A NEW MOBILE APPLICATION COMBINING AUGMENTATIVE & ALTERNATIVE COMMUNICATION (AAC) WITH SPEECH & LANGUAGE THERAPY

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Disclaimer

No part of this project has been submitted in support of an application for any other degree or qualification at this or any other institute of learning. A part from those parts of the project containing citations to the work of others, this project is my own unaided work.

Signature:  Date: 01/04/2014

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Abstract

Mobile technology has advanced greatly in recent years with an abundance of Android and iOS applications becoming available. Nevertheless, many avenues are yet to be fully explored. Augmentative & Alternative Communication (AAC) methods and speech and language therapy practices combined with mobile technology is an area that is only just beginning to be developed. It is a much needed area of research due to the large number of patients with speech and language difficulties. As a result, the project aims to create a mobile application allowing patients to access AAC and speech and language therapy anywhere.

The report covers the process undertaken throughout the project including: background research and requirements of the mobile application, followed by the design and creation of the mobile application. An evaluation of the project concludes the report; discussing how the mobile application has received great feedback and enhanced technologies relating to speech and language therapy and ACC. Furthermore, the report also acknowledges improvements that could be made including accessibility for those who speak different languages plus alternative speech and language exercises that could enhance the application further.

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Abbreviations

AAC	Augmentative Alternative Communication
App	Application
e.g.	exemplum gratia (for example)
etc	etcetera
FPS	Frames Per Second
GCS	Gus Communication Symbols
PCS	Picture Communication Symbols
SGDs	Speech Generating Devices
SLTs	Speech and Language Therapists
TOR	Terms of Reference
TTS	Text to Speech
UK	United Kingdom

1 Introduction

“In this country we are justly proud of the freedom of speech, that we can say what we want. But there is an even more basic freedom than the freedom of speech and that is the freedom to speak.”(Hawking, S: no date)

As ICAN (no date: 1) highlight:

> Language is one of the most important skills we will ever learn. Everything we do at home or work requires us to communicate with our families, friends and colleagues. Without language it is incredibly difficult to share our thoughts and feelings with others, to make lasting friendships, to give and receive information and to learn about the world in which we live.

Considering this, it is important those with language difficulties are supported in overcoming impairments which might cause barriers to communication.

Support in this area has advanced, including the combination of speech and language therapies and Augmentative & Alternative Communication (AAC) methods with mobile technology. However, research and patient feedback suggest that such technologies are yet to be fully utilised (Matthews, 2001). As a result, it was decided that research would be undertaken to establish what techniques work for patients with speech and language difficulties and how best these can be relayed on a mobile application; the aim being to create an extensive speech and language therapy app, superior to those already on the market.

The literature review highlights the important of providing a range of AAC and speech and language therapies in order to support a wide range of patients (Sutton & Olivier, 2013; Chinner et al, 2001). Consequently, this project aimed to include proven speech therapy methods in the completed application. Moreover, the literature review looks at how current strategies have been transferred to mobile technology and how their functionality, design and accessibility could be improved. Comparisons and reviews of current applications were analysed to inform the design of the application.

1.1. Aim

The project aim is to design, develop and launch an Augmentative and Alternative Communication (AAC) mobile application that is combined with Speech and Language Therapy principles, enabling those with communication difficulties to effectively convey information.

1.2 Objectives

- To develop a mobile application offering various AAC and Speech Therapy solutions.
- To develop a promotional website for the application.

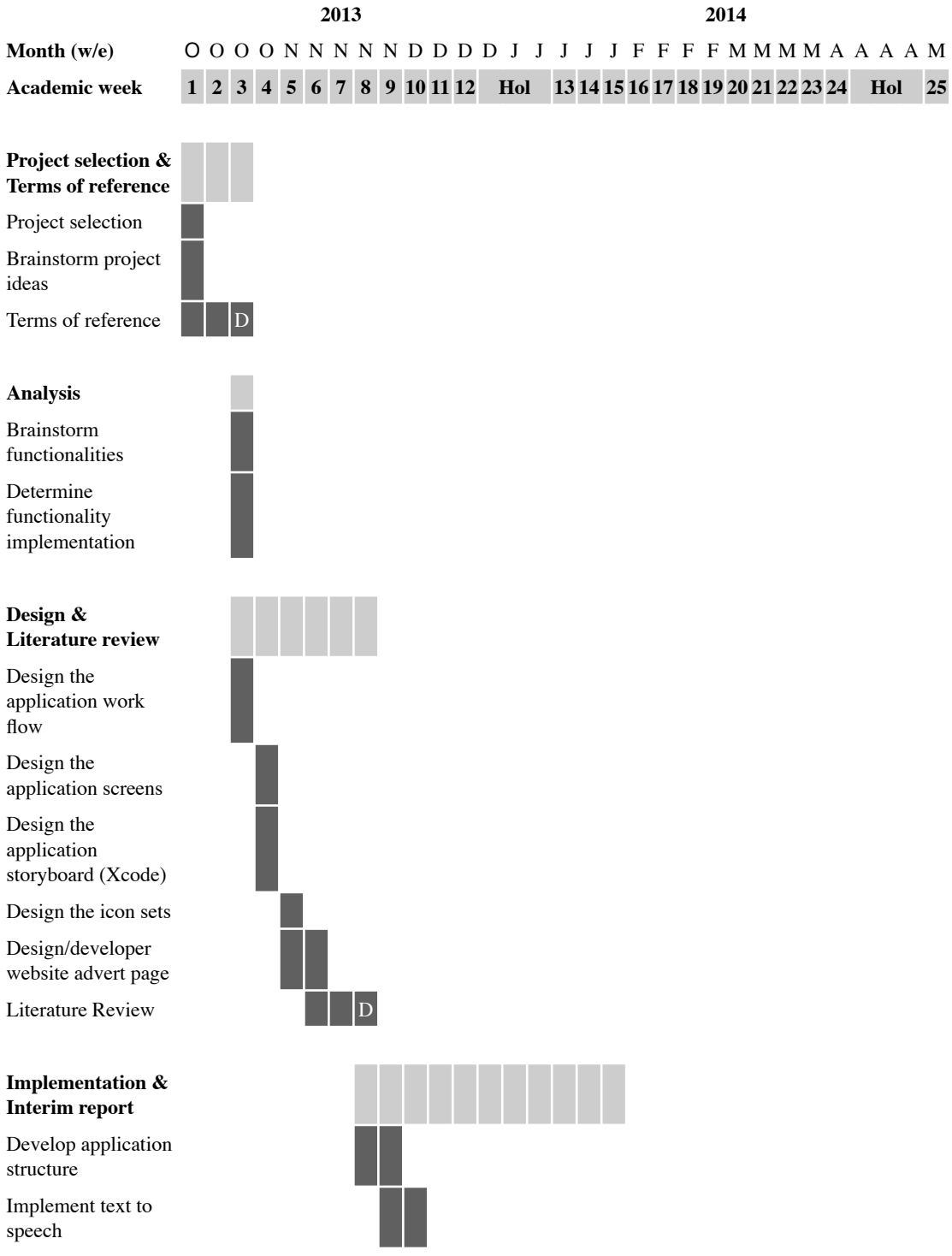
1.3 Minimum Requirements

- To develop an iOS application that offers Text to Speech.
- The iOS application should be able to offer the users an array of images libraries relating to every day life which can covered from Picture to Text.
- The application should be capable of offering a range of speech therapy muscle exercises.
- The application should offer a range of dynamic settings including; volume and speed of utterance.

- A promotional website should be developed to advertise and keep customers informed about the product.

1.4 Schedule

The first project schedule was produced during the Terms of Reference (TOR) component (see *Appendix A*). The schedule has changed fractionally due to the addition/removal of objectives. The Gantt chart below is a revised version of the initial schedule produced within the TOR component.



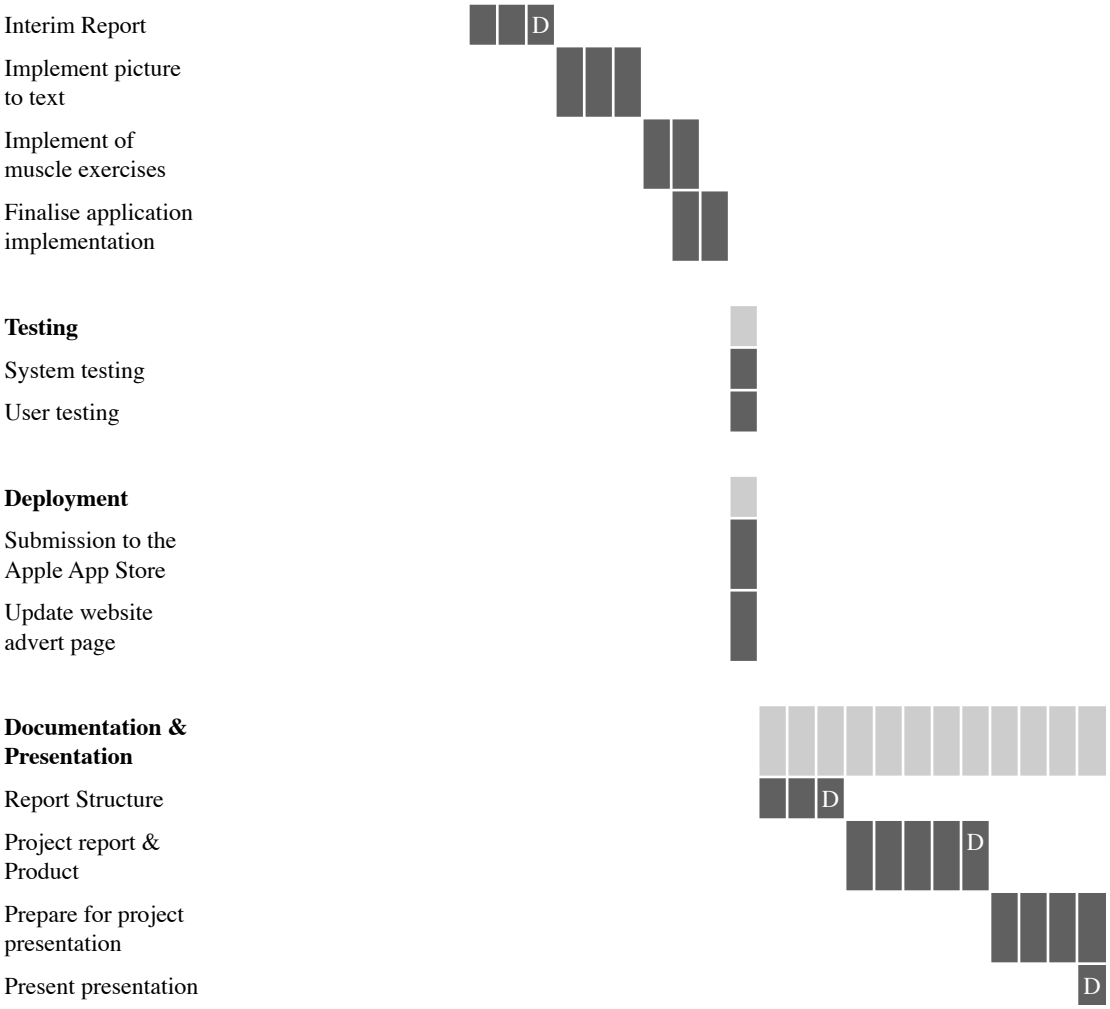


Table 1: Revised Schedule

1.5 Report Structure

The report is laid out in the following chapters:

- **Chapter 1:** an introduction to the project including the aims and objectives.
- **Chapter 2:** background research into AAC and Speech Therapy, methodologies and technologies that could be used in the project.
- **Chapter 3:** a presentation of the requirements analysis that was undertaken to be clear about functionality.
- **Chapter 4:** the initial designs of the solution.
- **Chapter 5:** the process of the implementation phase.
- **Chapter 6:** an overview of the testing carried out on the application.
- **Chapter 7:** a breakdown of the marketing of the product.
- **Chapter 8:** an evaluation to the solution.
- **Chapter 9:** the conclusion of the project.

2 Literature Review

2.1 Introduction

BUPA (2012) states that 'around 2.5 million people in the UK have speech, language or communication problems', these problems include forming sentences, selective mutism and use of the wrong sounds in speech. This is a number that is steadily rising with the increase in health conditions such as stroke and autism. Emphasising this, The Royal College of Speech and Language Therapists (2011) state that '50,000 people who have a stroke every year have speech and language difficulties'. Moreover, this is clearly a number that is not stagnant, '20% of the population may experience difficulties in communication at some point in their lives' (Royal College of Speech & Language Therapists: 2011). This highlights the large and vast patient group who require some form of speech and language support.

The importance of patients receiving the correct support cannot be disregarded, as Lee (2008) states:

> 'The development of speaking and listening skills requires fuller and more intensive attention to make sure that patients acquire a good stock of words, learn to listen attentively and speak clearly and confidently …they are prime communication skills, hugely important in their own right and central to intellectual, social and emotional development.'

Yet positively, it is common consensus that with suitable help and support, many people overcome or cope with these difficulties successfully (Hill, A. & Theodoros, D., 2002, EHealth Media, 2013; Royal College of Speech and Language Therapists, 2013).

2.2 Mobile technology in Speech Therapy

Speech and Language Therapists (SLTs) are continually looking at new and inventive ways to provide speech and language therapy, with many believing tablets and mobile technology are transforming the way speech therapists are teaching and the way patients are learning (Sutton & Olivier, 2013; Richards, 2013). There is an emerging evidence base to suggest that a combined approach (traditional direct speech therapy plus computer therapy) for people with communication difficulties is beneficial. McCall et al (2009) found that this approach helped improve the connected speech of even chronic and severely non-fluent speakers. Furthermore, there is evidence to suggest technology can help improve speech significantly, as it helps with pronunciation, volume and speech speed through the abundance of activities that can be undertaken (Sutton & Oliver, 2013; Toboleca & Karner-Hutuleac, 2011).

The use of technology as part of treatment has been growing over recent years, in line with the increase in technologies available. Research suggests that new computer-based technologies used for speech and language therapy can help traditional speech therapy by creating an updated atmosphere that keeps up with the working realities of the 21st century (Toboleca & Karner-Hutuleac, 2011). Exposing those, particularly children, to new and different technologies whilst working towards speech and language goals will help them adapt to a future involving continued technology use.

Moreover, it is suggested that using technology for speech and language therapy can help improve patients' motivation, thus, increase the likelihood they are to achieve. Roddam (2011) states that using technology can eliminate the frustration felt by patients having to

complete the monotonous exercises suggested by the speech therapist, potentially leading directly to the increase in the children's self-esteem.

2.3 Growth of mobile technology

Given the benefits highlighted it is not surprising 'interest in using applications for smart phones and tablets in speech-language treatment has exploded' (Kuster, 2012:20).
Many believe electronic systems are often first choice for those with communication difficulties as they can offer the added bonus of speech output and convey a positive message (Inclusive Technology, 2013). Yet, it is important to acknowledge disadvantages such as setting up and maintaining available vocabulary, breakdown of devices and ease of use. As Matthews (2001) states, it is not always clear to the patient how to use the technology correctly. As a result, any speech and language programme designed for an electronic device must consider simplicity and usability of its design. However, with interfaces becoming more standard, it is becoming easier for users to apply the skills learned to interact with one technology or computer programme to the next (Lewis, 1998).

Despite the increase in applications available, it has been highlighted that there is not one comprehensive application on the market; speech and language with technology is only just beginning to be explored (Sutton & Olivier, 2013). Consequently, it is important to consider the combination of speech and language practices that are effective in helping those with communication difficulties by analysing current applications and research. Creating an application with a breath of popular and effective techniques included will increase the chances of the end user making successful progress with the app and will fill the gap in the market.

