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Dissertation

School of Computing & Information Engineering

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[Key Stage 3 Science App "*Space Master: Science*"]

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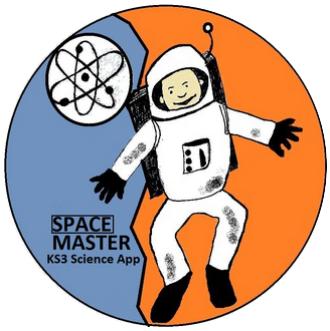
Contents

SPACE MASTER
KS3: Science App



Abstract

Science is an essential part of the key stage 3 curriculum but because of its complexities often pupils of all abilities find it unattractive and difficult to understand. Recently research conducted by BAE systems and the RAF concluded that:
"A quarter of parents say their children find science "too difficult" – despite the fact that their children want to pursue a science-based career" (Institution of Mechanical Engineers, 2014)

Because science is such a vast subject often students struggle to retain information when it comes to revising for class tests and because of this they sometimes lack motivation to study.
Today, many careers specify a solid background in science so it is necessary that the value of science is promoted throughout schools in the U.K.
A solution is needed that will make Key Stage 3 science more accessible, inspiring children's interest in the world of science throughout their lives.

This dissertation describes the work undertaken in the development of a new app for Key Stage 3 Science that is linked with the CCEA key stage 3 curriculum. The app is called *Space Master: Science*. It is not just blandly presented learning material from the KS3 guidelines.
Space Master: *Science* takes the novel approach of appearing to be a game, featuring animated characters with the theme of outer space and astronauts which makes it more approachable and attractive to the younger secondary school stakeholders.

Space Master: Science was developed as an educational application for Android Tablets and Mobile phones. The application takes full advantage of the technology's colour screen displays, touch screen functionality and audio playback.

The app has been developed with full consideration of the BCS project guidelines. The focus group has tested the app and suggested further amendments, allowing for development of the best possible application.

Introduction

Within Northern Ireland teenagers lack motivation to study science, they say that it is not interesting and there is too much to understand. As a result of this fewer students are choosing to continue studying science after GCSE.

The strenuous solution for many parents is to pay for after school tuition. One to one tutorials can help target a child's specific difficulties and needs. Although this may seem like a reasonable solution private tutorials are expensive and many parents cannot afford this luxury or are forced to stop their child's attendance after a few lessons because of this additional overhead.

It is important to appreciate how vital Science is for us economically. In this post-recession era better science understanding and skills prepare young people for rewarding careers in science and engineering. This is essential for the future of our country in terms of production. A stronger knowledge of science will help the state of the country and encourage the development of export goods. Ultimately, in doing so the country will be better prepared to compete and perform internationally in the global economy.

The Northern Ireland CCEA specifications in Science are indeed a complex area but despite clear Key Elements and well organised Curriculum Objectives, the recommended support materials are limited to a range of fact sheets on Key Concepts for teachers but crucially with no specific support app which children could use in research, revision and preparation at GCSE level.

With smartphone ownership for 12- 15 year olds increasing dramatically as well as growth in children having access to their parents' device within the household it would seem that taking a proactive approach to education in science, using this aspect of technology, is the logical approach in supporting our children's learning. Moving the focus of discovery directly into their domain of smartphone and tablet apps will prepare them better for their future life and at the same time address the problem of underachievement in science.

Space Master: Science tackles the problem of school children needing support in learning key stage 3 sciences by helping them revise and prepare for examinations. The app has been planned and designed in close liaison with both teachers and parents and is a much cheaper alternative to paying for a tutor. It tests children's knowledge of the science topics whilst remaining fun and offers students a motivational way of study by offering incentives and rewards students accordingly based on their effort and self-improvement.

Problem Statement

School children need support in learning key stage 3 sciences. They find science is a difficult subject to revise when preparing for exams. A new Key Stage 3 Science app that helps students to revise and that could be used for homework would be a great solution to this problem.

Aim

To develop a fun, challenging and motivational self-improvement tool for the use of science students at key stage 3 level. This application will be free of charge and will avoid any in-game advertising. It will be aligned with the CCEA science curriculum.

Objectives

The aim set above was accomplished by having a clear set of objectives:

1. Background research to get a clear picture of the problem and what is needed to achieve the best possible solution.

2. Research into the current revision and homework aids available for Key Stage Science.

3. Construct a focus group of parents, children and teachers from schools in the Mid-Ulster area.

4. Develop a suitable research questionnaire for the target group to establish key elements and functionality required for a Key Stage 3 Science app.

5. Based on requirements set by the focus group, design and develop an app with a simple interface, appealing design and challenging material.

6. Allow the focus group to test the app and to give feedback on the key elements of the application.

Requirements for Development

Space Master: Science was developed using current and up to date developing software which is already in existence.

The following utensils and skills were essential in the construction and completion of *Space Master: Science*:

- Programming Languages: Java, SQL
- A desktop or laptop computer running windows 7 or above
- Android Studio, Android SDK
- A computer with at least 4 GB of ram, 500 MB disk space for Android Studio and 1.5 GB for Android SDK
- A tablet or smartphone running android software, used to test the application.

Dissertation Outline

Chapter 2

The analysis section begins with research into the problem. Possible solutions have been investigated and analysed in detail. Following this the most appropriate solution is drawn. The chapter concludes with a competitive analysis. Recommendations have been made using these results.

Chapter 3

The requirements analysis presents a business case for a key stage 3 science app; following this the project risks are discussed along with ethical considerations. Finally, recommendations from questionnaires and user stories are used to provide a list of functional and non- functional requirements.

Chapter 4

The design section begins by discussing the various HCI Guidelines. Following this the architecture of the system is discussed in detail. The User Interface designs, colours, themes and logos have been illustrated and a story board gives a better understanding of how the system operates. The chapter concludes with an overview of the database design.

Chapter 5

The implementation section lists the hardware and software used in creating *Space Master: Science*. The approach to implementation is discussed and the various sprints involved in production are detailed with code and algorithms. Any resources that have been used to help aid the production of the app have been documented.

Chapter 6

The Testing and Evaluation chapter describes the hardware and software used to test *Space Master: Science*. The various techniques and approaches to software testing have been explained. Feedback and critique from focus groups has allowed the developer to build an overall conclusion with regards to the success of the final product.

Chapter 7

The conclusion section starts with an overall summary on the project. Following this an assessment of the product is made with an evaluation and suitable recommendations for any further developments of the application.

Analysis

Introduction

The following chapter begins with a review of the problem, highlights the effects and clearly shows the importance of promoting and encouraging science within schools. Current support for Key stage 3 level science is analysed in depth. The pros and cons of each are then documented to give a better understanding of what is needed to find the best suitable answer to the problem.

Science in education

Currently one of the biggest problems within schools in the U.K is that Children find science boring and difficult to understand.
A poll conducted by the Royal Institution L'Oreal Young Scientist Centre states *"One in two schoolchildren find science too difficult or too boring to study"* (Bowater D. 2012)

A big concern is highlighted as insufficient levels of quality teachers.
"Where weaknesses are identified, these concerns are typically around the leadership, challenge for pupils and quality of teaching." (Key Stage 3 the wasted years, 2015) (See Appendix 1)

These findings are particularly alarming considering that 70 per cent of the students surveyed said they wanted to be a vet, an astronaut or a pilot.

The impact

Obtaining a qualification of at least C grade GCSE Science is seen to be a necessary requirement for Universities and various apprenticeship opportunities within Northern Ireland.
A recent article in The Telegraph stated that *"Hundreds of thousands of teenagers are being denied the chance to pursue highly skilled careers after failing in science…. at secondary school", according to research. (*Paton. G, 2015).

Promoting Science

Currently it would seem Key Stage 3 level is been given low priority in schools, with teachers giving more attention to GCSE and A level preparation.

"Eighty five per cent of senior leaders interviewed said that they staff Key Stages 4 and 5 before Key Stage 3. Key Stage 3 is given lower priority" (Ofsted, 2015)

Every opportunity must be taken with promoting the subject within schools and supporting pupils at all levels of education as science is constantly and rapidly evolving with even parents struggling to keep up with new terminology and concepts.
"Science really is a moving target, forever advancing and getting more complicated. It's hard to keep up and really hard to catch up. Science changes faster than iPod models*."* (Susman.K, 2013)

It is important to keep pupils involved and to keep them interested in this most dynamic area of experience.

Benefits of promoting Science

Better science understanding and skills prepare young people for rewarding careers in science and engineering and these skills in science will make Northern Ireland much more internationally competitive.

"Countries with strongly supported science programs are better off economically have greater numbers of people creating new technologies." (Susman.K, 2013)

Therefore, It is crucial that Northern Irish primary and secondary schools are provided with any additional assistance that is needed to achieve the best possible results, allowing children to maintain a strong interest for the science subject throughout their lives.

As President Barack Obama says "*Science is more essential for our prosperity, our health, our environment and our quality of life than it has ever been before" (President Barack Obama 2010)*

Current solutions

Homework

It seems that giving students extra work to complete at home does not always help them. In fact pupils at Key Stage 3 level and their parents say that "homework never or only some of the time, helps them to progress" (Ofsted, 2015)

Private Tuition

Many parents feel the need to support their children and they must make sacrifices to further fund their child's education. They pay for extra tuition and private one to one lessons. These are expensive and it can be difficult to find a tutor that will inspire a child to reach their maximum potential.
Currently private key stage 3 science tuition ranges from £15/ hr. - £30/hr. (thetutorpages.com, Gumtree.com) This is a big expenditure considering the child will be likely need more than a few lessons.
On top of that many of the tutors in Northern Ireland are based in major cities such as Belfast and Derry. Students who live outside these areas would have to make travel arrangements, not to mention the cost to travel to these cities. These lessons are often at a fixed time creating additional pressure for the parent to make sure their child is punctual.

Another major concern for parents is that of quality assurance since tutors are not required to be on a register or to be recognised by any lawful body. Therefore anyone can look for work as a private tutor as they do not require qualifications. On top of this a parent needs to be sure that the tutor does not pose as a risk for the child. With the consideration of child protection many parents feel the need to do background checks on the potential tutor, checking their references and CV. (egfl.co.org.uk, 2016)

Online: Skype Tutor

Some parents find their child an online tutor costing around £20/hour (hometutorsdirectory.co.uk) Lessons can take place using software such as Skype. However, this software requires a high-speed internet connection. A low speed connection will result in choppy playback and distorted audio. Although Skype is free, high speed internet does not come cheap and on top of that it will be necessary to buy a web cam and a microphone. BT infinity costs £49 for installation and around £30/month (uswitch.com, 2016)

Online: Science Practice Websites

Another alternative is to use science practice websites. These websites can offer science practice 24/7 and for as long as necessary. Websites such as the BBC's bite size science offers a free service with a range of activities, games, quizzes for each of the Key Stage 3 topics. However, these websites require the user to be connected to the internet and many of the games are unplayable without a high speed connection.

Finding a solution

Initially, creating a CCEA Key Stage 3 Science website was deemed as the best solution to the problem. Websites can be accessed on multiple platforms meaning software does not need to be developed individually to suit a range of operating systems such as Google Android, Microsoft Windows Phone OS, Nokia's Symbian or Apple's iOS.

Using a website means that information can be easily accessed through the internet without having to download data and using up phone storage. Furthermore, using a website means updates and fixes to bugs can be easily updated. Using an app on the other hand requires the user to download additional information in order to have the latest amendments and fixes to their software.

However, websites have limitations. Firstly a website requires the user to have a Wi-Fi connection to access data. An app on the other hand can run in its own environment and is not affected by a web browser.
"if your goal is interactive engagement with users, or to provide an application that needs to work more like a computer program than a website, then an app is probably going to be required." (Summerfield .J, 2015)

Apps have more of a unique feel and this allows the user to have more of an engaging user experience. Native apps can take full advantage of additional features on a phone such as motion sensors and thumb print scanners.

Proposed solution

A new Key Stage 3 Science app which is aligned with the Northern Ireland CCEA syllabus proposes the most appropriate solution. Further verification of the effectiveness of this motion is outlined in detail on the following page.

Popularity of smartphones and tablets

Since the release of the first iPhone in 2007 our perception of what mobile phones and tablets can do has completely changed. Apple incorporated cameras, games consoles, GPS, MP3 players, pocket dictionaries etc. into an all in one device and has done this so successfully that it has almost deemed some of these devices obsolete.

The range of possibilities available on a smartphone or a tablet is endless and with a search you can find an app to help with just about anything. Apps such as Google maps allow us to use our phones as a GPS system helping us to find the fastest, route to a destination. Facebook and Twitter allow us to connect with friends and now we can keep up to date with all the latest news and entertainment at the touch of an icon.

Today, most young adolescents are compulsively attached to their smartphones and tablets. These devices allow them to remain in immutable contact with their friends and keep them in touch with the world.

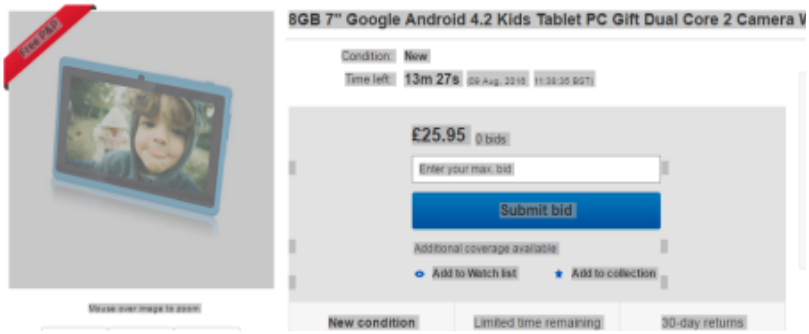
According to a recent survey conducted by Ofcom *"Over half of 3-4s (53%) and nearly three-quarters of 5-15s using a tablet in 2015 (73%), up from 39% for 3-4s and 62% for 5-15s in 2014."* (Ofcom.2015)

For many of these youngsters having a smart device is seen as socially acceptable and a "cool" way to appear involved and connected to the teenage environment.
Both shy, introverted types and more extrovert, confident characters have one thing in common. They carry their smartphone; their status symbol and they know how to use it efficiently.

Pupils' access to smartphones and handheld devices could be seen as a possible flaw in the proposal if the purchase of expensive devices was seen as a necessity for full access to the app. However, in the 21st century it has now become the norm for children as well as adults to have a phone in their possession or to have access to a handheld device in the home.

"Access to a tablet computer at home for 5-15s has increased by ten percentage points in 2015: from 71% to 81%. At least three in four children live in a household with a tablet computer" (Lenhart. A, 2015)

Before mobile phones and tablets, the use of ICT for homework and study in many countries was restricted. Many students had to share resources due to the expense of a computer. Now smartphones and tablets are getting cheaper and cheaper. Many tablets can be found on eBay for as little as thirty pounds. (Figure1)



(Figure 1: Cost of Android Tablet of eBay)

The average price of a newly released smartphone has decreased dramatically. An estimation set by the Consumer Electronic Association states "*The average price of a smartphone will fall to £180 this year – a third off from the average price of £270 in 2010 and down from £205 last year."* (Withers.P, 2014)

The Benefits of apps and games in Education

The major advantage to using mobile apps is that they allow for 24/7 access to education. Students are not restricted to set times of study. They can learn whenever and wherever they feel necessary. Without doubt the biggest advantage of many mobile apps is that they don't require an internet connection. A user can access all the information they need from the phone's storage without worrying about a slow Wi-Fi connection or if they're in an area with good 4G or 3G signal. The fact that these devices are so portable means they have no limitations on learning. Learning is not restricted to just within school.

