can influence the young adults to use the application. All of these groups must be convinced of the content and potential positive impacts that the application will have.

2.3.2 Cost

As discussed earlier the application shall be free of charge in order to make it accessible to a larger majority of the UK's population than would be if the application was costing the user. This will therefore maximise the benefits of the solution and will

in turn better equip the young adults to enter the workforce and hence enhance the UK's economy.

2.3.3 Content

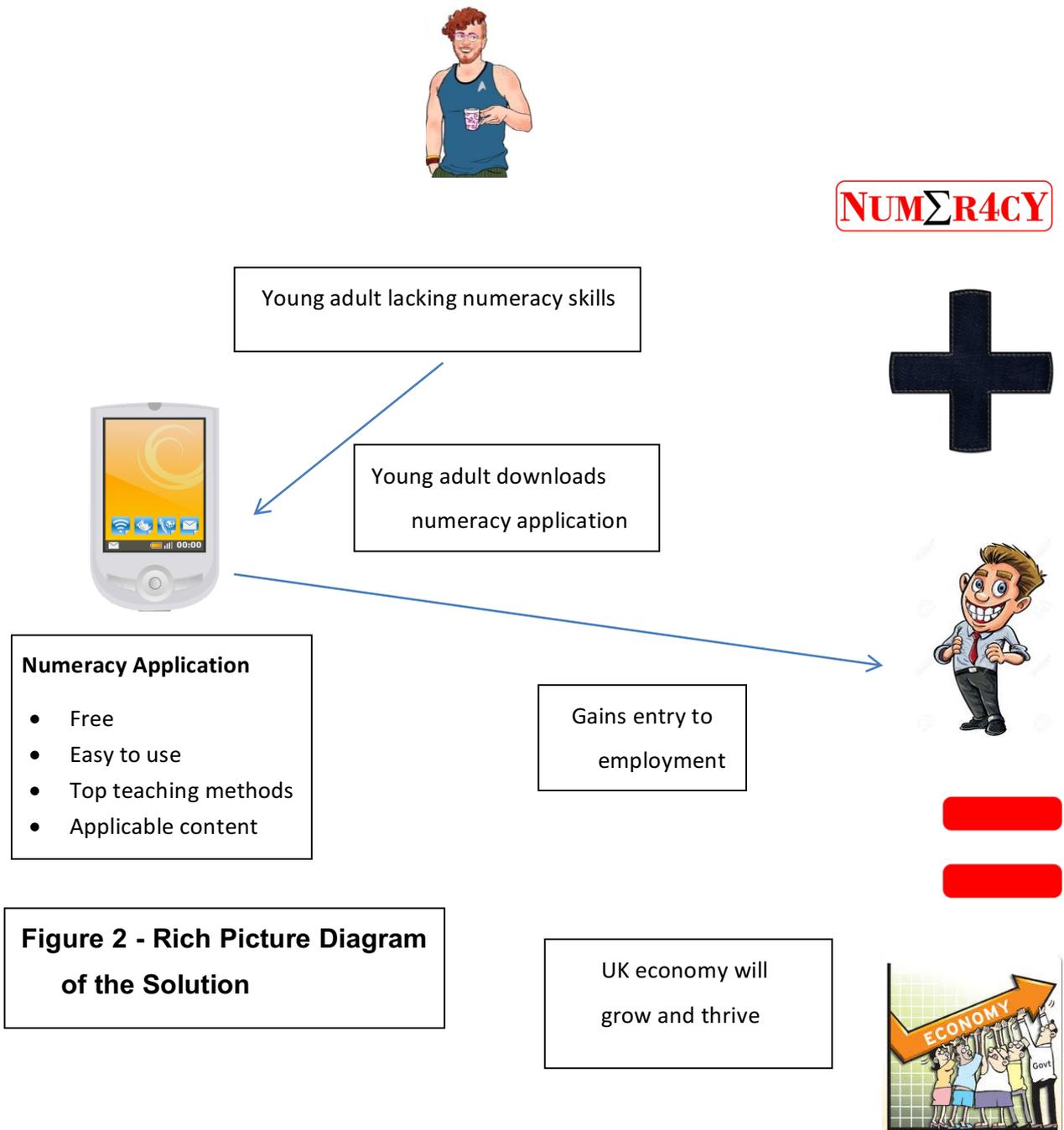
This application is an additional tool to help young adults raise their numeracy skills and in turn raise the numeracy skills of the future workforce in the UK in order for the UK's economy to compete on a global stage.

Recent reports have suggested that young adults lack the basic numeracy skills to fulfil even basic job functions in the workplace. Various bodies such as the Chartered Institute of Management Accountants have warned that there is a skills shortage which is "costing businesses and dragging down productivity" (Sarah Harris, 2015). It has been said that companies are taking months to fill junior roles as many young adults lack basic numeracy and literacy skills.

The solution shall mainly focus on teaching the user the below numeracy skills:

- Integer factorisation;
- Prime numbers;
- Lowest common multiples;
- Highest common factors.

On the following page is a Rich Picture Diagram to show the solution.



2.4 Smartphone Popularity

The market for smartphones has been growing vastly over the last number of years, in 2014; sales of smartphones to end users totalled 1.2 billion units. These figures look set to grow over 2015 and 2016. There is however a large selection of smart phone companies within the industry and therefore the manner in which the smartphone is built, that is the choice of operating system the phone operates on,

has a huge impact on its success. Outlined below are the two main operating systems on the market, Android and Apple iOS, along with an analysis of the strengths and weaknesses of each concluding with a decision on which operating system is most suitable to use.

2.4.1 Android

As an operating system android operates on an open sourced operating system, its own SDK and is free to run in any environment, essentially this means there are no proprietary constraints. Many people would prefer a free android SDK over other types due to its ease of availability.

Android is powered by JAVA language which is one of the mostly common and widely used coding languages used.

It has been forecasted that Android will continue to hold the dominant market share in the smartphone industry. In 2015 Android holds 81.1% of the market share (IDC, 2015).

However android is not without its drawbacks. As the android operating system is free and easily accessible there is less security which can lead to an increased amount of mobile applications that can be hijacked by advertisements and malware.

In addition to this android applications can often require Wi-Fi connectivity in order to run efficiently, if there is no Wi-Fi connection available the application may not run as it should. This will lead on to the problem of battery usage. As the application requires constant connectivity, there have been complaints of rapid battery usage.

Furthermore it can be said that the user interface does not run as smooth and efficient as Apple applications.

Android Advantages	Android Disadvantages
No proprietary constraints, functions on an open source Linux OS	Open sourced system, reduced security, increase chance of malware
Android is a free environment which means it can run on any computer environment	Constant Wi-Fi connectivity required to run applications efficiently.
Android runs off Java, most commonly used computer language in the world	Battery consumption a problem due to required connectivity to Wi-Fi
Android SDK is free	Because it is free, android applications more likely to be full of advertisements.
Android currently most popular smartphone in the world.	User interface criticised for not being as smooth and efficient as the Apple

Table 1

2.4.2 Apple iOS

iOS is a unified operating system, meaning that if the application can function on one Apple device it can run on all other apples devices. This is a big advantage over some other operating systems where the developer may be required to test the application for a range of platforms.

iOS is a closed system, meaning there is greater security with iOS. There are some examples where companies will ensure that their mobile applications are purely designed for iOS operating system only.

Through making their own hardware, apple devices run very smooth and efficiently. This contributes to the simple user interface design which is user friendly and smooth.

Another main advantage of iOS is that when compared to other operating systems stores iOS tends to give a far greater selection of applications when compared alongside other OS stores.

However Apple iOS is not without its drawbacks. Being a closed based system there is not the same freedom for developers to use the Apple SDK, as there is a cost attached.

Another problem is that Apple Mac computers only held a small fraction of the market share in the PC market (6%). It must be considered that in order to develop an iOS application an Apple PC must be used; this in turn means that 94% of the market share cannot develop an iOS application.