2.4 Speech and Language Therapy vs. Augmentative & Alternative Communication (AAC) methods

SLTs provide a range of techniques to improve speech. Formal speech and language sessions often consist of many strategies to help patients develop their speech, including: oral exercises (tongue, lip, and jaw movements) to strengthen the muscles of the mouth and articulation or sound production exercises to help with pronunciation of sounds and words (BUPA, 2012).

In some cases, it is necessary for SLTs to look at Augmentative & Alternative Communication (AAC) methods. AAC is a term that encompasses the communication methods used to supplement or replace speech for those with impairments in language. Practices include the use of images and/or symbols. The principle of AAC is 'to make communication as quick, simple and effective as possible when speech alone does not work' (Communication Matters, 2013:1).

There are several popular AAC applications on the market, with 'Proloquo2' (Niemeijer, 2013) being at the forefront. Many have praised this application for supporting young children in helping develop their speech. However, some believe AAC impedes the natural development of speech; the patient becomes reliant on the use of images and symbols and loses motivation to develop their own language (Van Tatenhove, 1987; Beukelman & Mirenda, 2012). Opposing this, Communication Matters (2013:1) state that 'AAC can help improve speech'. A plethora of established research agrees, indicating the introduction of

AAC correlates with the improvement of natural speech, as it supports the speech and language techniques being learned (Romski & Sevcik, 1996; Daniels, 1994; Lancaster, 2008).

Yet, there is also the opinion that AAC techniques highlight patients' difficulties in speech, making them less likely to be accepted within society, the perception being that people using symbols and images are not as mentally developed (Silverman, 1980). On the other hand, it could be argued that a person is at greater risk of being judged when he or she does not have the ability to adequately express him- or herself in any form, as a result, AAC can be used as a provision towards equality. Supporting this, there is evidence to show that there are now more children using AAC systems in schools than ever before, as schools look towards modifying their inclusion policies (Chinner et al, 2001).

This suggests that AAC is a valid and important tool in helping to aid the development of speech when used alongside speech and language therapy principles. However, this does raise the important issue that such techniques should be carefully designed and implemented with equality and diversity issues in mind. Any AAC methods used such as symbols and images should be appropriate for the age and speech level of all users/receivers, aiming to facilitate total communication and acceptance by others.

2.5 Type to Talk (TTS)

One AAC method commonly adopted is the use of Speech Generating Devices (SGDs) that work through the typing of text. They are also known as Voice Output Communication Aids (VOCAs). The user can type their word or sentence and the device phonetically decodes and expresses it in words, most commonly known as Text To Speech (TTS). Van de Meer et al (2012) found that SGDs that allowed for TTS were the preferred communication method for 75% of participants in their study. However, it is important to note that there is no one way of communicating that suits all, such studies have a limited participant group and offer a structured choice-making arrangement. Nevertheless, this is a system that is popular with many. A frequently cited advantage of SGD use is the ability to produce stored messages of virtually any length with the touch of a button (Blishack, et al: 2003). This enables users to communicate quickly and effectively.

However, it is important that devices convey sounds accurately. The most common complaints for TTS applications are that speech synthesis can still sound highly unnatural (Barron*, et al*, 2002). This is particularly important considering users of such devices are often trying to develop their speech at the same time as communicating; hearing irregular speech might make this process more difficult. From a speech development stand point there is preliminary evidence to suggest that SGD use supports the development of generative language. Cumley & Swanson (1999) reported an increase in utterance length in their case study of a 3 year old that received intervention with a SGD that contained both stored single words and multi-word messages. In support, a longitudinal study by Romski & Sevic (1996) found that hearing natural sounds aided speech development. This supports the many theorists that highlight the importance of hearing speech and sounds in language acquisition (Piaget, 1962; Aitchison, 1997). Moreover, it highlights the importance of looking at options with regards to speech tone and clarity. The best applications on the market have feedback that suggests a clear voice, adequate pace and normal tone are important (Niemeijer, 2013).

However, for learners with communication difficulties who have not developed the skills to be able to spell and read, the fact the user has to type their speech may not be the best approach. Although lots of systems phonetically decode written text, as Franzone & Collett-Klingenberg (2008) highlight, SGDs may be used with graphic symbols, as a well as alphabet keys to support those with more profound difficulties or those at the beginning of their language journey, as opposed to the user having to type their speech. Current text-to-speech applications on the market such as 'SpeakIt' (Stefanopoulos, 2013) and 'Speech Assistant AAC' (Schalke, 2013) have received this feedback, with users stating that those with particularly poor language skills may make implausible attempts at writing words; consequently, pictorial cues may be a more appropriate option. Nevertheless, 'Proloqou2' (Niemeijer, 2013) which provides both options has been highly praised.

2.6 Picture Talk

The most common technique SLTs use is having graphic symbols and/or pictures as a prerequisite to written words and speech. This AAC technique is accessible for both adults and children. As Hertzroni (2004: 1312) explains, 'graphic symbols appear usually alongside the printed word describing them.' It is generally considered good practice to have a text label accompanying a symbol, whilst not all symbol users will become literate, repeated exposure to the word with the symbol may eventually lead to sight recognition (Lancaster, 2008).

Despite the argument that users can become reliant on symbols, thus, the approach does not help develop their speech (Van Tatenhove, 1987; Beukelman & Mirenda, 2012), it is highly praised, with the majority believing graphic symbols used by AAC can present an opportunity to develop print awareness; associating a symbol with an idea and words facilitates understanding of further literacies (Lewis, 1998; Hertzroni, 2004; Lancaster, 2008). Moreover, picture symbols provide more concrete representations of concepts than other non-verbal gestures such as sign language, resulting in a greater understanding than be applied when speech does develop further (Chinner et al, 2001). It has been suggested that the approach is 'fortuitous for persons with learning disabilities, who may derive more information from a graphic' image (Lewis, 1998:24). This confirms picture talk is an important part in speech development.

Yet, it is important to consider the different types of symbols used, including photographs (see *fig.1*), Picture Communication Symbols (PCSs) (see *fig.2*) and Gus Communication Symbols (GCSs) (see *fig.3*). The debate continues over the effectiveness of each approach. Research shows that PCS are most widely used (Beukelman & Mirenda, 2012, Meng-Ju, 2013). However, it is important to acknowledge that this approach has been established longer, GCS were only introduced in 2006, however, have become widely popular due to their simplicity. Furthermore, many studies have shown no significant difference between user preferences (Alant et al, 2005; Emms and Gardner, 2010, Schlosser et al, 2012).

Figure 1: Photographs

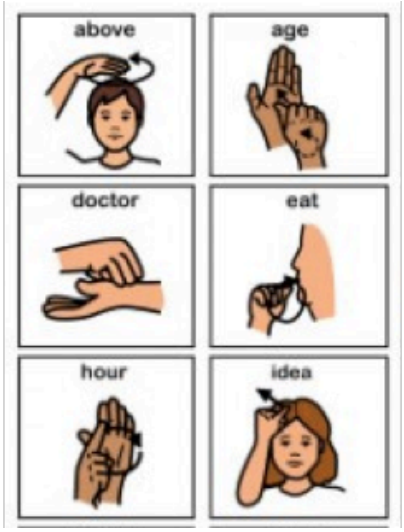


Figure 2: PCs

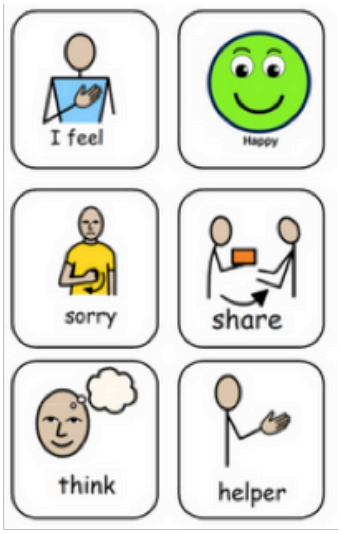


Figure 3: GCSs

However, such studies have highlighted important factors to consider when designing and choosing pictorial representations. The iconicity of symbols is particularly important. Emms and Gardner (2010) investigated the effect of iconicity of symbols on performance accuracy and found the symbols that related to concrete ideas supported children in performing better. In agreement, Schlosser and Sigafoos (2002) propose that symbols what need extra clues to be provided (opaque symbols) are not as effective as translucent and transparent symbols, these are symbols that can be recognised immediately by the majority without being provided with any additional clues. Typically, the most transparent symbols are good quality drawings of objects that are easy to identify. Consequently, images need to be clear, visual and easily recognisable.

Mainly symbols are used without the spoken representation of the word, such as in the application, 'Speech Sounds on Cue' (Bishop, 2011), an application that displays the images with the user having to verbally name it. However, the advantage of technology is that symbols can have the word spoken as well as written. As highlighted above, hearing speech and sounds is an important part of learning language. Moreover such pairing of speech output with visual representation of a referent may serve to strengthen both the association among the spoken word, graphic symbol and referent and an individual's internal representation of the spoken word. As Yeung & Walker (2009) found, adults who were presented with more visual images performed better phonetically than those who were presented with few, yet, those who were presented with both visual images and spoken representations performed the best.

2.7 Mirror Talk

Communication in face-to-face interactions is expressed through a number of channels, including the body, the voice, the face, and the eyes. Whilst talking, people's faces are rarely still; they not only use their lips to talk, but they raise their eyebrows, move or blink their eyes, or nod and turn their head. As Science Daily (2009:1) highlights, when someone is speaking, it is not just information from the lips, there is also 'movement of the teeth, tongue and other non-mouth facial features'. It is important for those with speech difficulties to train the face to make the correct movements as a way of improving pronunciation and aiding speech development. As Rosenblum (2010) states, physical movement of speech is an essential part of rehabilitation programmes.

Applications that have incorporated this element of speech and language therapy, such as 'SmallTalk Oral Motor Exercises' (Lingraphica: 2013) allow the user to copy mouth movements from a diagram/video. This is particularly important, as established research by Graham-Bell (1888) states 'the necessary preliminary to good speech is that the pupil has a definitive model which he attempts to copy'. The applications use simple and clear drawings / animations or videos of mouth movements (see *fig.4 & 5*). Such simplicity allows users to copy movements clearly.

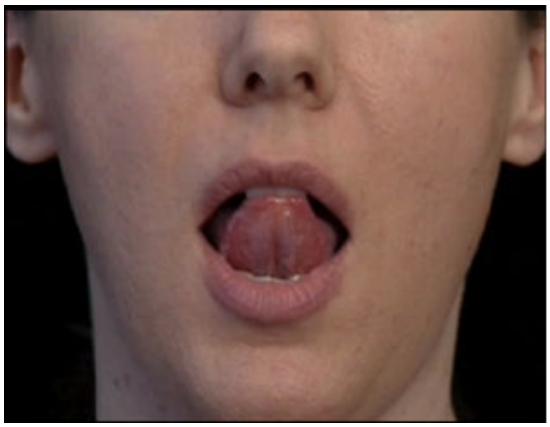


Figure 4: Video

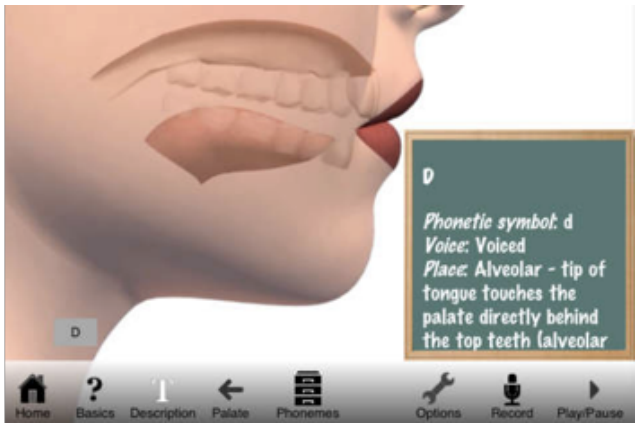


Figure 5: Animation

Yet fewer applications focus on the possibility of implicit learning of facial movement to help users improve their mouth and face movements before attempting speech. A number of studies have established quantitatively how the vision of visible articulators (lips, jaw, face, tongue tip, teeth) eases speech understanding, and how significantly it increases the performance of detection and identification of words. Erber (1975), Sumby & Pollack (1954) and Benoit & Le Goff (1998) amongst others, have quantified the gain in speech intelligibility provided by lip reading in comparison with the sole acoustic signal.

Yet despite this, only one application available in the Apple App Store focuses on this acclaimed approach. 'Speech Tutor' (Synapse Apps, 2013) offers a "Side View" and a "Front View" of each sound production. Being the only application to use lip reading and mouth movement techniques means patient choice is limited; as a result, another application that includes this approach would be welcomed.

'Speech Tutor' (Synapse Apps, 2013) also involves the production of speech (i.e. saying sounds, pronouncing sounds). Although such articulation therapies are good for speech development, it is important to acknowledge some patients with particularly poor muscle or facial control may have difficulties with such exercises and the addition of a sound to say as well may be too much. Oral motor exercises and facial massage may be used to improve muscle tone as a prerequisite before focusing on speech (Graham, 2012). Consequently, it is important to consider exercises that do not produce speech or sounds.

Moreover, 'Speech Tutor' (Synapse Apps, 2013) also does not allow the user to see their own face whilst conducting facial movements, this is true of other applications on the market such

as ‘SmallTalk Oral Motor Exercises’ (Lingraphica: 2013). Much research has advocated the use of a mirror to guide those with speech difficulties in making the correct facial movements (Hayes, 2009; Thieme, *et al,* 2012). Enabling the patient to see their own facial movements has the advantage of them comparing their movements to the guide given, thus, it can be used as a self-assessment tool. Patients can see whether they need to modify their movements or if they are doing them correctly. Nevertheless, this is particularly hard to implement. Animations and camera view are memory intensive, as a result, it is important to look at ways in which memory usage can be reduced in order to allow a succinct and smooth transfer between exercises.

There are many different facial movement exercises that speech and language therapists conduct with their patients. The NHS (2013) state that all exercises need to be gentle and should be aimed at relearning the movements for use of the face, as a result, a string of exercises should involve moving several facial muscles. It is important exercises are modelled correctly to support patients in progressing.

2.8 Speech Volume

Speech volume, or how softly or loudly a person speaks, can directly affect the way a speaker is perceived by others. Those who have speech and language difficulties often find it difficult to control the volume of their speech. For example, ‘Children with Aspergers and other autism spectrum disorders often have difficulties producing the appropriate voice volume in different settings’ (Shaul, 2011:1). Furthermore, ‘people with Parkinsons develop problems with their speech and communication that can include lack of volume’ (Miller, 2010:1). Consequently, it is important to consider how to support these patients most effectively.

Many sources suggest patients need to compare their volume to that of others as a model for appropriate volume, with the suggestion that a scale of loudness is appropriate for this (Graham, 2008; Miller, 2010; Shaul, 2011). The mobile application ‘Sosh' has implemented this by providing users with a scale measuring volume (see fig.6).

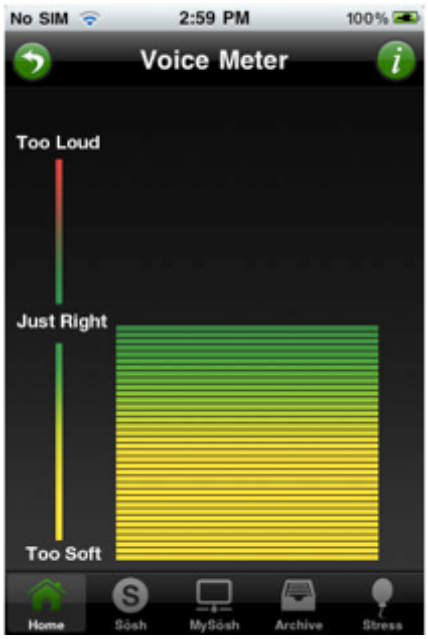


Figure 6: Volume Control

Although this is effective in monitoring speech volume, it could be suggested that modelling the appropriate volume thoroughly via an example may be more appropriate before the user attempts to use the scale, this would consequently aim to increase success rate. This is important, as Graham (2008) states, in speech and language therapy the feeling of accomplishment aids progress.