"Anywhere can be a classroom. App learning is not time-bound learning, its - relaxed learning." (Edsys.com, 2015)

The portability of these devices is even helping people with social anxiety. The recent, hugely successful game Pokémon Go has encouraged players to get outside and explore new things in their towns and neighbourhoods. The psychologist John M.Grohol reported:

"users are taking to social media to report an unexpected improvement in their depression and anxiety as a result of playing the game." (Grohol.J.M, 2016)

Thanks to educational science apps such as Professor Astro Cat's Solar System and Tiny Trees (discussed later) learning is fun, these apps capture the child's

imagination and motivate them to study and educate their minds in the world of science.
These educational apps test a child's memory. The player must remember information in order to solve a problem.

"Most games require children to think quickly. Moreover, they have to utilize their logic in order to think three steps ahead in order to solve problems and complete levels. " (teachthought.com 2013)

A survey conducted by a professor at Nottingham University even suggests that games can help children with attention disorders.

"With the aid of a computer display, attention-deficit patients can learn to modulate brain waves associated with focusing. With enough training, changes become automatic and lead to improvements in grades, sociability, and organizational skills."(Griffiths, M.D.2005)

Many games can help children build useful skills that they can use later in life. Games such as Football Manager educate children in dealing with money for example buying and selling players.
With the world we live in getting more and more technology orientated, it is important that we familiarise children with computer systems and their uses from an early age.
"As handheld computers have proliferated, their business applications have made them nearly indispensible in the workplace." (Keith Evans 2016)

Confidence in using this technology will have benefits in later life especially with the increase of mobile technology used within the workplace. There is greater support for getting pupils used to this type of data management as hand held devices are being used more and more within management and on the shop floor.

Kids' Science Apps: Competitive Analysis

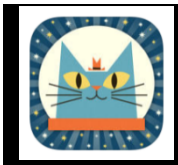
There are many science apps available on the market. An analysis and overview on five of the most popular science apps can be found on the following page. The pros and cons of the apps have been reviewed in terms of their content, quality, entertainment, usability, value, reliability and child security.

Professor Astro Cat's Solar System

Professor Astro Cat's Solar System (Figure 2) is an app designed and developed by Minilab Ltd. It aims to teach children about the solar system in a fun and interactive way. A key feature of the game is the use of a character- "Astro Cat". The high quality graphics and animations keep the game entertaining and attractive to the player. It was awarded the Webby Award 2016 for the Best Family and Kids app.

(Figure 2: Professor Astro Cat UI)

(Table 1: Pros and cons of Professor Astro App)

	**Pros**	**Cons**
Content	Focuses on each of the eight planets in the Solar System Detailed design- focusing on each planet. Suitable for all ages	Limited to just information about the solar system
Quality	High Quality Graphics and Animation- Colourful display very attractive to children	None
Entertainment	Challenging games which motivate and encourage the player- Motivating	Limited information, only information about solar system
Usability	Intuitive and slick animation allow ease of navigation	Only available for apple devices Not available on Android Can only be played in landscape view.
Value	£2.99 - One off Download Cheap in comparison to a private tutor to teach a child about solar system.	£2.99- For an app this is quite expensive considering it only focuses on one subject
Child Friendliness	No in game advertising No in app purchases	None

Tiny Trees

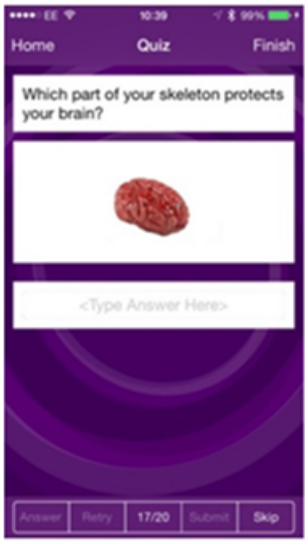
(Figure 3: Tiny Trees)

Tiny Trees (Figure 3) focuses on the idea of planting seeds and growing trees. It has similarities to the Professor Astro app in that of a space theme, The player learns about the actions needed in order to grow a tree including planting the seed, keeping the plant in sunlight, watering and fertilising etc. This game gives the child an understanding of the environment and what we need to do to protect it. A major theme in many of these children's apps is to have characters which the child can relate to. Tiny Tree features the characters Nora, her dad and Cosmo. *(Table 2: Pros and cons of Tiny Trees App)*

	**Pros**	**Cons**
Content	Very detailed and offers a child a great inside into gardening and conservation Good Music, Upbeat, uplifting Interactive	Limited to just information about planting seeds, growing trees
Quality	High Quality Graphics and Animation- Colourful display very attractive to children Interactive	Perhaps the animation is a little bit busy with too much detail. Too much colour is distracting.
Entertainment	Educational for kids, good music and interactive. Characters and themes relatable for children	Limited information, only information about planting seeds and growing trees
Usability	Intuitive and slick animation allow ease of navigation	Only available for apple devices Not available on Android Can only be played in landscape view.
Value	£2.99 - One off Download Cheap in comparison to a private tutor.	£2.99 - For an app this is quite expensive considering it only focuses on one subject
Child Friendliness	No in game advertising No in app purchases	None

I am Learning: KS3 Science

(Figure 4: I am Learning)



I am learning (Figure 3) is designed specifically for KS3 learning however it does not focus on the Northern Irish CCEA syllabus. I am learning has been praised highly for being a good way for children to learn science. "87% of teachers agree I am Learning is an effective way to learn" (itunes.apple.com ,2016)

Having played this game, the animation and quality aren't quite as slick as the previously mentioned games. The apps main theme of purple colour is visually distracting. Despite this however it does feature a wide range of content and students can choose areas to focus on. *(Table 3: Pros and Cons of I am Learning: KS3 Science app)*

KS3 SCIENCE	Pros	Cons
Content	Games designed to make revision and learning fun Over 1000 UK curriculum questions Can focus learning on specific needs.	Does not focus on CCEA curriculum
Quality	Well written questions Simple user interface	Purple coloured background and theme off-putting Low quality design
Entertainment	Wide range of content	Limited audio, no music etc.
Usability	Simple user interface. Clear instructions on how to play are provided. Available on both Android and Apple devices	Only playable in horizontal view
Value	£1.49- One off Download Cheap in comparison to a private tutor. Cheaper than previously discussed apps	None
Child Friendliness	No in game advertising No in app purchases	None

Thomas Edison's Secret Lab

The app developed by Fat Red Couch, Inc. teaches the player how to carry out various science experiments. It gives the student the opportunity to learn about scientists and inventors such as Edison, Newton, and Einstein. The animation throughout the game is of the highest quality. Characters, themes and environments have been designed with great attention to detail. For a game that is free to download it offers a wide range of content, fun games and puzzles which many apps that charge for their services fail to match. *(Table 4: Pros and Cons of Thomas Edison's app)*

(Figure 5: Thomas Edison's UI)

	Pros	Cons
Content	Educational Videos. Music Videos- very entertaining Fun and interesting experiments Good Games	Focuses on one area of learning
Quality	High quality application with detailed animation. Very Colourful illustrations, interactive	None
Entertainment	Wide range of content	Limited to one specific area of science
Usability	User Interface simple to use Instructions to explain how to play Available on both Android and Apple devices	Available on both Android and Apple Devices
Value	Free	None
Child Friendliness	No in game advertising No in app purchases	None

The Elements: A Visual Exploration

(figure 6: The Elements UI)

Considering the average price of an iPhone app is now 15 pence while the average cost of an iPad app is 38 pence The Elements: A Visual Exploration at £9.99 to download is extremely pricey .However, the app does feature a range of information and facts that provide hours of entertainment. Through the use of fun, upbeat songs it helps students learn the periodic table in an exciting, interactive way and the graphics and animation throughout the game are of the highest standard.

(Table 5: Pros and Cons of The Elements app)

Xe 54	Pros	Cons
Content	3D Images High Quality images Fun and interactive Music, Videos	Focuses on one area of learning Too much information
Quality	High quality application with detailed animation. Very Colourful illustrations, interactive	None
Entertainment	Wide range of content	Limited to one specific area of science
Usability	User Interface simple to use Instructions to explain how to play Available on both Android and Apple devices	Only available for iOS devices
Value	Offers a wide range of content and information	Expensive
Child Friendliness	No in game advertising No in app purchases	None

Key Findings

Apps such as Professor Astro Cat, Tiny Trees and Thomas Edison attract the user with colourful animation and well-designed graphics. Upbeat music and sound effects give these apps a welcoming atmosphere. The inclusion of cheerful, buoyant characters such as Astro Cat, Nora and Edison are attractive for their children and teenaged audiences. Mascots help to brand these applications giving them a feature which is instantly recognisable.

These games, designed to provide their users with an entertaining approach to learning, are cheap to download and some such as Thomas Edison's app are completely free. Despite this however, their content is limited as they only focus on one particular area of the science curriculum.

The Elements: A Visual Exploration offers a much more literacy based approach to learning. It provides the user with a breadth of information and details in an interactive encyclopaedia style format. However, the content provided is almost too much. Pages and pages of facts and figures are overwhelming and the app is designed for in depth consideration rather than a casual play. The IamScience app on the other hand is much less graphically sophisticated than the others; its use of multiple choice style quiz questions focus on a wide spectrum of content and many of the key elements in key stage 3 science are included. Despite this, none of these apps target Northern Ireland CCEA Key Stage 3 science specifically.

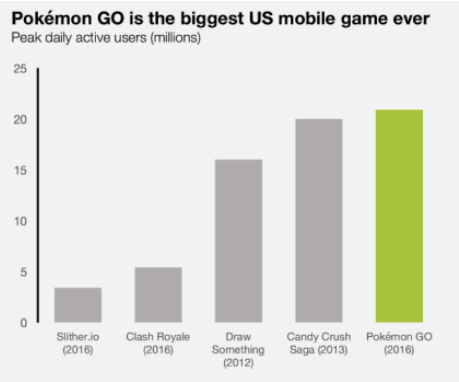
Recommendations

The following aspects should be considered when designing and developing the CCEA Key Stage 3 Science App:

- The application must be user friendly and should be easy to access and navigate through options and menus. Themes and colours should not be visually distracting and should not detract from the content within the game.
- The content should be aligned with the CCEA Key Stage 3 Science curriculum. The content should be to the point and it should not bombard the user with overwhelming amounts of information.

- The app should be fun and interactive. The inclusion of a game mascot or character could be considered to make the game more attractive to the young target audience.

The recent Nintendo app Pokémon GO which features many cute, friendly animated characters is now the biggest US mobile game ever. (Figure 7)



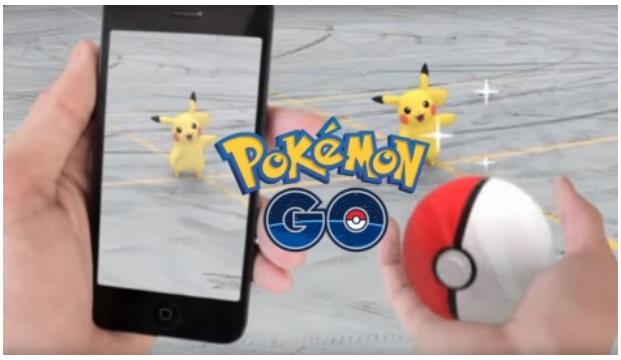


Figure 7: The success of Pokémon Go

- Inclusion of upbeat fun music would give the game a welcoming feel.

- If music is considered, a mute option should be included to allow the player to focus on their study quietly if they so desire.

Summary

In summary, research into the problem and possible solutions have been investigated and analysed in detail. The most appropriate solution has been drawn and a competitive analysis has been carried out to gain a greater understanding of the current market for Key Stage 3 science applications. Key findings were evaluated and having this background analysis has proven invaluable when developing and designing the *Space Master: Science* software.

Requirements Analysis

Business Case

- With an estimated wage of £10 an hour and development time of 600 hours the development cost could be £6000.

- Based on the figure of 141,000 in post primary education in 2015/2016, Department of Education statistical bulletin (2015), one could estimate that there are at least 50,000 pupils in Key Stage 3 currently. This could suggest that CCEA need only invest 0.12p per pupil in order to launch this app.

- If the app were to retail for 99p to download the cost of development would be covered after 6061 downloads and if 50,000 pupils were to download the app there might be a healthy income of £49,500

- The cost of promotion and marketing are difficult to assess at this point but would be manageable in either scenario.

To submit Android apps to the PlayStore for download by the public is £20
If this was possible and if a strong case for the app was presented parents and other stakeholders would strongly support the investment.
This would allow children to download the app to their smartphone or tablet absolutely free and naturally this would be popular with parents.

In a different scenario, if funding was not available from CCEA or the Department of Education, then commercial development would have to be explored using sponsorship by leading businesses who would certainly like to be associated with supporting education in Northern Ireland.

The third option would be to self-finance the project and to sell colourful advertising space throughout the various pages and to use cookies to store information about the users likes and dislikes directing advertisements in the light of their choices. This of course would not be desirable and would set a poor precedent for media used by young children.

Project Risks

There are certain risks that have to be considered in the development of this app. These include physical, technical and project management risks associated with the project. I have presented the main estimated risks in a table below. (Table 6)

Risk	Probability	Extent	Threat (PxE)	Contingency Plan
Physical Risks				
Illness	1	1	2	Stay ahead of Schedule to allow for flexibility.
Technical Risks				
Computer Failure	1	4	4	Access to multiple computers.
Data Loss	2	5	10	Structured hard drive storage and backup system.
App does not perform	2	2	4	Allow adequate time to test for app weaknesses.
Project management risks				
Project overrun	2	5	10	Strict time schedule and close liaison with tutor for continuous progress.

(Table 6 representing key project risks)

Ethical Considerations

- This project has been classified as category Z by the University Ethics Committee.
- This project is not invasive towards users but will involve children so close cooperation is needed at every stage with representatives of CCEA and in liaison with parents.
- Feedback from the initial research questionnaire and from the final testing of the website will be provided by teaching staff and parents initially to obtain their approval.
- It is considered improbable that schools will want their name and possible reputation to be affected by the potential results of the on-going game. In this era of Performance Tables the details of individual performance or of perceived school standards are best maintained as confidential. This will make it more likely that schools in general will support the use of this app.

In order to get a better understanding of the problem, specific to Northern Ireland initial data collection and research was conducted. Questionnaires have been completed by both KS3 CCEA students and teachers from two schools in the Mid-Ulster area. (Appendix 2 and 3).
Two separate questionnaires were made. One questionnaire was made specifically for Teachers whilst the others were made for the Students.
The questionnaire for the Teacher contained 10 questions.

Science teachers from St. Patricks College, Maghera and St. Pius X College, Magherafelt completed the forms to gain a better understanding of their views on some of the following topics: Difficulties in Science, Homework, Software in the classroom, Internet for learning, Learning with apps and Games in education.

