Veterinary Cardiopulmonary Arrest and Resuscitation Educational Resource App

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Abstract

Cardiopulmonary arrest (CPA) is one of the most intimidating scenarios encountered by veterinary professionals. Relative infrequency of CPA can make it difficult for veterinary professionals to have the experience necessary in these critical situations. The result of this can be that potential life saving measures are not initiated when appropriate. This research explores the creation of an e-learning app which educates and trains veterinary students and professionals on how to react in this emergency situation. After reviewing currently available e-learning platforms to gather knowledge on useful features, an initial design was developed which meets stakeholder and design requirements. This design was developed into a high-fidelity prototype and evaluated to reveal its usability and overall usefulness to its end users.

Research Ethics Approval

This project obtained approval from the Informatics Research Ethics committee.
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The participants' information sheet and a consent form are included in appendix A.

Declaration

I declare that this thesis was composed by myself, that the work contained herein is my own except where explicitly stated otherwise in the text, and that this work has not been submitted for any other degree or professional qualification except as specified.

(*Laura Bulloch*)

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Chapter 1

Introduction

1.1 Motivation

This project was proposed in collaboration with The Royal (Dick) School of Veterinary Studies. The aim of the project is to create an educational tool which can be used as a learning resource for animal cardiopulmonary arrest and resuscitation. Cardiopulmonary arrest is one of the most intimidating scenarios encountered by veterinary surgeons and nurses. With their fortunate relative infrequency, this can make it difficult for veterinarians to have the experience necessary in these cases. The result of this can be that potential life saving measures are not instituted when appropriate.

This report details the design and implementation of the veterinary learning resource. The resource is in the form of a smartphone app and is to be used by undergraduate students and qualified veterinary professionals. Undergraduate students would be using the resource for revision and learning as well as a reminder in emergency situations. While qualified veterinary professionals may use it as part of continuing professional development or as a refresher. The app is designed to be intuitive and easy to navigate, while maintaining good structure. Allowing resources needed to be found straight away in time-critical situations while simultaneously making the platform ordered, with a clear route of progression if being used to learn from. The development of the app is user and learner centred and incorporates widely studied methodologies and principles.

1.2 Project Goals

The main goal of this research project is to design a learning resource app that is easily used by, and helpful for, its end users: undergraduate veterinary students and qualified veterinary professionals. In order to achieve this overall goal, I aim to answer the following research questions:

RQ1: What e-learning tools are available?

RQ2: Can e-learning be effective in veterinary medicine?

RQ3: Is the application suitable for its end users?

RQ4: Would users choose to use the app?

1.3 Hardware

All work on this project was completed on a laptop running macOS Monterey version 12.5.1.

1.4 Report Structure

This project report follows the structure below :

Chapter 2: This chapter introduces information on cardiopulmonary arrest (CPA) and resuscitation (CPR) in animals. It discusses what CPA and CPR are and statistics that indicate standard guidelines may help increase success rates. This is combined with information on e-learning practices and learning tool reviews to form the background to this project.

Chapter 3: This chapter presents the design methodologies and techniques which are used to create the design requirements of this project, along with specific stakeholder requirements. The design requirements are influenced by stakeholder needs, personas of end users and widely used heuristics in the field of human computer interaction.

Chapter 4: This chapter presents the low-fidelity design of the app. The designs of each screen are discussed, along with an evaluation of this initial design with end user personas and a .

Chapter 5:: This chapter presents the high-fidelity implementation of the app developed using Expo. The use of Firebase for several app functions is discussed and explained.

Chapter 6: This chapter presents the evaluation of the high-fidelity implementation through user questionnaires and observation. The development of the user study is explained along with possible improvements from user feedback.

Chapter 7: This chapter discusses the results and limitations of the research overall. Possible extensions for the continuation of the project into 5th year are also presented.

Chapter 2

Background

2.1 Cardiopulmonary Arrest and Resuscitation

2.1.1 What is CPA and CPR?

Cardiopulmonary Arrest (CPA) occurs when the heart stops pumping blood around the body. The brain is then starved of oxygen causing unconsciousness and loss of breath. CPA requires fast paced assessment of the patient so that Cardiopulmonary Resuscitation (CPR) can start immediately, and the patient is given the best chance of survival. CPR is an emergency, life-saving procedure that uses artificial respirations and chest compressions in an effort to revive a patient when they aren't breathing or don't have a heartbeat.

2.1.2 CPA and CPR in animals

Guidelines surrounding human resuscitation are well established and documented, while also being regularly updated. Until the release of the Reassessment Campaign on Veterinary Resuscitation (RECOVER) Initiative in 2012, the same could not be said for animal resuscitation. RECOVER was developed to create a guideline for CPR in cats and dogs and to identify knowledge gaps in animal CPA. Compared to humans, there are different ways to recognise CPA in animals as well as its predominant underlying cardiovascular pathology [1]. These differences mean that a separate set of guidelines from the human medicine guidelines, set out by the International Liaison Committee on Resuscitation, were needed in Veterinary medicine [2].

The success rate of CPR in animals versus humans is low. The human survival rate is now around 20% in the best cases compared to around 4% for dogs and 10% for cats [3]. This rate decreases further in animals when looking at the outcome 'alive at discharge'.

The RECOVER guidelines are helping set a standard across veterinary medicine as there is an uptake in practices following the recommendations [4]. Recent studies have shown that RECOVER is having a global impact and with studies in Japan showing that using RECOVER takes return of spontaneous circulation from 17% to 43% in dogs [5].

2.2 E-learning

This section reviews e-learning and its recent rise in popularity. As well as how e-learning is used in health to indicate that it is similarly beneficial to veterinary medicine.

2.2.1 What is e-learning

Online learning, or e-learning, is the use of electronic resources to learn. Online learning has been an upcoming learning method for years but has had a sharp rise due to the Covid-19 pandemic and is now deployed worldwide. It offers students the chance to work wherever they want and whenever they want. The only common stipulation is an internet connection, but more course providers are allowing downloads so students can learn even more remotely. Most online learning systems provide a way for students to view course content via videos and readings but many also have features like quizzes, surveys and discussion rooms.

Institutions around the world faced closure during the Covid-19 pandemic. This led to accelerated development of online learning platforms as e-learning became a necessity rather than an option. While restrictions have eased, a lot of classes have remained online. As academia is now in a routine of using online resources, students and education professionals do not want to return completely to traditional learning as they value this newfound flexibility. They can structure their days more to their needs, and many spend less time and money commuting.

Although online learning has been a saviour for educational institutions around the world in recent years, the efficiency relies heavily on the self-discipline of the learner [6]. Students have reported that having a limited attention span can make online learning difficult as at times there is no interaction. To change this, courses should be structured to use a mix of online learning styles in an attempt to keep students engaged [7].

2.2.2 E-learning in health

E-learning for Healthcare (e-LfH) is a programme set up by Health Education England that provides online learning resources to the NHS health and social care workforce. Over 150 programmes are currently delivered through e-LfH which were created in partnership with accredited medical bodies such as Royal Colleges and associations and Department of Health policy teams [8].

Courses are provided 24/7 and are quality assured, meaning workers can structure their study time around their busy lives, while still getting professional standard education. The courses cover a range of subjects to benefit all divisions of the NHS, from emergency medicine to child safeguarding. The content is structured to be informative and engaging so knowledge is retained by learners. Some courses use case studies and real-life scenarios in an attempt to bridge the gap between online learning and learning from experience. Health professionals can use these courses as mandatory training, refresher courses or to get a better insight in subject areas they may not be as familiar with [8].

An increasing number of e-learning resources are being commissioned around the

country to help meet the needs of the health care work force. The National Patient Safety Agency have a new range of e-leaning resources which are freely available and online courses are being implemented as part of the Essence of Care programme [9].

When compared with each other, offline and online learning appear to have the same effectiveness in medical education. It really comes down to learner preferences. To guarantee success of online learning tools the design principles, student preferences and learning goals should be seriously evaluated [10].

2.2.3 RevivR

RevivR is an online health course made by the British Heart Foundation that aims to teach Cardiopulmonary Resuscitation (CPR) basics to the wider public [11]. They explain 'Many of us will witness a cardiac arrest in our lifetime. Be ready for that day with RevivR, our fast, free and easy-to-use online training course'. RevivR is estimated to take 15 minutes to complete and can be accessed on devices with internet access.

The course opens with a breakdown on the content and the materials users will need. There are video tasks which demonstrate the manoeuvres that users may need to execute. Additionally, the course has several activities such as simulating a 999 call, practising compressions on a pillow and positioning defibrillator pads on someone's chest. The pillow compressions task prompts users to allow camera usage as this is used to give feedback on chest compression speed. At the end of the course, there is a quiz and the ability to get a certificate of completion. Throughout the course there are a few pop ups which give answers to common questions: what is CPR and why dial 999?

2.3 Existing e-learning resources

This section reviews e-learning resources that are currently widely used. The smartphone app versions of the tools are used as this is most similar to the goal of the project.

2.3.1 Udemy

Udemy[1] is a popular online learning community that offers more than two hundred thousand courses [12]. Instructors can upload content and design courses using the Udemy format so that learners can enrol, often for a fee, and take that course. Many Udemy courses are considered to be of a professional standard and so certifications can be awarded on completion.

The app is easy to navigate, and users can search for course by category. The review was conducted on the 'Git & GitHub Crash Course: Create a Repository From Scratch' course [13]. When enrolled in a course, it is added to the users 'My learning' tab and as work is completed, the progress bar increases. When working on a course, the video is displayed in the top third of the screen and all other functionality in the rest of the screen. The video format allows users to play, pause, rewind, fast forward, change playback speed and download the video. There is a note taking functionality which lets users

[1] Udemy: https://www.udemy.com

make a note at that point in the video for them to refer back to later. When users have watched/viewed an item in the playlist, there is a tick of completion displayed next to it. A 'Downloads' section stores pre-downloaded content can be viewed offline. While the 'More' section is where users can find a course description, course certifications achieved, notes taken, announcements and the ability to favourite or archive.

The content of the course can be videos, articles or quizzes. An article is displayed as purely text on full screen, while a quiz is displayed as multiple choice, where users select an answer and submit. If correct there is a good job message, if false there is a prompt to review related material and start again. At the end of the quiz, a breakdown of what was answered correctly and what the user needs to review is given.