In addition to this Apple fails to provide users with any additional memory space than that which is provided at the outset of buying the device. Other operating systems often provide memory cards. The advantages and disadvantages are outlined in the table on the next page:

Apple iOS Advantages	Apple iOS Disadvantages
An application written on one apple device will operate on all apple devices.	SDK is not free, not the same freedom therefore for developers to use and build on.
Closed security means increased Security – Some companies have decided to only have their apps on the iOS	Apple iOS can only be written on Apple PCS, this eliminates 94% of PC market
Simple design that's smooth and sleek. User Interface very friendly.	Apple devices a lot more expensive than other devices.
The iOS application store more developed than any of the other application stores. Greater choice.	Apple offers no extra memory – Other mobile OS's offer an expandable memory card
By making their own hardware, apple phones run a lot more efficiently with their own specifically designed software	

Table 2

The application was developed using the android operating system. This is mainly down to the lack of proprietary constraints coupled with the free environment under which android operates giving the most freedom and the best conditions to develop the application.

2.5 Analysis & Market Research

Having discussed how this Numeracy application is a solution to the problem being presented it is necessary to analyse similar applications on the market. The review has taken into account three popular alternatives; Factor Calculator, Prime Factorization Calculator and Just Factorizer.

2.5.1 Factor Calculator

Factor calculator is a simple app which takes the number and gives all the factors it could produce. It is available on both Apple iOS and Google Android. It has over 40,000 android downloads with a rating of 3.9 out of 5.

Advantages	Disadvantages
Easy to use	Doesn't provide any demonstrations on how calculations work
Free to download	Doesn't provide user with formulas used
Clean and simple user interface	
Finds factors and prime numbers	
Large and small integers calculated	

Table 3

2.5.2 Prime Factorization Calculator

This application focuses on prime factorisation. It is able to calculate the prime factorisation of over 1 Quadrillion and over. It is a simple application available on both Apple iOS and Google android with 5,000 downloads on android with a rating of 4.4 out of 5.

Advantages	Disadvantages
Easy to use	Doesn't provide any demonstrations on how calculations work
Free to download	Doesn't provide user with formulas used
Finds prime factorisation	Unattractive user interface
Large and small integers calculated	Focuses totally on prime factorisation

Table 4

2.5.3 Just factorizer

Just Factorizer is a simple app which takes the number and gives all the factors it could produce. It is available on Google Android. It has over 4,000 android downloads with a rating 4.4 of out of 5.

Advantages	Disadvantages
Easy to use	Doesn't provide any demonstrations on how calculations work
Free to download	Doesn't provide user with formulas used
Finds factors	Unattractive user interface
Large and small integers calculated	Focuses totally on factors

Table 5

2.6 Chapter Summary

This chapter has provided the developer with a solid foundation of knowledge in order to know what is necessary in order to make the numeracy application a success. Taking into account all of the above the application will be developed using Android as the platform. It will offer a range of tutorials, examples and a quiz in order for the user to develop their numeracy skills.

3.0 Requirement Analysis

3.1 Introduction

This chapter will look at the requirements of the application. The developer will take into account all the research conducted in order to draw conclusions on what system requirements there will be for the application.

3.2 Questionnaire

In order to determine user system requirements a total of 15 questionnaires were distributed; 7 to post GCSE students, 4 to A-Level teachers, 2 to young unemployed adults and 2 to employees of a government careers service.

The young post GCSE students were the main focus of the research as these are the most likely to use the application. They are also the group of the population whom are aware of career options and the importance of numeracy in career search.

A-Level Teachers are a very important element of the research as they have professional experience and have most contact with young adults in an educational environment. Teachers would have worked with young adults with dyslexia and other disorders that could affect their accessibility to the application content and therefore their feedback was deemed essential in this research.

Of 15 copies distributed, 11 were successfully completed totalling over a 73% response rate, providing adequate feedback to investigate further for the purposes intended.

In addition to this 91% have agreed to test the first version of the application when available.

The results from the questionnaire were tabulated in an Excel spreadsheet in order to determine the website features and requirements as specified.

The findings are presented below:

Questionnaire Results

Question 1

Please indicate whether you are a student, teacher, unemployed or work for careers service:

Teacher	27%
Careers service	9%
Post GCSE Student	55%
Unemployed	9%

Question 2

a) Please indicate which of the following numeracy applications you are aware of?

b) Please indicate which of the following numeracy applications you have used and which you would recommend?

	Aware of	Have Used	Recommend
Factor Calculator	45%	27%	9%
Prime Factorization Calculator	27%	9%	0%
Calculator ++	55%	36%	18%

Question 3

Please indicate the extent to which you agree or disagree with the following statements:

	Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree	Don't know
Young adults would benefit from using a numeracy app	18%	64%	0%	9%	0%	9%

Question 4

Please rate the suitability of the following names for a numeracy application by choosing from "very suitable"

	Very Suitable	Quite Suitable	Neither	Not very suitable	Not at all suitable	Don't Know
Numeracy Fun	0%	9%	9%	82%	0%	0%
Factoring 4 Adults	82%	18%	0%	0%	0%	0%
Numeracy Cracker	0%	18%	27%	27%	9%	18%
Adult Numeracy	18%	0%	82%	0%	0%	0%
Numeracy 4 Adults	27%	27%	0%	45%	0%	0%

Question 5

Please rate the importance of the following content for a Numeracy application by choosing from “very important” to “not at all important”:

	Very Important	Quite Important	Neither	Not very Important	Not at all Important	Don't Know
Tutorials	73%	9%	0%	0%	0%	18%
Practice Questions	82%	9%	9%	0%	0%	0%
User Input	82%	18%	0%	0%	0%	0%

Question 6

Please rate the suitability for a numeracy application to cover the following requirements by choosing from “very suitable” to “not at all suitable”:

	Very Suitable	Quite suitable	Neither	Not very suitable	Not at all suitable	Don't know
Integer Factorisation	100%	0%	0%	0%	0%	0%
Lowest common multiple & Highest common factors	91%	9%	0%	0%	0%	0%
Prime numbers	100%	0%	0%	0%	0%	0%

Question 7

Please rate the suitability of the following features for a numeracy application by choosing from “very suitable” to “not at all suitable”:

	Very Suitable	Quite suitable	Neither	Not very suitable	Not at all suitable	Don't know
Time limit for practice q's	9%	45%	36%	9%	0%	0%
Application designer and maintenance contact	0%	0%	9%	73%	0%	18%
Audio assistance during tutorials	27%	45%	18%	9%		
User score in practice q's	36%	55%	0%	9%	0%	0%

Question 8

Please indicate if you would be willing to test the application once available?

Yes	91%
No	9%

3.3 User Stories

The results from the questionnaires have cumulated in the following application features and requirements presented below as user stories:

As a user I want Maths tips to help me become more comfortable with Maths.

As a User I would like Tutorials in each given topic in order to help me get better in Maths.

As a visually impaired user I would like an audio button to press so I can listen to the tutorial.

As a user I would like the application to be user friendly and easy to navigate in order to create an environment easy to learn within.

As a teacher I would like practice questions in order to gage a student's level of competence with the topic at hand.

As a user I would like the practice questions to have a timer in order to see how I handle the topic whilst under pressure.

As a developer I want users to be able to contact me with feedback and/or comments they may have, along with any problems encountered.

As a dyslexic user I would like the application's font to be user friendly and easy to read in to allow me to use the application too.

As a careers advisor I would like the application to offer advice to the user on the importance of maths to gain employment.

As an unemployed user I would like the application to be free so that it is accessible to me.

3.4 Chapter Summary

This chapter has provided the developer through the use of a questionnaire cumulating in user stories with a good grasp of what system requirements there are in order for this application to be a success. The application will include audio assisted tutorials, timed quiz and calculators in order to satisfy the system requirements.

4.0 Design

4.1 Introduction

This chapter will look at the design phase of the application. Problems and requirements which were identified in the background research will be brought together so that the developer can come up with a relevant solution. Firstly we will look at the style of development which was employed then we will look at the inner workings of the chosen mobile platform along with initial designs of how the final application may look will be included. In addition to this user navigation and professional issues will be a feature within this chapter.