Moreover, volume appropriateness changes for different situations, consequently, having a fixed scale may not be appropriate. As Miller (2011) highlights, patients with speech and language difficulties need to train their voice to speak in different situations. As a result, a more appropriate method may involve having a scale that can be altered by the user.

2.9 Home therapy – is it the best solution?

Many believe the main advantage of mobile applications is that they allow patients to practise speech and language principles at home. As Sutton & Olivier (2013:1) state,

> 'enhancing communication between the patient, their carers and the SLT through app functions could be a route for providing opportunities to discuss and encourage the process of developing effective therapy sessions at home'.

In support, Smith (2013:2) highlights, this is particularly important, as 'the greatest amount of success in correcting speech and language issues includes involvement and home therapy'. Yet, there is the concern that speech and language therapy practices through mobile technology 'do not provide the same quality of care as face to face sessions' (E-Health Insider, 2013:1). As a result, it is important to ensure applications make it clear that they do not replace formal speech and language sessions merely supplement them, offering speech and language therapists, patients and those wishing to communicate with them an alternative avenue to explore.

This also emphasises the issue that applications should be simple to use so that patients are able to access the practises at home, to make the quality of care as personal as possible. However, as Matthews (2001) highlights, it is not always clear to the patient how to use the technology correctly. Consequently, technology is not being utilised and patients are becoming frustrated. Considering this, it is important to consider design principles. In their survey, Summers (2013) found that users found applications easier to use when they included instructions, had clear images, pages that were easy to navigate and a clear typeface. Considering such design specifications will go someway to making patients feel more confident in using applications, as they have a scaffolded understanding of how to do so. This is particularly important as Sutton & Olivier (2013) highlight, patients need to feel secure in using mobile applications in order to make them effective.

3.0 Age Concern

A mobile application providing elements of speech and language must be accessible to all yet, with a diverse patient group as discussed earlier, this is particularly difficult. Matthews (2013) highlights this issue stating, 'it is important not to forget the patient group [with speech and language problems] involves those from a range of backgrounds with differing needs'.

Many applications on the market focus those at the beginning of their language journey as they are based on the principles of early phonics. Two highly praised applications include:

‘ArtiPix’ (Sailers, 2013) and ‘Language Forest’ (Synapse Apps, 2012) that flash card sounds and provide sound matching activities with words, helping the user produce correct letter sounds and blends. However, such applications have child-oriented graphics (see *fig.7*) that are not suitable for older learners.

Figure 7. Child-oriented graphics

This is particularly significant considering the wide patient group. Moreover, applications aimed at early leaners solely focus on phonics, dismissing other strategies discussed above. On the other hand, applications aimed at older patients have the risk of not being appealing to younger learners. As Barron et al (2002) state ‘enjoyment is an important part of learning’. Consequently, it is important to consider how a balance can be achieved.

3.1 Cost effectiveness

AAC can be expensive, with Huckvale (2012) highlighting that equipment can cost as much as £1000. Yet, applications such as ‘The Speech Pathology Tookit’ (Speech and Language Solutions Ltd, 2012) provide therapists and patients with the similar outcomes for only £11.99. In agreement, Huntersville (2013) states that ‘for technology that can be used with every patient, [applications] save therapists from purchasing additional materials making it cost effective’. On the other hand, Kuster (2012) argues that ‘downloading apps can be expensive. Few are free, most are reasonable but many can be extortionate for what is offered’. Consequently, it is important to ensure any application produced is cost effective to the end user, especially since the top 10 iPhone applications of 2013 in Mashalbe were all below £1.99 (Wagner, 2013).

4.0 Appropriate Technologies

From the research conducted thus far, it is clear that the final solution will offer an iOS application and a promotional website to advertise the application. Considering this, the technologies required for implementing such a solution are divided into the following two sections:

- iOS Application
- Promotional Website

4.0.1 iOS Application

The technologies required to develop the iOS application are as discussed in the sections to follow:

4.0.1.1 Dapp Application Prototyping Tool

A full what you see is what you get (wysiwyg) editor that you can use to immediately start building iPhone apps. Before beginning to work on the core development within Xcode, this application would be used to create an initial proof of concept application to test navigational structure and layout.

4.0.1.2 Xcode & Objective-C

There is an array of softwares available in the industry enabling the development of applications for iOS, however, native applications can only be achieved using Apple's Integrated Development Environment (Xcode). Xcode is a complete toolset for creating applications for both iOS and OS X. The environment includes performance analysis tools, iOS simulators, and the latest iOS and OS X SDK's.

Within the Xcode application the programming language Objective-C is used. Objective-C is an object-oriented programming language. It is defined as a small but powerful set of extensions to the standard ANSI C language. Xcode will be used to develop the application and within Xcode, the programming language Objective-C will be used to programme the application.

4.0.1.2 Adobe Illustrator

Both the iOS application and the promotional website require extensive vector-based graphical designs and elements. To create early stage mockups and to design components such as images and icons, Adobe Illustrator would be used. Adobe Illustrator is the industry leading software for vector-based design, offering an extensive range of tools.

4.0.2 Promotional Website

The technologies required to develop the promotional website are as discussed in the sections to follow:

4.0.2.1 Sublime Text

The promotional website will be hand-coded using standard HTML/CSS. The chosen text editor is to code within is Sublime Text. Sublime Text is a sophisticated text editor for code, markup and prose.

3 Analysis

The requirements analysis provides a breakdown of the functionalities needed to be implemented in order to meet the objectives. Moreover, it clarifies the objectives as a prerequisite to the development stages of the application and website. Knowledge achieved from background research combined with experience has set out the requirements to be met that are defined below:

3.1 Functional Requirements

The requirements to be met are as follows:

1. iOS Application
2. Promotional Website

3.1.1 iOS Application

The iOS application is to be implemented using Xcode as discussed above.

- **Text to Speech -** allows the user to type a string of words that can then be read back aloud using a speech synthesiser.
- **Picture Talk -** provides the user with a library of graphical symbols that relate to every day life, when clicked theses are spoken via a speech synthesiser.
- **Mirror Talk -** uses the front camera of the device to display the users face on screen. Provides them with an array of mouth exercises that they can copy/follow overlaid over the top of the camera screen as a transparent model.
- **Volume settings -** enables the user to adjust all volume for the application universally within the settings pane.
- **Utterance speed settings -** allows the user to adjust the speech utterance speed universally within the settings pane.

Additional Extensions:

If time permits the following additional extensions will be made:

- **Word Talk -** allows the user to tap the screen of their phone and to have a random word appear. The word is then read to them via the speech synthesiser. The user reads the word back to the phone in order to check their speech volume.
- **Mini Game -** provides a fun game whereby the user must smile to enter the application. By smiling they will receive a “tick”, if done incorrectly they will receive a “x” and be asked to repeat. The user will be able to “skip” this game if they do not wish to play.
- **Pitch Settings -** allows the user to adjust the pitch of the speech synthesiser using a universal setting in the settings pane.
- **Language Settings -** allows the user to change the language in which the speech synthesiser speaks. Offering five languages: English, Chinese, Spanish, French and German.

3.1.2 Promotional Website

The promotional website will advertise the application. The website will be developed using the website development software Macaw.

- **Website -** brief description of what the application offers in terms of functionality and where to download it.
- **Video -** provides the user a short “How to” for the application.
- **Blog/Twitter -** provides updates and deals with queries

3.2 Non-functional Requirements

Listed below are the non-functional requirements that play a crucial a role in the success of the project:

3.2.1 Usability

The iOS application must be accessible for those with disabilities, furthermore, the user interface must be enjoyable to use. The application should follow the guidelines and principles from the iOS Human Interface Guidelines see: http://bit.ly/1mA4mYN.

3.2.2 Compatibility

The iOS application should be a universal application working on iPhone, iPod Touch and iPad. The promotional website should be a fully responsive site meaning both desktop and mobile users can view the website with ease.

3.3 Challenges

The requirements detailed above present both technical and practical challenges in the design and implementation stages. The design and implementation stages will describe how these challenges were overcome.

3.4 Summary

The functional and non-functional requirements stated in this section will be followed carefully, however, changes may be required during the design and implementation stage to ensure all requirements are met and lead to a successful solution. If all standard functional requirements are met then the additional extensions will be considered.

4 Design

This section discusses the system development lifecycle chosen to develop the application effectively. Specific design solutions are then discussed, as it is important to have initial designs of the application before the implementation begins.

4.1 System Development Life Cycle

An analysis into different system development life cycles was undertaken. The Waterfall model, Iterative-prototyping model and Spiral model were all considered. An in-depth description of each model would not add value to the report, consequently, it will be assumed the reader has a good understanding of these models already. However, the reasoning behind the selected system development life cycle will be discussed.

The model chosen is the Waterfall model as it is less time consuming to use than comparable models. This model requires a stage to be completed before work on the next stage can begin. This ensures no stages are overlooked or left incomplete. However, it should be noted that

small iterations and improvements may be considered in the implementation that were not outlined in the design section. The nature of creating an iOS application is that ideas present themselves during the development process that were overlooked during the design stage, so this is ideal. Any improvements that arise will be either implemented during the implementation stage or discussed as future work within the evaluation stage where time does not permit the improvements.

The Iterative-prototyping model would suit the creation of application yet due to time constraints it is not feasible to produce multiple prototypes. However some elements of this model will be used, as discussed later in the implementation stage. The Spiral model was the least suited as a choice of development life cycle as it requires many people, not an individual.The Spiral model is usually used by large companies.

4.1.1 Unit Testing

Although not represented on the Gantt Chart shown in *section 1.4* it should be noted that development of each task included unit testing to ensure that the unit was functioning as intended. User testing would then be undertaken following the the development of the application being completed.

4.2 Interface Designs

Before moving onto the implementation stage, three design stages took place; (1) application interface designs created, (2) proof of concept application created and (3) promotional website sketch. The interface designs represent an initial idea of how the application screens could look, the designs are also accompanied by a description of possible functionalities. The application would be made up of five screens; (1) Loading screen, (2) Type to Talk, (3) Picture Talk, (4) Mirror Talk and (5) Settings (see *fig 8*). All the interface designs where created using Adobe Illustrator and icons and images where exported as PNG images using the format “ImageName@2x.png” the “2x” being the naming convention used to support retina displays.

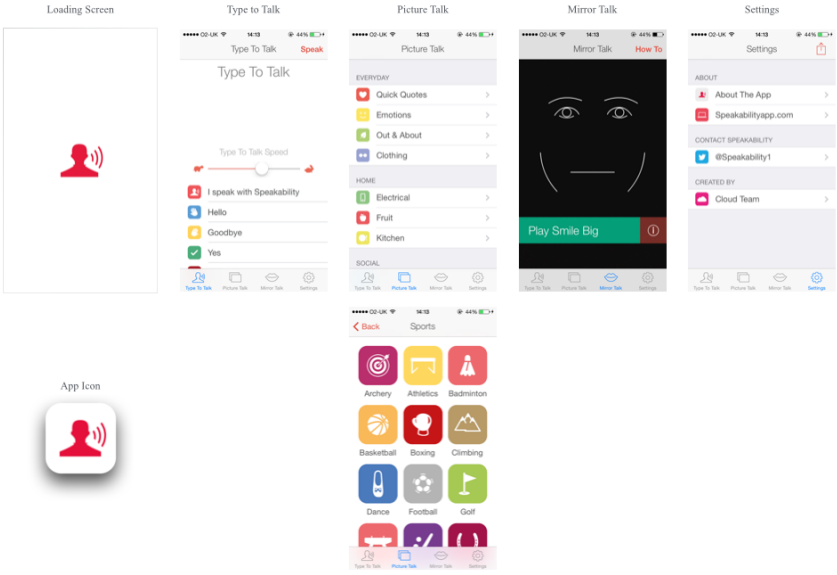


Figure 8: Interface Designs (1)

4.2.1 Application Icon
The application icon has been created with a view to represent the application in its entirety. Furthermore, it has been designed to create a memorable icon that the user will identify with, without reading the words “Speakability”.

4.2.2 Loading Screen
The loading screen would be made up of a simple photograph purchased from ImageShack, that has a gaussian blur applied with the Speakability logo overlaid over the top. The idea of this screen is that it will be displayed for the 1-5 seconds before the main application screens opens - “Type to Talk” to fill any loading periods when opening.

4.2.3 Type to Talk
The Type to Talk screen would have a large text field in the centre of the page allowing the users to type what they wished the speech synthesiser to say. Having typed the text they they require, they would click the “Speak” label to have the text spoken.

4.2.4 Picture Talk
The Picture Talk library will be made up of a main page view controller which lists all the different picture libraries in a TableView and a sub-view for each library displaying all the icons for said library. e.g Picture Talk > Quick Quotes. The TableView will be within a ScrollView allowing the users to scroll through the different libraries, click a library and in turn be taken to the another view controller displaying the library of clickable pictures/icons.

4.2.5 Mirror Talk
The Mirror Talk screen will use the users front camera to display their face on the screen, the camera will be within a ScrollView thus allowing the user to scroll through the nine facial exercises that are planned to be offered. The exercises will be created as simple Flash animations which are overlaid over the top of the camera view so that the user can align their face accordingly and mirror/copy the animation. The facial exercises animation will be created based on those described at http://lynch.c.tripod.com/therapy/speech_face.htm. The concept of the mirror talk facility was derived from a meeting with myself, Baihua Li (Supervisor) and Claire Mitchell (Speech Therapist) back in October 2013 (see *fig 9*).

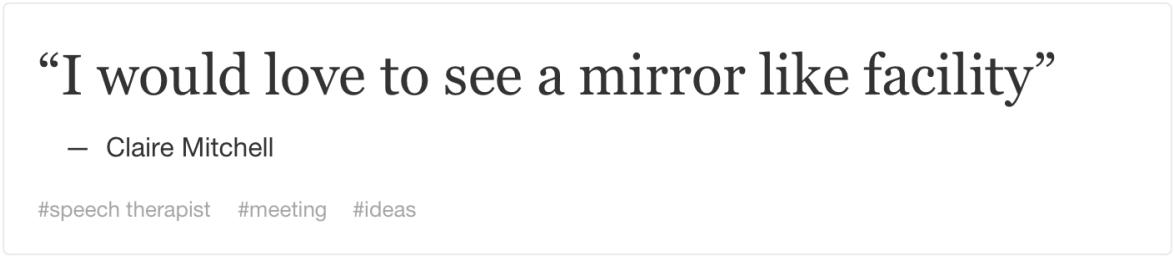


Figure 9: Claire Mitchell’s Quote

4.2.6 Settings

The settings screen will allow the users to adjust both the volume and speed of the speech synthesiser universally. Additionally, the settings will also save to the users iCloud account so that they are saved between sessions and mirrored on other devices they own (i.e a user may have an iPhone and iPad and use the app on both). The user can also view the Speakability website and Twitter account via external view controllers with web views within.

4.3 Application Variables

As well as designing the interface; it was important to gain an understanding of how the navigation, screen orientation and other components of the application would look and function. The sections to follow discuss these topics.