2.3.2 YouTube

YouTube[2] is a online video sharing platform which is used by many as an educational resource where users can stream courses from educational creators [14].

The course reviewed was the Git & GitHub Tutorial for beginners by The Net Ninja [15]. As YouTube is not specifically designed for learning, it is harder to navigate to the educational content. Courses tend to be uploaded into playlists so that learners can work their way through bit by bit. When selecting a playlist, there is a 'Play All' button which starts the first video and works down. The video has several functionalities including: next video, previous video and alternative playback speed. You can save the course playlist to your library but there is no way to 'enrol' as such. Comments can be publicly added to each video which can be helpful for getting other learners views on some topics or allowing learners to discuss between each other. Content is in video format, but instructors can set learners tasks to do after each video although there is no way to track this. YouTube is a great video streaming resource but as it was not designed for education, it has much less functionality for learning than other resources available.

2.3.3 Learn

As a student at the University of Edinburgh, access to the Blackboard Learn[3] platform is provided [16]. This review was undertaken on the Data Protection Training course. At the top of the home page, the student's grade is displayed based on any submitted work as well as a tab for any upcoming assessment due dates. This makes it easy for students to keep track of how they are performing and what deadlines they need to plan for. Under the course materials section, users will find announcements such as course changes, messages from instructors, course content, as well as a link to the course live streams and class discussions.

All sections can be accessed from the main page and at the end of every topic, there is a link to the next section. The content is displayed as text and graphics but could have an embedded video link using the Kaltura Capture[4]. At the end of the course there is an assessment in the form of a multiple-choice quiz. Feedback is given by displaying

[2]YouTube: https://www.youtube.com

[3]Blackboard Learn: https://www.learn.ed.ac.uk

[4]Kaltura Capture: https://knowledge.kaltura.com/help/kaltura-personal-capture-overview

all questions and entered answers along with a correct or incorrect banner below. If an answer is incorrect, the correct answer is not displayed but learners can retake the test as many times as they wish. If the learner achieves the required amount on the assessment, an award is added to their record to signify completion.

Learn has all the resources needed to create a good course. However, a criticism of Learn would be the layout can be a bit bulky meaning users need to open several pages to find what is needed but despite this it is easy to use on the go.

2.3.4 Khan Academy

Khan Academy[5] is an online learning resource for learners of all ages that allows them to work at their own pace [17]. The app was reviewed by enrolling in the Computers and the Internet course and taking the 'Computers' unit [18].

The layout of the app makes it easy to find specific courses. Courses can be added to bookmarks so that it is easy for users to go back to. Courses can be downloaded for off-line learning purposes. When a task has been completed, it is indicated visually by a green tick. The content is typically a mix of reading sections, videos or quizzes. The readings are in the form of textbook inserts with graphics and text to explain the concepts of the topic. The video tasks allow play, pause, fast forward, rewind and speed adjustment. Quizzes are multiple choice and questions are answered one at a time so that the answer can be checked and if wrong, a second chance is given. At the end of the quiz, points are awarded based on number of correct answers. Every couple of tasks there is a mini test and mid-way through the unit there is a quiz, finished off by an end of unit test. The unit is completed if enough points are achieved through the various tests and quizzes.

Khan Academy is very easy to use for all ages and has a great simple navigation. It is easy to bookmark and view enrolled courses while providing a way for users to track progress within each course.

2.3.5 Coursera

Coursera[6] is an online course provider which allows universities and companies to upload learning resources, with a large percentage of courses providing certification [19]. Coursera enables users to enrol for free in some courses if they do not want a certificate. The review was conducted on the EDIVET course [20].

All enrolled courses are accessible through the 'Learn' tab. Within that the 'Home' tab allows users to view all course tasks broken down by week. There is an estimate of how much work is left for the week with a progress bar and an option to download content. Tasks for the week can include readings, videos or quizzes. Readings are populated just like a text file. Video tasks are displayed with the option to save a note which is saved at that section in the video. As well as the usual video functionalities, there is the ability to watch screen in screen. Each quiz has a home screen where the grade is displayed

[5]Khan Academy: https://www.khanacademy.org
[6]Coursera: https://www.coursera.org

on completion. The quiz follows a multiple-choice format, with all questions marked instantly at the end. The quiz can be completed 3 times in 8 hours until the student achieves 60% or more. The 'Grades' section allows students to track their performance while the forums section creates a group discussion board for each week. Extra links are stored in 'Resources' while course contacts are under 'Info'. A feature Coursera has is 'Learning Reminders', this allows pupils to schedule time each day for when they want to be notified to learn.

Coursera has been designed with many intuitive and user friendly features. The 'Learning Reminders' function would be ideal for learners who have busy schedules and like to plan need to keep very on top of their work. Being able to see a content breakdown by week is also helpful in a long course but on a course used for additional learning, this is not necessary.

2.4 Design in e-learning

It has been challenging for Human Computer Interaction designers to develop e-learning tools which both stimulate and engage learners. It is good practice to use both User-centred Design and Learner-centred Design, introduced in Sections 3.1.1 and 3.1.2, techniques to make new learning platforms both accessible and productive for learners [21] [22]. This is due to the novice nature of e-learning system users. E-learning platforms should mask their inner system with an easy to follow and engaging interface. Poorly designed interfaces with low usability obstruct a user's ability to learn. With regards to e-learning, usable interfaces should incorporate interaction metaphors, images and concepts used to address functions and concepts on the screen in only one design, to create an interactive system that does not confuse learners [23]. Learners that are forced to spend time navigating an interface with poor usability will ultimately spend less time understanding the learning content which will curb retention.

2.5 Summary

There is a need for standardised CPA and CPR training across veterinary professionals to increase the outcome 'alive at discharge'. E-learning has been successful in human medical education and therefore is likely to be successful within veterinary education. The use of an e-learning app could be beneficial to increase the outcome 'alive at discharge' and so research on current e-learning platform is conducted. Following trials of several e-learning resources, several key features stood out for inclusion in the app. Udemy's notes functionality and quiz layout seemed particularly helpful to learners. Learn's ability to navigate directly between sections would provide users with seamless navigation. Using a green tick to show user progress on the main screen is a feature from Khan Academy which should be considered in the design. While Coursera's 'Learning Reminders' function would be useful for learners with hectic schedules. All identified features will be considered throughout the design process which will use User-centred Design and Learner-centred Design.

Chapter 3

Design

This chapter provides information on the design of the app including the methods used in its design and reasoning as to why these decisions were made. It will also detail the principles and methodologies followed. This chapter contains the requirements gathering stage of development.

3.1 Design Methodologies

3.1.1 User-centred Design

User-centered design (UCD) is a design process in which developers focus on user needs in each phase of the design and development cycle [21]. Users are involved throughout the design process using several research and design techniques with the aim of creating highly usable and accessible products [24]. The app is being designed as a learning tool for current students as well as a revision resource for qualified veterinary professionals. The design of the app should prioritise finding features which are of most use to its end users while maintaining a intuitive layout.

User-centred Design defines four interdependent processes which structure the development of the product [25]:

1. Specify potential context of use
2. Specify requirements
3. Produce design solutions
4. Evaluate design against requirements

3.1.2 Learner-centred Design

Learner-centred design (LCD) puts the learner's experience at the forefront of the design [22]. It is a learner-centric approach that creates a relevant, engaging, and personalized experience out of learning content. User-centred Design assumes common culture and similar experiences in the application domain, whereas Learner-centred

Design considers a variety of learners, because of personal learning strategies, different experience in the learning domain and different motivations in affording the learning task [23]. Zharias and Poulymenakou specify a prototype used for e-learning which has the following guidelines [26]:

ZP1: "Use of highlighting to avoid split attention effect."

ZP2: "Learners should control their own pace of learning."

ZP3: "Allow learners to discover things for themselves."

ZP4: "The learning objectives are clearly presented."

ZP5: "Informative feedback must be provided."

ZP6: "Learning content must be sequenced properly."

ZP7: "Learning must enhance retention and transfer."

ZP8: "Learners' guidance and support must be provided."

ZP9: "Gain learner's attention."

ZP10: "Hierarchical organization of the course."

ZP11: "Use of visual means to enhance learning."

ZP12: "Learning must encourage use of transferred knowledge."

ZP13: "Social learning must be facilitated."

ZP14: "Provide various resources."

3.1.3 Stakeholder Interview

Interviews are especially useful when designing an application. They allow in-depth questions to be asked in order to gather information which may be missed using other research methods.

Stakeholder Interviews are conversations a developer conducts with individuals who have an interest in the project [27]. The interview helps prioritise features and define key performance indicators. Throughout the project, there has been constant communication with the veterinary school in order to gather some key requirements and an idea of what was expected.

3.1.4 Personas

Personas are a short representation of a fictitious user that describes a large segment of the target user group. Once developed, personas are used as a lasting human reference by teams throughout all phases of the project [28]. Personas are useful in both the design process and evaluation of the design. Using personas while designing the app allows a developer to step into their shoes and envision their thought process, helping identify features which would be useful to them. Evaluating with personas is useful as it allows developers to think back and question if the user goals and ability, align with

that of the design and check specific use case scenarios. Personas are beneficial in this project as it is easy to identify several key characteristics of the end user group; either undergraduate veterinary students or qualified veterinary professionals, while meaning potential content of use is specified as part of the first process in User-centred Design.

3.1.5 Stages of Development

The development methodology used throughout this project is similar to that of Scaife and Rogers five stage design [29]. These stages are:

1. Requirement Gathering
2. Design
3. Low-fidelity prototype and evaluation
4. High-fidelity implementation
5. High-fidelity user testing and evaluation

3.2 Design Principles

It is important to follow design principles in the creation of the learning tool, as well as the technical requirements, as they can influence the design of the learning tool positively. The design of the learning tool will follow Jakob Nielsen's 10 Heuristics as these are some of the most widely followed principles within the field of Human Computer Interaction [30].

The heuristics are:

JN1: **Visibility of system status**
"The design should always keep users informed about what is going on, through appropriate feedback within a reasonable amount of time."