The questionnaires for the students contained eight questions which focused more on their ICT usage in learning, their favourite apps, suitable system requirements for a potential science app and preferences within current applications.

A total of thirty three questionnaires were completed from St Pius X College and thirty nine from St. Patrick's College, Maghera.

Following the questionnaires further discussions were made and ideas were brainstormed with all the stakeholders involved in order to draw system requirements and additional features that would make this a successful piece of software.

These focus groups offered a clear insight into the current problems around study and homework for Key Stage 3 Science as well as helping in the completion of clear and manageable system requirements. Their cooperation and consolidation proved to have a crucial effect in the production of the prototype as well as in the final application.

Key Findings

Questionnaires: Teachers

- Out of the four teachers questioned two answered that Physics was the topic their students struggled with, whilst two teachers said Chemistry was problematic and none of the teachers answered Biology.

- Students struggle with the sheer amount of information in Physics and find it difficult to remember technical terms. The difficulties in Chemistry showed correlation in that students encounter issues when dealing with chemical

reactions and that they find it hard to remember the names of chemicals and materials in particular.

- For Physics the teachers concluded that forces and remembering equations were areas that their students found difficult to grasp.

- It was alarming to find teachers rarely assigned homework which involved the use of ICT however the majority said they used ICT within the classroom.

- 75% of the teachers asked said that their students use ICT to aid their research and learning.

- All 100% of the teachers agreed that if there was a science app it could help pupils learn key stage 3 science.

- All of the teachers agreed that the use of games in general helps pupils of different abilities in their learning.

- All 100% of the teachers agreed that if there was a science app that involved playing games it would help pupils learn key stage 3 science.

Questionnaires: Students

- The answers of the students and teachers showed similarities in that 75% of the students said that Physics was the most difficult of the three sciences whilst 25% of students said Chemistry was the most difficult

- 80% of the students said that they used ICT to help with homework

- Students said they used the Google app to help with their homework

- 90% of the students said they enjoyed playing games to make school work more fun.

- 90% said that a science app that involved playing games would help them learn science

- The most popular apps amongst this group were Snap Chat and Facebook

Key Stage 3 Science App: Requirements

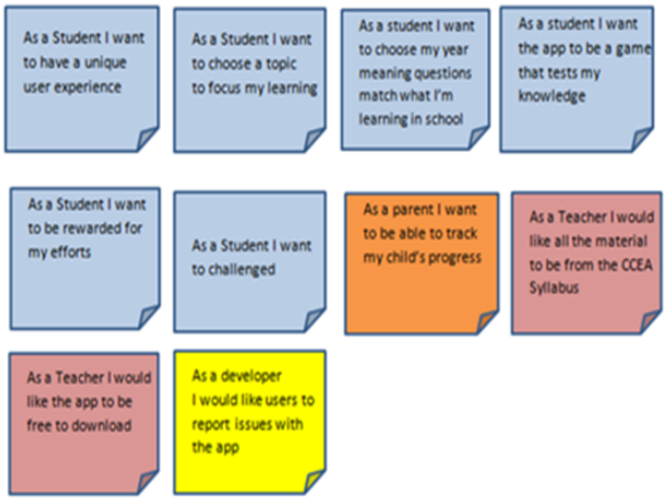
Further to the questionnaire a discussion with students and teachers was conducted to draw system requirements for the application. Suggestions were made and students shared their preferences and dislikes about apps currently on the market.
When asked what areas a science app should focus on in particular the teachers suggested that it would be good if the app could focus on all the key areas of the science curriculum in general. However, the user should be able to select their year and topic in order to focus their learning.

Teachers and students were in mutual agreement that they did not want to be presented with pages and pages of information. They would prefer if the app was more concise and just tested their knowledge. One student said she loved the game Quiz Up and liked the idea of quiz style questions. This suggestion fuelled the idea that a bank of questions could be made for all the topics in the syllabus rather than focusing on one particular area.

It was agreed that the app should present itself as a game designed to quiz the child's knowledge rather than a source of information and research. Following a quiz style it should offer points for each correct answer and the addition of a time limit to answer each question would add to the excitement forcing the player to think fast.

Additionally the group agreed that the user should be able to track their progress and a high score page would allow them to view a collection of their top results and accomplishments.

(Figure 8: User Stories)



User Stories

The main requirements suggested in the discussion with my focus group have been evaluated in the user stories below. The first diagram shows requirements suggested by the focus group in the form of user stories. (Figure 8) The second table proposes criteria to match these requirements (Table 7)

Number	User Story	Criteria
1	As a Student I want to have a unique user experience	An enter name option which will be recorded and used to record the students' progress
2	As a Student I want to choose a topic to focus my learning	A roller menu with Chemistry, Physics, Biology selection
3	As a student I want to choose my year meaning questions match what I'm learning in school	A roller menu with year eight, nine, ten options
4	As a student I want the app to be a game that tests my knowledge	Questions in multiple choice style
5	As a student I want to be rewarded for my efforts	A scoreboard where the user gains points for correct answers and loses points for incorrect answers
6	As a student I want to be challenged	A time limit to answer questions
7	As a parent I want to be able to track my child's progress	A high score screen showing student's top ten results
8	User should be able to report issues	Have an email address included for players to report issues.

(Table 7 A table showing key criteria for the system)

System Requirements

The suggestions and criteria have been organised below in the form of both functional and non-functional requirements. This is a key piece of information in the success of the project as it outlines how the system should function and it formed the basis of everything the system should incorporate.

a. Functional requirements

- The user should be able to record a name.
- The user should be able to choose a topic to focus their learning
- The user should be able to select their year group to further focus learning
- The questions should be in multiple choice format
- Questions should have a time limit
- The game should have a points system
- The game should have a high score table.
- The application must be user friendly and should be easy to access and navigate through options and menus

b. Non-Functional requirements

- The application must only use questions and content that is associated with the CCEA science Key stage 3
- The application must be attractive to key stage 3 students - The game should have a theme.
- The application must feature a range of questions and learning materials for key stage 3 students
- The application must provide useful learning information for the user

Summary

The requirements analysis has presented a business case for a key stage 3 science app; following this the project risks were discussed along with ethical considerations. Finally, recommendations from questionnaires and user stories helped to provide a list of functional and non - functional requirements.

Design

Introduction

Following discussions with students it was clear that the design element of this software was something that was going to be important to get right.
At this stage in the development of the app various Human Computer Interaction guidelines have been considered. This ensured an efficient, clear understanding of what was needed to complete the software's User Interface.
It is important to understand the importance of good design within a system.
As Drew Davies states:

"Good design must be defined by appropriateness to audience and goals, and by its effectiveness, not by its adherence to Swiss design or the number of awards it wins." (Davies.D, 2010)

The application has been designed with full consideration of all the stakeholders' behaviour and preferences allowing for an effective user experience. There are common features which maintain consistent positioning of buttons and media that allow the game to be easily mastered and efficiently operated.

HCI Guidelines for Mobile Applications

In order to create an effective, well designed user interface it was necessary to consult various Human Computer Interaction guidelines.

The following sources were considered in completion of the User Interface:

- Guidelines for Handheld Mobile Device Interface Design
  (Jun Gong 1 Peter Tarasewich 2 College of Computer and Information Science, North-eastern University)

- Apples iOS User Interface Guidelines

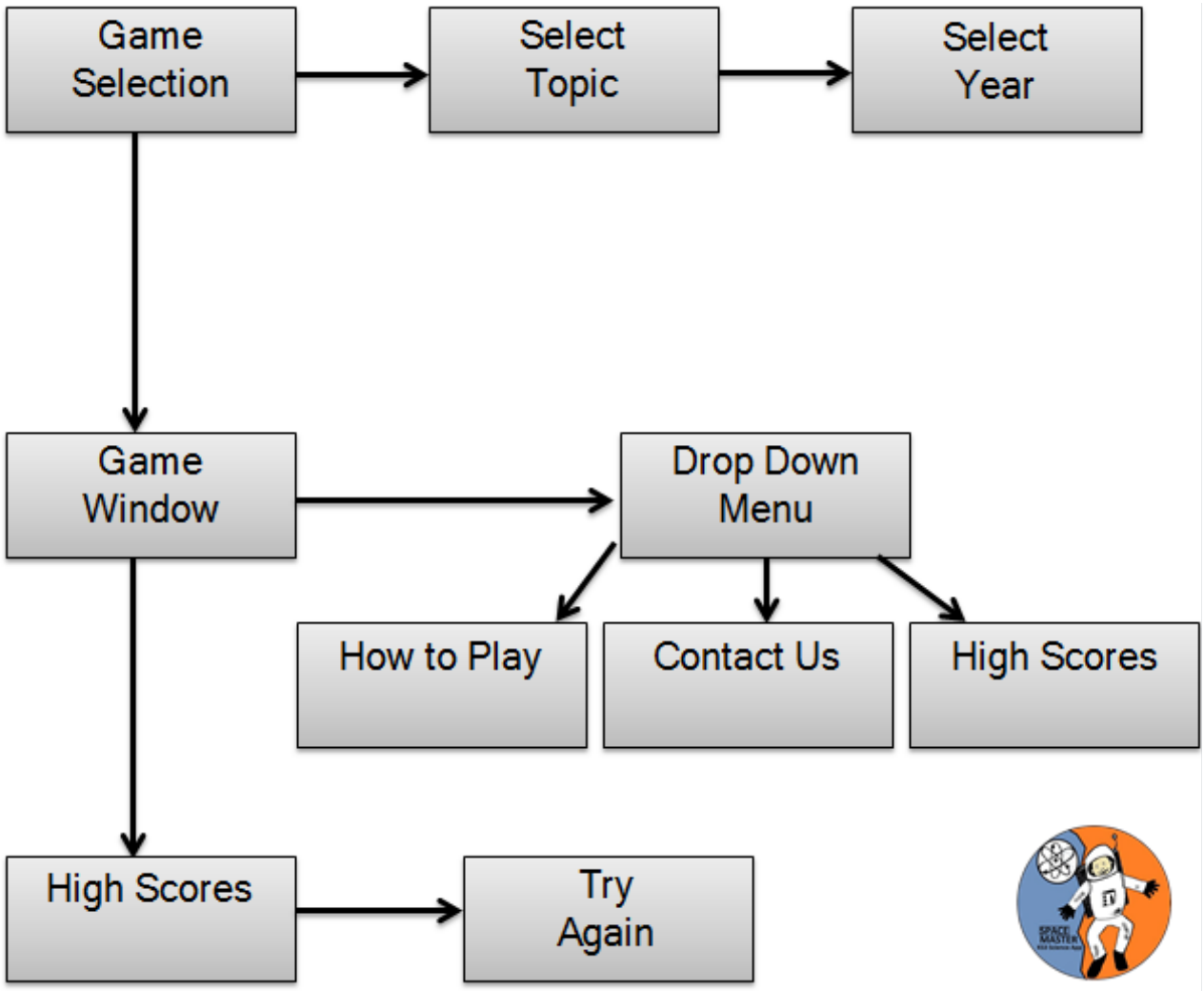
- Software Engineering Issues for Mobile Application Development
  (Anthony I. Wasserman Carnegie Mellon Silicon Valley)

The consideration of these guidelines is discussed in the later sections of this chapter.

Application Architecture

Before designing a suitable user interface for *Space Master: Science* it was important to understand the systems architecture. There are four main windows in the system that the user will navigate through. The app will begin at the game selection page where the user will enter their name, select their topic of focus and then select their year, following this they will be led to a question window where questions from their chosen subject will be randomly selected from a database. In the question window there is also a drop down menu where users can navigate to the screen for giving feedback. Following game completion the user will be led to the high score screen where the user has the option to try again. Figure 9 maps out the architecture of the final system.

Figure 9: Diagram illustrating the architecture of system



User Interface

Prior to making decisions on colour schemes and graphics it was important to have a clear vision of the user interface. Planning the layout of each window with basic wireframe diagrams ensured that all the criteria proposed in the analysis section had been met. (Figure 10)

Criterion: An enter name option which will be recorded and used to record the students' progress

Criterion: A roller menu with Chemistry, Physics, Biology selection

Criterion: A roller menu with year eight, nine, ten options

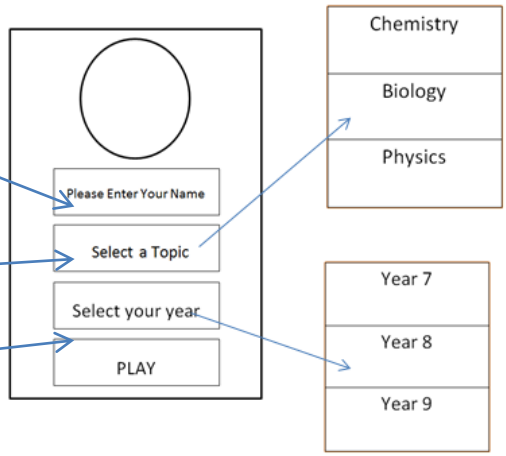


Figure 10: Diagram illustrating the Game Selection Page

The Guidelines for Handheld Mobile Device Interface Design suggests that the user's interaction should be made as efficiently as possible.

"As the frequency of use increases, so does a user's desires to reduce the number of interactions and to increase the pace of interaction." (Guidelines for Handheld Mobile Device Interface Design 2010)

It is possible that the user will want to try again following game completion. In order to improve game efficiency the user interface has been designed to remember previous selections and therefore allow for speedier access.

It is also suggested that a good app will offer informative feedback.

"For every operator action, there should be some system feedback, such as a beep when pressing a key or an error message for an invalid input value" (Guidelines for Handheld Mobile Device Interface Design 2010)

In *Space Master: Science* if a user does not enter a name a pop - up is provided with the helpful advice "Please enter a name to proceed"

Criterion: A scoreboard where the user gains points for correct answers and loses points for incorrect answers

Criterion: A time limit to answer questions

Criterion: Questions in multiple choice styles

Multiple choice questions were deemed the most suitable style. With multiple choice questions the answer is either right or wrong meaning points can be easily calculated.

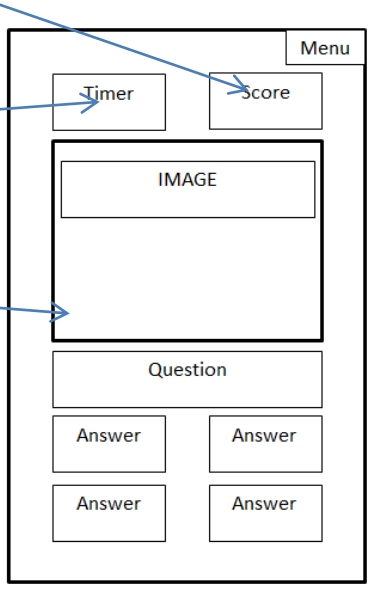


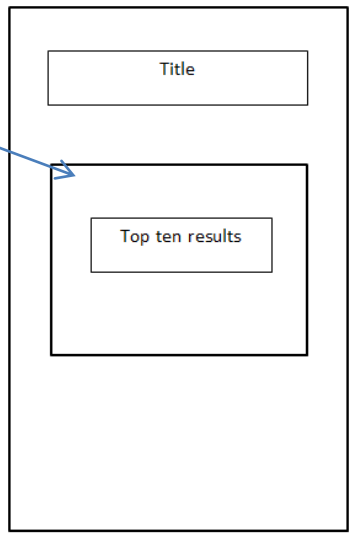
Figure 11.: Diagram illustrating the question window

Further advantages have been summarised in Brenda Kupshs research which was funded from the Health Resources and Service Administration, Rockville, Maryland:

> *"Allow for assessment of a wide range of learning objectives, Objective nature limits scoring bias*
> *Students can quickly respond to many items, permitting wide sampling and coverage of content, Difficulty can be manipulated by adjusting similarity of distractors, Efficient to administer and score, Incorrect response patterns can be analysed, Less influenced by guessing than true-false "(*Kupshs.B, 2003)

Criterion: A high score screen showing students top ten results

Criterion: Have an email address included for players to report issues.