4.2 Agile Development

Throughout the production of this project an agile development approach was employed. This safeguarded that the application was developed in an organised and specific manner, leading to a high standard project.

Agile development is founded on the idea of incremental and iterative development, revisiting each phase of development over and over improving the quality of the software through regular feedback from the users.

The main principle of agile development is dividing the development cycle up into small parts. Each part is passed through the cycle, completing each individual task bit by bit, allowing the software to be developed in an efficient manner.

The principles of the agile approach were employed during this project to ensure all deadlines are met. Below shows a cycle in an agile approach:

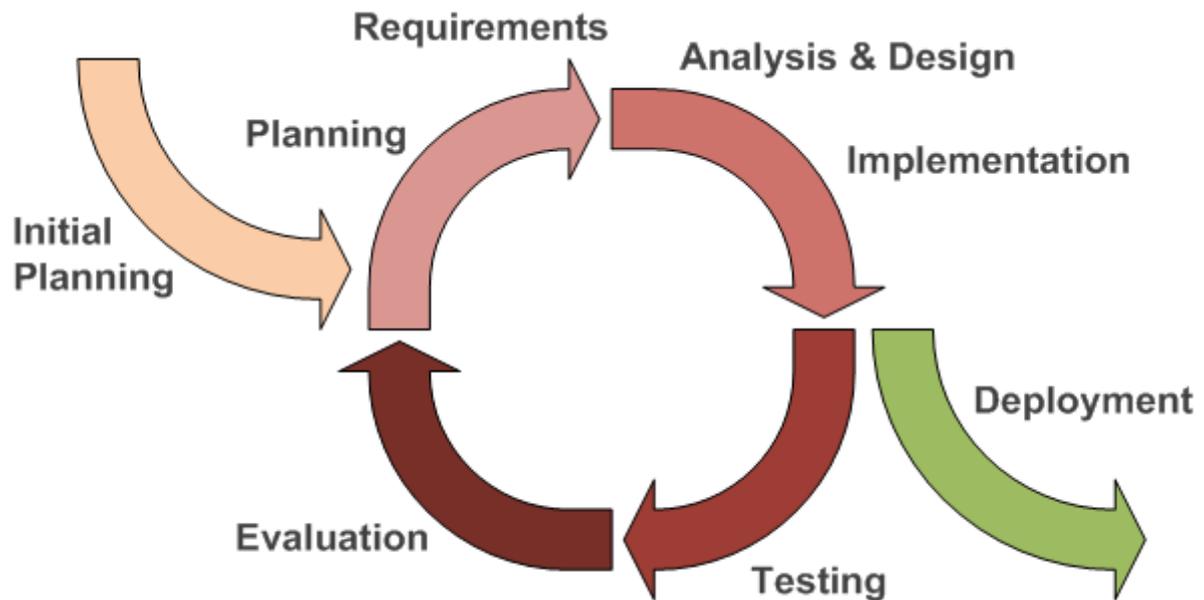


Figure 3

4.3 Chosen Platform

A key area which the developer explored was the architecture of the application. The developer chose an Android Operating system over other systems such as IOS and Intel XDK. It is important that each individual sequence was available within the numeracy application to ensure that the users' device is used efficiently and effectively.

The android operating system is often referred to as a stack of software components which is divided into five layers. The below diagram illustrates the android operating system.

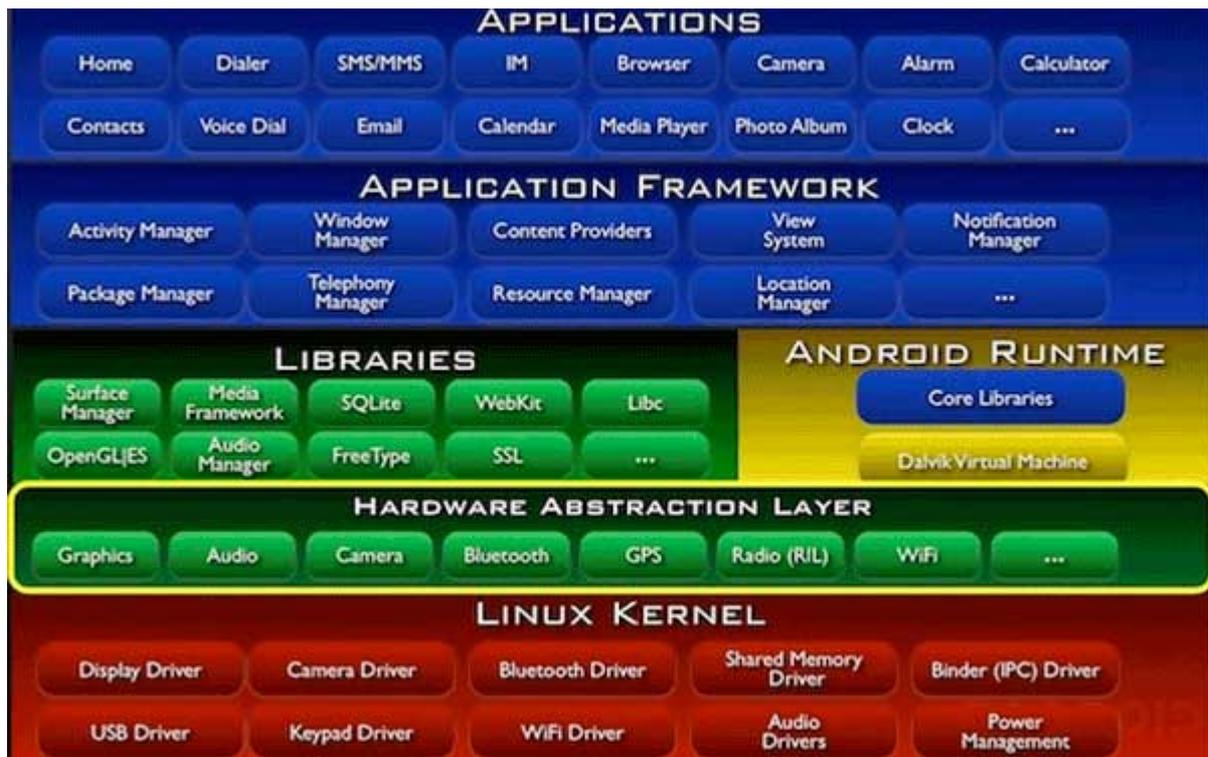


Figure 4

The bottom layer is known as the Linux Kernel containing all the essential drivers such as keypad driver and power management.

The next layer is the hardware abstraction layer; this layer provides a level of abstraction between the device hardware. The hardware abstraction layer contains hardware such as the camera, Bluetooth and essential for this application the keypad.

On the third layer up there we find the libraries and runtime on the same level. The library layer contains a set of libraries such as SQLite database as well as various other libraries such as the audio manager. The runtime contains elements such as core libraries and the dalvik virtual machine which is like a Java virtual machine specially designed and optimised for Android.

On the fourth and penultimate layer is a provider of higher-level services to applications. This is done through the form of Java classes which the developer made use of.

And finally on the top layer is the applications layer, this is where the developer wrote their application and the application was installed on this layer. This is the level in which the developer will interact with.