JN2 : **Match between system and the real world**
"The design should speak the users' language. Use words, phrases, and concepts familiar to the user, rather than internal jargon. Follow real-world conventions, making information appear in a natural and logical order."

JN3: **User control and freedom**
" Users often perform actions by mistake. They need a clearly marked 'emergency exit' to leave the unwanted action without having to go through an extended process."

JN4: **Consistency and standards**
"Users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform and industry conventions."

JN5: **Error prevention**
"Good error messages are important, but the best designs carefully prevent problems from occurring in the first place. Either eliminate error-prone conditions, or

check for them and present users with a confirmation option before they commit to the action."

JN6: **Recognition rather than recall**
"Minimize the user's memory load by making elements, actions, and options visible. The user should not have to remember information from one part of the interface to another. Information required to use the design (e.g. field labels or menu items) should be visible or easily retrievable when needed."

JN7: **Flexibility and efficiency of use**
"Shortcuts may speed up the interaction for the expert user so that the design can cater to both inexperienced and experienced users."

JN8: **Aesthetic and minimalist design**
"Interfaces should not contain information that is irrelevant or rarely needed. Every extra unit of information in an interface competes with the relevant units of information and diminishes their relative visibility."

JN9: **Help users recognize, diagnose, and recover from errors**
"Error messages should be expressed in plain language, precisely indicate the problem, and constructively suggest a solution."

JN10: **Help and documentation**
"It's best if the system doesn't need any additional explanation. However, it may be necessary to provide documentation to help users understand how to complete their tasks."

To compliment the above heuristics, Reeves et al. suggest additional heuristics specific to e-learning [31]. These heuristics are:

R1: **Interactivity**
"The e-learning program provides content-related interactions and tasks that support meaningful learning."

R2: **Message Design**
"The e-learning program presents information in accord with sound information-processing principles."

R3: **Learning Design**
"The interactions in the e-learning program have been designed in accord with sound principles of learning theory."

R4: **Media Integration**
"The inclusion of media in the e-learning program serves clear pedagogical and/or motivational purposes."

R5: **Instructional Assessment**
"The e-learning program provides assessment opportunities that are aligned with the program objectives and content."

R6: **Resources**
"The e-learning program provides access to all the resources necessary to support

effective learning."

R7: **Feedback**
"The e-learning program provides feedback that is contextual and relevant to the problem or task in which the learner is engaged."

3.3 Persona Development

The below personas, Katie & Kevin, were developed using information from the initial stakeholder interview and the project brief. These two personas should replicate a large portion of the target users. They cover both veterinary students and qualified veterinary professionals as well as users with a lot of exposure to technology and those with only a little.

Student Persona - Katie

Katie is a final year Veterinary Student who is currently undergoing a placement in the Emergency Care unit at the Hospital for Small Animals. She has been using a mobile phone for most of her life and it comfortable using most mobile applications. She needs to be able to access the information on the app in an emergency situation so that she can use the content as a prompt.

Professional Persona - Kevin

Kevin is a long time serving general practitioner vet at the Hospital for Small Animals. He has had a smartphone for 2 years but occasionally needs some assistance as to how to do some tasks. He needs to use the app as part of his compulsory yearly training. This means he must complete all of the quiz sections and have proof he has the necessary training.

3.4 Stakeholder Requirements

A stakeholder interview was conducted with a lecturer at The Royal (Dick) School of Veterinary Studies. They will be referred to from now on as Veterinary Expert or VE. The main outcomes from the initial stakeholder interview with the VE are the list of requirements below, which make up part of the specifying requirements process in User-centred Design (Section 3.1.1). If these correlate with a principle in e-learning or design this is noted, using the abbreviation ZP for Zharias and Poulymenakou (Section 3.1.2) or R for Reeves et al (Section 3.2).

VE1: The application should be a downloadable smartphone app.

VE2: Users should be able to access information in any order in the event of an emergency.

VE3: The app would include nine courses: 'Recognition, Causes and Treatment', 'Performing CPR', 'Emergency Procedures', 'Monitoring and Interpreting Results', 'Circulation Return', 'Neonatal CPR', 'Post Arrest Care', 'CPR Kit and Organisation' and 'Useful Resources'.

VE4: The app should support different forms of content such as videos, pictures and text (ZP14, R4).

VE5: Users should be able to see their progress (R7).

VE6: There should be a form assessment for each course which may later be used to track routine training (ZP12, R5).

VE7: The app should be structured to allow integration of another app, simultaneously in development, which prompts vets in the event of a CPR event.

3.5 Design Requirements

Alongside the requirements set out by the VE, design requirements should also apply which consider the design principles on usability and e-learning above. I have then been able to define the design requirements to fulfill the specifying requirements process in User-centred Design (Section 3.1.1) below, along with the principle they have been derived from. The abbreviation JN is used to indicate the link to one of Nielsen's heuristics (Section 3.2), along with ZP for Zharias and Poulymenakou (Section 3.1.2) and R for Reeves et al (Section 3.2).

DR1: The task pages will be minimalist as cluttered pages can cause confusion (JN8)

DR2: Menus will be simple and easy to navigate between (JN8)

DR3: Layouts used for each type of task will remain the same across all courses available (JN4)

DR4: Any icons or metaphors used will be relevant to the real world (JN2)

DR5: Back buttons will be available on all pages (JN3)

DR6: Colours will be used to highlight positive or negative actions (JN2)

DR7: Helpful error messages will be displayed whioh are easy to dismiss (JN3, JN9, ZP8)

DR8: There will be a progress bar so students can keep track of their progress both on each courses and throughout individual quizzes (JN7)

DR9: Use loading wheels to inform users of system status (JN1)

DR10: Users are given feedback after every quiz (ZP5, R7)

DR11: There will be no set time for users to complete a course (ZP2)

DR12: Any information not in the app, will be linked (ZP14, R6)

DR13: Each course will be displayed in a structured order but also accessible in any order (JN5, ZP6)

Chapter 4

Low-fidelity Prototype

This chapter discusses the design of a low-fidelity prototype based on the list of stakeholder requirements and design requirements extracted in Chapter 3. Firstly, a low-fidelity prototype was developed using Figma[1], as presented in Section 4.1. This design is then evaluated against the personas developed in Section 3.3, with another stakeholder interview and against the requirements. Some initial design concepts are also discussed as part of the low-fidelity design process along with a flow diagram of the prototype.

4.1 Design

Based on background research and evaluation of several learning resources (Section 2.3), several features were noted that would be useful to implement. From this, an initial low-fidelity prototype was created in Figma [32] as part of User-centred Design process 3 from Section 3.1.1. Figma is useful for not only designing user interfaces but allowing connections between the interfaces in order to simulate how a user would interact with the screens and navigate through them. By combining the features identified from the review of existing e-learning tools along with the individual stakeholder and design requirements it is possible to develop a prototype using Figma which has the look and feel similar to that of a working app. Creating the prototype in Figma allows researchers from the Veterinary School to gain a better appreciation of how the finished app would look and work. Compared to paper prototyping, using Figma demonstrates a much more realistic representation of interaction and has the ability to reveal usability issues that could be missed using paper prototyping. The following sections present the app interfaces. The main colour scheme of the app is red, white and black. The red was chosen as it is similar to that of the colour commonly used at The Royal (Dick) School of Veterinary Studies within The Hospital for Small Animals.

To demonstrate the flow and interactions of the app, Figure 4.1 is a diagram which showcases the structure of the app.

[1]Figma: https://www.figma.com

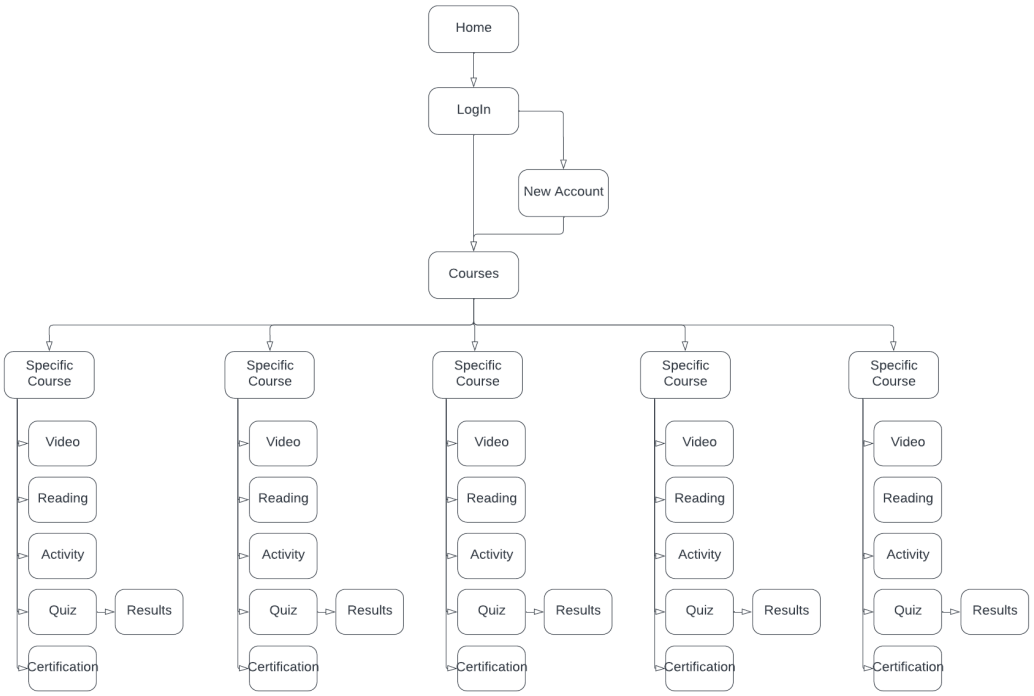

Figure 4.1: Flow diagram of low-fidelity design

4.1.1 Home Screen

The first screen the users see is the `Home` screen shown in Figure 4.2. There are two buttons on the screen 'Start CPR' and 'Learn CPR'. The first button, 'Start CPR' is aimed to link a related undergraduate honours project which records instances of CPR (VE7). Implementation of this link is regarded as future work. The second button, 'Learn CPR', navigates the user to the work completed throughout this project.