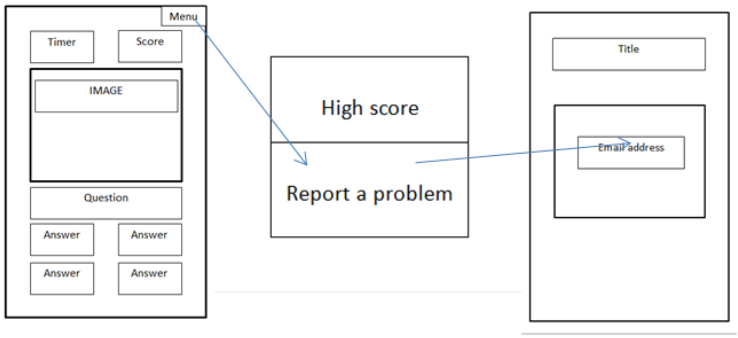
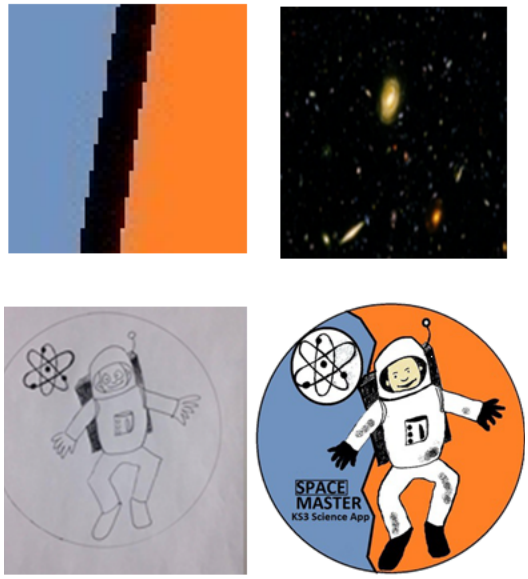


Figure 12: Diagram illustrating the high score screen and drop down menu

Colours Logo and Theme

Figure 13 : Colour Scheme and Logo



A main non-functional requirement was for the app to look attractive to the key stage 3 student. The students suggested that most of their favourite apps featured a character that they could relate to. They agreed that they loved the cartoon animations in games such as Angry Birds, Lego and Snap Chat. Following a discussion with their science teachers, it was suggested that the students particularly enjoyed the astronomy and space topic. Proposing a space theme to the students, they concurred that this would be an exciting feature to implement in the design.

Several caricatures focusing on the space theme were drawn and presented to the students; they then chose their favourite which would be used for the logo and branding of the application. (Figure 13)

Asking the students about colours, some said they were learning about complementary colours in their Art and Design classes. The students agreed that this should be considered in designing the logo. Having shown the pupils the image to the right, blue and orange were deemed the most suitable colours.

The image for the logo was scanned and coloured using Microsoft Paint and Adobe Photoshop. (Figure 14)

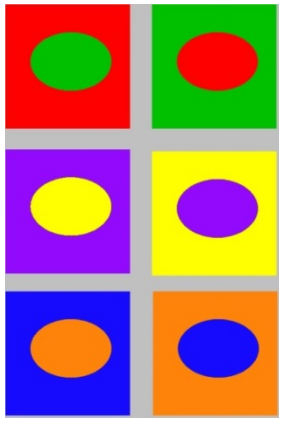


Figure 14: Complementary Colours

The logo features #FF7F26 and #7092BF colours (Figure 15)

Figure 15: Colour Scheme

The background image, in keeping with the space theme is consistent throughout the application. The dark image allows the white text to stand out, ensuring that all the questions are visible throughout the application.

Graphic User Interface Design Welcome Screen

As this is the first page that the user is presented with it was important to make this page as welcoming as possible. The warm complementary colours in the logo attract the player and the space theme is in line with the non-functional requirement stipulating that the application must be attractive to key stage 3 students.

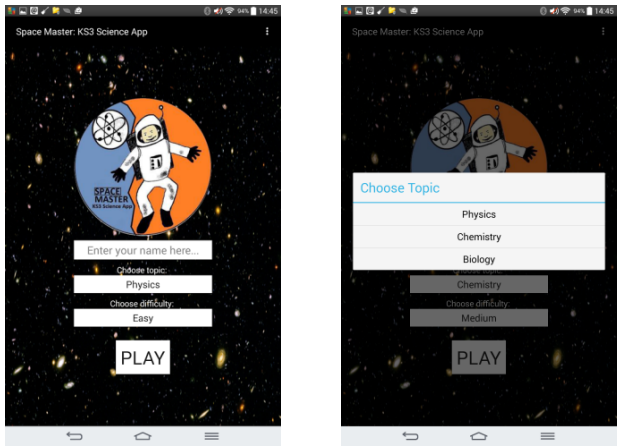
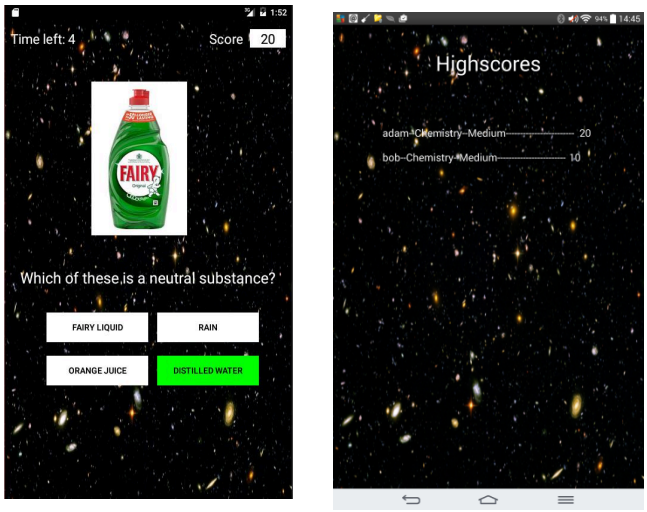


Figure 16: Welcome Screen

A spinner has been designed allowing the user to select one of the three options. Full consideration has been taken into account as regards “Fat fingers” allowing for suitable spacing between topics.
As well as this there is an option to select the player year where the questions allow the user to focus their area of study. A play button has been included to allow the player to navigate to the following screen.

Figure 17 : Question and High Score Screen



Question and High Score Screen

The Apple developer tips propose that the developer should

“Provide high-resolution versions of all image assets. Images that are not @2x and @3x will appear blurry on the Retina display”(UI design Do’s and Don’ts, 2016)
Space Master: Science includes high quality images which have been centred and have been designed to stand out against the dark background.(Figure 17)

Checks have been made for grammatical errors or spelling mistakes on all the games pages. This ensures that the user fully understands what they are being asked.
The text throughout is in white, whilst the answer buttons have white backgrounds. For a correct answer the button shows green and for wrong answers the buttons show red demonstrating clarity and visual consistency throughout the game experience.

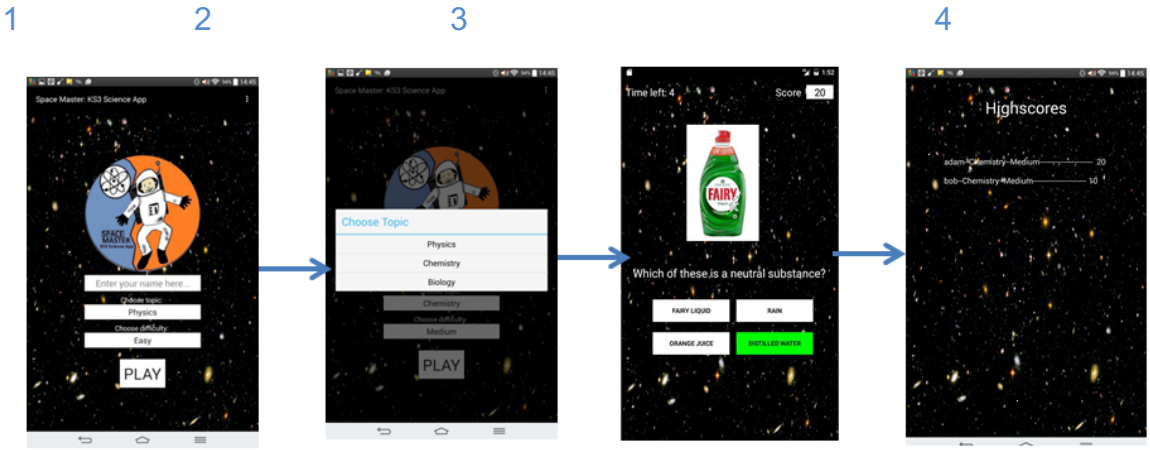
References for images used in the game can be found in the References section. A dropdown menu has been added to allow for intuitive navigation around the various pages within the app. This can be found at the top right hand corner of the screen.

Storyboard

A storyboard has been created with the design for the prototype application. It demonstrates the connection between various pages and their attributes. The storyboard demonstrates an understanding of how the various pages and their processes should evolve. The player's journey through the app should be smooth and intuitive with a clear understanding of navigation and menu options.

A diagram of the relationship between pages has been included below, Appendix 4 shows an in depth diagram of the java classes and the complex algorithms involved in each process. This ensures a clear understanding of how the game should unfold.

Figure 18: Storyboard



1. The user enters their name.
2. They select a topic to focus their study and they select a difficulty.
3. The player will begin the game by answering the questions with four possible options. They have five seconds to answer and will be given five seconds extra for every correct answer. Ten points are given for every correct answer.
4. The user is shown their score in a high score table showing their name, difficulty, topic and score.

Database

A relational database was needed in order to store information such as the players and their high scores. It was also used to store the questions for the main game screen. This was done using the internal database of the device. No external network connection is needed to run the app thus allowing it to be played anywhere at any time. Using a database internally is usually not as fast as the external option however

"the delay would probably be unnoticeable to the users if the database has only a few tables" (StackOverflow,2011)

Each table in the database is clearly named so its purpose is easily identified. All tables have primary keys so that each row can be uniquely identified. On top of this primary keys are not null. The player and high score table are connected by a foreign key within the high scores table. This is also the primary key in the player table.

The database consists of three tables: player, highscores and questions. The Player table holds the players id, which is the primary key and the player's name.

The highscores table holds information about how well the player performed when answering questions. It holds information such as the difficulty the player chose, the topic on which the questions were based on, the score itself and the player id as a foreign key. The highscores table also has a primary key, id.

Finally, the questions table holds information about each individual question.

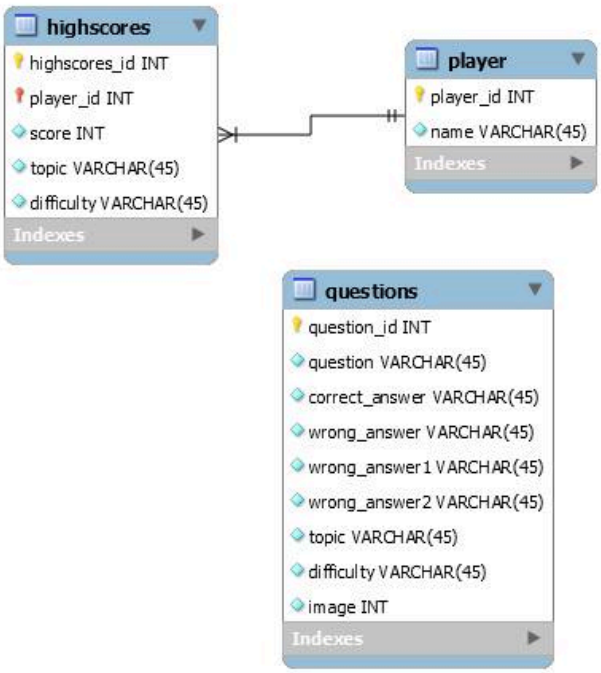


Figure 19: ER diagram to show the relationships between all 3 tables

Within the answer table are the attributes: correct answer, three wrong answer attributes, the year under which the question is classified, the topic which the question is relevant to, the question itself and an image which is associated with the question. The questions table has a primary key, id.

The id field is the primary key which uniquely identifies each question along with the question of type String, each answer which are of type String, the topic of type String, the year of type String and the image which is of type integer due to the way it is loaded into the application in android.

The tables are in 3NF as they are in 2nd normal form and have no transitive function dependency. In the highscores table all the attributes are dependent on the highscore_id and in the player table only the name is dependent on the player_id. The highscores_id determines the player_id.

Summary

The design section began by discussing various HCI Guidelines. Following this the architecture of the system was discussed in detail. The User Interface designs, colours, themes and logos have been highlighted and a story board gives a better understanding of how the system operates. The chapter concluded with an overview of the database design.

The Implementation

Introduction

The implementation chapter provides a detailed analysis of the process involved in developing *Space Master Science*. This includes:

- Hardware and software used in the production of the app and the tools used to support the development process
- A description of the approach to production.
- Details of any significant code with screenshots of specific algorithms.

Explanations of decisions and the rectification of problems will be discussed throughout the chapter.

Hardware

Initial development began on an Apple MacBook Pro which was boot camped to run windows 7. It has 4 GB of ram and a 2.66GHz Intel Core 2 Duo processor. However, it soon became apparent that this laptop was not going to support Android Studio efficiently. It was clear that a computer with 8 GB of ram and a faster process was needed.

Following this the implementation process took place on a HP desktop computer with 8 GB ram and an i7 processor.

A Lenovo Tablet running Android 4.4 Kit Kat was used to test software. A Samsung Galaxy S7 smartphone was also used to test how the app looked and performed on a smaller screen.

Software

Implementation began using Intel XDK. Considering the dynamic nature of the mobile market Intel XDXs cross platform capability seemed to be very attractive.

Using the Intel Software would allow *Space Master Science* to be produced for a range of mobile operating systems including many of the market leaders such as iOS, Android and Windows without having to make various versions for each platform.

However, it was soon clear that there were many disadvantages to using this approach to mobile app development.
A non-functional requirement was that the application was attractive to key stage 3 students and the game should have a theme. Designing a high quality user interface using HTML and JavaScript was difficult and proved to have limitations.

"The majority of successful consumer apps are built on either Native iOS or Android. Let's remember that Facebook started out with a Cross-Platform mobile app but changed directions to Native iOS and Android after realizing the User Experience was not optimal." (worryfreelabs.com 2014)

The alternative was to produce a native application for Android tablets and phones.
The fact that native apps are specific to a given platform means they can take advantage of all the key features associated with each device. Using Android Studio software would allow for high quality animation which was an important consideration in the production of *Space Master: Science*. Unlike Intel XDK, Android had a wide range of support and documentation available on both the internet and in Books. The decision to change development to Android proved to be a good choice.