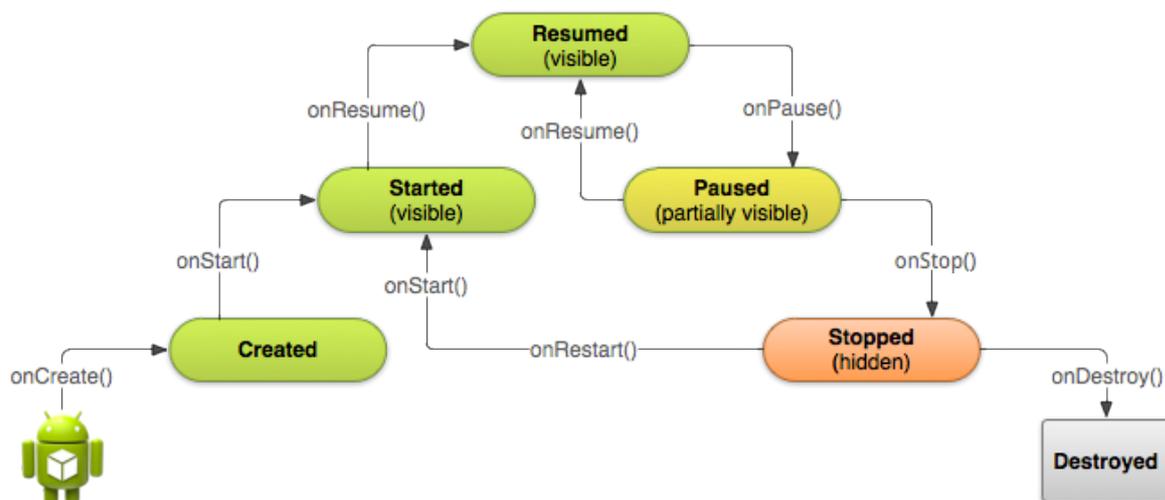


Figure 5

Throughout the life of the application the android system calls on methods in a set order, similar to a step pyramid where each different stage of the activity is a different step. At the peak of this step pyramid is the stage where the activity is active and the user interacts with the application. As the user leaves the peak other calls are being processed and resulting in the activity state of the application being dismantled as it moves down through the step pyramid. Throughout the process there is the pause to wait whilst the user may be interrupted by a phone call or moving onto another application. At any one point in the cycle the activity can always make its way back to the user via moving the pyramid and resume where it had left off.

4.4 Build your UI to be fast, responsive and simplistic

However powerful mobile android devices are today in comparison to PCs the processor power is weak meaning the developer must create an application which is efficient utilising the power available to it. Users need the application to be fast and

responsive and as mobile devices are used in many different environments, including those without a strong network connection, the user needs the application to be clean and simple.

4.5 Understand touch mode and use consistent design

Android devices operate using touch screen and therefore during the development process the developer must make sure buttons and widgets provided by Android SDK are large and clear enough to be pressed by a finger or thumb. In addition to this, the size of each button is very important to ensure the likelihood of pressing two buttons at once instead of one is minimised.

4.6 Structure your application to be efficient

It is essential that the developer structures the UI in such a manner that the user is allowed to achieve the targets of the application.

4.7 User Interface Design (UID)

The user interface (UI) and logo combined with various other visual features heavily influences the way the public and potential users perceive the application. The ultimate aim of User Interface Design is to establish a professional and appealing looking product which is accessible to the targeted audience.

4.8 Application Proposals

The aim of the application is to provide functions which have been identified to the developer through initial research. The user should be able to do the following:

- Select which topic they would like to study;
- Select tutorials on the topic;
- Select an audio button for tutorials;
- Enter numbers for application to perform calculations;
- Complete a quiz testing their knowledge

The user interface of this application is of very high importance when considering the usability, attractiveness and marketability of the application. The user interface was designed in such a manner that even a user who is not technical can easily navigate their way through the application. It is also vital that a simplistic consistent user interface is employed so that there is not an information overload, as this may have a very negative effect on the users' experience.

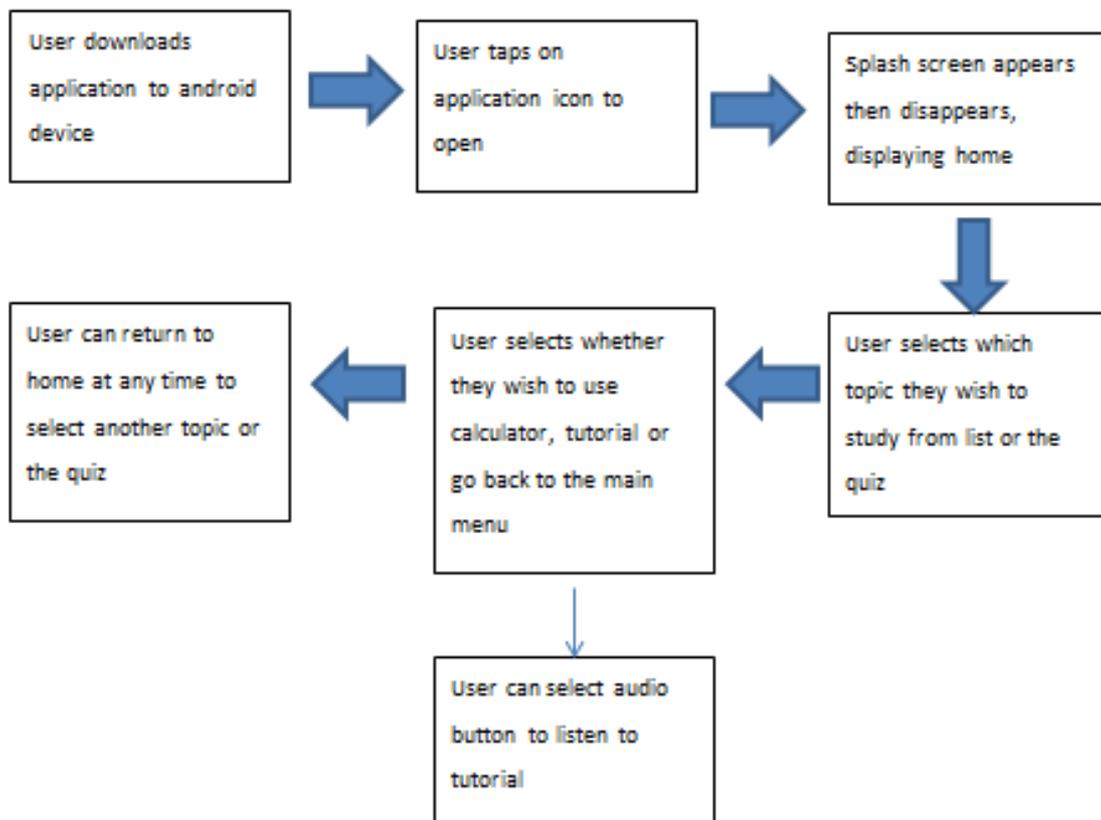


Figure 6

The layout of the home screen is illustrated in the above image. This design highlighted a number of important features. In particular the colour scheme which will be kept consistent throughout the content of the application. Careful consideration of the colour scheme was of high priority. Through the use of contrasting colours the developer is designing a user interface which is fresh, crisp and bold. These

attributes are attractive in regards to an end user. They also allow for easier use for users who suffer from slight visual disabilities and those with dyslexia.

4.9 Storyboard



4.10 Application Layout

Firstly upon opening the application, a splash screen will load up, grabbing the attention of the user and informing the user the application is loading.

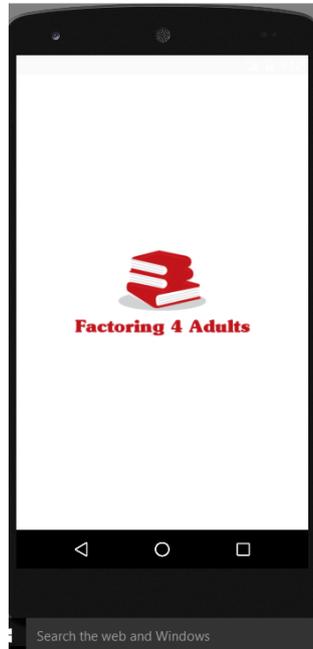


Figure 7

Once opened the user will be met with a menu giving them the options of selecting which topic they wish to study or if they wish to test their knowledge with the quiz.



Figure 8

Once the user selects which topic they wish to study it will bring them to another menu with the options of a tutorial assisted with audio and examples, the calculator or an option to return to the main menu.