4.1.2 Login Screen

The `Login` screen presents a system where users can either login or register for the system. There are two text input boxes for a 'Email' and 'Password', as well as two buttons for 'Login' and 'Register' which can be seen in Figure 4.3

4.1.3 New Account Screen

The `New Account` screen, shown in Figure 4.4, is only seen by first-time users. The screen includes two text input boxes 'First Name' and 'Last Name' as well as a 'Confirm' button.

4.1.4 Courses Screen

`Courses` screen displays all of the courses available to the user, as specified in the Stakeholder Requirements Section 3.4, requirement VE3. These are all presented as

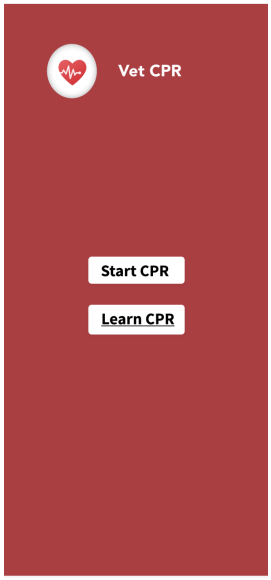

Figure 4.2: Home Screen Design

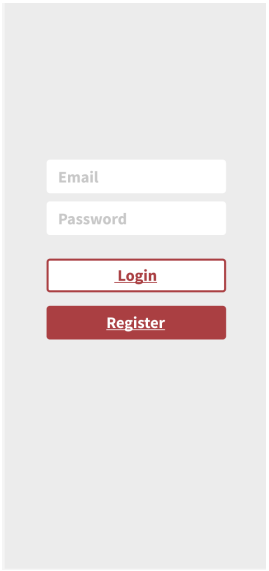

Figure 4.3: Login Screen Design

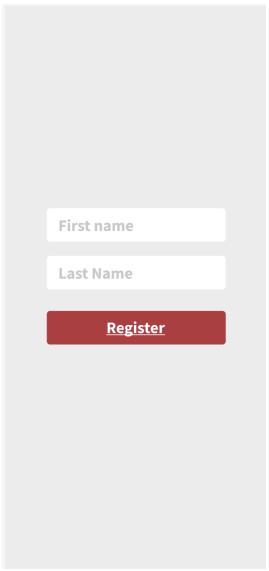

Figure 4.4: New Account Screen Design

buttons as shown in Figure 4.5. At the bottom of the screen there is the words 'Sign Out' which when used will log the user out of the app.

Figure 4.5: Courses Screen Design

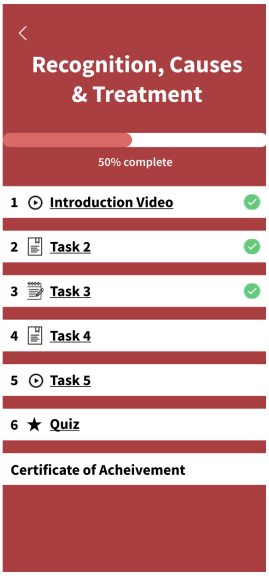

Figure 4.6: Course Specific Design

4.1.5 Course Specific Screen

Each `Course Specific` screen has the same layout but the name of the course and its tasks will change depending on which course the user is on. The design shown in Figure 4.5, demonstrates the screen for the 'Recognition, Causes & Treatment' course. The screen allows users to view how many tasks relate to a course, track their progress

and gives them access to their Certificate of Achievement, if they have one. There is a progress bar at the top of the screen which indicates the users progress. To further indicate user progress, after a task is completed, a green tick symbol appears on that task item. The tasks are listed numerically to provide users with structure and show them the number they have to complete. Along with this, there is an icon to indicate to the user which type of task they are about to start.

4.1.6 Task Screens

There are three types of task which a user can be provided with. These are:

- Video tasks displaying a video for users along with a text description, as designed in Figure 4.7.
- Reading tasks displaying text segments for users to read which is shown in Figure 4.8.
- Activity tasks which contain text and images that describe or demonstrate a task which the user is expected to try, shown in Figure 4.9.

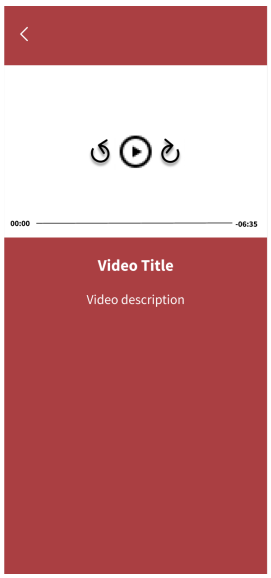

Figure 4.7: Video Screen Design

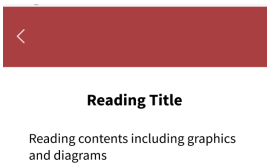

Figure 4.8: Reading Screen Design

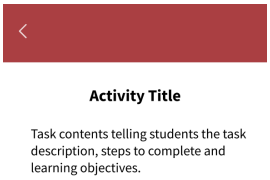

Figure 4.9: Activity Screen Design

4.1.7 Quiz Screen

There is a `Quiz` at the end of every course. At the top of the screen, 'Your Progress' is displayed followed by indication as to what question the user is on. Under this there is a progress bar to give the user a visual clue as to how much more of the course they must complete. The question is then displayed and under this the possible answers are shown in boxes. When clicked on, the boxes border thickens indicating user selection. Once the user has selected an answer, the 'Next Question' button becomes visible and users can progress with the quiz. A demonstration of user flow through the quiz can be seen in Figure 4.10, along with the layout.

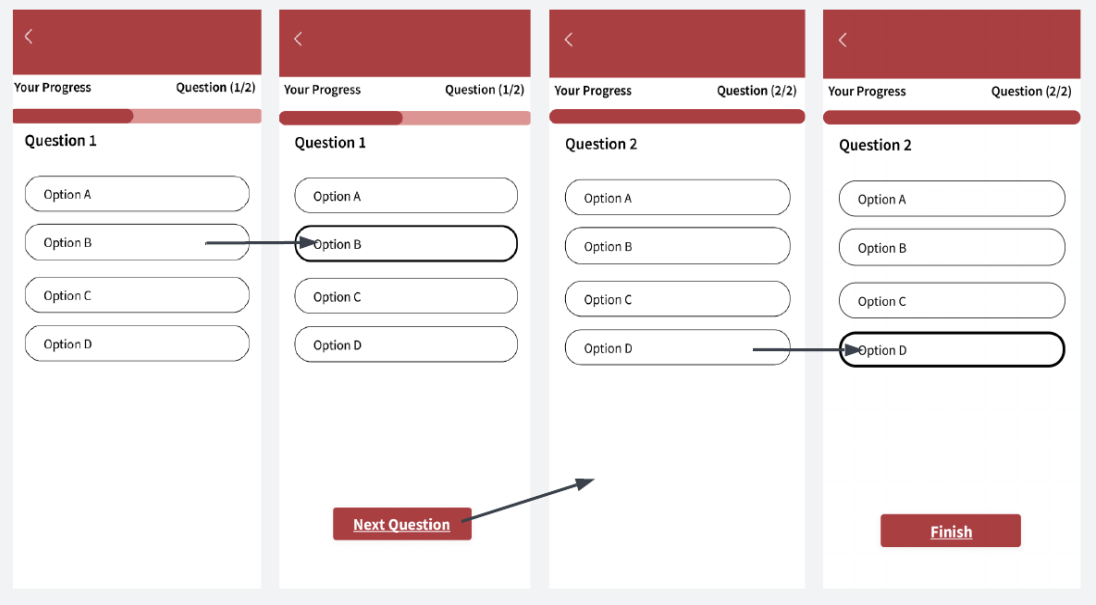

Figure 4.10: Interaction example of Quiz

4.1.8 Results Screen

The `Results` screen is shown to the user at the end of each quiz. This page appears differently when users pass or fail. At the top of the screen, the word 'Pass' or 'Fail' will be displayed to the user and under this they can see their mark. Next, there is a 'Score Card' which indicates to the user which questions they got correct and incorrect using green ticks or red crosses, respectively. A message is displayed below this which either congratulates the user or informs them of the mark they must achieve and prompts them to try again. At the bottom of the screen, there is a red 'Continue' button which returns the user back to the `Course Specific` screen. The design of both the pass and fail screens can be seen in Figures 4.11 and 4.12, respectively.

4.1.9 Certification Screen

When a user passes a course quiz, they can view a 'Certificate of Achievement'. This certificate displays the name of the user who achieved it, the course it was achieved for and the date of which it was achieved on in the layout shown in Figure 4.13.

4.2 Evaluation

4.2.1 Stakeholder Interview

The first evaluation of the low-fidelity prototype was a second stakeholder interview with the same Veterinary Expert (VE) as before. The interview was held on the 8th of December 2022 on Microsoft Teams. The VE had access to the Figma design and memos were taken. The VE tested out the prototype and was asked questions regarding design and additional features. Overall feedback included:

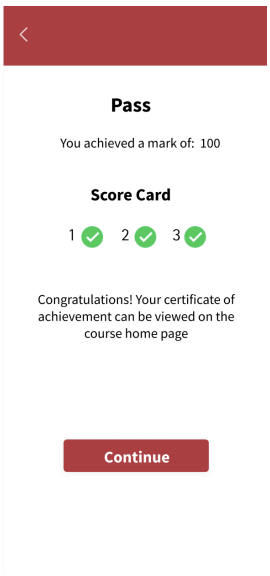

Figure 4.11: Pass Result Design

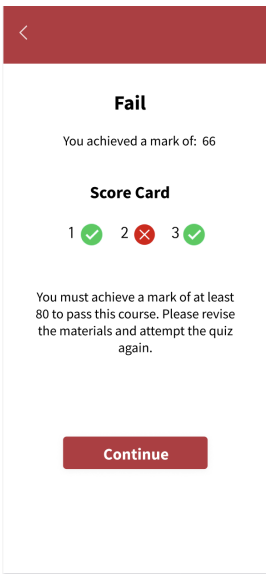

Figure 4.12: Fail Result Design

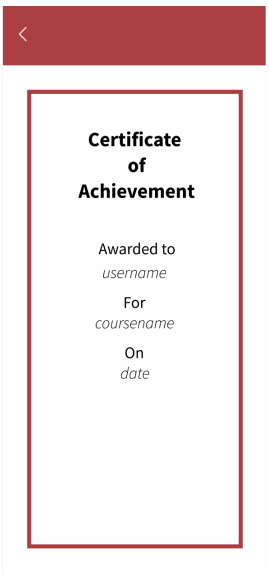

Figure 4.13: Certification Design

- Good colour scheme and contrast
- Good layout of the separate kinds tasks
- Easy to follow and intuitive design

Possible additional features noted by the VE were:

- Database link of user marks for records
- A time monitor that could check how long a user is active on the app
- Exportable certificate of achievement
- Add an introductory page with information on the ins and outs of the app

At this stage the veterinary school did not have any content specifically available for inclusion in the app but it was requested that content be made for at least the first course `Recognition, Causes & Treatment`.