4.3.1 Application Navigation

The application will by default open on the Type to Talk screen. A tabular view controller system will be used to allow the user to navigate between the screens with ease. Screens that are not on the tabular bar along the bottom will use a “back” button and/or swipe motion to allow the user to get back to the main view associated (e.g. Picture Talk > Quick Quotes), although the main tabular system would still be along the bottom of these pages allowing them to navigate away from Picture Talk.

4.3.2 Interface Orientation

The application will be locked to a portrait mode and rotation of any type will be disabled as the user interface has not been designed to support a landscape view.

4.4 Application Proof of Concept

Following on from the interface designs, a proof of concept application was created using the prototyping application Dapp; this allowed for the creation of a proof of concept that would physically work on an iPhone or iPad and could be navigated as you would expect. Of course, this had no functionality, however, by doing this it ensured that the navigational set up was meaningful.(see *fig 10*).

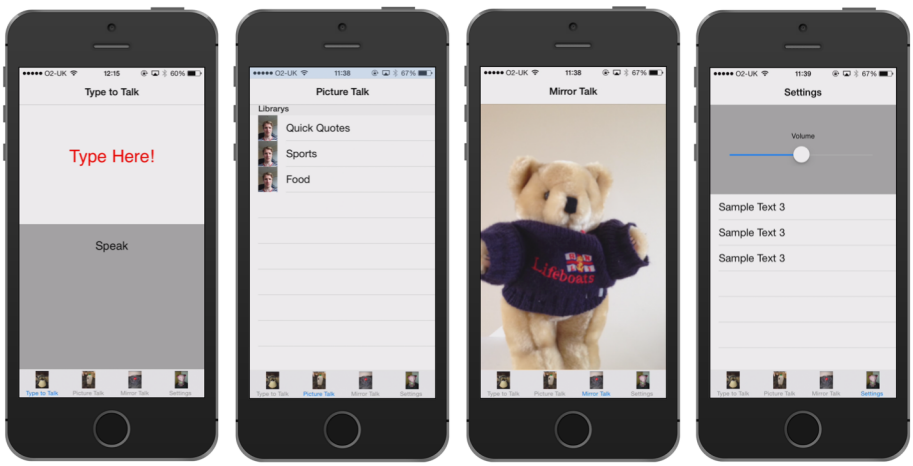


Figure 10: Proof of Concept

4.5 Promotional Website Design

An early stage design of the promotional website was created using Sketch, to aid the development of the website during the implementation stage. As can be seen in figure 11 the website would consist of one page detailing the title, brief description of the application, application screenshot and three links to download, tweet and contact us.

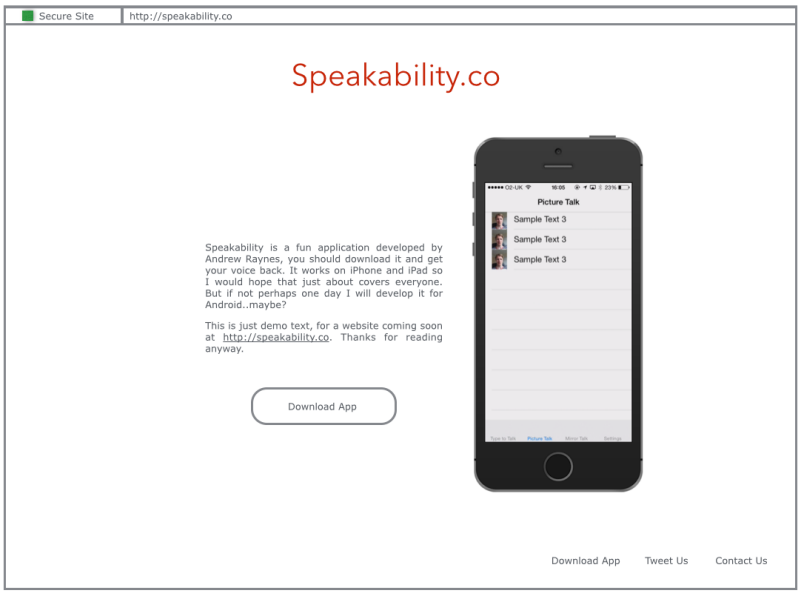


Figure 11: Promotional Website Design

4.6 Summary

The completion of the design stage saw the Waterfall model selected as the chosen system development life cycle for the applications development. Also initial interface designs were created and discussed in depth relating to usability. These designs will be utilised in the implementation stage of the project.

5 Implementation

Within the implementation stage the methods used to develop both the iOS application and website will be discussed. The implementation of the application and website used elements from both the Waterfall model and the iterative model. The development process will be broken up into two iterative stages to allow for user testing at the end of each iterative stage. Using iterations also means that required objectives within iteration one and the possible extensions within iteration two could be created.

5.1 Iteration One

The first iteration of the implementation stage focuses on the initial set up of the iOS application within Xcode and then the implementation of Type to Talk, Picture Talk and Mirror Talk functionalities within the application. It should also be noted that before development began preparation took place to learn Xcode, having never programmed using Objective-C before.

5.1.1 Preparation

The initial two weeks time were designated to learn about using Xcode and programming using Objective-C. The Apple developer site (https://developer.apple.com/library/ios/navigation) provides extensive code samples and additionally explains the UI guidelines and the iOS frameworks in detail. The preparation also involved watching tutorials provided by Ray Wenderlich (http://www.raywenderlich.com/). Throughout the implementation stage, Apple's iOS documentation and a book "iOS 7 App Development Essentials" were used for reference.

- **Xcode Installation & Setup**

In preparation for the development of the application, Xcode was downloaded and installed on a MacBook Pro. The software required no further configuration following the install. Xcode then allows the development of any type of iOS or OS X application without any other software; the integrated development environment provides an interface builder and a variation of different simulators (iPhone & iPad) to build and test applications. Nevertheless, it would be recommended to build and test applications on personal devices as simulators do not support camera views. Following the download and install of Xcode, a 1 year subscription to Apple's iOS developer program was purchased, enabling the submission of the application to the app store at the end of iteration one and also providing access to the Apple Developer forums that answer any queries relating to application development.

A new iOS project it contains numerous files, examples include the compiled code that is executable and the frameworks. The infrastructure of an iOS app is built from objects in the UIKit framework that provides support for handling events, displaying content on screen and interacting with the rest of the system. On the inside of the application bundle, nib files are present. Nib files contain the essential files to run the application such as details about object relationships. Additionally, nib files describe a different objects and inform each object how they relate to each other. The application will also have resources such as images for views, sounds, graphics and any other necessary elements. Moreover, all applications have a XML file describing basic parameters for running the application, named an info.plist (Information Property List file).

All iOS applications are based on the Model-View-Controller software architecture, a software that separates the application into three parts: the model, the view and the controller. It is an important acknowledgement that the view and the controller depend on the model, however, the model does not depend on the view nor the controller. This separation allows independent testing and building of the application away from the visual presentation.

Following the initial preparation stage, development began on the first iteration (see *table 2*).

Task	Description
1	Setup the iOS Project
2	Creation of Storyboard
3	Type to Talk
4	Picture Talk
5	Mirror Talk
6	Settings

7	Startup Screen
8	Tutorial Screens
9	Promotional Website
10	Unit Testing
11	Submission to App Store

Table 2: Iteration Plan One

5.1.2 Setup the iOS Project

The first task was to create a new project within Xcode. This was named "Speakability". Throughout the setup process Xcode offers several built-in app templates that can be used to develop common styles of iOS apps, such as games, apps with tab-based navigation and table-view-based apps. These templates come with a preconfigured interface and source code files to start working with. As outlined in *chapter 4.3.1* a tab-based navigational system was to be offered within the application, consequentially a "tabbed application" template was selected. Finally the option to build a universal application was selected, so that Xcode would automatically generate storyboards for both the iPhone and iPad screens . Although the application was solely being developed for iPhone (as this would function on iPad anyway) this option was chosen in foreseeing future development.

5.1.3 Creation of Storyboard

The iPhone storyboard was now ready to be worked on (See *fig 12*). A storyboard is a visual representation of the applications user interface showing screens of content and the transitions between them. Storyboards are used to lay out the flow of the application. Xcode provides all UI elements such as buttons, tableviews, sliders, scrollviews, etc and these can be dragged onto each view controller with ease. Using the interface designs created in *chapter 5.1.2* as an aid, the storyboard was created. This was the point changes to the application flow were made including the addition of four introduction tutorials that show the user how to use the application on first use.

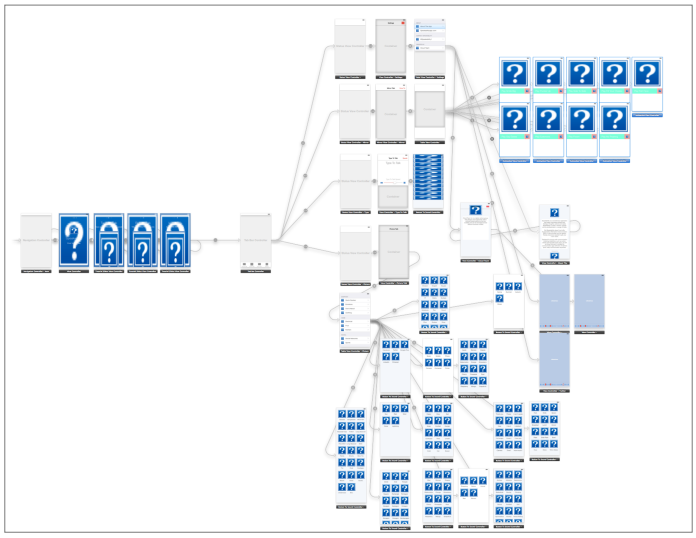


Figure 12: Storyboard Iteration One

5.1.4 Type To Talk

At this stage the best methods for the implementation of the Type to Talk functionality were researched. The solutions to complete this task seemed some what limited to begin with and it seemed that the Open Ears API developed by 'PolitePix' was the only solution to the problem. However, this solution was not an option, as the API was extremely expensive and also very advanced. Neverthless, AVSpeechSythesizer was found on a blog post by NSHipster (2013), listing all the new classes that had been made available in the iOS 7 update in September 2013.This option was more applicable to the needs of the project. A screencast created on the research undertaken to find out more about the AVSpeechSythesizer can be found at this link: https://vimeo.com/89882063.

'The AVSpeechSynthesizer class produces synthesized speech from text on an iOS device, and provides methods for controlling or monitoring the progress of ongoing speech" (Apple, 2013). The implementation began with guidance from the following tutorial (http://jonathanfield.me/avspeechsynthesizer-ios-text-speech-ios-7/). First, two new frameworks were added to the project "AudioToolbox.framework" and AVFoundation.framework". Following this the AVSpeechSyntheziser class was instantiated within the "CTViewController.m" class as can be seen in the code snippet below:

```
1  //Instantiate the object that will allow us to use text to
   speech
2  self.speechSynthesizer = [[AVSpeechSynthesizer alloc] init];
3  [self.speechSynthesizer setDelegate:self];
```

Once the AVSpeechSyntheziser class was instantiated within the project it was then ready to use with the elements placed on the Type to Talk view controller during the *chapter 5.1.4.* The elements were evinced to the desired code snippets. Two code snippets where added linking to the UITextView and UISlider to allow (1) take the contents of UITextView and output it as synthesised speech and (2) allow the user to use the UISlider to control the speed of speech utterance, this slider controlled the speed of just the text typed within the UITextView on the Type to Talk view controller (at this point). The code snippet below shows a sample of the code used for 1 & 2 mentioned above:

```
1  //Take the current contents of the TextView and output it
   through the speakers of the user's device and rate setup
2  AVSpeechUtterance *utt = [AVSpeechUtterance
   speechUtteranceWithString:toBeSpoken];
3      utt.rate = [self.speedSlider value];
4      [self.speechSynthesizer speakUtterance:utt];
5  }
```

Finally eleven icons relating to every day life where added below the text to speech functions, so that the user didn't need to navigate to the Picture Talk facilities for some of the more common Picture Talk icons. This enabled to user to click the icons and the related word would be spoken via the speech synthesiser. The technology behind the Picture Talk functionality will be discussed in greater in *chapter 5.1.6*.

5.1.5 Picture Talk

The Picture Talk functionality is a library of icons associated with daily life. The user navigates to the Picture Talk area via the tab system and is presented with thirteen categories of icons displayed in a table view (For Example: Food, Sports and Quick Quotes). Selecting a category (For Example: Sports) the user would then be taken to a new view controller displaying all the icons of the selected category to them. When clicking an icon the associated word would be read via the Speech Synthesiser.

This functionality was implemented, again using the AVSpeechSythesizer class. Each icon was given a tag number (For Example: Football Icon = 1). A plist (a plist is an XML-based database) was then created associating each of these tags to a word e.g 1 = Football. When the user clicked the icon, the database would be checked for image name and the word would be read via the Speech Synthesiser (see *fig 13*).

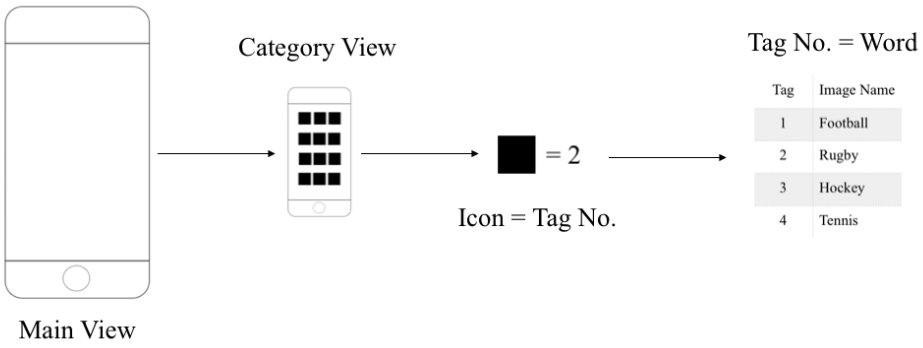


Figure 13: Picture Talk Process

5.1.6 Mirror Talk

The Mirror Talk functionality was challenging. First, each of the nine speech therapy exercises where created using Adobe Flash. This involved drawing 100-200 keyframes for each of the nine 9 animations. Each keyframe was then saved as an individual image and named with a number according to order within the particular animation. Then Ia ScrollView was set-up on the Mirror Talk controller (see *fig 14*) which spanned the length and width of the controller and within this controller a camera view was placed that defaulted to using the front camera of the device only.

Next, the nine animations were then placed within the ScrollView but above the camera view, meaning that as the user looked at the camera, the face outline was visible as well as their own face. Each animation had a "Play" button to play the animation and a "?" to acquire further information on the activity; further information was displayed in the form of a pop up window. When the user clicked the "Play" button an array would be run moving through the images at 25 Frames Per Second (FPS). The snippet of code below shows the setup of the array:

```
1 //setup animation
2 NSMutableArray *exercise1array = [[NSMutableArray alloc]
  initWithObjects:
3 @"facetest0001.png",
4 @"facetest0002.png",
5 @"facetest0003.png",
```

The functionality was tested on an iPhone Model 5c and then on a iPhone Model 4. Due to the lesser processing power in the iPhone 4 it appeared that whenever the user entered the Mirror Talk view controller, an out of memory issue would occur and the device would consequently crash. This issue took sometime to resolve. The Apple developer forum was consulted and a fix was found. The items where (1) to large - in terms of file size (2) initially the animation was created at 35 FPS for optimum quality but this was far to many frames for the lesser processors provided in the iPhone 4.