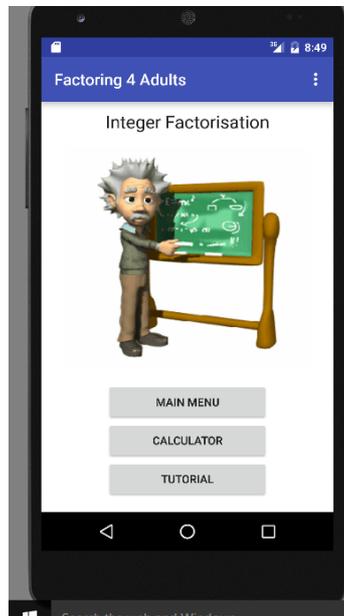


Figure 9

On selecting the tutorial, the user will have a learning experience which is targeted to GCSE level. The user will be able to avail of the worked examples in order to visualise and enhance understanding of the topic.

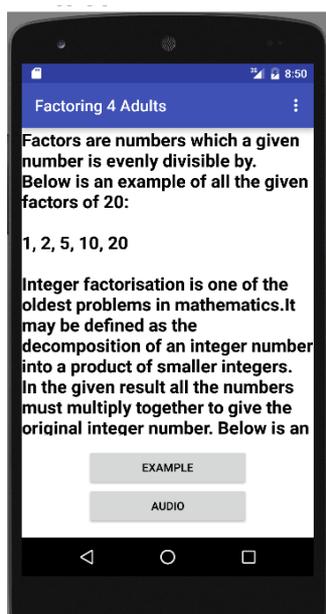


Figure 10

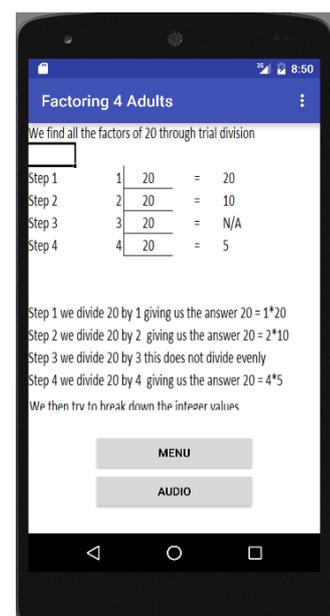


Figure 11

The user may also avail of the calculator feature in the application. Within this element the user can quickly enter a number and the application calculates the answer.

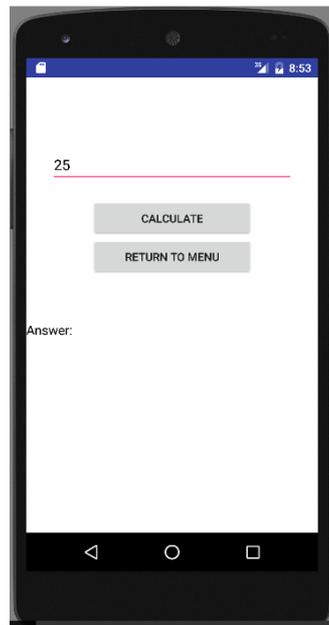


Figure 12

The final option for the user is the quiz; this is designed to test the users knowledge of all the topics studied. There are ten questions with a time constraint in order to put a little pressure on the user. Once the user completes the quiz a final score and a piece of advice is offered to the user.

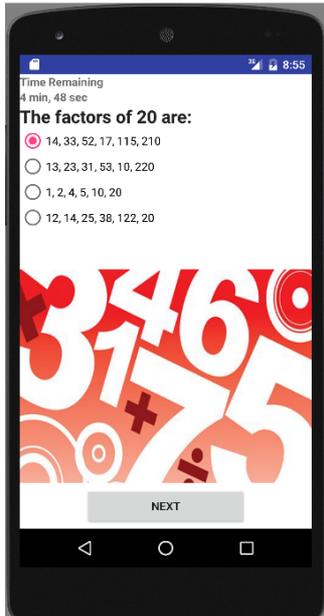


Figure 13



Figure 14

4.11 Professional Issues

4.11.1 Business Case

This application has not been conceived with the intentions that it will be a commercial application with the aim of making financial gains for the developer. It is not forecasted that any financial gain will be generated by any means such as advertisement.

The application is a free to use application with the objective of raising the numeracy skills of young adults in the UK to allow for entrance into the workforce and therefore raising the numeracy skills of the population to allow the UK to compete on a global stage. There were 8,061,975 aged between 15 and 24 in 2015 (Index Mundi, 2014). This highlights that there is significant number of potential users in the UK.

Having a low numeracy skill set has many negative effects such as lack of self-esteem, unemployment, failure to manage money efficiently, poorer health and

higher crime rate. The overall aim of this application is to elevate the numeracy skill set of the UK's population.

It is very difficult to quantify the benefits of such an application in monetary terms. However the UK will benefit from lower unemployment, crime and health costs and as earlier stated poor numeracy skills is currently costing the UK "£20.2 billion per year equating to 1.3% of the UK's GDP" (National Numeracy, 2014).

The cost of delivering a successful Numeracy application includes the following:

- Based on a minimum wage of £6.70 p/hour and development duration of 600 hours, the total labour cost for developing the website is anticipated to be £4,020.

4.11.2 Project Risks

Management Risks				
Risk	Probability	Loss	Threat	Contingency Plan
Time management	3	4	12	Plan project with a realistic schedule
Sickness	2	4	8	Have planned schedule with buffer to hand in date

Table 6

Technical Risks				
Risk	Probability	Loss	Threat	Contingency Plan
Data loss	2	5	10	Ensure adequate data backups
Software Malfunction	2.5	5	12.5	Do not rush coding, and make sure program is efficient. Test code regularly.
Incomplete Code for Android App	2.5	5	12.5	Have planned schedule with buffer to hand in date. Test code to detect mistakes
Hardware issues	2	4	8	Ensure all devices are updated regularly

Table 7

4.11.3 Ethical Considerations

This project has been classified as category Z by the University Ethics Committee.

This project is not invasive towards users and will not involve children.

5.0 Implementation

5.1 Introduction

Throughout this chapter the focus will be on how the objectives which were identified in the research section of this project were put together. The problems which the developer encountered in the application development will also be discussed along with potential future potential lines of development for the application.

5.2 Gym Application Environment

This numeracy application was designed and created by the developer using Android Studio. Through using this platform the developer was enabled to create an android application which can be used on any android device on the market. The laptop which the developer used was a HP Pavilion. Throughout the development of the application there was regular testing using the emulator and the application was continuously evolving so that it would create what the developer felt would create the most user friendly app.

5.3 Splash Screen

Firstly upon opening the application, a splash screen will load up, grabbing the attention of the user and informing the user the application is loading. This splash screen was designed and implemented using two different files; the splash_screen.xml and SplashScreen.java files.

The SplashScreen.java contains the java code which runs and controls the splash screen. This is done through using a thread 'Timer', included in this thread is a run method. This 'run' method will start a new intent called 'mainActivity'. Within the android manifest the developer calls this intent ensuring that once the timer on the

splash screen runs the main menu of the application opens. The screenshot below shows the code contained in SplashScreen.java file.

```
public class SplashScreen extends Activity {  
  
    @Override  
    //relating back to layout  
    protected void onCreate(Bundle savedInstanceState){  
        super.onCreate(savedInstanceState);  
        setContentView(R.layout.splash_screen);  
  
        Thread startTimer = run() -> {  
            try{  
                sleep(5000);  
                Intent i = new Intent(SplashScreen.this, MainActivity.class);  
                startActivity(i);  
                finish();  
            }//try  
            catch(InterruptedException e) {  
                e.printStackTrace();  
            }//catch  
        };//thread timer  
        startTimer.start();  
    }//method  
}  
//class
```

Figure 15

The splash screen is instructed to sleep for 5 seconds. In effect this puts the thread on pause for 5 seconds, holding the image below on screen. Once the timer has reached 5 seconds the Main activity will open the main menu screen. The design of the splash screen is held within the splash_Screen.xml which is shown below:

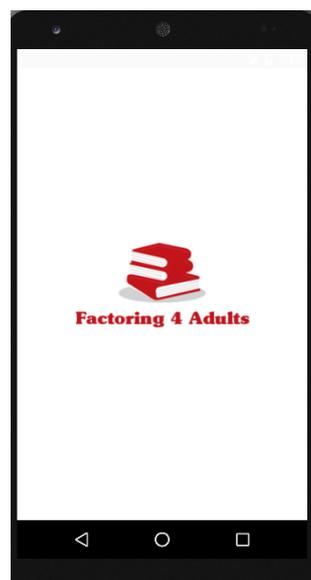


Figure 16

5.4 Main Menu

Once opened the user will be met with a menu giving them the options of selecting which topic they wish to study or if they wish to test their knowledge with the quiz. When designing the main menu it was of utmost importance to the developer that menu was kept to a simple basic layout, which in turn lends to the theme of easy user navigation. The figure below shows the layout of the main menu; comprising of the logo and five buttons (the four topic areas and the quiz).