4.2.2 Personas

As stated in Section 3.1.4, personas can be used as a human reference throughout all phases of the project. The low-fidelity design was made with reference to the personas of Katie and Kevin.

Katie would be using the app as a quick reference in an emergency situation. The app is easy to navigate and there are no restrictions as to the order which courses can be accessed. Courses and tasks are clearly labelled so that Katie can find the resources she needs quickly, while the back buttons ease her ability to navigate between sections.

Kevin would be using the app as a learning resource. The app demonstrates a clear

structure and hierarchy for Kevin to learn demonstrated by task numbering. Back buttons allow Kevin to navigate freely around the app. Kevin can see his progress in each course with a progress bar which means he can manage his time better and see how much more work he must do. He is given visual feedback after the quiz so that he knows which questions he answered wrong and should revise again.

4.2.3 Requirements

With the creation of the low-fidelity design, the stakeholder requirements from Section 3.4 and design requirements from Section 3.5 can be evaluated as part of User-centred Design process 4.

4.2.3.1 Stakeholder

The app is designed in the format of a smartphone app in-line with VE1. The courses screen includes options for all 9 of the specified courses (VE3), all of which can be accessed in any order (VE2). The `Home` screen is designed that the CPR event recording feature can be accessed in future by the `Start CPR` button (VE7). The `Course Specific` screen allows tasks to be accessed in any order, also in-line with VE3, while displaying a progress bar (VE5). To display different forms of content (VE4), there are different types of tasks. While VE6 is met by users having to complete a quiz after every course. Additionally, the quiz screens include a progress bar in-line with VE5.

4.2.3.2 Design

The task screens that have been created are minimalist in design and only contain necessary content (DR1), they also set a strict layout for tasks across all courses (DR3). Icons are used in the `Course Specific` screens to give the user a visual cue as to what type of task to expect which are relevant to real life (DR4). The tasks on each `Course Specific` screen are numbered to give structure to the app, however this structure is not enforced to conform with DR13. Menus like the `Courses` screen throughout the app have been designed in a simple and easy to follow manner (DR2). All pages include back buttons in-line with DR5, however it is not possible to go back between quiz questions. In the `Results` screen, feedback is given and, as part of this feedback, the scorecard displays a green tick for a correct answer or a red cross for an incorrect answer to implement DR10 and DR6. `Course` screens show users a progress bar, as does the `Quiz` screen (DR8). A splash screen has been designed and can be seen in Appendix B.

Design requirements which cannot be evaluated at this point are DR7, DR9, DR11 and DR12. Helpful alerts will be shown when a user clicks a feature which is not yet available, or there are issues with signing in such as wrong passwords. These alerts will be easily dismissed to allow user control and freedom. Loading wheels cannot be implemented in this low-fidelity design. The design intends to not implement a time restriction for courses and link all the relevant information that users may need to the app. These will therefore be evaluated after the high-fidelity implementation.

Chapter 5

High-fidelity Prototype Implementation

This chapter discusses the implementation of a high-fidelity prototype following the low-fidelity design in Chapter 4. Firstly, the choice and experience of platform is discussed, along with choice of Integrated Development Environment. This is followed by an introduction to what Firebase is and the ways in which it was useful for the app. A breakdown of the app structure is given which details changes made from the low-fidelity design. Some challenges which arose during implementation are discussed and a new flow diagram of the prototype is given.

5.1 Choice of Platform

The app is made to run on smartphone devices. This was a requirement that the had set out since the beginning of the project. When choosing a platform to develop the app in that would allow for several operating systems to be trialled, Expo[1] appeared to be a great choice. Expo advertises itself as a platform to "Build one JavaScript/TypeScript project that runs natively on all your users' devices." [33]. Expo combines mobile and web development to enable the most important features for building and scaling. While React Native app features are enabled by the included expo npm package, using Expo meant the project could be developed without using Xcode or Android Studio which only allow for the development of either iOS or Android apps, respectively.

Choosing to use Expo meant that React Native[2] could be used instead of the OS specific Java[3], Kotlin[4] and XML for Android or Swift[5] for iOS apps. This was appealing due to having prior experience with ReactJS[6]. ReactJS is similar to React Native however ReactJS is used for user interfaces of web applications whereas React Native combines ReactJS and JavaScript to use in development of applications that run on iOS and

[1]Expo: https://expo.dev
[2]React Native: https://reactnative.dev
[3]Java: https://dev.java
[4]Kotlin: https://kotlinlang.org
[5]Swift: https://developer.apple.com/swift/
[6]React: https://react.dev

Android devices. Having prior experience using ReactJS meant that using React Native throughout this project was sensible as previously acquired skills could be used.

5.2 Developing in Expo

The prototype app was developed using Expo SDK version 47.0.12. Expo is made for development of JavaScript and React systems. Using Expo allows for cross-platform development between iOS, Android and the web.

A helpful feature of Expo is Expo Go[7]. Whenever a project is started in Expo, a QR code is generated. Expo Go is a native app which allows the QR code to be scanned in order to connect to the development server from a mobile device. Whenever small changes are made to the app's code, they can be seen instantly on a working version of the app. This is particularly helpful for styling changes.

When it comes to deploying the application, Expo Go is not suitable for use in public distribution. However, Expo do offer a suite of tools to help submit projects to the app stores which is useful at the end of the project.

5.3 Choice of IDE

Programmers use Integrated Development Environment's (IDE) to develop software code efficiently. An IDE is a software application that can be used to increase productivity by combining editing, building, testing, and packaging in one application.

WebStorm[8] is an IDE for JavaScript and related technologies developed by JetBrains [34]. It has built in tools for developers so that code can be ran or debugged at the click of a button, it also incorporates an advanced version control system. There's also a code refactoring feature, which makes the code more efficient and maintainable. WebStorm is an ideal option as I am familiar with the environment and have previously used other JetBrains products such as IntelliJ[9] and PyCharm[10].

5.4 Firebase

Firebase[11] is a mobile application development platform by Google [35]. It provides developers with a tool set to "build, improve and grow" their app. It's services are hosted and maintained by Google, some of which are authentication, analytics, databases and file storage. To interact with these services directly, Firebase provides client software development kits (SDK). There is no need for any middleware between the app and the service meaning that to communicate, code is typically written in the client app. This removes the need for a frontend and backend system within this project.

[7]Expo Go: https://expo.dev/client
[8]WebStorm: https://www.jetbrains.com/webstorm/
[9]IntelliJ: https://www.jetbrains.com/idea/
[10]PyCharm: https://www.jetbrains.com/pycharm/
[11]Firebase: https://firebase.google.com

Firebase is compatible with both iOS and Android, while there is growing functionality for web apps. To be able to track user progress within courses and store their course marks, the best option seemed to be creating user accounts and linking this to a database. Firebase authentication was then used and combined with their real-time database.

Firebase Authentication takes care of user login and identification. This is essential for using some of the other Firebase services. Making logins secure is difficult to implement properly and so Firebase Authentication simplifies this task.

Firebase Realtime Database provides a database service. What's essential about this is that it gives "real-time" updates to data as it changes in the database. Developers use the client SDK to set up a "listener" at the location of the data their app wants to use, and the "listener" gets invoked with that data repeatedly, every time a change is observed. This ensures the app's display is fresh, so there is no need for polling the data of interest.

5.5 App Structure

The app is used to provide users with content relating to Veterinary CPA and CPR. The first pages of the app include a `Login` screen followed by a `New Account` screen. These screens are primarily used to authenticate and gather user data. The main app screens consist of `Home` screen, `Courses` screen, `Course Specific` screen, `Task` screens, `Quiz` screen, `Result` screen and `Certification` screen. Implemented versions of all app screens can be seen in Appendix C.

5.5.1 Home Screen

The app opens with the `Home` screen. There are no changes to the low-fidelity design but the implemented screen can be seen in Figure C.1. The screen has two buttons for the user to navigate to different sections of the app. The 'Start CPR' button is intended to navigate to a feature which is currently being developed by another undergraduate student. The link to this will be implemented next year, once the feature is finished, but for now an alert is shown to inform the user that this is a work in progress which can be seen in Figure C.2. Clicking the 'Learn CPR' button has a different outcome depending on the users log-in status. Users may already be signed into the app as a result of not signing out on their last use. If the user is not signed-in then it will navigate the user to the `Login` screen, however if they are already signed-in then they will be taken to the `Courses` screen.

5.5.2 Login Screen

This screen is presented to users who aren't currently signed into the app and was implemented to look the same as the low-fidelity design (Figure C.3). Users enter an email and password which is over 6 characters and can either 'Login' or 'Register'. The 'Login' button is to be used by users who already have an account. When clicked, the request shown in Listing 5.1 will be made to Firebase authentication to verify the user and as long as the password is correct or the account exists, they will be considered

signed-in and navigated to the `Courses` screen. When an invalid password is given, the message in Figure C.5 will be displayed. If a user does not have an account, they will be shown the message displayed in Figure C.4. In this case, they should click the 'Register' button and be directed to the `New Account` screen, providing they have entered an email and password. If this is successful, a request will simultaneously be sent to Firebase authentication to create a new user with those credentials.

```
1 const handleLogin = () => {
2     auth.signInWithEmailAndPassword(email,password).then(
          userCredentials => {
3         const user = userCredentials.user;
4         console.log('Log in with:', user.email);
5     }).catch(error => alert(error.message))
6 }
```

Listing 5.1: Snippet of how Login system connects to Firebase Authentication.