The approach to development

Production on the app began using an agile development cycle.
Choosing the waterfall methodology would mean full completion of the app would be made before getting any feedback and perhaps by then the client's requirements might have changed.
Using the agile approach to development meant smaller pieces of the project were delivered earlier. This allowed for continuous feedback which proved invaluable in refining the system. The agile approach allowed for continual adaption and changes of features without issue.

Each iteration of the system was videoed and photographed. These documents were then emailed to the teacher, who replied with amendments and tweaks that were necessary in order to produce a successful app for the Northern Ireland Key Stage 3 science syllabus.

The table below provides a summary of the different cycles of production for the *Space Master: Science* application. Following this each sprint is discussed in details. Listing the implementation involved.

Sprint	Description of Implementation	Code Used	Environment
1	Started implementing application in Intel XDK, but due to various factors implementation was moved to Android Studio	HTML, CSS, JavaScript	Intel XDK with emulators
2	Start-up menu screen including backgrounds and images and data validation	Java, Android XML	Android Studio with emulator
3	Main game screen, including layout of questions and background and correct/incorrect answer Validations	Java, Android XML	Android Studio with emulator
4	Setting up database and implementing questions table to store questions	Java, MySQL	Android Studio
5	Researching questions appropriate for application and inserting into database, testing display of question in main game window	Java, MySQL	Android Studio with emulator
6	Implementing tables for highscore and players to store each individual score	MySQL	Android Studio
7	Extracting information from highscores and players tables and displaying in a highscore screen in descending order.	MySQL, Java, Android XML	Android Studio with emulator
8	Added other minor screens such as how to play, report bug and suggest a question	Java, Android XML	Android Studio with emulator

(Table 8 A table showing the implantation sprints for the system)

First Sprint

At the start of the implementation, Intel XDK was used to setup the main menu screen. Intel XDK uses HTML5, CSS and JavaScript. The app ran in a browser on the phone which interpreted the HTML, CSS and JavaScript code. Due to limited knowledge of the languages and the limited functionality of Intel XDK other options for the implementation were investigated.

```
<!DOCTYPE html>
<html>
<!--
  * Please see the included README.md file for license terms and conditions.
  -->
<head>
    <title>Science App</title>
    <meta http-equiv="Content-type" content="text/html; charset=utf-8">

    <!-- see http://webdesign.tutsplus.com/tutorials/htmlcss-tutorials/quick-tip-dont-forget-the-viewport-meta-tag -->
    <meta name="viewport" content="width=device-width, initial-scale=1, user-scalable=no">
    <style>
        /* following two viewport lines are equivalent to the meta viewport statement above, needed for Windows */
        /* see http://www.quirksmode.org/blog/archives/2014/05/html5_dev_conf.html and http://dev.w3.org/csswg/css-device-adapt/ */
        @-ms-viewport { width: 100vw ; zoom: 100% ; }  @viewport { width: 100vw ; zoom: 100% ; }
        @-ms-viewport { user-zoom: fixed ; }           @viewport { user-zoom: fixed ; }
    </style>

    <script src="cordova.js"></script>          <!-- phantom library, needed for Cordova api calls, added during build -->
    <script src="js/app.js"></script>           <!-- recommended location of your JavaScript code relative to other JS files -->
    <script src="xdk/init-dev.js"></script>
    <script src="js/dbscripts.js"></script>  <!-- normalizes device and document ready events, see README for details -->
</head>

<body style="text-align:center;">
    <div style="margin-top:25%">
    <img src="imgs/logo.png" height="200" style="border-radius:50%;"/>
    <h4 style="margin-bottom:0;">Enter your name</h4>
    <input type="text" style="border:2px solid #adadad;border-radius:5px;width:70%"/>
        <p><a href="questionWindow.html">Enter</a></p>
    </div>

</body>
</html>
```

Figure 20: Intel XDK code

Following research, Android studio was deemed the most appropriate software to complete the task in hand.

Second Sprint

The second sprint was devoted to setting up the selection screen launched on start-up; this was called Main_Activity.java, in Android Studio “Main_Activity” is the default name of the start-up class. Along with the Main_Activity class an xml layout file was created to implement the layout of the Main_Activity.

```
<EditText
    android:layout_width="300dp"
    android:padding="5dp"
    android:textAlignment="center"
    android:layout_alignParentRight="true"
    android:layout_height="wrap_content"
    android:id="@+id/playername"
    android:background="#fff"
    android:layout_gravity="center_horizon
    android:hint="Enter your name here..."
    />

<TextView
    android:textColor="#fff"
    android:text="Choose topic: "
    android:layout_gravity="center"
    android:layout_marginTop="10dp"
    android:layout_width="wrap_content"
    android:layout_height="wrap_content" /
```

```
<Spinner
    android:background="#fff"
    android:textAlignment="center"
    android:layout_width="300dp"
    android:layout_height="wrap_content"
    android:padding="5dp"
    android:id="@+id/topicspinner"
    android:layout_gravity="center"
    android:spinnerMode="dialog"
    android:layout_below="@+id/playername"
    android:entries="@array/topic_array"
    android:prompt="@string/prompt"
    />
<TextView
    android:layout_gravity="center"
    android:textColor="#fff"
    android:text="Choose year: "
    android:layout_marginTop="10dp"
    android:layout_width="wrap_content"
    android:layout_height="wrap_content" />
```

Figure 21: Layout of Main_Activity.

The image above shows part of the structure for the xml layout file for the main menu.

The main function of the Main_Activity screen is to ask players to enter their username, select their year and choose what topic of questions they want to answer. This was achieved using the built in android GUI elements such as textView and Button.

For the menus under which the user chose the difficulty and the topic, modification of the auto-generated strings.xml file was required. It needed to include the items of each dropdown menu and within the main activity xml layout file it would have to add the data within the strings.xml class to the dropdown menus.

```
<string-array name="topic_array">
    <item>Physics</item>
    <item>Chemistry</item>
    <item>Biology</item>
</string-array>

<string-array name="difficulty_array">
    <item>Year 7</item>
    <item>Year 8</item>
    <item>Year 9</item>
</string-array>
```

Figure 22: Strings.xml for the dropdown menus .

The main activity xml layout file is where the logo was added with the background including modified font and colour settings for the main menu screen.
The data was validated so that the name entered by the user could not be left blank before playing the game. The user's name, the difficulty and topic chosen would be passed onto the main question window.

Third Sprint

During the third sprint, the java file used to implement the answering of questions was created; essentially this was the main game. This class was called questionWindow.java and along with it was an Android XML layout file.

The layout file was needed to arrange the answer buttons in a grid with the answer text on each one and then the questions are displayed above the buttons along with relevant images. The user is able to see their score and the amount of time left to answer the question on the screen in the top corners.

The score is incremented according to the year selection and the time remaining is also depended on this selection. The background was added through the

layout file. The built in CountdownTimer class of Android was used to show how much time the user had remaining.

```
}

public void setupTimer(long secondsRemaining){
    timer = new CountDownTimer(secondsRemaining, 1000) {
        @Override
        public void onTick(long millisUntilFinished) {
            timeTextView.setText("Time left: "+millisUntilFinished / 1000);
            secondsLeft = millisUntilFinished;
        }
```

Figure 23: CountdownTimer class

The setupTimer method is shown above; this method implements the countdown of the timer which it displays. It takes a parameter of type long which is the amount of time remaining. A new object is created which takes the time left along with the interval. The onTick method is called after each interval passes so it updates the text in the textbox and sets the secondsRemaining variable to how long is left.

Fourth Sprint

During the fourth sprint a database was developed to hold all the questions in Android Studio. This database was the internal database of the device and was created using MySQL with java being used to link the data from the relations into the application functionality. The images of the questions were taken from various science websites and each image related to the question. (Referenced in references sections)

A questions relation with the attributes id, question, correct answer, 3 wrong answer attributes, image, topic, difficulty was setup. Once complete the questions were chosen from the database based on topic and difficulty and put into an array list and then a random number generator was used to display the chosen question on screen. Following this a fifty-fifty button was added which allowed the user to remove two wrong answers, but could only be used for every 4 correctly answered questions.

Figure 24: query to create the questions table upon creation of the database

```
    db.execSQL(
            "create table questions " +
                    "(id integer primary key, question text, correctanswer text, wronganswer1 text," +
                    " wronganswer2 text, wronganswer3 text, image integer, topic text, difficulty text);"
    );
}
```

Figure 25: selects the questions from the database based on topic and difficulty chosen

```
Cursor res =  db.rawQuery( "select * from questions where topic = ? and difficulty =?",
        new String[]{topic, difficulty});
```

Figure 26: removeWrongAnswers method

```
public void removeWrongAnswers(){
    int chosenWrongAnswer1 = random.nextInt(4);
    int chosenWrongAnswer2 = random.nextInt(4);

    while((chosenWrongAnswer1 == chosenWrongAnswer2) ||
            ((questions.get(randomNumber).getCorrectAnswer()== answers.get(chosenWrongAnswer1))
                    ||(questions.get(randomNumber).getCorrectAnswer()== answers.get(chosenWrongAnswer2))))
    {
        chosenWrongAnswer1 = random.nextInt(4);
        chosenWrongAnswer2 = random.nextInt(4);
    }
        answers.set(chosenWrongAnswer1, "");
        answers.set(chosenWrongAnswer2, "");

        answerA.setText(answers.get(0));
        answerB.setText(answers.get(1));
        answerC.setText(answers.get(2));
        answerD.setText(answers.get(3));
```

In the removeWrongAnswers method, 2 random wrong answers are chosen by firstly getting two random numbers. The numbers keep randomising if they are the same or if either answer chosen to be removed is the correct answer.

The two wrong answers are set to blank strings and printed on the buttons.

Fifth Sprint

The highscores needed to be stored in a database relation and linked with a foreign key to a players relation; once again this was done using the internal database of the device and in MySQL using java to link to the android application.

```
public boolean insertQuestion (String question,String correctAnswer,String wrongAnswer1,String wrongAnswer2,
                               String wrongAnswer3,int image, String topic, String difficulty)
{
    SQLiteDatabase db = this.getWritableDatabase();
    ContentValues contentValues = new ContentValues();
    contentValues.put("question", question);
    contentValues.put("correctanswer", correctAnswer);
    contentValues.put("wronganswer1", wrongAnswer1);
    contentValues.put("wronganswer2", wrongAnswer2);
    contentValues.put("wronganswer3", wrongAnswer3);
    contentValues.put("image", image);
    contentValues.put("topic", topic);
    contentValues.put("difficulty", difficulty);
    db.insert("questions", null, contentValues);
    return true;
}
```

Figure 27: insertQuestion method

Sixth Sprint

During the sixth sprint, the highscores were added to the game. The users score is automatically added to the database once they reach the highscore screen and using SQL commands the top 10 highscores are displayed in descending order along with the difficulty(year) played, topic chosen and name of the user and this is added to an arrayList, looping through the list to display on the screen. Once again, a layout XML field was used for display purposes. The highscores screen was tested with different topics and difficulties.

```
if(scores.size() > 0){

    for (int i=0;i<scores.size();i++){
        highScores.append(scores.get(i).getName()+"--"
                +scores.get(i).getTopic()+"--"+
                scores.get(i).getYear()+"------------------------\t" +
                scores.get(i).getScore()+"\n\n");

    }
```

Figure 28: displays the highscores on the screen by looping

```
db.execSQL(
        "create table highscores " +
                "(id integer primary key, name text, score integer, topic text, year text);"
);
```

Figure 29: creates the highscores table upon creation of the database

The highscores table was created and within the program the player name was included in the table. This was done to save time however if it was to be done again there would be two relations, one of player and one of highscores both linked by a foreign key which was highlighted earlier in this document.
The way this was implemented within the program worked well despite the changes to the initial plan. The benefits of doing it differently the second time round would mean the database would be more normalized so query execution would be more efficient and there would be greater data integrity.

Seventh Sprint

During the seventh sprint questions started being inserted into the database. All questions used were from the CCEA Key Stage 3 science curriculum.

```
public void initQuestions(){

    db.insertQuestion("What state is shown in the following image?", "Solid", "Liquid", "Gas", "Dogs", R.drawable.soli
    db.insertQuestion("What does this symbol mean?", "Corrosive", "Flammable", "Harmful", "Stop", R.drawable.corrosive
    db.insertQuestion("What is formed when a metal carbonate reacts with an acid?", "A salt, water and carbon dioxide",
    db.insertQuestion("What does this image show?", "Element", "Mixture", "Compound", "Nothing", R.drawable.element, "
    db.insertQuestion("Which of these is a neutral substance?", "Distilled Water", "Rain", "Orange Juice", "Fairy Liqu
```

Figure 30: inserts questions into database

The initQuestions method calls the insertQuestion method of the DatabaseHelperClass and passes in all of the relevant information of each question. This method is only called once as it counts the rows in the database and if there are not rows the method returns null.

```
ArrayList<questions> array_list = new ArrayList<questions>();
    SQLiteDatabase db = this.getReadableDatabase();
    Cursor res =  db.rawQuery( "select * from questions where topic = ? and difficulty =?",
            new String[]{topic, difficulty});
    res.moveToFirst();

    if(res.getCount()==0){
        return null;
    }
    while(res.isAfterLast() == false){
        array_list.add(new questions(res.getString(res.getColumnIndex(QUESTIONS_COLUMN_QUESTION))
                , res.getString(res.getColumnIndex(QUESTIONS_COLUMN_CORRECTANSWER)),
                res.getString(res.getColumnIndex(QUESTIONS_COLUMN_WRONGANSWER1)),
                res.getString(res.getColumnIndex(QUESTIONS_COLUMN_WRONGANSWER2)),
                res.getString(res.getColumnIndex(QUESTIONS_COLUMN_WRONGANSWER3)),
                res.getInt(res.getColumnIndex(QUESTIONS_COLUMN_IMAGE)),
                res.getString(res.getColumnIndex(QUESTIONS_COLUMN_TOPIC)),res.getString
                (res.getColumnIndex(QUESTIONS_COLUMN_DIFFICULTY))));
        res.moveToNext();
    }
    return array_list;
}
```

Figure 31: getAllQuestions method gets all questions from the database and adds to arrayList

Following this the multiple choice functionality, was rigorously tested to ensure when the correct answer was chosen the next question was displayed, score and time remaining was increased and when an incorrect answer was given that the score was reset to zero and another question was chosen at random. Once the time was up the plan was to have the user's advance to the high score screen.

```
public void checkAnswer(Button button){
    if(button.getText().equals(questions.get(randomNumber).getCorrectAnswer())){
        button.setBackgroundColor(Color.GREEN);
        score = score +10;
        scoreTextView.setText(""+score);

        handler.postDelayed(() -> {
                secondsLeft+=5000;
                timer.cancel();
                addQuestionToScreen();

        }, 1000);

    }else{
        score = 0;
        scoreTextView.setText(""+score);
        button.setBackgroundColor(Color.RED);
        timer.cancel();

        handler.postDelayed(() -> { addQuestionToScreen(); }, 1000);
```

Figure 32: checkAnswer method

This method checks for the correct answer after a user has chosen. It checks the txt of the button the user has clicked against the correct answer in the arrayList and if true it increments the score by 10. The handler is set to delay the time between the user choosing the answer and a new question showing so that buttons change colour to green if correct and red if incorrect. The procedure is delayed by 1 second. If the user is incorrect the score is reset to zero.