Figure 17

Below is a snippet of the code from MainActivity java file containing the java code for the main page:

```
public class MainActivity extends AppCompatActivity {  
  
    //relating back to layout  
    protected void onCreate(Bundle savedInstanceState) {  
        super.onCreate(savedInstanceState);  
        setContentView(R.layout.activity_main);  
  
        //assigning buttons to categories  
        Button IntegerFactorisation = (Button) findViewById(R.id.IF);  
  
        IntegerFactorisation.setOnClickListener((v) -> {  
            startActivity(new Intent(MainActivity.this, IntegerFactorisationMenu.class));  
        }); //onClickListener  
  
        Button PrimeFactorisation = (Button) findViewById(R.id.PF);  
        PrimeFactorisation.setOnClickListener((v) -> {  
            startActivity(new Intent(MainActivity.this, PrimeFactorisationMenu.class));  
        }); //onClickListener  
    }  
}
```

Figure 18

Buttons are designed and created in the content_main.xml file (figure 17). Each of the buttons are given an individual id which corresponds to specific code within the MainActivity.java file. The developer implemented the setOnClickListener allowing the buttons to be receptive when clicked leading to the next page within the application.

```
<Button
    style="?android:attr/buttonStyleSmall"
    android:layout_width="wrap_content"
    android:layout_height="wrap_content"
    android:text="Integer Factorisation"
    android:id="@+id/IF"
    android:layout_gravity="center_horizontal"
    android:layout_below="@+id/logo"
    android:layout_alignParentLeft="true"
    android:layout_alignParentStart="true"
    android:layout_alignParentRight="true"
    android:layout_alignParentEnd="true"
    android:onClick="buttonOnClick" />

<Button
    style="?android:attr/buttonStyleSmall"
    android:layout_width="wrap_content"
    android:layout_height="wrap_content"
```

Figure 19

5.5 Sub Menus

Once the user selects which topic they wish to study it will bring them to another menu with the options of a tutorial assisted with audio and examples, the calculator or an option to return to the main menu.

This screen takes the form of being of similar layout to the main menu in order to keep a semblance of the consistency throughout the application, helping with user navigation.



Figure 20

5.5 Tutorial/Example

On selecting the tutorial, the user will have a learning experience which is targeted to GCSE level. The user will be able to avail of the worked examples in order to visualise and enhance understanding of the topic.

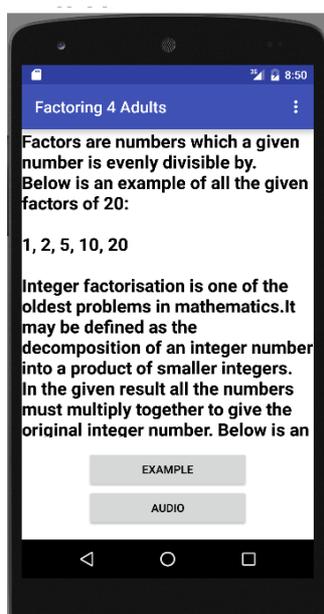


Figure 21

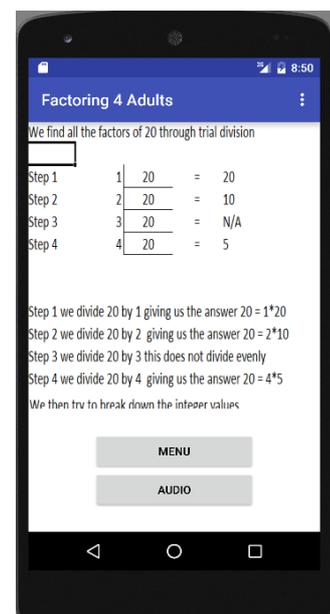


Figure 22

The user may work through the tutorial and the example along with audio assistance. Below is the java code for the audio assistance. The audio file is an mp3 file which was created by the developer and is stored in the raw folder within the application.

```
Button nextButton;  
private MediaPlayer mediaPlayer;  
  
@Override  
protected void onCreate(Bundle savedInstanceState) {  
    super.onCreate(savedInstanceState);  
    setContentView(R.layout.integer_factorisation_tutorial);  
  
    nextButton = (Button) findViewById(R.id.Nextbutton1);  
    mediaPlayer = MediaPlayer.create(this, R.raw.integer_tutorial);  
}
```

Figure 23

5.5 Calculator

The user may also avail of the calculator feature in the application. Within this element the user can quickly enter a number/numbers and the application calculates the answer. Below are two figures showing the calculator screens:



Figure 24

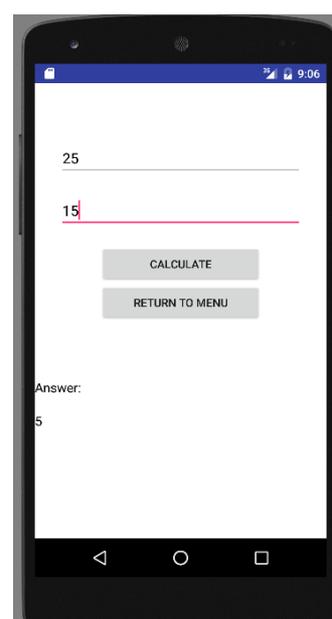


Figure 25

There will be two buttons on the screen; one to calculate and the other to return to the menu. The screen will also need to be scrollable in order to allow for all of the answers to be displayed for the Integer Factorisation calculator. Below is a snippet from the iml to allow for the scrollable view:

```

<ScrollView
    android:id="@+id/scroll_data"
    android:layout_width="fill_parent"
    android:layout_height="0dp"
    android:layout_marginTop="10dp"
    android:layout_weight="1" >

    <LinearLayout
        android:id="@+id/lnlayout"
        android:layout_width="fill_parent"
        android:layout_height="wrap_content"
        android:orientation="vertical" >
    </LinearLayout>

</ScrollView>
</LinearLayout>

```

Figure 26

5.5.1 Integer Factorisation Calculator

This calculation involves inputting one number and the java code in IntegerFactorisation.java will calculate the answer. Below in figures 27 and 28 shows the java code which is the main embodiment of the calculation. This comprises of for loops and if statements, this part of the application was the most time consuming for the developer.

```

public int find_fact(int sub_number, int p_min)
{
    int i = 2, j=0, sub_min = sub_number;
    for(i=2;i<sub_number;i++)
    {
        if(sub_number%i == 0 && i <= sub_number/i)
        {
            String str = "";
            for(j=0;j<count;j++)
            {
                if(factor[j] != 1)
                {
                    str = str+factor[j] + "*";
                    System.out.print(+factor[j] + "*");
                }
            }
            System.out.println(i+"*"+(sub_number/i)+"="+number);
            row(str+i+"*"+(sub_number/i)+"="+number);
            if(i<sub_min)
                sub_min = i;
        }
    }
}

```

Figure 27

```

if(sub_number % 4 == 0)
{
    for(i=3;i<sub_number/4;i++)
    {
        String str = "";
        if(sub_number%(4*i) == 0 && i <= sub_number/(4*i))
        {
            for(j=0;j<count;j++)
            {
                if(factor[j] != 1)
                {
                    str = str+factor[j] + "**";
                    System.out.print(+factor[j] + "**");
                }
            }
            System.out.println("4**i"+"*(sub_number/(4*i))"+"=number");
            row(str+"4**i"+"*(sub_number/(4*i))"+"=number");
        }
    }
}
return sub_min;
}

```

Figure 28

5.5.2 Prime Factorisation Calculator

This calculation involves inputting one number and the java code in PrimeFactorisation.java will calculate the answer. The java code which is the main embodiment of the calculation is the same as with the Integer Factorisation shown in figure 27 and 28; only in this calculation the display only shows the last line when the number is fully factorised and the result only comprises of prime numbers.