5.5.3 New Account Screen

The `New Account` screen should only be shown to users on their first time using the app. The implemented design remains the same as the low-fidelity version and can be seen in Figure C.7. This screens use is purely to gather some user information which will be needed throughout the app e.g. their first and last names. On clicking 'Confirm', users will be directed to the `Courses` screen and a query will be sent to the Firebase database to add the users' first and last name, as long as they have entered a value for each of the fields. If a value is not entered for both fields, the alert displayed in Figure C.8 appears.

5.5.4 Courses Screen

This screen displays all the possible courses which users can take. Again, the design is consistent with that of the original low-fidelity prototype. This can be seen in Figure C.9. Courses are accessible by clicking on the relevant button. At the bottom of the screen, there is a 'Sign Out' option which signs the user out of the app by sending a request to the Firebase authentication service again.

In the scope of this project, only the `Recognition, Causes & Treatment` course was able to be implemented. This was due to several factors but mainly because of The Royal (Dick) School of Veterinary Studies not being able to have the app content ready in time. Due to this, a warning message, shown in Figure C.10, is displayed whenever a user tries to select a course which is not functioning yet.

5.5.5 Course Specific Screen

Figure C.11 demonstrates the implemented design of the `Course Specific` screen for `Recognition, Causes & Treatment`. The green ticks of completion have not been implemented yet, however each `Course Specific` screen still has a progress bar at the top where a user can see their progress on that specific course. The information used to fill the progress bar comes from the Firebase database. Each time a user visits a task,

a measure of their progress is sent to the database. This metric is then used to update a user's progress via the progress bar. An example of the progress bar after the user has completed both the `Recognising Arrest` and `Causes` tasks can be seen in Figure C.12. There is a list of tasks which when clicked, take the user to a `Task` screen. The last task on each course is a quiz, while the final option on each screen is to navigate to the `Certification` screen.

5.5.6 Task Screen

Each course will have multiple `Task` screens linked to it. `Task` screens were initially designed to be of three types: `Reading`, `Video` or `Activity`. The content that The Royal (Dick) School of Veterinary Studies were able to provide, meant the design of the implemented tasks had to change. There is currently only `Reading` or `Video` tasks in the app as the veterinary school could not develop any activity tasks within this time. On top of this, `Video` tasks which were originally meant to include one video and a text description, now have several short videos in between text. These pages are scroll-able as there is a lot of information on them, however breaking up the text with short videos, allows the user a break from all the text.

5.5.6.1 Reading Task

`Reading` screens are simple, scroll-able and feature purely text. The implemented reading task is for the `Recognising Arrest` task which can be seen in Figure C.13.

5.5.6.2 Video Task

`Video` screens now include videos in between text segments. All the videos have the features play, pause, rewind, fast forward and maximise. There are two video tasks implemented. These are the `Causes` and `Treatment` tasks which can be seen in Figures C.14 and C.15 respectively. An example of code rendering a video can be seen in Listing 5.2.

```
<Video
        ref={video}
        style={styles.video}
        source={require ("../data/content/Hyperkalaemia.mp4")}
        useNativeControls
        resizeMode="contain"
        isLooping={false}
        isMuted={true}
        volume={1.0}
        playsInSilentLockedModeIOS ={ true}
        onPlaybackStatusUpdate={status => setStatus(() => status)}
/>
```

Listing 5.2: Snippet of how each video is rendered.

5.5.7 Quiz Screen

The `Quiz` screens are very similar to that of the low-fidelity design and can be seen in Figure C.16, note that the 'Next Question' button is not visible. Once an answer is selected a 'Next Question' button appears unless the user is on the final question, where a 'Finish' button will appear which directs the user to the `Results` screen. When a user clicks an answer, it's border increases in thickness giving the user a visual cue. The progress bar is at the top of the screen and updates as a user progresses through the quiz questions. An example of the progress bar and the visual cue can be seen in Figure C.17, along with a visible 'Next Question' button. A code snippet showing how each question and its possible answers are rendered can be seen in Listing 5.3.

```
<Text style={styles.textQuestion}>{currentQuestion.question}</Text>

{currentQuestion?.answers.map((answer, index ) =>
<Pressable
    onPress={() => setSelectedAnswerIndex(index) }
    key={answer.text}
    style={selectedAnswerIndex != null &&
    selectedAnswerIndex === index ? (styles.containerAnswerSelected)
        : (styles.containerAnswers)}
    >
    <Text style={styles.textAnswer} >{answer.text} </Text>
</Pressable>)}
```

Listing 5.3: Snippet of how quiz questions are rendered.

5.5.8 Results Screen

The `Results` screen follows the initial low-fidelity design. The screen makes use of a useEffect which writes the user's mark to the Firebase database if they have achieved a passing mark. A useEffect is a Hook which tells React a component needs to do something after rendering. The use of this useEffect can be seen in Listing 5.4. This database link was implemented as it is one of the VE's additional features from Section 4.2.1. Examples of the `Results` screen in both a passing and failing situation can be seen in Figures C.19 and C.20 respectively. When the user clicks `Continue` they are returned to their `Course Specific` screen.

```
function writeUserData(userId, score, date) {
    database.ref('users/' + userId + '/recognitionCausesTreatment').
        set({
         progress: 4,
         score: score,
         date: date,
    });
}
useEffect(() => {
    if (mark >= 80 ){
          writeUserData(userId, mark, moment().format("DD/MM/YYYY"));
     }
}, [])
```

Listing 5.4: Snippet of how quiz results are sent to the database.

5.5.9 Certification Screen

Until the user achieves a passing mark for the relative course, the `Certification` screen displays a help message which is shown in Figure C.21. When a passing mark is achieved, the screen is populated with a Certificate of Achievement. The screen uses information from the Firebase database including the user's name, the course they passed and the date on which it was passed. For an example, see Figure C.22.

5.6 App Content

All the specific CPA and CPR training content on the app was developed by The Royal (Dick) School of Veterinary Studies. The content was created specifically for this project by staff in the Veterinary School and supplied by them for inclusion in the app.

5.7 Flow-diagram of High-fidelity Implementation

The below diagram can be used to demonstrate the flow of the implemented app screens and their interaction with the database.

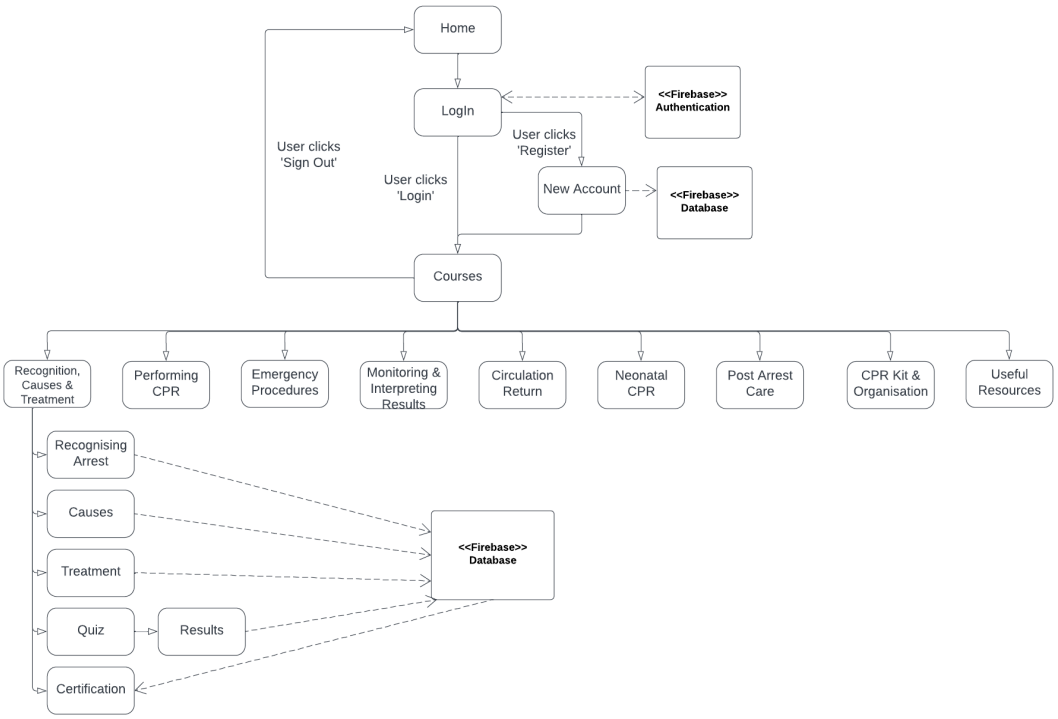

Figure 5.1: Flow diagram of high-fidelity design

Chapter 6

Evaluation of high-fidelity prototype

This chapter discusses the evaluation of the high-fidelity prototype following its implementation in chapter 5. Firstly, the development of the study plan is discussed, followed by the study plan and finally the results of the study with the evaluation.

6.1 Development of Evaluation

A mixed methods study was used to evaluate the high-fidelity prototype. A mixed methods study is a lab study which incorporates a mix of several Human Computer Interaction methods together to gain a more thorough understanding of the topic. This allows more data to be gathered at one time and using multiple methods should provide a more comprehensive evaluation because one method will likely catch what another method missed.

Following the study creation methodology laid out in the Human Computer Interaction course at The University of Edinburgh, the following steps should be taken to create the study [36]:

- Define what usable means
- Select a study methodology
- Identify the data to be collected
- Design the study structure
- Plan the evaluation

6.1.1 Defining what usable means

To define usability in this project, the following definition is used: “A design is not usable or unusable per se, its features, together with the users, what the users want to do with it, and the users’ environment in performing tasks, determine its level of usability” [36].

Using the findings from the stakeholder and design requirements gathering in Section 3.4 and 3.5, there are five usability goals of the app:

1. Users can make a new account.
2. Users can complete all of the tasks associated with the `Recognition, Causes and Treatment` course and they are then able to see their Certificate of Achievement.
3. Users like the layout and design of the app.
4. Users rate the app highly.
5. Users would use the app again.

6.1.2 Select a study methodology

The first method used is Observation. Observation allows qualitative information to be gathered on user behaviour so their capability can be assessed.