Eighth Sprint

With the main functionality of the game mostly complete, the users needed to have access to a screen which explained the main features of the game and how to play. The how to play screen was added along with a suggest a question screen, which allows users to email questions which they think would be worth adding to the game and also a report a bug feature which will help developers maintain the application, detect faults and update them with a release in the feature.

Programming aids

The programming of *Space Master: Science* did not come without its difficulties and frustrations.
The following sources were used to aid implementation. The knowledge gained from the following documentation was crucial in the success of the Key Stage 3 science application.

- Stack Overflow
- YouTube- thenewboston
- developer.android.com

Summary

The implementation section began by listing the hardware and software used in creating *Space Master: Science*. The approach to implementation was discussed and the various sprints involved in production were detailed. Any resources that have been used to help aid the production of the app have been documented.

Testing and Evaluation

Introduction

The testing chapter provides a detailed description of the thorough process involved in testing *Space Master Science*. The primary methods of testing included: in-house developer testing and the use of several focus groups. These approaches are explained and results are discussed. Both praise and criticism of the system have been analysed allowing for an overall evaluation of the final product.

Hardware

A Lenovo Tablet running Android Lollipop 5.1.1 was used primarily to test software. Final testing was done on a Samsung Galaxy S7 smartphone running Android 6.0.1 Marshmallow and a cheap tablet running 4.4 Kit Kat. This allowed for an overview of what the app looked like on a range of screen sizes and how it performed on distinct versions of the android operating system.

Developer- Software Testing

As *Space Master Science* has been developed as an application for Android OS it was crucial that the app was tested on the three most recent versions of Android. Testing was done using Kit Kat, Marshmallow and Lollipop to ensure user requirements and HCI guidelines were met respectively.
An overall checklist was comprised using criteria from the requirements and an inventory of the key features within the app. The table below presents the benchmarks and results of the testing process. The full table of results can be found in appendix 7 which includes full testing of the functionality for each year and topic selection. All the test criteria were passed on each version of the Android system.

.

(Table 9: A table showing the testing of the system)

Test Criteria	4.4 Kit Kat	6.0.1 Marshmallow	Lollipop 5.1.1
QUESTION WINDOW			
Pop up if no name entered	✓	✓	✓
Topic Selection functionality	✓	✓	✓
Year Selection functionality	✓	✓	✓
Press play to proceed to the next page	✓	✓	✓
Dropdown- High Scores	✓	✓	✓
Dropdown- Report a problem	✓	✓	✓
GAME WINDOW (Full testing of functionality for each year and topic selection can be found in appendix 7)			
Time left: countdown	✓	✓	✓
Score- adds points for correct answers	✓	✓	✓
Score zeroed for incorrect answers	✓	✓	✓
Correct answer green, incorrect answer red	✓	✓	✓
50/50 option working fully	✓	✓	✓
Quit option	✓	✓	✓
Proceed to high score page when time out	✓	✓	✓
High score window			
Try again button	✓	✓	✓
Navigation	✓	✓	✓

Developer- Hardware testing

As the app isn't always going to be played on a tablet with high performance specification it was important to view how it would perform and look on various pieces of hardware. A cheap tablet was bought on eBay for £20 to compare its performance against the Lenovo tablet.

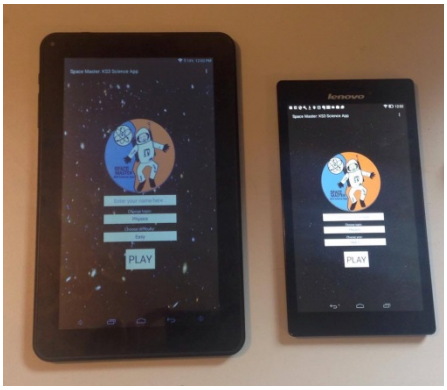


Figure 33: App performing on multiple hardware

There was noticeable difference on how the app looked, the screen quality on the cheap tablet left colours looking washed out in comparison to the more expensive Lenovo. Despite this, the app performed just as well, all the features worked perfectly and the screen quality did not have a major effect on the overall user experience. (Figure 33)

User Testing and evaluation

A selection of six children and two Teachers from the original focus group tested the final app. Each participant was asked to complete a questionnaire rating various functions and features of the application out of 5. The focus group were given a Lenovo Tablet and a Samsung Galaxy S7 smartphone. It was decided the cheap tablet should not be used for this part of the evaluation so that testing apparatus were of equal specification.

Appearance

The first section in the questionnaire focused on the appearance of the application. The participants rated each point relating to the appearance out of 5.

- Appeal for Key Stage 3 Student
- Colour scheme
- Layout of text and images
- Clarity

Included was a comments box were the participants could explain further details of their experience.

The table below shows the average mark for each point relating to the appearance of the system. (Each mark has been rounded to the nearest whole number) *(Table 10: A table showing the average marks for appearance of the system)*

Point		Average mark
1	Appeal for Key Stage 3 Student	5
2	Colour scheme	4
3	Layout of text and images	4
4	Clarity	4

Regarding the apps appeal one correspondent commented that the space theme was an attractive additional feature for the young Key Stage 3 learners.

Four of the correspondents rated the colour scheme 4/5 whilst the remainder awarded 3/5. A member of the group commented that perhaps the play button should feature colour rather than a grey button. A new colour scheme for this button could be implemented in the next version.

Although the testers said the app was clear and easy to read, a few members suggested that amendments could be made to the sizing of buttons especially within the game window. The developer agrees and this will be considered in any additional versions of the application.

Functionality and Features

The second section in the questionnaire focused on the functionality of the application. The participants rated each page for functionality out of a possible 5 marks. *(Table 11: A table showing the average marks for Functionality and Features of the system)*

Point	Page	Average mark
1	Welcome Page	5
2	Game Page	4
3	High Score Screen	3
4	Menus / Navigation	4

Again, this section ended with a comments box. In general the focus group rated the functionality of the system highly, they liked that they could focus their learning and liked that the games difficulty increased depending on year selection. Another positive comment was on the functionality of the welcome screen. The focus group appreciated that their name was automatically saved and entered following selection of the try again option.

A constructive piece of feedback on functionality was on the high score screen. A teacher suggested that maybe the system could record all the scores so that the user could perform analysis on results, for example identifying the best/worst answered questions.

Content

The third section questioned the user's opinion of the content within the app
(Table 12: A table showing the average marks for content of the system)

Point		Average mark
1	Range of content covered	5
2	Entertainment	4
3	Motivational	4
4	Rewarding	4

Although the students and teachers agreed that there was a good range of content within the app a few commented on ways to improve the entertainment factor suggesting that the game could increase the number of possible answers as the game progressed. This is a good suggestion and certainly will be considered in any further implementation of the system.

Dealing with user requirements

The final section of the questionnaire was designed to ascertain whether or not the focus group believed all the system requirements were achieved.

The system requirements were listed and participants were asked if they agreed or disagreed that the specification was achieved.

100% of the focus group agreed that all the specifications set within the user stories and non-functional and functional requirements were achieved.

Unbiased user testing

Following in house testing and testing from the focus group it was important to get an unbiased opinion of the final product. The app was given to two key stage 3 students who had no previous involvement in the apps development. They tested and evaluated the app giving an overall review of their experience.

The children agreed that:

- The app was attractive to Key Stage 3 Students
- They liked the Space Theme and logo
- The app was challenging
- The app featured content that they were learning in class

- It was easy to navigate around the various functions within the app

The children's feedback was generally very positive however they did offer some constructive feedback suggesting that app should develop the space theme further with additional characters and animation. This has been duly noted and will be considered in any further developments of Space: Master Science

Summary

The Testing and Evaluation chapter has described the hardware and software which has been used to test *Space Master: Science*. The various techniques and approaches to software testing have been explained. Feedback and critique from focus groups have allowed the developer to build an overall conclusion with regards to the success of the final product.

Conclusion

Summary

An investigation into education in Northern Ireland revealed that many Key Stage 3 students are struggling to understand science. This in turn has led to a much greater concern for the Northern Irish economy.

Questionnaires were conducted to get a greater appreciation of the problem specific to Northern Ireland. Teachers and Children from schools in the Mid Ulster area participated in the survey and their views were in correlation with much of the background research. It was clear that School children in Northern Ireland needed support in learning key stage 3 Sciences.

Following this, existing solutions to the problem were investigated. Initially, a website with specific content to the Northern Ireland syllabus was deemed as the most appropriate solution to the problem. However, with further research it was clear that creating an app had a much greater market potential.

Research into the current market for science apps was conducted. Recommendations were made and along with feedback from the focus group a list of requirements was made. The developer has considered this speciation as well as HCI guidelines when designing and implementing the functionality of the *Space Master: Science* app.

The design process began by drawing up mock-ups of the potential user interface. Colour schemes, architecture and various user interface designs were shared with the stake holders and they suggested and recommended changes that would be implemented in the development of a prototype application.
The architecture and miscellaneous blueprints have been included in the design chapter of this document.

Implementation began using an agile approach to development. Java, SQL and XML languages were used to create the prototype application. The agile approach allowed the app to be built in cycles where stakeholders would give feedback with each iteration.

Following completion of the app, the testing and evaluation process took place. Thorough and rigorous testing of the app ensured that the app had met all the specifications. The use of questionnaires and discussions with a focus group have led to an overall evaluation of the product.

Assessment of application

All of the criteria stipulated in recommendations and the requirements set by the focus group have been met. Testing and evaluation has proven that this app has successfully implemented all the stakeholder's expectations of how a Key Stage 3 Science app should look and perform.

Space Master: Science has a user friendly interface which allows players to navigate freely around the system. Menus allow for intuitive navigation granting students the means to focus learning and accomplish their goals in each area of the science discipline. The use of the CCEA syllabus means that content matches what the children are learning about in school.
Space Master: Science has clear and precise information with multiple choice questions allowing a player to test their knowledge whilst ultimately having fun. Within the game questions can be repeated, testing a student's memory and giving them confidence that they have learned something new.

The multiple choice questions have proven to be effective. However, additional activities and games could be included to give the game more variety.

Count down timers and a point based system motivate learning and encourage self-improvement. A high score window is a means to view achievements, providing parents and guardians a way to access a child's learning.

The high score screen is informative, however it has limitations. It only shows a list of the top ten results. On top of this it does not show when the student got these results. This could be restrictive if a parent is trying to access any improvements in their child's performance.

The space theme should be implemented further with additional characters and animations (See appendix 6) a variety of game mascots would keep players interested and motivated. The use of this theme attracts the young players and is an invaluable feature in an app whose target audience is of young teenage students.

Setting clear and achievable goals, objectives and carrying out thorough research was a key factor in the success of this project. An agile approach to development proved to be an effective way to tackle the problem. Continuous feedback allowed for progress and for improvement of skills. Regular meetings with a project supervisor insured that deadlines were being kept throughout the development process.

The project did not come without its problems and it was necessary to adapt and improve the much needed skills to achieve all the specification. Websites such as YouTube and Stackoverflow allowed understanding of new ways to tackle problems. These helpful resources and a supportive, thorough project supervisor were without doubt an additional catalyst in the production of this application.

Recommendations

After many discussions with stakeholders and game testers the following recommendations have been made for future developments of *the Space Master: Science* application.

- Extend space theme with additional characters. Animation could be a good feature. A plot alongside the game could capture the player's imagination and increase their attention span.

- Regarding the design, further spacing of questions and the sizing of images should be implemented to make full use of the game screen.

- Additional activities and content could be included to give the game more variety.

- The high score screen could show the date in which a score has been achieved. This would help parents access their child's performance.

The focus group have stated that *Space Master: Science* has matched all their recommendations and specification. The schools used in the focus group have been provided with copies of the *Space Master: Science* application and the app will be used as an additional resource within the classroom. The recommendations will be considered in any further developments of the *Space Master: Science* application.

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Appendix 1: Ofsted: Key Stage 3 the wasted years?

Ofsted

Overall, the survey found that, while pupils generally had the opportunity to study a broad range of subjects throughout Key Stage 3, in too many schools **the quality of teaching and the rate of pupils' progress and achievement were not good enough**.

Inspectors reported concerns about Key Stage 3 in one in five of the routine inspections analysed, particularly in relation to the **slow progress made in English and mathematics** and the **lack of challenge for the most able pupils**.

Inspectors observed MFL, history and geography lessons at Key Stage 3 in 51 routine inspections carried out during June and July 2015. Inspectors reported significant weaknesses in all three subjects. Too often, inspectors found teaching that failed to challenge and engage pupils. Additionally, low-level disruption in some of these lessons, particularly in MFL, had a detrimental impact on the pupils' learning. **Achievement was not good enough in just under half of the MFL classes observed, two-fifths of the history classes and one third of the geography classes.**

It is no surprise, therefore, that there is low take-up in these subjects at GCSE. Some pupils told inspectors that they were not taking these EBacc subjects at Key Stage 4 because they did not enjoy them or had found them difficult at Key Stage 3, particularly MFL. A small number made an explicit link between their choices and the quality of teaching that they had received at Key Stage 3. **This is a serious concern given the government's ambition for all pupils starting Year 7 in September 2015 to take the EBacc subjects when they reach their GCSEs in 2020.**[4] Improving the Key Stage 3 provision in these subjects will be crucial to raising the EBacc success rate in the coming years.

The weaknesses in teaching and pupil progress identified by inspectors reflect **the lack of priority given to Key Stage 3 by many secondary school leaders**. The majority of leaders spoken to as part of this survey said that they **staffed Key Stages 4 and 5 before Key Stage 3**. As a result, some Key Stage 3 classes were split between more than one teacher or were taught by non-specialists.[5]

The status of Key Stage 3 as the poor relation to other key stages was exemplified in the way schools monitored and assessed pupils' progress. Inspectors found that **too many secondary schools did not work effectively with partner primary schools to understand pupils' prior learning and ensure that they built on this during Key Stage 3**. Worryingly, some secondary leaders simply accepted that pupils would repeat what they had already done in primary school during the early part of Key Stage 3, particularly in Year 7.

[4] Policy paper: English Baccalaureate (EBacc), Department for Education, June 2015; www.gov.uk/government/publications/english-baccalaureate-ebacc/english-baccalaureate-ebacc

[5] A 'non-specialist' is defined as a teacher who does not have that subject as part of their undergraduate or teaching qualification.

Ofsted

In addition, half of the pupils surveyed said that their homework never, or only some of the time, helped them to make progress. Inspectors found that, too often, homework did not consolidate or extend pupils' learning.

It was evident that some school leaders did not use **the pupil premium effectively in Key Stage 3 to ensure that gaps between disadvantaged pupils and their peers continued to close on transition to secondary school.** Instead, any additional support was typically focused on intervention activities in Key Stage 4, which often sought to compensate for ineffective practice in the earlier years of secondary education.

In general, careers education, information, advice and guidance (CEIAG) was particularly sparse in Year 8 and improved only slightly in Year 9. In schools that offered it, CEIAG typically focused on option choices for Key Stage 4 but lacked any advice on the GCSEs required for different careers.