5.5.2 Highest Common Factor Calculator

This calculation involves inputting two numbers and the java code in HighestCommonFactor.java will calculate the answer. The java code which is the main embodiment of the calculation is known as Euclid's Algorithm shown in figure 29.

```

private long hcf(long a, long b) {
    while (b > 0) {
        long temp = b;
        b = a % b;
        a = temp;
    }
    return a;
}

```

Figure 29

5.5.2 Lowest Common Multiple Calculator

The last calculator is the lowest common multiple. The developer used a for loop with an if statement in order to work this answer out (shown in figure 28).

```
private long lcm(long number1, long number2) {  
    long lcm = 0;  
    for (int i = 1; ((long) i) <= number2; i++) {  
        lcm = number1 * ((long) i);  
        if (lcm % number2 == 0) {  
            break;  
        }  
    }  
    return lcm;  
}
```

Figure 30

5.6 Quiz

The final option for the user is the quiz; this is designed to test the users knowledge of all the topics studied. There are ten questions with a time constraint in order to put a little pressure on the user. Once the user completes the quiz a final score and a piece of advice is offered to the user.



Figure 31

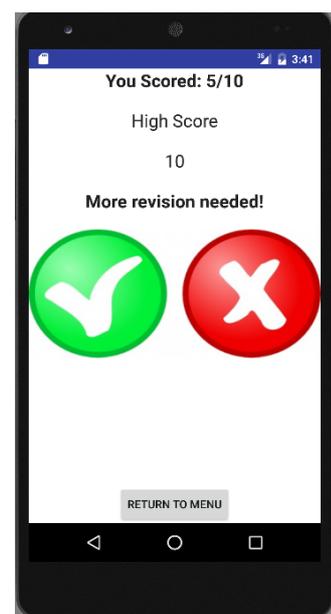


Figure 32

The QuizQuestions.java file consists of string arrays which hold the questions, answers and options. The application will randomly select a question and the relevant answer along with a selection of other random options. The user must select an answer and hit the next button and the next question will be generated. Below is a snippet of the java code.

```
public static int marks, correct, wrong;

// Strings showing questions, correct answers and all possible options
String questions[] = {"The factors of 20 are:",
    "The factors of 36 are:",
    "Prime factorisation of 40 is:?",
    "Prime factorisation of 100 is:",
    "Lowest Common Multiple of 12 and 15:",
    "Highest Common Factor of 12 and 15:",
    "Highest Common Factor of 90 and 50:",
    "Lowest Common Multiple of 8 and 22:",
    "Prime factorisation of 56:",
    "The factors of 56 are:"};

ArrayList<String> questionList = new ArrayList(Arrays.asList(questions));

String answers[] = {"1, 2, 4, 5, 10, 20",
    "1, 2, 3, 4, 6, 9, 12, 18, 36",
    "2*2*2*5 "};
```

Figure 33

A snippet from the QuizResults.java can be seen below. This shows how the message is selected to be shown to the user at the end of the quiz.

```
//if statements to comment on users score
if (QuizQuestions.correct > 8) {
    StringBuffer scoretext = new StringBuffer();
    scoretext.append("Superb!");
    scoreOptions.setText(scoretext);
} else {
    if ((QuizQuestions.correct > 7) && (QuizQuestions.correct < 9)) {

        StringBuffer scoretext = new StringBuffer();
        scoretext.append("Good Result!");
        scoreOptions.setText(scoretext);

    } //if

    else {
        if ((QuizQuestions.correct > 3) && (QuizQuestions.correct <= 7)) {

            StringBuffer scoretext = new StringBuffer();
            scoretext.append("More revision needed!");
            scoreOptions.setText(scoretext);

        }
    }
}
```

Figure 34

5.7 Chapter Summary

This chapter outlines to the reader what all has been implemented by the developer and a short explanation along with snippets of code of how this has been implemented. The application will includes audio assisted tutorials, timed quiz and calculators in order to satisfy the system requirements.

6.0 Testing and Evaluation

6.1 Introduction

The following chapter will look into the steps of testing the application implemented in the previous chapter. There will be a series of different software testing techniques employed in order to ensure all the different aspects of the application performs as expected.

Throughout the implementation of this application the developer has been continuously testing the application. So that this process has been efficient, time has been managed, allowing for suggestions along with many changes to be made throughout the development.

This continuous testing has been done through the use of the emulator, an android mobile phone and through the use of the focus group. This continuous testing has been key to ensure the end result being well refined and has met the end users system requirements.

To ensure that the application functions properly the developer has decided that the functionality of the application should be tested and evaluated.

6.2 What to test?

In order for the developer to effectively test the application it must be first outlined what exactly has to be tested. Below the developer has outlined exactly what has to be tested:

- The application must open and display the splash screen first before moving to the main menu;
- All buttons must function and create the desired effect such as moving to the next page or calculate;

- The user must be able to navigate through the application without crashing or getting lost;
- Does the tutorial audio work?
- Does the quiz work to randomly select question from a bank and keep a high score?
- Does the application work on external devices?

6.3 Testing Results

Identified appropriate testing	Pass	Fail
Can the user navigate through the application with ease?	X	
Do all buttons and user-views function correctly?	X	
Do the calculators produce the correct results?	X	
Do the audios in the tutorials work?	X	
Does the quiz work to randomly select question from a bank?	X	
Does the application keep a high score?	X	
Does the application work on external devices?	X	

Table 8

6.4 Functionality Testing

From developers perspective functionality testing is extremely important this will enhance the usability and effectiveness of the application. Functionality testing can range from navigation to buttons, to audios. It is of utmost importance that all criteria in the application are tested so that productivity is at its highest. The developer has outlined a set of steps to follow in order to carry out functional testing efficiently:

- The identification of functions that the software is expected to perform
- The creation of input data based on the function's specifications
- The determination of output based on the function's specifications
- The execution of the test case
- The expect outputs against actual outputs

The table on the next page shows a number of the functionality tests carried out on the application.

User Input	Expected Output	Actual Output	Comparison of Output
User selects topic area to study	Sub Menu will display	Sub menu displays	Match
User selects tutorial	Application should go to a tutorial with an option to display an example. Both the tutorial and example will be audio assisted.	Application goes to a tutorial with an option to display an example. Both the tutorial and example are be audio assisted.	Match
User navigates to calculator and inputs data	User enters data and selects calculate and answer displays.	Correct answer displays.	Match
User navigates to quiz and completes	Application will show a series of randomly selected questions and answers. User must select an answer for each question. The results page will show the result and a high score.	Application shows a series of randomly selected questions and answers. The results page shows the result and a high score.	Match

Table 9

6.5 Usability Testing

This testing technique uses actual users to test the android application out. When completing the questionnaire ten people agreed to test the application when available; however only 5 actually took part. The developer felt that this technique would give them scope to uncover any problems with the application. These users then gave feedback in the form for a questionnaire (a sample of this questionnaire may be found in the appendix).

6.5.1 Usability Testing Results

Test	Yes (%)	No (%)
Navigation easy	80	20
Able to access all features	100	
Able to use audio assistance	100	
Able to input numbers for calculation	100	
Calculation produce desired results	100	
Able to complete quiz	100	
Quiz randomise questions and answers	100	
Able to store high score	100	
Quiz timer working correctly	100	
Any runtime errors		100

Table 10

The participants of the focus group were also able to complete a recommendation part of the questionnaire; below is a number of these recommendations:

- More in-depth tutorial;
- More examples;

- Ability for two users of the application on different devices to compete in the quiz.