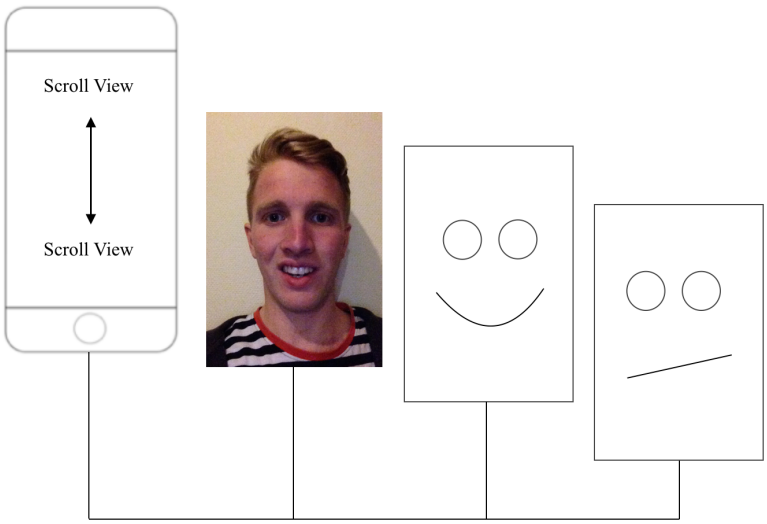


Figure 14: Mirror Talk View Controller Set Up

5.1.7 Settings

Within iteration one, the settings view controller did not offer an array of settings but this option was there ready for the addition of settings within iteration two. At this point, as described within the design stage, the settings area would offer two UIWebViews allowing the user to view the Speakability website and Twitter account directly from the application. This functionality was implemented by adding two additional view controllers linked to the settings view controller that each had a UIWebView within linking to a pre-defined url. An example code snippet is shown below:

```
1 //display Speakability site in a UIWebView
2 NSString *fullURL=@"http://www.speakability.co";
3 NSURL *url=[NSURL URLWithString:fullURL];
4 NSURLRequest*requestObj=[NSURLRequest requestWithURL:url];
5 [webView loadRequest:requestObj];
```

5.1.8 Startup Screen

A startup screen also known as the 'splash screen' is shown whilst the application is loading. Although the application only took a second to load, this made the loading process more visually appealing for the user.

5.1.9 Tutorial Screens

- **Requirements Change**

Although in the design chapter tutorial screens where not initially planned, it became apparent that they where required in order to inform first time users about what each functionality did and how it worked to increase ease of use. Therefore time was made within the schedule to create tutorial screens. The screens where designed within Adobe Illustrator and placed on view controllers, the tutorials would be shown to users the first time they enter the application with the option to skip the tutorials if they wished *(see Appendix C)*.

5.1.9.1 Promotional Website

Although the initial intention was to hard-code the website using the initial design created in *chapter 4.5*, due to time constraint the website was developed using the WordPress theme Appify (http://appifywp.com) which allowed for the rapid construction of a promotional website.

5.1.9.2 Unit Testing

Upon completion of the first iteration, the iOS application was throughly tested on a range devices (iPhone & iPad) and models to ensure there where no unforeseen issues or bugs.

5.1.9.3 Submission to App Store

The first iteration of the iOS application and website where complete and the iOS application was now ready for submission to the app store as - Version 1. Submitting an application to Apple's app store was a fairly lengthy process which involved the following;

1. Signing up for an iOS Developer Account (As described in the design chapter)
2. Adding the application to iTunes Connect (e.g. Application Name, Description, Version Number, App Icon, etc)
3. Creating a release build within Xcode
4. Within the "Organiser" in Xcode the application can now be submitted to App store for approval

Following the submission of the application, within iTunes Connect the status of the application will change to “Waiting For Review” and Apple will take around 5-7 working days to review the application and in turn approve/deny it access to the App store. Speakability was successfully approved for the app store first time. The application was then made available at the following link: https://itunes.apple.com/gb/app/speakability/id784509467?mt=8.

5.1.9.4 Summary

The iteration details the implementation of the Type to Talk, Picture Talk and Mirror Talk. All of the requirements were met successfully and within the scheduled timings.

5.2 Iteration Two

The second iteration was carried out to complete the remaining must have requirements which where settings; the volume and speed needed to be universally controllable and if time permitted additional extras needed to be added (see *table 3*).

Task	Description
1	Settings Properties
2	Storyboard Updated
3	Word Talk
4	Smile Game
5	Promotional Website (Hard-coded)
6	Unit Testing
7	Submission to App Store

Table 3: Iteration Plan Two

5.2.1 Settings Properties

At present the user was only able to control the *rate* (i.e speed) of the utterance for the Type to Talk UITextField using the UISlider on the Type to Talk view controller, as implemented within *chapter 5.1.5*. The AVSpeechSyntheziser class allows you the ability to use the utterance object to control parameters affecting its speech, such as *volume, pitch, and rate* and then, pass it to the speakUtterance: method on a speech synthesiser instance to speak that utterance. Three UISliders where added to the settings view controller to control the volume, pitch and rate. the settings where also saved between user sessions (to iCloud) so that the user preferences where saved as well as synced between multiple devices. A small code snippet is shown below:

```
1 _SliderReadingSpeed.value = delegate.reading_speed;
2 _SliderReadingPitch.value = delegate.reading_pitch;
3 _SliderReadingVolumn.value = delegate.reading_volumn;
```

5.2.2 Storyboard Updated

The additional view controllers and elements where added to the storyboard enabling the additional functionalities Word Talk and Smile Game to be added.

- **Requirements Change**

Having attained feedback from a number of users on the first iteration, the general feedback on the design of the application was that it was a little bland and could be more visually pleasing. The applications interface was therefore redesigned (see *fig 15*). Following the redesign, it was applied to the storyboards within the project.

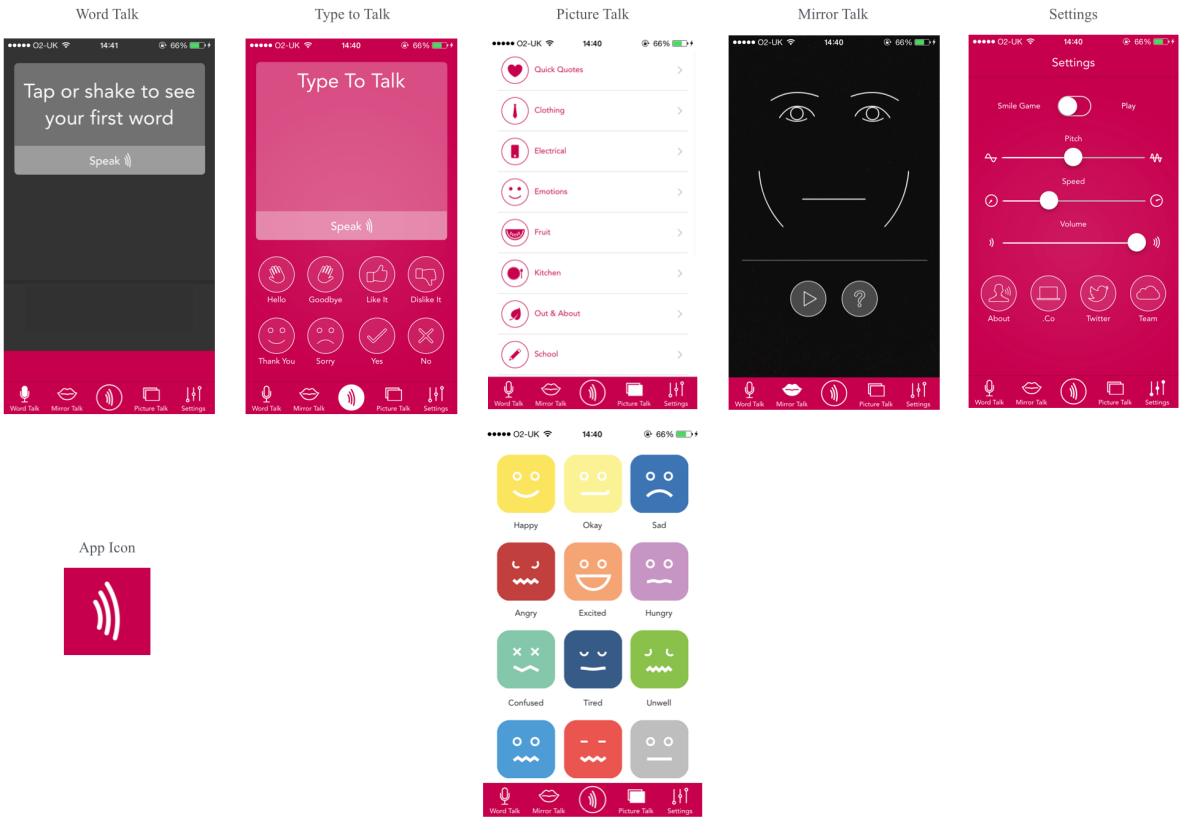


Figure 15: Interface Designs Two

5.2.3 Word Talk

The idea of the Word Talk functionality was that the user would have an array of random words at their fingers tips. The words would be read to them and in turn they would read them back to the device to both practise punctuation and to measure the volume in which they spoke at.

The implementation of the Word Talk functionality (see *fig 16*) first involved creating a plist with several hundred words within, a sensor was then added to the view controller to recognise both tap and shake gestures and *if* a gesture was found, the UITextField at the top of the view controller would print one of the words from the plist at random. The idea then would be that the user clicks the "Speak" button to have the random word read to them using the same speech synthesiser functionality used in Type to Talk and Picture Talk.

Furthermore, following the word being read to the user, they then had to practise saying it themselves by simply reading the word out loud, the users voice volume would at this point be shown in real time so that they could measure roughly at what volume they where speaking. This functionality was to help those that suffer from a very low level voice. To implement this functionality the AVAudioRecorder class was used to obtain input audio-level data that was transcribed as a metering level. By default, audio level metering is off for an audio recorder because it uses significant memory, so this first step was to enable this, allowing me to record the volume and display it within a UILabel element. This blog post was used significantly to aid the development of the Word Talk audio level capture functionality: http://bit.ly/Oe5l4F

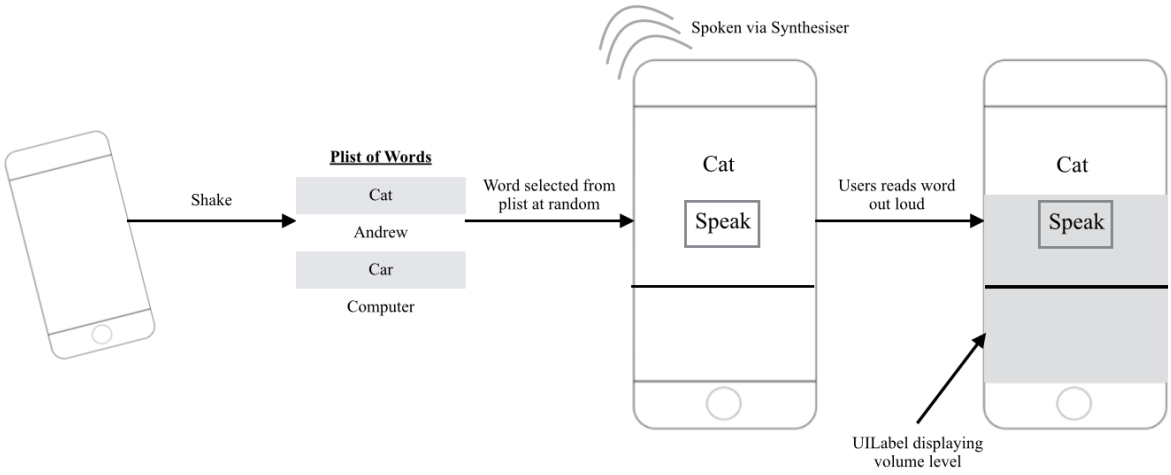


Figure 16: Word Talk Process

5.2.4 Smile Game

The smile game was to be a small unique speech muscle exercise game that users would have to complete each time they opened the application to progress to the main view controller screen (with the option to skip). The user would simply hold the front facing camera towards there face and smile, within a few seconds the application would then give them the results identifying if the smile was a good or bad smile. Face detection has been present in iOS since iOS 5, in both the AVFoundation and CoreImage SDK's. However in iOS7, the face detection in CoreImage has been enhanced, to include feature detection - including looking for smiles and blinking eyes. This was implemented using the the face detection in AVFoundation to determine when to take a photo, and then the CoreImage SDK to search for smiles and closed eyes to in turn let the user know if it was a smile or not.

Firstly the AVCaptureMetadataOutput class as part of the AVFoundation was used to detect a was face, faces are treated as metadata objects similar to QR codes. The code snippet below demonstrates this:

```
1 AVCaptureMetadataOutput *output = [[AVCaptureMetadataOutput
  alloc] init];
2 // Have to add the output before setting metadata types
3 [_session addOutput:output];
4 // We're only interested in faces
5 [output setMetadataObjectTypes:@[AVMetadataObjectTypeFace]];
6 // This VC is the delegate. Please call us on the main queue

7 [output setMetadataObjectsDelegate:self
  queue:dispatch_get_main_queue()];
```

A delegate method was implemented within SCViewController.m to allow us to take a photo of the input (face) following the five second count down timer; which is what "`captureStillImageAsynchronouslyFromConnection:completionHandler:`" does and when notified that AVFoundation has detected a face, it takes a still image of the current input, and stops the session. A JPEG representation of the captured image is then created;

```
1 NSData *jpegData = [AVCaptureStillImageOutput
  jpegStillImageNSDataRepresentation:imageDataSampleBuffer];
```

The CoreImage API is then used to search for a smile, checking for blinking, general smile and image orientation, as shown below:

```
1 NSArray *features = [_faceDetector featuresInImage:image
```

```
2 options:@{CIDetectorEyeBlink: @YES,
3 CIDetectorSmile: @YES,
4 CIDetectorImageOrientation: @5}];
```

In order to have the detector perform smile and blink detection, this was specified to the detector options (`CIDetectorEyeBlink` and `CIDetectorSmile`). Finally we perform the callback on the main queue, the callback updates the photo with a transparent layer over the image with an "X" for no smile found and a "tick" for smile found demonstrates the smile game in use showing what the CoreImage API detects (see *fig 17*).

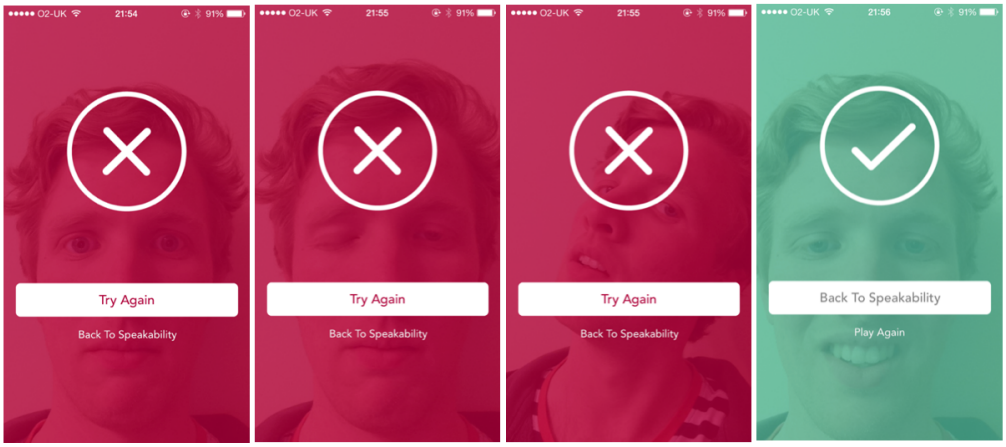


Figure 17: CoreImage Facial Feature Detector Results

- **Requirements change:** Having spoken to a supervisor, it was agreed that having the smile game appear each time the user opens the application could become annoying for regular users. As a result, the smile game was turned off by default and a switch was added within the settings view controller to allow the user to switch it on when the application opens. Furthermore, an addition play button was added next to the switch which allowed the user to play the game at any given time.