Nevertheless, inspectors also found examples of good practice. In the best secondary schools, leaders set the right culture and ethos to create the kind of orderly, purposeful learning environment that is the bedrock for successful learning. Teachers had a comprehensive understanding of pupils' prior learning, gained through well-established ways of working with their partner primary schools. As a result, they were able to ensure that they built on this at Key Stage 3. The headteachers in these schools made Key Stage 3 a high priority for all staff, pupils and parents. In order for secondary schools to continue to improve, this good practice needs to become the norm.

Key findings

- **The Key Stage 3 curriculum in the schools surveyed is generally broad and balanced.** Almost all schools offer the full range of Key Stage 3 national curriculum subjects. Most senior leaders reported that they allocate around two fifths of curriculum time to core subjects.
- **Inspection evidence highlights weaknesses in Key Stage 3.** From September 2014 to March 2015, one in five inspection reports identified Key Stage 3 as an area for improvement. Where weaknesses are identified, these concerns are typically around the leadership, challenge for pupils and quality of teaching.
- **Too frequently, teaching in MFL, history and geography at Key Stage 3 does not lead to good levels of achievement.** Evidence from 51 routine inspections chosen randomly in the summer term 2015 indicates that in just under half of the classes observed in MFL, approximately two fifths in history and one third in geography, achievement was not good enough. In these lessons, pupils were not challenged or engaged sufficiently. Low-level disruption was a key detractor from the pupils' learning, particularly in MFL.
- **Key Stage 3 is not a high priority for many secondary school leaders in timetabling, assessment and monitoring of pupils' progress.** Eighty five per cent of senior leaders interviewed said that they staff Key Stages 4 and 5

Appendix 2: Teacher Questionnaire

Teacher

Key stage 3 Science

1. Which part of science do your students struggle mostly with?

Biology Chemistry Physics

2. Which areas of Biology do your students find most difficult?

Photosynthesis

3. Which areas of Chemistry do your students find most difficult?

Chemical reactions

4. Which areas of Physics do your students find most difficult?

Moments

5. How often do you assign homework which involves the use of ICT ?

Rarely

6. How often do you use ICT software within your classroom (Word processing, Games, Websites)

Very Often Often Sometimes Never

7. Do your pupils use websites or software to aid their research and learning?

Yes Not Sure No

8. Do you think your students would benefit from using a tablet/smartphone app to help learning KS3 Science?

Yes Not Sure No

9. Would you agree that the use of games in general helps pupils of different abilities in their learning?

Yes Not Sure No

10. Do you think that if there was a science app that involved playing games that this could help pupils to learn Key Stage 3 science?

Yes Not Sure No

Thank you for your valuable assistance in my research.

Key stage 3 Science

1. Which part of science do your students struggle mostly with?

Biology Chemistry Physics

2. Which areas of Biology do your students find most difficult?

respiratory system, heart structure

3. Which areas of Chemistry do your students find most difficult?

Recognising elements in compounds

4. Which areas of Physics do your students find most difficult?

Electricity, speed = distance/time, magnetic fields, refraction

5. How often do you assign homework which involves the use of ICT ?

once a month (feel that I can't use it more often as some pupils say they don't have access to internet)

6. How often do you use ICT software within your classroom (Word processing, Games, Websites)

Very Often Often Sometimes Never

7. Do your pupils use websites or software to aid their research and learning?

Yes Not Sure No

8. Do you think your students would benefit from using a tablet/smartphone app to help learning KS3 Science?

Yes Not Sure No

9. Would you agree that the use of games in general helps pupils of different abilities in their learning?

Yes Not Sure No

10. Do you think that if there was a science app that involved playing games that this could help pupils to learn Key Stage 3 science?

Yes Not Sure No

Thank you for your valuable assistance in my research.

TEACHER COPY

Key stage 3 Science

Teacher to complete and return to Miss Hanson.

1. Which part of science do your students struggle mostly with?

Biology Chemistry Physics

2. Which areas of Biology do your students find most difficult?

Long names, amount of information

3. Which areas of Chemistry do your students find most difficult?

Acids, Alkalis, Chemical Reactions, Names of Chemicals, Materials.

4. Which areas of Physics do your students find most difficult?

Forces, Equations

5. How often do you assign homework which involves the use of ICT ?

rarely

6. How often do you use ICT software within your classroom (Word processing, Games, Websites)

Very Often Often Sometimes Never

7. Do your pupils use websites or software to aid their research and learning?

Yes Not Sure No

8. Do you think your students would benefit from using a tablet/smartphone app to help learning KS3 Science?

Yes Not Sure No

9. Would you agree that the use of games in general helps pupils of different abilities in their learning?

Yes Not Sure No

10. Do you think that if there was a science app that involved playing games that this could help pupils to learn Key Stage 3 science?

Yes Not Sure No

Thank you for your valuable assistance in my research.

Appendix 3: Students Questionnaire

Key stage 3 Science

1. Which part of science do you find most difficult?

Biology Chemistry Physics

2. Do you use a computer to help your research and learning in science?

Yes No

3. Have you ever used a tablet/smartphone app to help learning in any subject?

Yes Not Sure No

Which subject? English

4. Have you ever used a tablet/smartphone app to help learning KS3 Science?

Yes Not Sure No

Which apps?

5. Do you enjoy using games to make your school work more fun?

Yes Not Sure No

6. Do you think that if there was a science app that involved playing games that this could help you to learn Key Stage 3 science?

Yes Not Sure No

7. What apps/games do you enjoy using on your tablet/ smartphone?

Snapchat, Instagram, Youtube, Facebook, Whats my I.Q?

8. What do you like about these apps?

They're fun to use.

Key stage 3 Science

1. Which part of science do you find most difficult?

Biology Chemistry Physics

2. Do you use a computer to help your research and learning in science?

Yes No

3. Have you ever used a tablet/smartphone app to help learning in any subject?

Yes Not Sure No

Which subject? English

4. Have you ever used a tablet/smartphone app to help learning KS3 Science?

Yes Not Sure No

Which apps? google

5. Do you enjoy using games to make your school work more fun?

Yes Not Sure No

6. Do you think that if there was a science app that involved playing games that this could help you to learn Key Stage 3 science?

Yes Not Sure No

7. What apps/games do you enjoy using on your tablet/ smartphone?

google

8. What do you like about these apps?

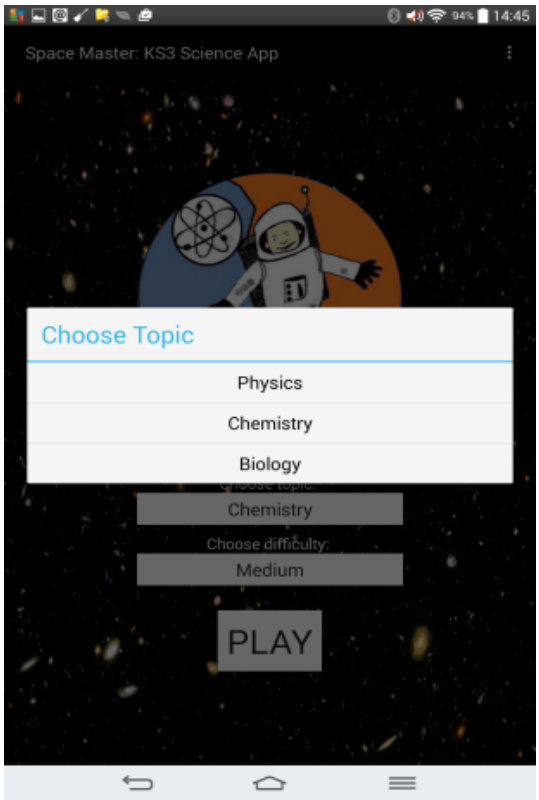
not sure

Appendix 4 Storyboard with Algorithms

1. The user enters their name and the system will allow the player to proceed if one or more characters are entered.

IF play selected AND username contains one or more characters THEN load questionWindow.java

2. They select a topic to focus their study and they select their year.



IF year selected is Year 7 THEN set difficulty to easy AND set secondsLeft to 15 load questions from database WHERE difficulty = 'easy' into questions ArrayList. ELSE IF year is Year 8 THEN set difficulty to medium AND set secondsLeft to 10 AND load questions from database WHERE difficulty = 'medium' into questions ArrayList.
ELSE

3. The player will begin the game by answering the questions with four possible options. The player will be given ten seconds for every question and will be given ten seconds extra for every correct answer; the ten seconds will be added to the time remaining on the previous questions. Ten points are given for every correct answer.
The user has a 50/50 option which can be used once through the game.

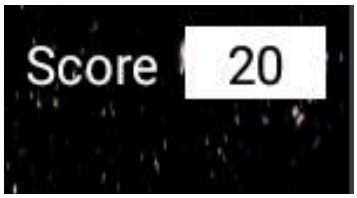
IF user chooses correctAnswer

THEN set button clicked to green and add bonus to score

ELSE

THEN reset score to 0 and set button clicked to red

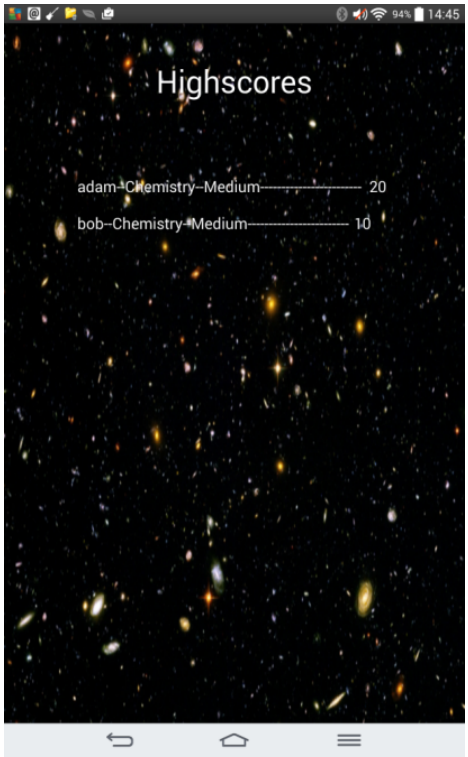
Randomise index and choose question from ArrayList and display on screen.



IF user clicks fiftyfiftyButton

THEN remove two incorrect answer buttons and disable fiftyfiftyButton

4. The user is shown their score in a high score table showing their name, difficulty, topic and score.

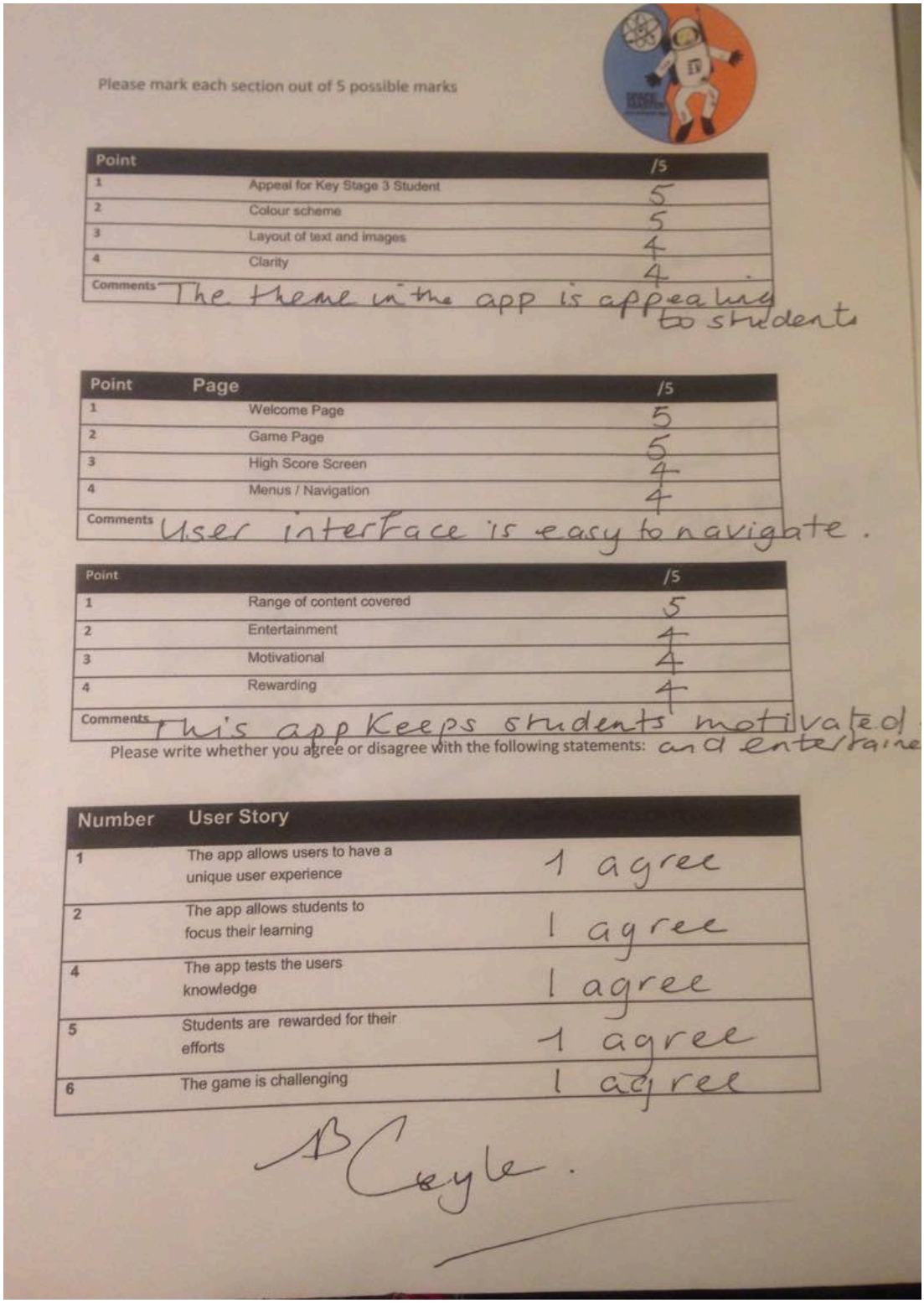


IF time reaches 0 THEN load highscoresScreen.java AND save score to database and display top 10 highscores

5. The user can navigate around the various screens using the dropdown menu

IF user chooses highScores THEN load highScores.java ELSE IF user chooses reportaProblem

Appendix 5: Questionnaire 2



Please mark each section out of 5 possible marks

Point		/5
1	Appeal for Key Stage 3 Student	5
2	Colour scheme	5
3	Layout of text and images	4
4	Clarity	4
Comments	The theme in the app is appealing to students	

Point	Page	/5
1	Welcome Page	5
2	Game Page	5
3	High Score Screen	4
4	Menus / Navigation	4
Comments	User interface is easy to navigate.	