6.6 User Defined Testing

In conjunction with the usability testing the developer decided it was appropriate to have user defined testing. This is where a user is set out a number of tasks to complete whilst using the application. They are asked to report back on the results and report back on the ease at which these tasks were able to be performed. A questionnaire is given to them to complete, helping the developer to ascertain if the application is easy for a user to use. The user ranks the ease of completion from 1 to 5 (5 being easiest). The tasks and results are outlined below:

Task	Easily completed? Yes/No
Navigate to Prime factorisation calculator and enter figure 25.	5
Locate the tutorial and example for Highest Common Factor	4
Locate the quiz	5
Complete the quiz and set a high score	4
Re-do quiz and see if high score remains	4

Table 11

6.7 User Defined Results

These results are very positive feedback to the developer. The above table showed that the user rated the application highly and the average score was 4.4. This means the application was easily navigated and is key in communicating to the developer that the application is a success.

6.8 Constraints and Issues

A major constrain experienced by the developer whilst implementing and evaluating this project was the availability of android devices for testing purposes. Limitations of the emulator meant that the developer was not able to solely rely on the emulator for testing and as a result had to purchase a LG android mobile phone.

6.9 Chapter Summary

The objectives of this chapter have been met with an in-depth array of testing of the application. The feedback from the focus group, users defined and developers own testing has been largely positive and as a result the application can be said to be functional and easily navigated.

7.0 Conclusion

7.1 Introduction

This chapter will draw all conclusions on the success of the application and overall project, highlighting the experience which the developer gained in completing this project. Based on the user feedback and the developers experiences, recommendations will be made on how the application may be improved in the future.

7.2 Project Appraisal

To determine whether this project has been a successful one or not the developer must first compare the application with the objectives which were set out early in the project.

Initially when the market research was carried out it was clear to the developer there was a need for a numeracy application to act as an aid in the education of post-GCSE adults. An application providing a calculator, tutorial and quiz on the topics of Integer Factorisation, Prime Factorisation, Highest Common Factor and Lowest Common Multiple would be ideal in the achievement of this.

Then the most common operating systems were identified as Apples IOS and Googles Android systems. After careful consideration of both operating systems, weighing up the pros and cons of each the developer decided that the application will be developed on the Android operating system.

The aim of designing the layout of the application was to design an application which is simple and easy to use so that even a user who would not be considered as being technically savvy could use and navigate the app with relative ease.

The final application is a fully developed and functional application is a fully developed and functional application, allowing users to develop their numeracy skills in the four selected topic areas, through the use of audio-assisted tutorials and the quiz questions.

7.3 Project Review

The code for this application was all written using Android Studio with java and xml files. Testing was carried out continuously on the emulator and the LG mobile phone purchased for this purpose. The purchase of the android device was a sound expenditure as it allowed the developer to test the application on a real device to evaluate and manipulate the user interface accordingly.

Through the use of agile development the project was able to be completed with a systematic manner. Through the use of internal project deadlines set out by the developer the project was completed with a smooth professional manner. As well as allowing for the project to be completed in a professional manner the use of internal deadlines meant that the developer could give time and patience to be figured.

7.4 Recommendations

Throughout the development of this application and based on the feedback, the developer has considered any potential features which have not been implemented on the product but could extend its use. These features include new ideas and also ideas which were discarded during the development of the final application. These recommendations are listed below:

- More in-depth tutorial – this was a recommendation by one of the focus group however it was felt by the developer that the tutorial was in-depth enough and to clutter the tutorial any further would be at the detriment to the application;

- More examples – as with above the developer felt this would clutter the example sections;
- Ability for two users of the application on different devices to compete in the quiz – this would enhance the effectiveness of the quiz, however this would mean that there would have to be internet connectivity and a larger database to hold all the users names and scores. This could be implemented in future versions of the application;
- Consider detailed answers for the calculator- the developer looked at this as a possible development in the application, however the developer concluded that whilst this would help with the understanding of the topic at hand it would mean the calculator page would become very cluttered when larger numbers are entered, making it hard for the user to actually determine the correct answer.

7.5 Project Summary

On completing this project the developer feels they have gained invaluable project management and android development experience. The project has thrown up many difficult and yet satisfying moments challenging and expanding the knowledge of the developer.

The project afforded the developer an opportunity to fully immerse themselves in software development for extended periods of time, and despite being a great challenge accompanied with stress the experience has been on the whole an enjoyable experience.

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Appendix 1

Q1 Please indicate whether you are a student, teacher, unemployed or work for careers service:

Please tick all that apply

I am currently a teacher

I am currently employed by the
Careers service

I am currently a student

I am currently unemployed

Q2 a) Please indicate which of the following numeracy applications you are aware of?

b) Please indicate which of the following numeracy applications you have used and which you would recommend?

Please tick all that apply

	Aware of	Have used	Recommend
Wolfram Alpha	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
MyScript Calculator	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Math Ref	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
MathBoard	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Q3 Please indicate the extent to which you agree or disagree with the following statements:

Please tick one box in each row

	Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree	Don't Know
Young adults would benefit from using a Numeracy application	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Q4 Please rate the suitability of the following names for a numeracy application by choosing from “very suitable” to “not at all suitable”:

Please tick one box in each row

	Very suitable	Quite suitable	Neither suitable nor unsuitable	Not very suitable	Not at all suitable	Don't Know
Numeracy Fun	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Fun Numeracy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Numeracy Cracker	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Adult Numeracy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Numeracy 4 Adults	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Are there any other names you would like to suggest: _____

Q5 Please rate the importance of the following content for a Numeracy application by choosing from “very important” to “not at all important”:

Please tick one box in each row

	Very important	Quite important	Neither important nor unimportant	Not very important	Not at all important	Don't Know
Tutorials	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Practice Questions	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
User input	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Q6 Please rate the suitability for a numeracy application to cover the following requirements by choosing from “very suitable” to “not at all suitable”:

Please tick one box in each row

	Very suitable	Quite suitable	Neither suitable nor unsuitable	Not very suitable	Not at all suitable	Don't Know
Integer factorisation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Lowest & Highest common Multiples	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Prime numbers	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Q7 Please rate the suitability of the following features for a numeracy application by choosing from “very suitable” to “not at all suitable”:

Please tick one box in each row

	Very suitable	Quite suitable	Neither suitable nor unsuitable	Not very suitable	Not at all suitable	Don't Know
Time Limit for practice questions	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Application Designer and Maintenance Contact	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
User score in practice Questions	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Q8 Please indicate if you would be willing to test the application once available?

Please tick one box

	YES	NO
I am willing to test the application when available	<input type="checkbox"/>	<input type="checkbox"/>
Please include your name for contact purposes when the application is available*	<input type="text"/>	

* Please note that any name provided will not be transcribed anywhere else. It will only allow me to contact you once the application is available in order to test it. Also all completed forms will be destroyed once the project is completed.

Free Comments

Please include below any comments you wish to make related to the design of this new application:

Thank you for participating in this study. Your time and effort is much appreciated.

Appendix 2

Q1 Please indicate whether you found navigation easy:

Yes

No

Q2 Please indicate whether you were able to access all features:

Yes

No

Q3 Please indicate whether you were able to use the audio assistance:

Yes

No

Q4 Please indicate whether you found navigation easy:

Yes

No

Q5 Please indicate whether the calculations provide desired results:

Yes

No

Q6 Please indicate whether you were able to complete the quiz:

Yes

No

Q7 Please indicate whether the quiz was randomised:

Yes

No

Q8 Please indicate whether the high score was stored:

Yes

No

Q9 Please indicate whether the quiz timer was acting properly:

Yes

No

Q10 Please indicate whether there was any runtime errors:

Yes

No

* Please note that any name provided will not be transcribed anywhere else. It will only allow me to contact you once the application is available in order to test it. Also all completed forms will be destroyed once the project is completed.

Free Comments

Please include below any comments you wish to make related to possible enhancements of this new application:

Thank you for participating in this study. Your time and effort is much appreciated.