5.2.5 Tutorial Screens

In iteration one, tutorials were created in the form of images to demonstrate how each functionality of the application worked to a new user. Feedback from users on Twitter was that the tutorial screens where far to basic and did not engage the user. Consequently, a tutorial screen was created allowing the user to play with the functionality whilst having a test explanation as a way to engage and add interest. This functionality was of course a requirements change from the originally planned tutorial screens, however due to the nature of the update it was completed within two/three days and so did not have a significant effect the schedule.

5.2.6 Promotional Website

The next task was to update the website with the new screenshots and relevant information. Given the project was running smoothly, in order to improve the website it was hard-coded as originally planned. A new promotional website was created (*See Appendix D*) which can be viewed here: speakability.co, In addition, a project page; project.speakability.co which details the journey of the project and includes videos and a blog was created; blog.speakability.co. Finally a Twitter account was created for marketing purposes, the Twitter handle is @Speakability1.

5.2.7 Unit Testing

Throughout the development of iteration two, unit testing was carried out on both the built-in simulators Xcode provides, the iPhone 5c used to test and the departmental iPad 2, this was to ensure that the application worked across a range of iOS devices. During the unit testing it was found that three of the social networking Picture Talk icons had been incorrectly mapped with the wrong tag numbers, meaning they where reading the wrong word on click, this fix was simple and involved adding the image tags correctly within the plist.

5.2.8 Submission to App Store

Following the process explained in, the application was submitted to app store as - Version 2. The plan was that iteration two was to be the final submission of the application as it had met all initial requirements and all extra functionalities were created apart from support for additional languages.. However the day the application was approved and “Ready For Sale”, a new iOS operating system update (iOS 7.1) also became available, this update caused a number of depreciation issues within my applications code base which caused the Type to Talk feature to stop functioning. An unexpected bug fix needed to be submitted to the app store asap and so iteration three began.

5.2.9 Summary

The iteration details the implementation of the settings and additional extras. All of the requirements were met including the additional extras such as; Word Talk and Smile Game. Although the implementation of the features was a success in this iteration, the iteration did end on a bad note with the iOS 7.1 update causing deprecation within the code base, which lead to a third iteration.

5.3 Iteration Three

As mentioned in *section 5.2.8*, following the submission of the application the app store an iOS update was released causing some deprivation to the code base. Of course, this iteration was not but a patch needed to be submitted immediately to avoid users be effected by the issue (see *table 4*).

Task	Description
1	Bug fix
2	Word Talk - Requirements Change
3	Unit Testing
4	Submission to App Store

Table 4: Iteration Plan Three

5.3.1 Bug Fix

To combat the depreciation the iOS update had caused, the latest Xcode which accompanies the operating system update was downloaded from Apple's development site and the existing Xcode project was opened in the new Xcode program. Having updated the Xcode version, Xcode then automatically removes all deprecation and updates the application to work with iOS 7.1.

5.3.2 Word Talk

In iteration two a line was added to the centre point of the view controller to allow the user to measure roughly the volume of their speech. Following a discussion with a supervisor, it was decided that although the line was practical to roughly gauge speaking volume, having an adjustable line would be more beneficial so users can set their own target. As a result, the line was added within a scroll view allowing the user to adjust the volume.

5.3.3 Unit Testing

The application was tested on an iPhone and iPad device running the latest version of iOS (7.1) to ensure that all depreciation had been removed and that the application had no further issues. Fortunately testing found no further issues and so it was time to submit the application to the app store as an emergency change (this a submission status Apple allows developers to use where a major bug is present in ones application).

5.3.4 Submission to App Store

Iteration three was quick, it took around five hours to update the software (Xcode), remove the depreciation from the code base, add a line within a scroll view to the Word Talk view controller and the same day submit the application for review to the app store. The application was pushed to the app store within two days of the emergency submission change.

5.4 Summary

Upon completion of this iteration, a complete solution was produced. However, further testing was undertaken to attain feedback on the implementation.

6 Testing

Testing had been performed throughout the duration of the implementation stage, in the form of unit testing, to ensure that each individual component developed functioned as expected. The aim of this stage is to perform user testing on both the iOS application and website and to in turn take away some feedback which can be used to improve the application and website to better please the user base in the future.

6.1 iOS Application User Testing

User testing of the iOS application is essential to future development, a survey was created using 'Survey Planet', asking users to complete seven questions which attained the users ratings and thoughts. It asked for details on design and features. The survey (http://bit.ly/1g80VTN) was purposefully kept short and all questions where optional to encourage as many users to complete the survey as possible, as they knew it would not take a lot of time. The survey was disturbed via the following means: website, Twitter and additionally to friends and family. 34 participants completed the survey which provided a good range of opinions. Ratings where gathered and the results of the survey can be seen in the table below (see *table 5*). The results show all questions, other than question seven as these where personal opinions that added little value to the report.

No.	Questions	Average Results	No. of Partipants
1	What is your gender?	Male	31
2	What age are you?	27.5 years	31
3	Do you like the name Speakability?	Yes	34
4	What would you rate the application in terms of design?	7/10	34
5	What would you rate the application in terms of usability?	10/10	34
6	What was your favourite functionality?	(1) Smile Game (2) Mirror Talk (3) Type to Talk	32

Table 5: Results of Survey

It should be noted that within these results where the thoughts of speech therapist - Claire Mitchell who was met for a meeting during the design stage of the project. She also sent the survey onto like minded individual who will have also completed the survey. On the whole, it can be said that the results have come from various background ranging from family, friends, university tutors, speech therapists and anyone that came across the survey on the blog or Twitter. This adds validity to the findings.

6.2 Website User Testing

It was important that feedback was attained on very component of the project in order to improve upon each individual component accordingly. Using 'Peek' three users tested the website functionality to (1) ensure everything worked, (2) to receive opinions on the design and content it provides and (3) provide suggestions for improvements. The videos can be found at the following links:

Review 1: https://vimeo.com/89942005
Review 2: https://vimeo.com/90376783
Review 3: https://vimeo.com/90376784

The general consensus from the user testing was that although the site was visually pleasing, it offered little information on the applications functionalities. Suggestions included (1) adding more text to explain the application, (2) adding a video.

6.3 General Feedback

As well as feedback being gathered from the survey and Peek user testing, the application also received a number of tweets via Twitter (see *fig 18*). The tweets help to create a good brand for the Speakability application and additionally provided a positive ethos around the project.

Figure 18: General Feedback on Twitter

6.4 Summary

User testing was an essential to provide a true reflection of the projects success. The user feedback for the application was all positive and many of the comments for future improvements suggested included: support for multiple languages, the use of notifications to remind people to use the application and finally one noteworthy suggestion was that IF in iOS 8 an SDK is made available for developer to use SIRI, then this should definitely be included in the application (the application already uses the latest SDK's iOS has to offer). The user testing results from the Peek videos, highlight that with time a website with greater information and/or videos needs to be created to fully promote the application.

7 Marketing

Although marketing was not an objective, it has been a major part of the project. The sections to follow will discuss the marketing and analytics tracking that have been performed throughout the duration of the project.

7.1 Blogging & Social Networking

Throughout the project users of the application have been informed via the blog: blog.speakability.co, project site: project.speakability.co and Twitter: @Speakability1.

7.2 Marketing Materials

Throughout the project a collection of promotional materials have been created, including; videos, posters and images (see *appendix E*).

7.3 Analytics Tracking

Tracking application statistics following submission is as important as the development of an application. Throughout the project the application has been tracked using App Annie. Some of the results are listed below;

- Over 700 downloads (January 31st - March 31st 2014).
- Featured #109 in the UK App Store for the Health & Fitness category.
- Ranks in the top 500 Health & Fitness applications in eight countries.
- Downloaded in over 35 countries.

(See *appendix F*).

7.4 Summary

The marketing of Speakability has been as important as the development, the stats shown above demonstrate the project has been a success and that it is a purposeful application that has been downloaded internationally.

8 Evaluation

The objective of the project was to create a mobile application superior to those already on the market that provided AAC and speech and language therapy exercises to suit a range of patients with speech and language difficulties.

The AAC method 'Type to Talk' (TTS), whereby user can type their word or sentence and the device phonetically decodes and expresses it in words was coded onto the application, thus, met the objective of providing a Voice Output Communication Aid. Nevertheless, the most common complaints for TTS applications are that speech synthesis can still sound highly unnatural (Barron*, et al*, 2002). This functionality on Speakability correctly decodes words, however, as the words are computer generated and consequently, there is still an element of unnatural speech. Nevertheless, the speed and pitch in which the device outputs the speech can be altered, thus, giving the user control over the outcome and this does go someway to improving the sound output. However, future version could look at the possibility of providing a bank of spoken sounds that are not computer generated that can be put together when typed, yet, with this it is important to acknowledge accents and regional differences.

The application aimed to provide a 'Picture Talk' functionality, whereby patients can communicate by tapping images, once tapped the word the image represents is then spoken. As Yeung & Walker (2009) found, adults with communication impeding illnesses who were presented with both visual images and spoken representations performed better than those who were just presented with visual images. This was successfully implemented, as the application provides 150 images arranged in 13 categories; when tapped these images are transmitted as speech.

Considering the iconicity of symbols is important for those with speech and language difficulties the clarity of the images was important. The images were made on Adobe Illustrator. Feedback has stated they are clear and well-organised, this is essential for patients understanding and usability. The images are unique to the application; although this is an advantage as it adds identity and builds a brand, it should be acknowledged that symbols such as Gus Communication Symbols (GCS) are widely recognisable so it could be argued that these would reach a wider range of patients. Consequently, on future updates providing the users with the option to use 'Speakability' symbols or GCS might be a possibility, to ensure all patients can fully access the application.

Another feature the application aimed to provide was 'Mirror Talk'; a range of speech and language exercises that the user could copy directly. The application aimed to be the first on the market that enabled the patient to see their own facial movements as a mirror-like feature, providing them with a direct comparison to the exercises they would be copying. This was implemented successfully, with 9 exercises suggested by a speech and language therapist being clearly displayed as an overlay over the users own face.

As speech volume, or how softly or loudly a person speak, can directly affect the way a speaker is perceived by others, as a result, the application aimed to provide the function whereby patients can say words and the application could measure their success in volume. Speakability has the functionality allowing patients can set a scale for how loud they wish to speak, then they repeat spoken words and aim to meet the target they set, with a visual scale showing them how successful they have been. The words the user repeats are pre-generated, consequently, for younger users some might be difficult to comprehend. This may impact the outcome of the task, as the user spends more time thinking about how to pronounce the word or what the word may mean rather than the volume that they need achieve. Consequently, for future versions of the applications words pre-determined by the user might be more effective. This would result in them solely thinking of volume rather than understanding and moreover, they could focus on the words which they feel they need to specifically practise; this would provide a more personalised service.

During the submission of Version 2.0 of the application to the app store, problems were encountered. The application was submitted the same day as the update for the iOS operating system was introduced for iOS 7.1, this caused the application to have a number of issues, resulting in a patch V2.1.1 having to be released in quick succession. On evaluation, as part of the iOS developer programme, there is the option of downloading the iOS operating system update 2 months in advance of its launch to the general public. This allows app creators to test their products and consequently, refine any issues that may occur as a result of updates before their launch in the app store. Downloading the update in advance would have been better for preparation.

Nevertheless, on the whole the application was developed successfully; objectives have been met and further developments have been made, with possible additional extras being included such as; Smile Game, Pitch Settings and Word Talk all being included to enhance the functionality of the application and provide users with a wider range of exercises to support their communication.
Exemplifying this success, the application has received interest from the national charity Speakability who wish to acquire the product to support their charity that focuses on helping those with communication difficulties. Moreover, the application has been entered to the Little Chip Awards, has over 400 followers on twitter and has had over 700 downloads since its submission to the app store three months ago.

9 Conclusion

The project aim was to "*design, develop and launch an Augmentative and Alternative Communication (AAC) mobile application that is combined with Speech and Language Therapy principles, enabling those with communication difficulties to effectively convey information*" as outlined in chapter 1. Overall the project has been a success with the aim achieved, the report has shown the in depth background research carried out and also presented the process behind creating the application and promotional website. Hence, the objectives outlined in chapter 1 have also been achieved. One of the main achievements of the project is that implementation to the solution, went beyond the initial plan and the additional extra features where also implemented. Finally the user testing yielded very positive results and feedback given to improve the application in the future will be discussed below.

9.1 Future Work

Potential future work is limitless, both in terms of improvements to the current solutions offered and the addition of new features. Firstly the application currently only supports iOS 7 or later, this is limiting a large part of the iOS device market with users with devices such as; iPhone 3gs and iPad 1 not being able to use the application, moreover there is no support for Android users. In terms of improving the current solutions, the first feature looked to be improved would be Type to Talk, to include features such as; support for multiple languages and smaller updates such as a copy to clipboard tip.

From the user testing, it is clear that the smile game is favoured. For this reason, further work could be carried out to gamify existing features and develop new mini games within the application. Finally, user feedback highlighted that users like data, as a result, within the settings area of the application stats such as; number of Picture Talk clicks, number of times application opened and number of times the Smile Game has been completed could be recorded to provide the user a profile of stats on their application use.

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11 Appendix A - Terms of Reference

Title: *A New Mobile Application Combining Augmentative & Alternative Communication (AAC) with Speech & Language Therapy*

Student: *Andrew Raynes* Supervisor: *Baihua Li*

1 Introduction

'Around 2.5 million people in the UK have speech, language or communication problems', these problems include forming sentences, selective mutism and use of the wrong sounds in speech (BUPA, 2012). Nevertheless, although the smart phone has become increasingly analogous to a "Swiss Army Knife", providing a plethora of tools for every day life, there are few mobile applications to support those with communication impeding disabilities. With a wide and varied patient group including those with Autism, Parkinson's disease, stroke, brain injury and stuttering, it is clear that the integration of speech therapy with technology will be beneficial for a large audience. It is very important that everyone has a voice that reflects their own age, gender and nationality (Niemeijer, 2013).

Formal speech and language sessions often consist of many strategies to help patients develop their speech, including: oral exercises (tongue, lip, and jaw exercises) to strengthen the muscles of the mouth and articulation or sound production exercises to help with pronunciation of sounds and words. There are several mobile applications on the market that include these practices: 'Articulation Station (Little Bee Speech, 2013) highlights the sounds within words and allows the user to hear words being pronounced correctly and 'Speech Tutor' (Synapse, 2012) models mouth movements for each sound. Yet, as Sutton & Olivier (2013) state, 'the potential for using apps in Speech and Language Therapy has only just begun to be explored', most applications are aimed at children who are at the beginning of their language journey, rather than those with speech difficulties.

The majority of applications aimed at those with speech difficulties are based around Augmentative and Alternative Communication (AAC). AAC is a term that encompasses the communication methods used to supplement or replace speech for those with impairments in language; this includes using images and text to form sentences and using narrators (BUPA, 2012). Such AAC techniques are already being developed in line with technology, yet, it is clear that there are an insufficient number of mobile applications that have implemented AAC principles successfully. 'Proloquo2Go' (Niemeijer, 2013) is an image-to-speech application which allows users to turn pictures into words, 'SpeakIt' (Stefanopoulos, 2013) and 'Speech Assistant AAC' (Schalke, 2013) are text-to-speech applications that allow typed words to be spoken and 'Speech Sounds on Cue' (Bishop, 2011) is an iPad application that displays pictures with the user having to verbally name the image.