The second methodology used is a questionnaire. This questionnaire uses a mix of set answer questions and open-ended questions. The aim of the questionnaire is to gather attitudinal data which will provide greater insight on their experience using the app.

6.1.3 Identify the data to be collected

Measurements collected can be dependent, independent or controlled.

Dependent measurements are: times interface misleads the user, times the user encountered an error and qualitative data from the questionnaire.

Independent measurements are: prior experience with e-learning tools and participants professional background.

Aspects of the study that are controlled are: the room the trial was conducted in, the OS the trial is conducted on and what course the users are asked to complete.

6.1.4 Design the study structure

The participants of the study are given a pre-questionnaire to gather their consent and details about their prior opinions and experience. This is followed with users being set a task “Complete the ‘Recognition, Causes & Treatment’ course”. Once this is completed, the participants are given a longer follow-up questionnaire which evaluates the usability and design of the app.

6.1.5 Plan the evaluation

Evaluation analyses the data collected which should be a mix of open-ended and statistical. The findings are then compared to the initial usability goals and remaining design requirements.

6.2 Aim

The aim of this mixed-methods study is to evaluate the usability of the high-fidelity prototype which has been presented in Chapter 5. The main questions I will be answering is if the usability goals set out in Section 6.1.1 have been met.

6.3 Participants

There was a total of seven participants used in this evaluation. All of which turned out to be undergraduate students at the University of Edinburgh's Royal (Dick) School of Veterinary Studies. These participants were chosen as they were on placement at the Hospital for Small Animals with the . The study was meant to include some veterinary nursing staff and general practitioner vets from the Hospital for Small Animals, but unfortunately when the user study was being conducted, they were unavailable.

6.4 Data Collection Methods

The participants of the study were given a pre-questionnaire. This gathers their consent and asks them questions surrounding their occupation, their preferred method of learning, if they choose to use e-learning resources and if so, which have they tried.

This was followed with users being set a task "Complete the 'Recognition, Causes & Treatment' course". While intuitively completing this task, participants were observed, and I completed an observation questionnaire (Appendix E). This observation questionnaire tracks if users are able to complete each stage of the task. If tasks were not completed, or there were any errors, they were detailed in the questionnaire. Questions included: "Was the user able to register successfully?", "Was the user able to complete the quiz?" and "If the user had any issues during the observation period, detail them below.".

When the observation was completed, the participants were given a longer follow-up questionnaire which evaluated the usability, navigation and design of the app. The participants were also asked for possible improvements and features.

6.5 Materials

The Participant Information Sheet and Consent form were combined into one as the questionnaire was filled out digitally (Appendix A). This document gives the participants the information necessary to understand the motivation and procedures of the study and sources of information to answer any further questions. This includes: the researcher's information, the impact of participation, information on risks and benefits, and information about data protection and data storage. The document also asks the user for their consent and in the questionnaire, there is an "I agree" button.

There was a list of questions produced for the pre-questionnaire, observation questionnaire and post-questionnaire. These question sets can be seen in Appendices D, E and F

respectively. Questionnaire participants were expected to answer most questions but if some didn't apply to their app experience, it was okay to leave blank.

6.6 Procedure

The participants were not contacted before the day of the study. A convenient day for the study was established with the and they asked participants on the day. The participants were shown the information sheet and consent form as part of the pre-questionnaire and informed they could leave at any part of the study.

The study was based in a room in The Hospital for Small Animals at The Royal (Dick) School of Veterinary Medicine. Participants tested the app one by one with me being the only other person in the room to observe. Firstly, they were asked to give consent within the pre-questionnaire. Once they had filled this in, I explained how the session was going to work and what they were expected to do. When I was sure they understood, I gave them a smartphone which was set to the `Home` screen and set them the task. The task was "Complete the 'Recognition, Causes & Treatment' course". Participants were given no help throughout this task as their actions were being recorded in an Observation questionnaire. This was to test that the app design was intuitive and given a task, the users could navigate the app on their own to complete this. The task meant they had to navigate through an entire course and complete the quiz at the end. Once the participants had finished the quiz, they were asked to fill out a post-questionnaire where they were asked to reflect on their experience and give their opinions. After this had been filled in, I thanked the participants for their time and prepared for the next user.

6.7 Results

6.7.1 Pre-Questionnaire

The pre-questionnaire was mainly to gain participant consent and gather information on the participant demographic. All participants were final year students at the Royal (Dick) School of Veterinary Studies. When participants were asked what methods they use to learn, some responses were reading textbooks, watching lectures, reading notes and taking part in practical's for hands on experience (figure G.3). Six out of seven respondents had previous experience with online learning tools. These tools included Udemy, Tophat, YouTube and Quizlet. Udemy and YouTube were trialled in Chapter 2 as part of the e-learning platform reviews aimed at identifying potential features to include in this project. Graphical representations of all the data found in the pre-questionnaire can be found in Appendix G.

6.7.2 Observation Questionnaire

During observation, all participants were seen being able to register a new account on the app, shown by Figure H.1, with ease. This therefore satisfies usability goal 1. All users were able to complete the task set, which meets the first part of usability goal 2. They also all completed it using the recommended path which suggests the

app is straight forward to navigate and intuitive. One user did not attempt to view their Certificate of Achievement, however all users which did attempt to, were able to, answering the second half of usability goal 2. Hence it was observed that usability goals 1 and 2 had been successfully achieved.

Three potential issues that occurred during observation are listed in table H.1. One participant swiped with too much force which triggered the iOS gesture to leave the app. The participant was then returned to the phone's home screen. As this error is to do with the phone operating system, it can be disregarded. The second issue identified, as previously mentioned, was that one participant did not attempt to view their Certificate of Achievement. The final issue was a user thought a quiz question they got correct was displaying a red cross on the score card. Upon observation, the question they thought they were getting wrong was question 5 but they were getting question 4 wrong. So, when they were going back and re-reading the content, they had been looking for information related to question 5 when they should have been looking for information on question 4. Having replicated the scenario several times to confirm the observation was correct, this error can be put down to user error.

Results of all questions asked in the Observation questionnaire can be viewed in Appendix H.

6.7.3 Post-Questionnaire

The post-questionnaire contained a large number of questions. Several participants did not answer all the questions. A full set of results are provided in Appendix I.

6.7.3.1 Outcomes

Goal 1: Users can make a new account

When asked if it was easy to sign-in/register for the app, all respondents answered yes. When queried as to why they found it easy, one reported "Very straightforward and simple". Usability goal 1 is achieved with this information. It was implied that if users were met with a complex sign-in system, it may deter them from further progressing with using the app.

Goal 2: Users can complete all of the tasks associated with the `Recognition, Causes and Treatment` course and they are then able to see their Certificate of Achievement

All participants reported being able to complete the 'Recognition, Causes & Treatment' course. However, one of the seven participants inadvertently forgot to view there Certificate of Achievement. The remaining six participants were able to view Certificate of Achievement with ease.

Goal 3: Users like the layout and design of the app

All the respondents liked the layout of the app. Some participants commented "It was straightforward and concise. It would be very easy to study from" and "Liked the categories, liked having videos, quiz was easy to complete, certificate was accurate". All

of the respondents liked the colour scheme with some noting it allowed good contrast (table I.4). Further, the progress bar on the courses page was thought to be a useful feature by all the respondents.

Following the task screen design change from the low-fidelity prototype, it was important to get feedback on the new layout. The participants were asked "How did you feel about the layout of the 'Causes' & 'Treatment' tasks where the videos are among text?". All of the respondents reported positively about the layout with comments such as "I liked that you have a video or picture to accompany the task. It is nice to see the example." and "Everything was split up well. Liked the videos next to the text they were relative to.".

When participants were asked about why the app was easy to navigate, one respondent said: "The layout was really straightforward and I liked how clear the subheadings were". Showing the clear layout helps other aspects of the app.

Another screen which required a lot of feedback was the quiz screen. This is because there are a lot of different features to the quiz screen. All the respondents were able to clearly see which answer they had selected in the quiz and found the progress bar in the quiz helpful.

Goal 4: Users rate the app highly

The overall app achieved a usability rating of 4.71/5 from users. The participants were also asked to rate different aspects of the app and the results can be seen in table 6.1. All average ratings are above 4/5 and so usability goal 4 is met.

Table 6.1: User Ratings

Aspect	User Rating
Ease of use	4.86
Navigability	4.57
Design	4.57
Usability of the quiz	4.86

Goal 5: Users would use the app again

All seven of the participants thought the app would be a useful learning tool and that they would consider using it if it was developed further 6.1 & 6.2.

6.7.3.2 Improvements

Participants were asked if they would change anything about the navigation, three mentioned a way to move straight from one task to the next, without having to move back to the relevant `Course Specific` screen between tasks. A participant also suggested a quicker way to move between tasks when asked for possible changes to the `Recognition, Causes & Treatment` page. As this feature was suggested several times, it is clear it would be a useful feature and something that should look to be included in further development. Two other suggestions from the participants was the

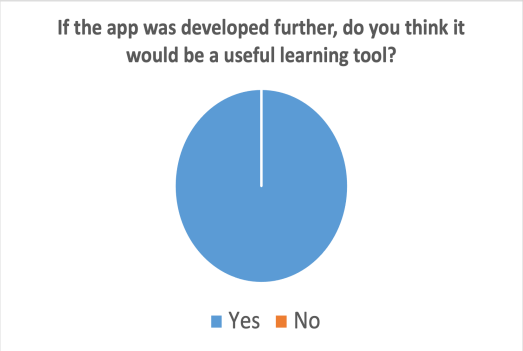

Figure 6.1: Users opinion on if they think the app is a useful learning tool

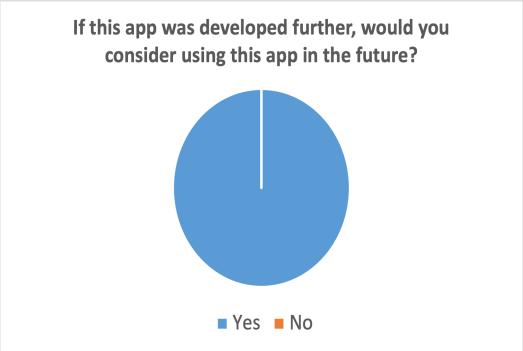

Figure 6.2: Users opinion on future use of the app

inclusion of a menu button or a search bar to search for key terms. A menu tab would be a helpful navigation feature while a search bar would be useful in emergency situations so that users could quickly look up the necessary information.