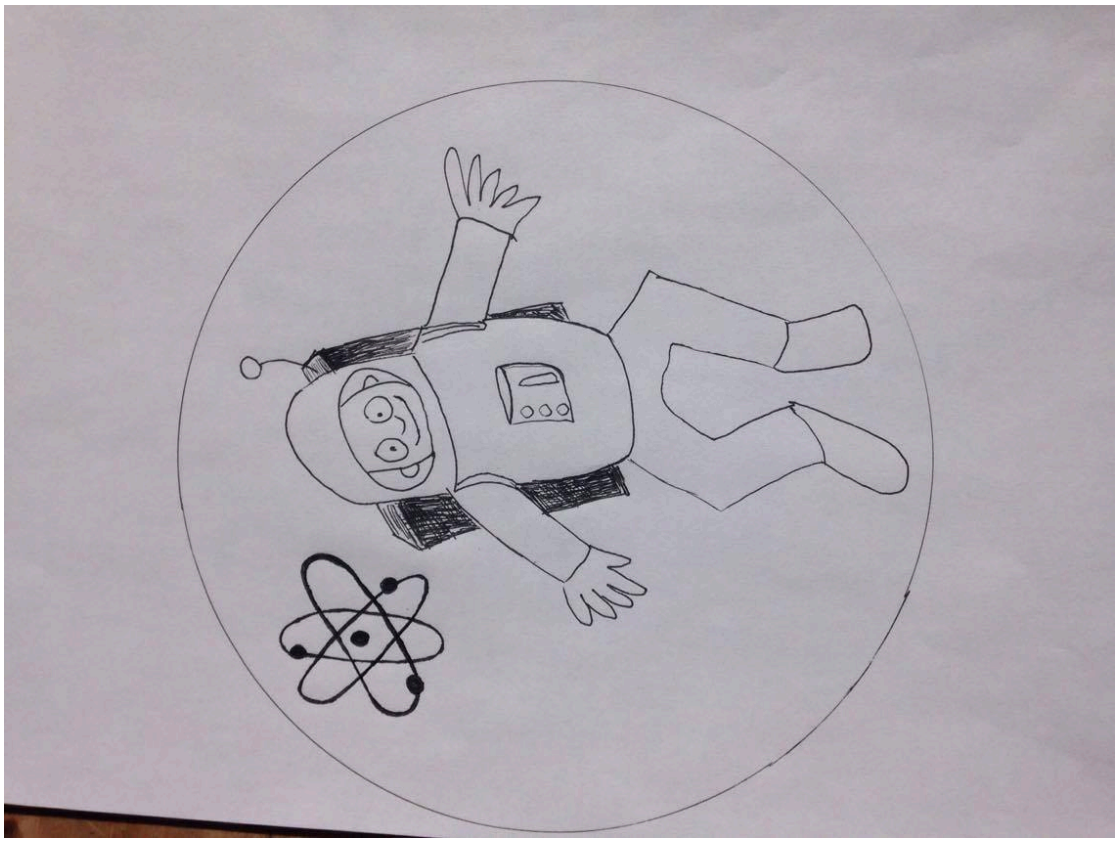
Point		/5
1	Range of content covered	5
2	Entertainment	4
3	Motivational	4
4	Rewarding	4
Comments	This app Keeps students motivated and entertaine	

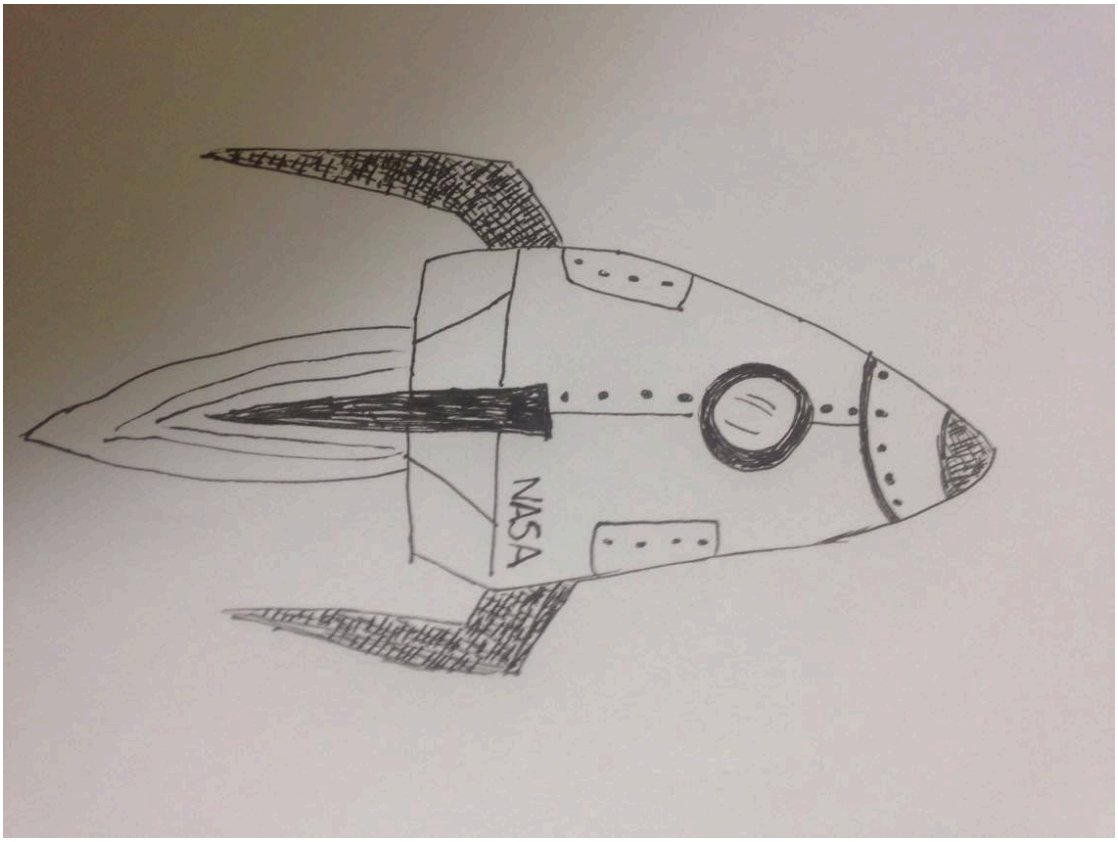
Please write whether you agree or disagree with the following statements:

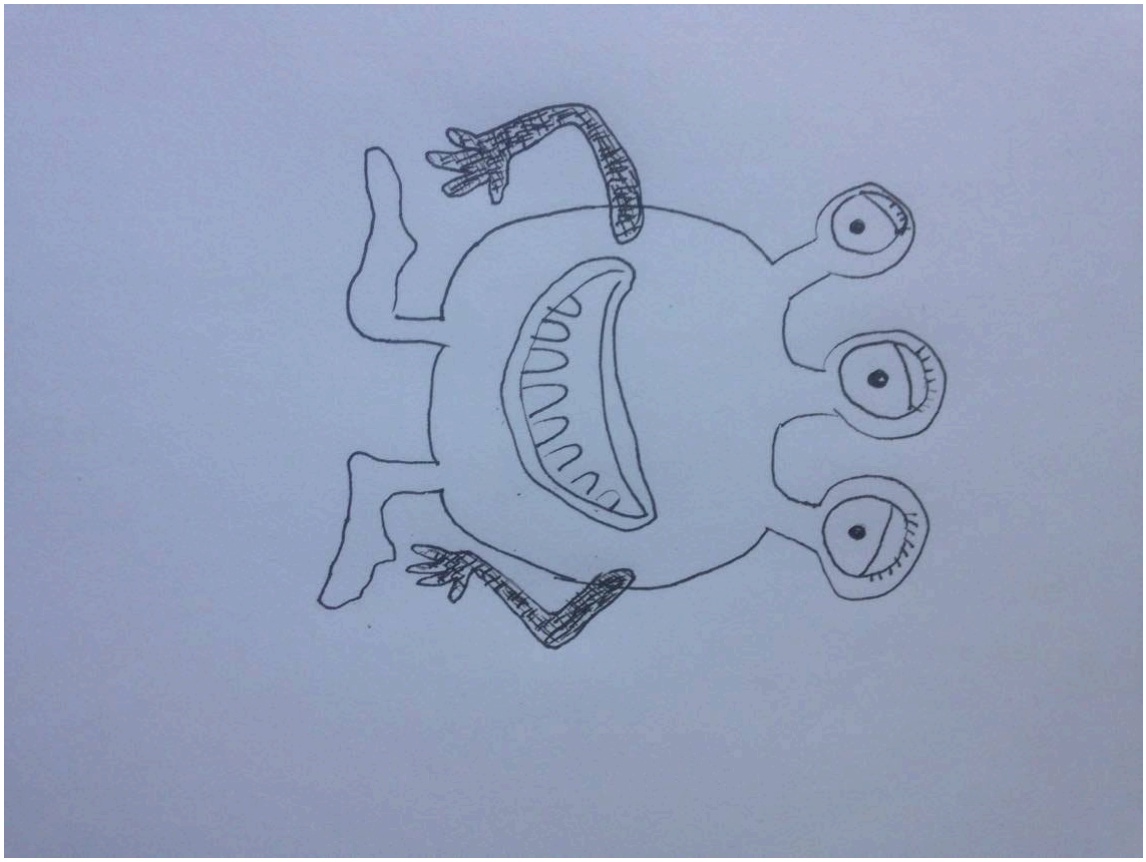
Number	User Story	
1	The app allows users to have a unique user experience	1 agree
2	The app allows students to focus their learning	1 agree
4	The app tests the users knowledge	1 agree
5	Students are rewarded for their efforts	1 agree
6	The game is challenging	1 agree

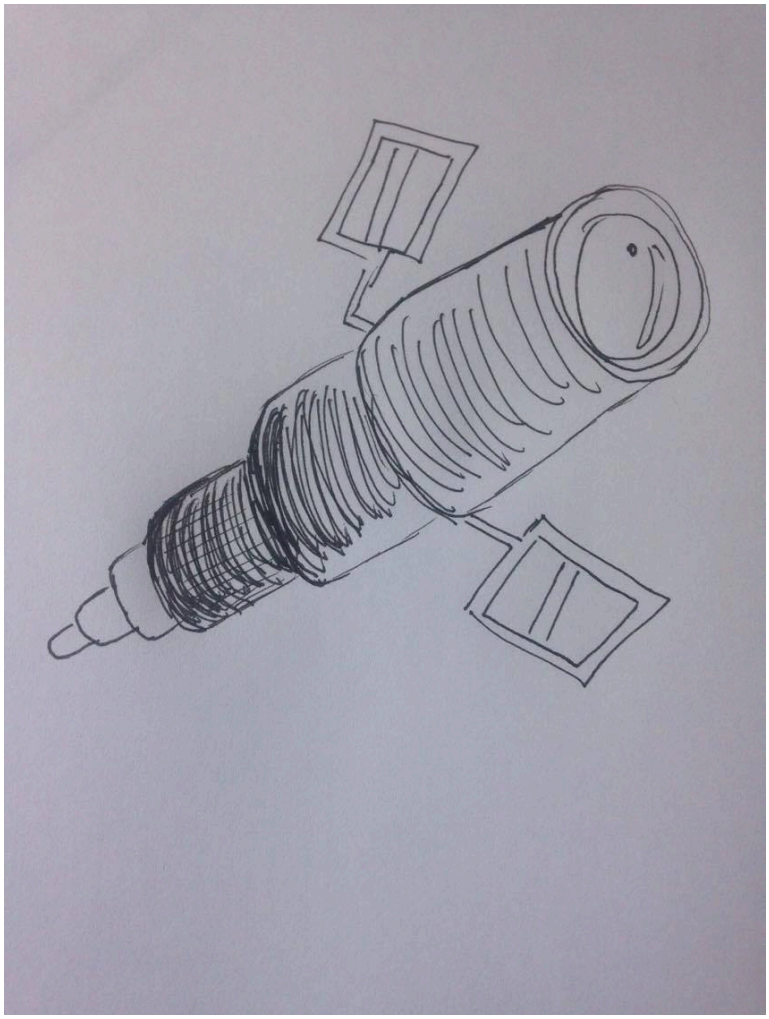
B Coyle.

Appendix 6 Drawings









Appendix 7: Full testing of the system

Test Criteria	4.4 Kit Kat	6.0.1 Marshmallow	Lollipop 5.1.1
QUESTION WINDOW			
Pop up if no name entered	✓	✓	✓
Topic Selection functionality	✓	✓	✓
Year Selection functionality	✓	✓	✓
Press play to proceed to the next page	✓	✓	✓
Dropdown- High Scores	✓	✓	✓
Dropdown- Report a problem	✓	✓	✓
GAME WINDOW Physics year 7			
Time left: countdown	✓	✓	✓
Score- adds ten for correct answer	✓	✓	✓
Score- Zero for incorrect answer	✓	✓	✓
Correct answer green, incorrect answer red	✓	✓	✓
50/50 option	✓	✓	✓
GAME WINDOW Chemistry year 7			
Time left: countdown	✓	✓	✓
Score- adds ten for correct answer	✓	✓	✓
Score- Zero for incorrect answer	✓	✓	✓
Correct answer green, incorrect answer red	✓	✓	✓
50/50 option	✓	✓	✓
GAME WINDOW Biology year 7			
Time left: countdown	✓	✓	✓
Score- adds ten for correct answer	✓	✓	✓
Score- Zero for incorrect answer	✓	✓	✓
Correct answer green, incorrect answer red	✓	✓	✓
50/50 option	✓	✓	✓
GAME WINDOW Physics year 8			
Time left: countdown	✓	✓	✓
Score- adds ten for correct answer	✓	✓	✓
Score- Zero for incorrect answer	✓	✓	✓
Correct answer green, incorrect answer red	✓	✓	✓
50/50 option	✓	✓	✓
GAME WINDOW Chemistry year 8			
Time left: countdown	✓	✓	✓
Score- adds ten for correct answer	✓	✓	✓
Score- Zero for incorrect answer	✓	✓	✓
Correct answer green, incorrect answer red	✓	✓	✓

50/50 option	✓	✓	✓
GAME WINDOW Biology year 8			
Time left: countdown	✓	✓	✓
Score- adds ten for correct answer	✓	✓	✓
Score- Zero for incorrect answer	✓	✓	✓
Correct answer green, incorrect answer red	✓	✓	✓
50/50 option	✓	✓	✓
GAME WINDOW Physics year 9			
Time left: countdown	✓	✓	✓
Score- adds ten for correct answer	✓	✓	✓
Score- Zero for incorrect answer	✓	✓	✓
Correct answer green, incorrect answer red	✓	✓	✓
50/50 option	✓	✓	✓
GAME WINDOW Chemistry year 9			
Time left: countdown	✓	✓	✓
Score- adds ten for correct answer	✓	✓	✓
Score- Zero for incorrect answer	✓	✓	✓
Correct answer green, incorrect answer red	✓	✓	✓
50/50 option	✓	✓	✓
GAME WINDOW Biology year 9	✓	✓	✓
Time left: countdown	✓	✓	✓
Score- adds ten for correct answer	✓	✓	✓
Score- Zero for incorrect answer	✓	✓	✓
Correct answer green, incorrect answer red	✓	✓	✓
50/50 option	✓	✓	✓
GAME WINDOW Physics year 8			
Time left: countdown	✓	✓	✓
Score- adds ten for correct answer	✓	✓	✓
Score- Zero for incorrect answer	✓	✓	✓
Correct answer green, incorrect answer red	✓	✓	✓
50/50 option	✓	✓	✓
High score window			
Try again	✓	✓	✓