Although the above applications all provide aspects of Speech and Language Therapy there is not an application currently on the market that amalgamates AAC and speech and language practices to provide a complete speech application. Moreover, all the applications listed are internationally made, with international voice recognition and narrators. This means that there is no such app in the field to support English patients and those wishing to bridge the communication gap with them. This project is to address the issues highlighted above by (1) developing a mobile application for Apple iPad and iPhone which combines and updates current features (Prologquo2Go, Speak It and Speech Assistant AAC) using Apple development application 'Xcode' and programming language Objective C (2) developing on current features (Speech Sounds on Cue) by adding a video and speech recording system.

2 Aim of Research

The project aim is to design, develop and launch an Augmentative and Alternative Communication (AAC) mobile application that is combined with Speech and Language Therapy principles, enabling those with communication difficulties to effectively convey information.

3 Objectives

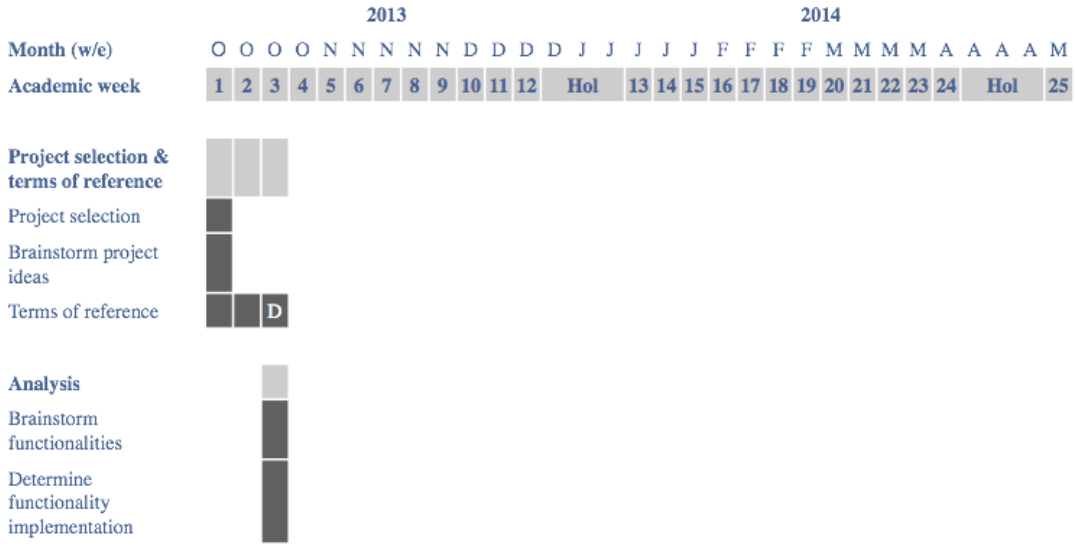
1. Review existing Augmentative and Alternative Communication applications.
2. Design user interface, work flow and website application advertisement page.
3. Implement text to speech functionality.
4. Design all picture to text icons and devise a new accessible work flow to display the pictures to the user.
5. Implement video recording functionality.
6. Application testing and submission to the Apple App Store.
7. Document project analysis, design and results.

4 Course Specific Learning Outcomes

1. Make effective decisions based on the key technical characteristics of digital media technologies in terms of storage, manipulation, and encoding.
2. Implement design principles and methods specific to interactive multimedia software solutions and value-added media components (including text, graphics, audio and video) for a range of platforms and domains.
3. Develop and deploy reusable and modular interactive multimedia software components.
4. Select and use relevant communication, interaction and educational theories in evaluating e- learning development, environments and technologies.
5. Use a range of scripting skills to produce effective 3D and data-oriented applications.

5 Timetable & Deliverables

The required resources for my project are as detailed below.




Design & literature review
Design the application work flow
Design the application screens
Design the application storyboard (Xcode)
Design the icon sets
Design/developer website advert page
Literature Review
D
Implementation & interim report
Develop application structure
Implement text to speech
Interim Report
D
Implement picture to text
Implement Video Recording
Finalise application implementation
Testing
System testing
User testing
Deployment
Submission to the Apple App Store
Update website advert page
Documentation & presentation
Report Structure
D
Project report & Product
D
Prepare for project presentation
Present presentation
D

6 Required Resources

The required resources for my project are as detailed below;

Item	Purpose	Specification
MAC Book Pro	The MAC Book Pro will be used to run the following softwares: Xcode, Adobe Illustrator and iWork.	Mac Book Pro 15" Retina
iPhone/iPad	Both devices will be used to test the application on.	iPhone 4 and iPad 3 (Both running IOS7)
Xcode	Xcode is the complete toolset for building IOS applications. This will be used to develop the applications main infrastructure.	Xcode 5
iOS Developer Account	Access to extra resources that will aid the project: Developer libraries, Developer forum and the ability to upload the application to the app store on completion.	developer.apple.com
Adobe Illustrator	The best vector graphics editor to design application screens and icons.	Adobe Illustrator CC
iWork (Pages, Numbers & Key Note)	iWork will be used to document (Pages), create plans (Numbers) and present (Key Note) my project from beginning to end.	iWork '09

7 References

Bishop, C. 2011. Speech Sounds on Cue (version 1.0). [Mobile app]. [Accessed 13th October 2013].

BUPA (2012) Speech and Language therapy. [Online] [Accessed on 14th October 2013] http://www.bupa.co.uk/individuals/health-information/directory/s/speech-therapy

Little Bee Speech. 2013. Articulation Station (version 1.5.1.). [Mobile app]. [Accessed 2nd November 2013].

Niemeijer, D. (2013) 'Australian smartphone app Proloquo2Go helps give children with speech difficulties a voice'. News.com.au. [Online] May 14th [Accessed on 14th October 2013] http://www.news.com.au/technology/australian-smartphone-app-proloquo2go-helps-give-children-with-speech-difficulties-a-voice/story-e6frfro0-1226641783691

Niemeijer, D. 2013. Prologquo2Go (version 2.0). [Mobile app]. [Accessed 13th October 2013].

Schalke, T. 2013. Speech Assistant AAC (version 3.0). [Mobile app]. [Accessed 13th October 2013].

Stefanopoulos, J. 2013. Speak It (version 2.6) . [Mobile app]. [Accessed 13th October 2013].

Sutton, S. and Olivier, P. (2013) 'Speech and Language Therapists, their Patients and Mobile Apps.' Newcastle: Culture Lab. ACM CHI 2013 A.

Synapse Apps, LCC. 2013. Speech Tutor (version 1.03). [Mobile app]. [Accessed 2nd November 2013].

12 Appendix B - Ethics Form

Manchester Metropolitan University

ETHICS CHECK FORM

This checklist must be completed for every project. It is used to identify whether there are any ethical issues associated with your project and if a full application for ethics approval is required. If a full application is required, you will need to complete the 'Application for Ethical Approval' form and submit it to the relevant Faculty Academic Ethics Committee, or, if your research falls within the NHS, you will need to obtain the required application form from the National Research Ethics Service available at www.nres.npsa.nhs.uk/ and submit it to a local NHS REC.

Before completing this form, please refer to the University's Academic Ethical Framework (www.rdu.mmu.ac.uk/ethics/mmuframework) and the University's Guidelines on Good Research Practice (www.rdu.mmu.ac.uk/rdegrees/goodpractice.doc).

Project and Applicant Details

Name of applicant (Principal Investigator):	Andrew Raynes
Telephone Number:	07510 411878
Email address:	andrew.raynes@stu.mmu.ac.uk
Status:	Undergraduate Student
Department/School/Other Unit:	School of Computing, Mathematics and Digital Technology
Programme of study (if applicable):	Multimedia Computing
Name of supervisor (if applicable):	Dr Baihua Li
Project Title:	A NEW MOBILE APPLICATION COMBINING AUGMENTATIVE & ALTERNATIVE COMMUNICATION (AAC) WITH SPEECH & LANGUAGE THERAPY
Does the project require NHS Trust approval? If yes, has approval been granted by the Trust? Attach copy of letter of approval.	No

Ethics Checklist (Please answer each question by ticking the appropriate box)

	Yes	No	N/A
1. Will the study involve recruitment of patients or staff through the NHS, or involve NHS resources? If yes, you may need full ethical approval from the NHS.		X	
2. Does the study involve participants who are particularly vulnerable or unable to give informed consent (e.g. children, people with learning disabilities, your own students)?		X	
3. Will the study require the co-operation of a gatekeeper for initial access to the groups or individuals to be recruited (e.g. students at school, members of self-help group, nursing home residents)?		X	
4. Will the study involve the use of participants' images or sensitive data (e.g. participants personal details stored electronically, image capture techniques)?		X	
5. Will the study involve discussion of sensitive topics (e.g. sexual activity, drug use)?		X	
6. Could the study induce psychological stress or anxiety or cause harm or negative consequences beyond the risks encountered in normal life?		X	
7. Will blood or tissue samples be obtained from participants?		X	
8. Are drugs, placebos or other substances (e.g. food substances, vitamins) to be administered to the study participants or will the study involve invasive, intrusive or potentially harmful procedures of any kind?		X	
9. Is pain or more than mild discomfort likely to result from the study?		X	

Ethics Matters

10. Will the study involve prolonged or repetitive testing?			
	Yes	**No**	**N/A**
11. Will it be necessary for participants to take part in the study without their knowledge and informed consent at the time (e.g. covert observation of people in non-public places)?		X	
12. Will financial inducements (other than reasonable expenses and compensation for time) be offered to participants?		X	
13. Is there any possible risk to the researcher (e.g. working alone with participants, interviewing in secluded or dangerous)?		X	
14. Has appropriate assessment of risk been undertaken in relation to this project?		X	
15. Does any relationship exist between the researcher(s) and the participant(s), other than that required by the activities associated with the project (e.g., fellow students, staff, etc)?		X	
16. Faculty specific question, e.g., will the study sample group exceed the minimum effective size?		X	

If you have ticked 'no' or 'n/a' to all questions, attach the completed and signed form to your project approval form, or equivalent. Undergraduate and taught higher degree students should retain a copy of the form and submit it with their research report or dissertation (bound in at the end). MPhil/PhD, and other higher degree by research, students should submit a copy to the Faculty Research Degrees Sub-Committee with their application for registration (RD1) and forward a copy to their Faculty Academic Ethics Committee. Members of staff should send a copy to their Faculty Academic Ethics Committee before commencement of the project.

If you have ticked 'yes' to ***any*** of the questions, please describe the ethical issues raised on a separate page. You will need to submit your plans for addressing the ethical issues raised by your proposal using the 'Application for Ethical Approval' form which should be submitted to the relevant Faculty Academic Ethics Committee. This can be obtained from the University website (http://www.rdu.mmu.ac.uk/ethics/index.php).

If you answered 'yes' to question 1, you may also need to submit an application to the appropriate external health authority ethics committee, via the National Research Ethics Service (NRES), found at http://www.nres.npsa.nhs.uk/, and send a copy to the Faculty Academic Ethics Committee for their records.

Please note that it is your responsibility to follow the University's Guidelines on Good Research Practice and any relevant academic or professional guidelines in the conduct of your study. **This includes providing appropriate information sheets and consent forms, and ensuring confidentiality in the storage and use of data.** Any significant change in the question, design or conduct over the course of the research should be notified to the relevant committee (either Faculty Academic Ethics Committee of Local Research Ethics Committee if an NHS-related project) and may require a new application for ethics approval.

Approval for the above named proposal is granted

I confirm that there are no ethical issues requiring further consideration. *(Any subsequent changes to the nature of the project will require a review of the ethical consideration(s).)*
Signature of Supervisor (for students), or Manager (for staff): _____
Date: 02/05/2014

Approval for the above named proposal is not granted

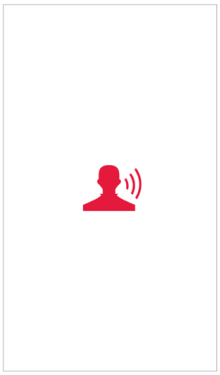
I confirm that there are ethical issues requiring further consideration and will refer the project proposal to the Faculty Academic Ethics Committee.
Signature of Supervisor (for students), or Manager (for staff): _____
Date: 02/05/2014

Ethics Matters

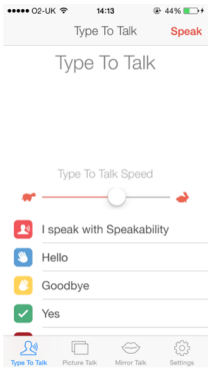
13 Appendix C - Application Designs

Interface designs as seen in V1 of the application;

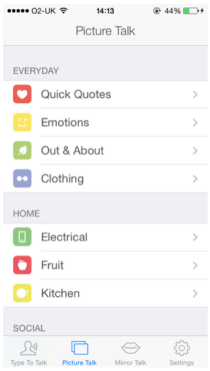
Loading Screen



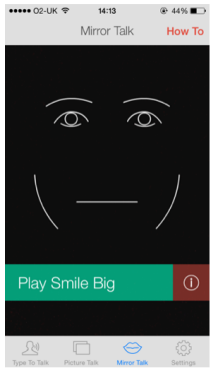
Type to Talk



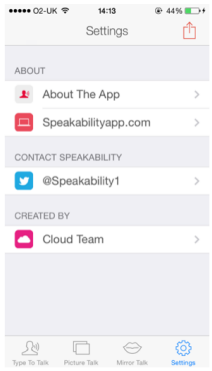
Picture Talk



Mirror Talk



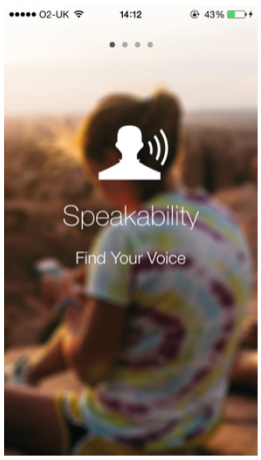
Settings



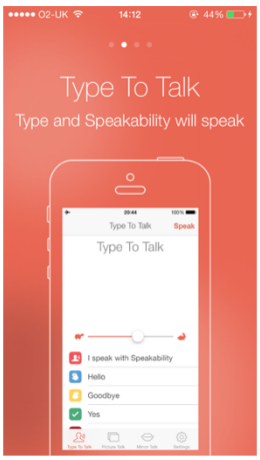
App Icon

Tutorial Screens

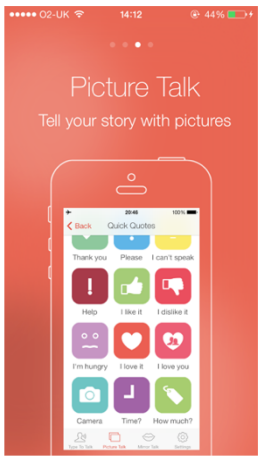
Screen 1: Welcome



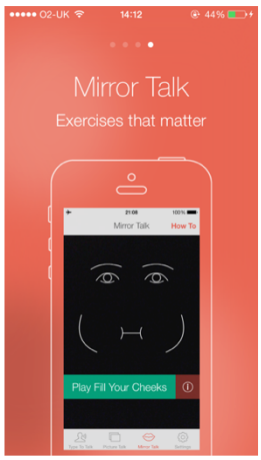
Screen 2: Type to Talk



Screen 3: Picture Talk



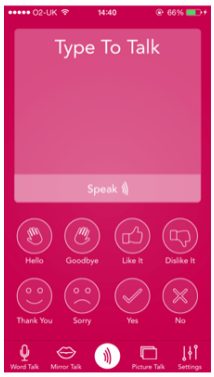
Screen 4: Mirror Talk



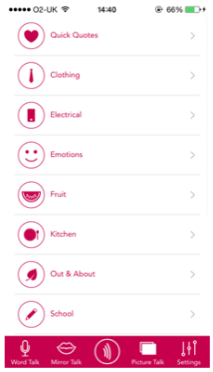
Interface designs as seen in V2/V2.0.1 of the application;

Word Talk

Type to Talk



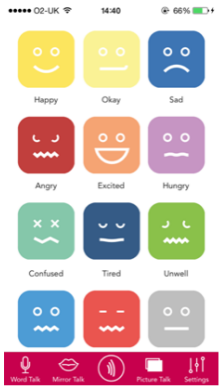
Picture Talk



Mirror Talk

Settings

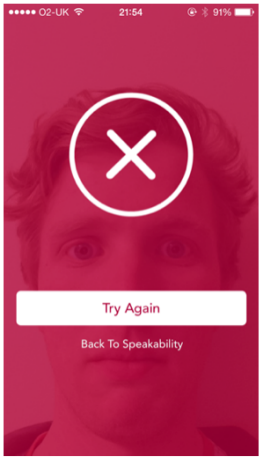
App Icon



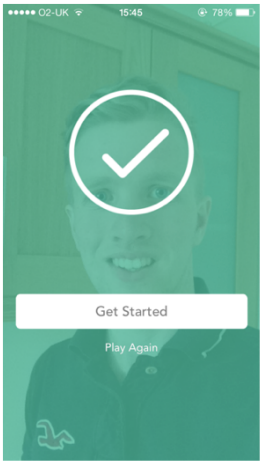
Word Talk

Smile Game Count Down

Smile Game: Fail

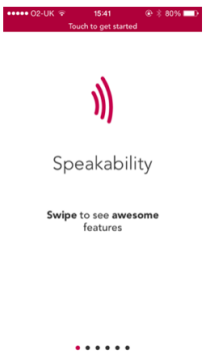


Smile Game: Pass

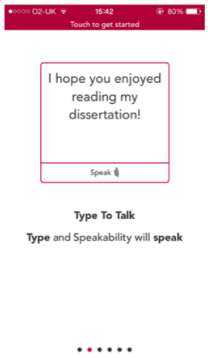


Tutorial Screens

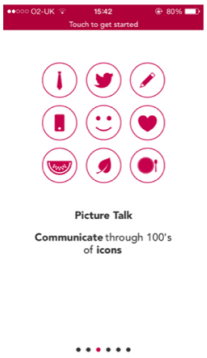
Screen 1: Welcome



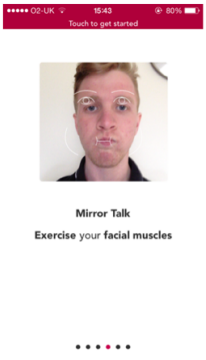
Screen 2: Type to Talk



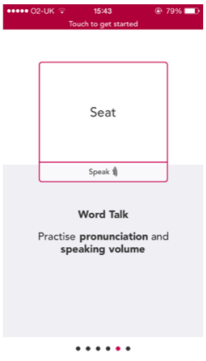
Screen 3: Picture Talk



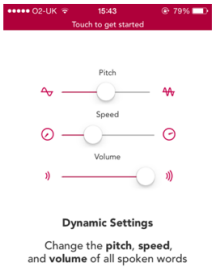
Screen 4: Mirror Talk



Screen 5: Word Talk

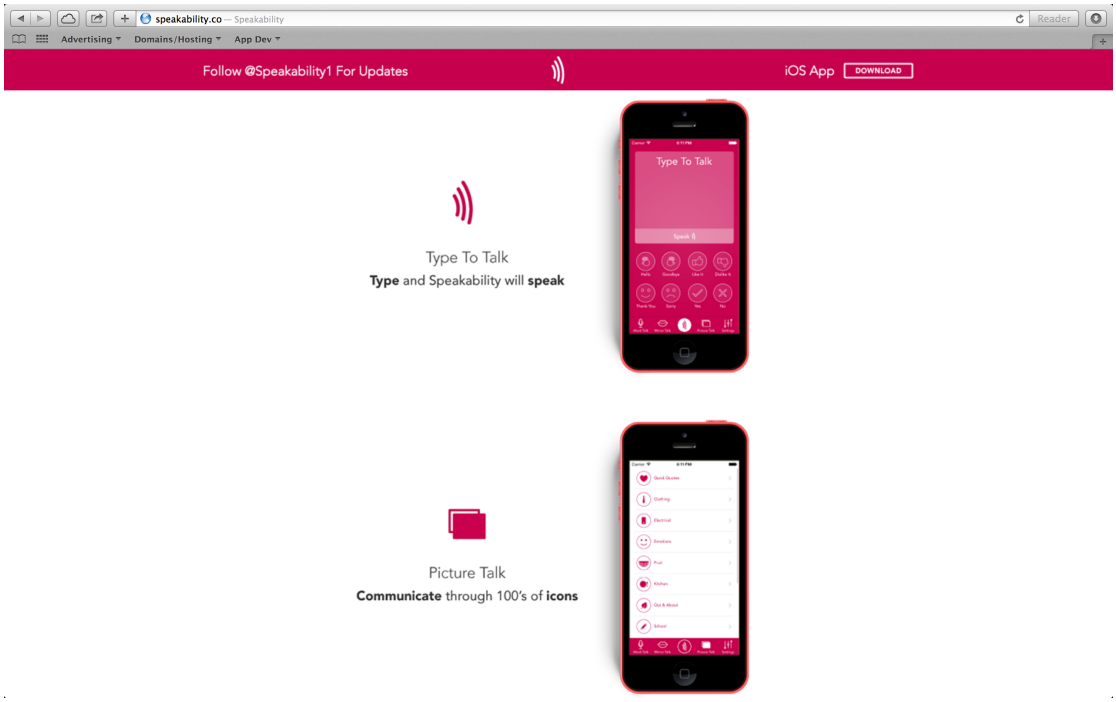


Screen 6: Settings

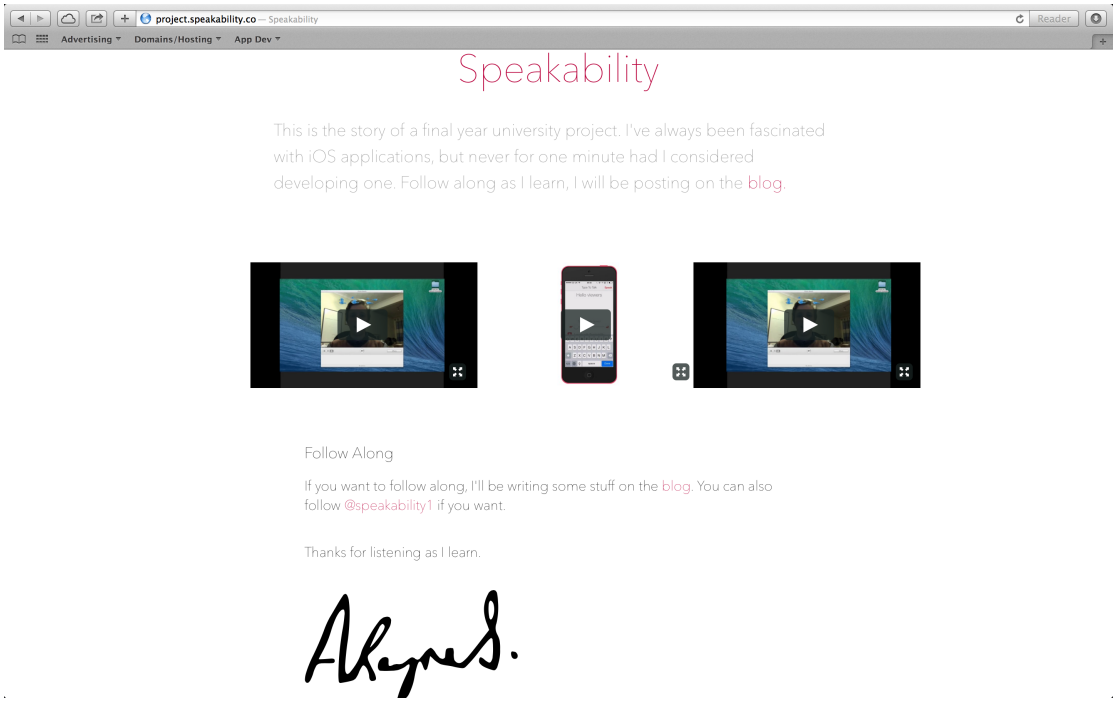


14 Appendix D - Websites

Main promotional website (http://speakability.co);

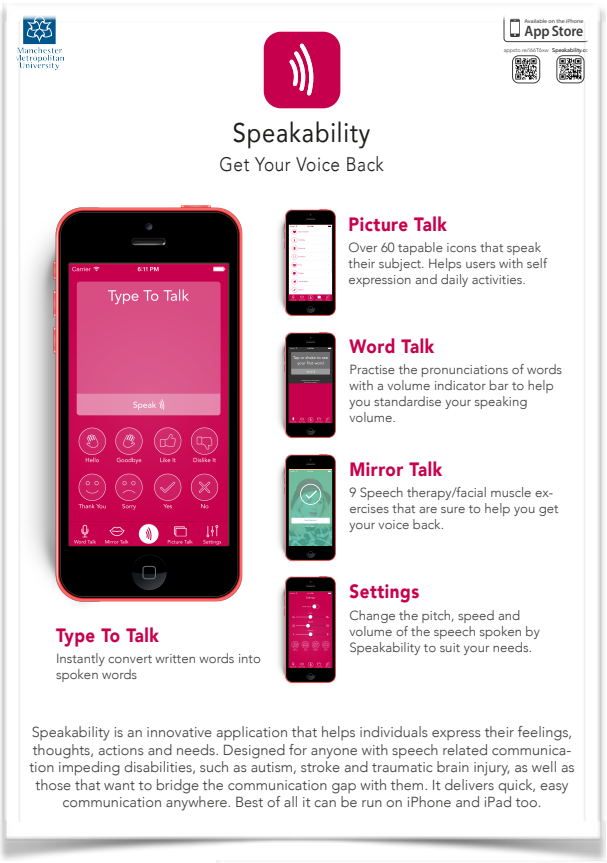


Project website (http://project.speakability.co);



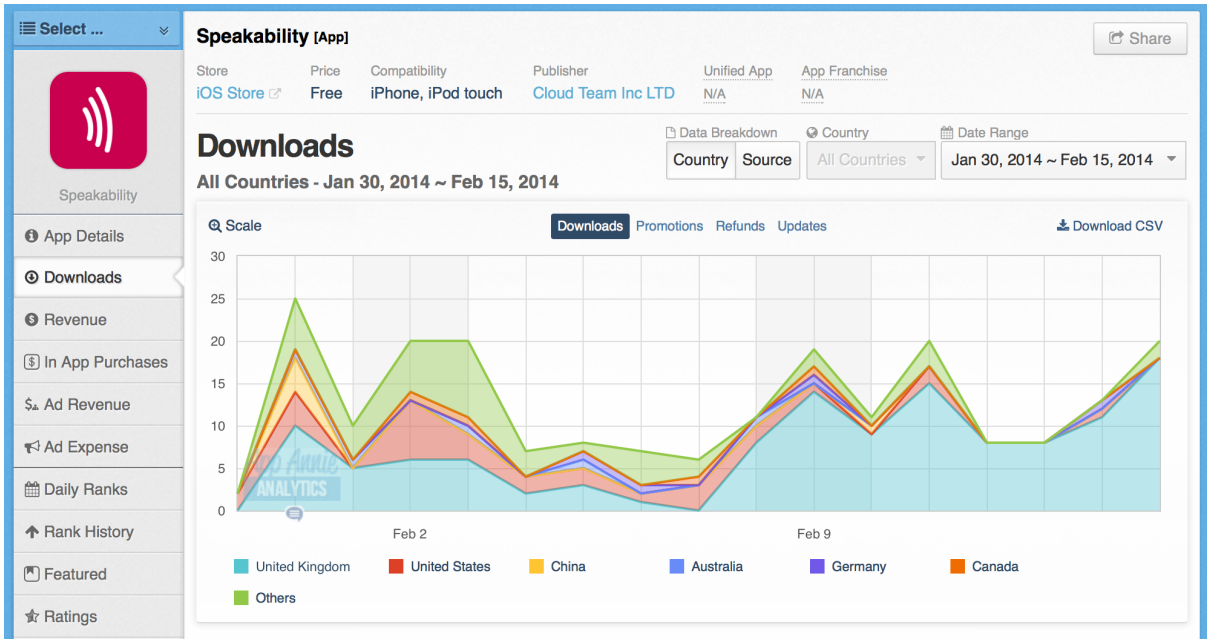
15 Appendix E - Promotional Material

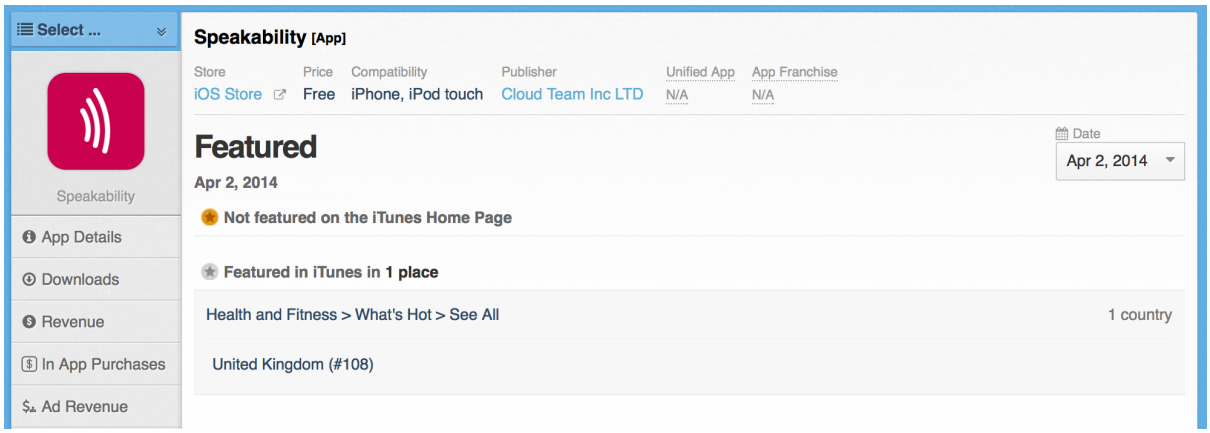
The promotional materials created to enter the Big Chip Awards and to generally advertise the application.



16 Appendix F - Analytics

The screenshots below show some analytics on the application, attained via App Annie.





17 Appendix G - Speakability Charity Communications

The email below is a sample of the communications carried out with the Chief Executive of the National Speech Charity "Speakability".

Melanie Derbyshire 1 April 2014 12:11
To: Andrew Raynes Hide Details
RE: Speakability Application

Dear Andrew,

Many thanks for the link and information about the Speakability Application that you have been working on. I would very much like to let some of our Group Members have a trial run with the existing set up. A number do already use the Lingraphica App successfully and you might find it helpful to look at this if you haven't already done so. It would be good to meet up once I have some 'customer' feedback and I will be in touch soon about this.

Just a couple of general comments :

- the opportunity to choose a male or female voice would make this more 'user' friendly.
- white out of coloured backgrounds can be difficult for individuals where there are also visual problems.

You have obviously worked hard on this application and it has a really positive feel to it. Well done!

Kind regards,

Melanie

Melanie Derbyshire
Chief Executive

Speakability (Action for Dysphasic Adults)
240 City Road, London EC1V 2PR
Tel: 020 7261 9572
www.speakability.org.uk