When asked about task screens, changes suggested included labelling videos and clearer separation of topics (Table I.8). These suggestions will be implemented in the future as they would help the user understand the content and overall improve their learning experience. One participant suggested some information should be numbered and not bulleted to indicate steps; this is another change which should be made.

When asked for their thoughts or any changes on the results page, some comments were "results page was informative" and "loved it - showing what question I got wrong really helped". Two participants suggested providing the answer when a user gets a quiz question wrong. The quiz is available to take several times and users are told this on the `Results` screen in a prompt that says "You must achieve a mark of at least 80 to pass the course. Please revise the materials and attempt the quiz again". This is to encourage learners to go over the content and refresh their memory, so they learn from their mistakes. If the quiz showed them the correct answer, they may not take in all the information and potentially just try the quiz straight away now that they have the answer. Therefore, this is not a change that will be made within the app.

One participant suggested that the design of the `Certification` page was quite basic and could be made more aesthetically pleasing. All of the necessary information is on the `Certification` screen, and it resembles a certificate you would receive in real life. This is therefore not a prioritised improvement as it is only for aesthetics, but one that will still be noted.

Six out of seven participants reported no errors while testing the app. The other respondent reported the error discussed in the observation questionnaire evaluation, in which they thought a quiz answer was incorrect.

The user replies when asked what additional features they would like to see in the app can be seen in Table 6.2. The feedback regarding more videos and what types they should be, will be passed onto the vet school for use when they are developing more content, along with the idea to use pictures in the quiz questions. The creation of an

emergency drug dose page will be discussed with the vet school but is another potential improvement. Visual representations are used within the the `Course Specific` screens via a progress bar, but adding something to the `Courses` screen would help users recognise their progress without having to click several times on different courses.

Table 6.2: Additional Features

What additional features would you like to see in the app?
More examples and videos to supplement the learning
Perhaps videos with a person explaining and pointing out specifically what we were looking at in terms of clinical signs
I think the quizzes are very helpful maybe including pictures as part of the quiz to practice identifying ECGs is helpful
emergency drug dose page
some visual representation that a course is complete on the main courses screen
a search bar

Finally, the participants were asked for any additional comments which can be seen in Table 6.3.

Table 6.3: Additional comments

Any other comments about the app?
Very cool, something I would have liked to use in previous years
I liked the information being condensed as in emergency its better to retain small important bits of information. Maybe adding a page with additional resources if people want to read further on topics.
Very easy to use and helpful refresher of CPR basics!
Seems like it would be useful!

There are no notable improvements from these comments but one of the options on the `Courses` page is `Useful Resources` which aims to have all additional information for users to do more in-depth reading if they wish.

6.8 Requirements Evaluation

Following the low-fidelity evaluation in Section 4.2.3, four design requirements are still to be evaluated. These are DR7, DR9, DR11 and DR12 which are defined in Section 3.5. All other requirements evaluated in Section 4.2.3 still apply as changes made since the low-fidelity design only apply to DR7, DR9, DR10 and DR11. Error messages are displayed at several places in the app, all of which contain helpful messages and are easily dismissed in-line with DR7. DR9 specified that loading wheels should be added to indicate content is loading. This is currently not implemented and is regarded as future work. There is no time restrictions throughout the app in-line with DR11. DR12 is also regarded as future work and will be included in the planned `Useful Resources` section.

Chapter 7

Discussion, Future work & Conclusions

This report explored the design and creation of an e-learning app for use by veterinary medicine students and qualified veterinary professionals. The research began with background reading exploring CPA and CPR, e-learning in health and a review of e-learning tools available. Following this there has been two iterations of design which have both been evaluated. This chapter discusses the results and reviews if each research question, introduced in Section 1.2, was successfully answered while considering the limitations and possible extensions for 5th year.

7.1 Discussion

RQ1: What e-learning tools are available and what features do they include?

To answer this question, background research was conducted into the current platforms and resources available (see Chapter 2). This was necessary to identify what users would expect of an e-learning resource. Several e-learning tools were trialled and tested, taking note of the features and layouts. There are a huge variety of e-learning resources available from Udemy to Coursera. All resources had similarities such as supporting different forms of tasks for users and commonly assessing in the form of a quiz.

RQ2: Can e-learning be effective in veterinary medicine?

The answer for this question draws upon on the research within Chapter 2. Not much research was found on e-learning in veterinary medicine so e-learning in the neighbouring discipline of human health was investigated. E-learning resources are currently available to staff within the NHS health and social care workforce, along with many other reputable health bodies. When looking to compare online and offline learning in medical education, both forms appear to have similar effectiveness and success of each form comes down to user preference. Given the similarities between veterinary and human medicine, it is thought that e-learning would have the same level of success for educating veterinary professionals.

RQ3: Is the application suitable for its end users?

The answer for this question is the result of findings at the following stages: low-fidelity

prototype (Chapter 4) and high-fidelity prototype evaluation (Chapter 6). Throughout the design in Chapter 4, personas were used as a human reference. Katie, a persona of an undergraduate student who needs the app in an emergency and Kevin, a general practitioner vet who is using the app as a refresher. As the app was designed with these end user personas in mind, it therefore should be made to fit their needs as discussed in Section 4.2.2. The design of the low-fidelity prototype successfully addressed both the stakeholder requirements and the design requirements following their evaluation in Section 4.2.3. This is reinforced by the findings of the end user study in Chapter 6. The users had mostly positive comments about the app and overall rated the app's usability 4.71/5. However, the study findings only support the usability of the app by students - persona type Katie. As no qualified veterinary professionals were available to participate in the user study, it is unclear what the opinion of the persona type Kevin would be.

RQ4: Would users choose to use the app?

This question was answered when usability goal 5 was achieved within Chapter 6. The participants of the end user study were asked "If this app was developed further, would you consider using the app in the future?" and all the respondents answered yes, answering RQ4. Additionally, when users were asked for extra comments, one answered that the app is something they would have liked to use in previous years while another said the app would be useful.

7.1.1 Limitations

The main limitation to the development of the app, was the limited amount of content that was readily available to display within it. The Royal (Dick) School of Veterinary Studies were not able to provide a full course worth of content until the 20th of February 2023. This led to implementation having to start without all of the necessary content.

A further content related issue arose when the content was made available, it was not in the discussed format displayed in the initial low-fidelity prototype. This meant that the task layouts had to be re-designed in the middle of the high-fidelity implementation.

The low number of suitable participants in the study was also a limiting factor. This was due to a number of circumstances including a limited students on rotation within the Hospital for Small Animals and all the nursing staff being busy when the user testing was being conducted. Due to limited numbers, students in 4th year were contacted but none could commit as their semester schedule meant the user study was during their exam season. The study would have benefited from the involvement of qualified veterinary professionals as they represented one of the identified personas the app was designed to assist with e-learning and emergency guidance. Unfortunately, on the day of the user study, no qualified veterinary professionals were available to participate.

An issue encountered during the user study was that a lot of feedback was given on the content instead of the learning tool design, layout and platform. A disclaimer was given at the start of the user study telling the participants that they were meant to focus on the app features and not the content, despite this a large amount of the feedback still related to the content on the app.

7.2 Extension to 5th Year

As this research is part one of an MInf Project, considerations should be taken as to what the second part may include.

Evaluation with Experts

To understand the design and implementation from a professional perspective, human computer interaction and teaching experts should to be interviewed. This will give a well-rounded view of the project from an industry standard in both design and creation of learning materials, while hopefully giving feedback which will improve the app.

Further user testing

Qualified veterinary professionals were missed in the user testing. To get a full opinion from end users, it is imperative to test the app with them.

Development of the app

When the remaining technical content is received from the veterinary school, all the courses can be implemented in the app. This content should currently be in the development process. It is likely that this will be a large portion of next year's work as only one course is currently implemented and functioning. As part of this `Useful resources` will be populated with additional information in-line with DR12 from Section 3.5. Loading wheels will also be implemented to abide by DR9. The green ticks shown in the `Course Specific` screen of the low-fidelity prototype have not yet been implemented but following user feedback suggesting a visual cue to show progress on the `Courses` screen, it should be investigated which page these would be most useful on before implementation. If the other app referred to in VE7 (Section 3.4) has been completed, a development could be to link these together.

Potential to make the system dynamic

With the amount of content that will be available for the app, research may have to be done into ways of hosting the app in a dynamic manner so that information on the page is only retrieved when needed, instead of stored within the app. The hope is that if this can be optimised, the app will run faster.

Adding additional features

From the user feedback came a lot of good suggestions for app features. I would aim to implement at least some of these such as: a way to navigate from one task to another and a menu button. During this project, there have been additional features noted by the VE in 4.2.1 which have not yet been implemented. These are the ability to time user activity on the app, the ability to export a Certificate of Achievement and an introductory helper page detailing the ins and outs of the app. These features should be explored in the second part of research.

7.3 Self-evaluation

From researching and trialling current e-learning resources to conducting user studies, this research has allowed me to gain a number of new skills and knowledge in several areas. Despite having previous experience in web app development, I designed and developed a smartphone app for the first time in this research. I was able to create the low-fidelity prototype to fit the needs of a stakeholder while considering well used heuristics within the field of human computer interaction and e-learning. To evaluate this design I used personas and a stakeholder interview to make sure I was continuing to meet the needs of the stakeholder while making the app suitable for its end users. From this, I implemented the current functioning high-fidelity prototype which allowed me to gain experience in several new technologies: Expo and Firebase. When it came to evaluating the app, I had never created or conducted a user study therefore I gained a lot of understanding on what data to gather and how to gather it. Overall, this research forms a strong basis for the continued work into 5th year where I will be able to build upon the skills acquired so far.

7.4 Conclusion

This project explored the design and development of an e-learning tool within the field of veterinary medicine. A low-fidelity prototype was developed and evaluated which influenced the implementation of a functioning high-fidelity prototype. The implemented app was then evaluated and trialled by end users to give valuable feedback. On the back of this feedback, the successes and limitations of the project can be seen and with that suggestions for improvement and future work can be given. This project brought several contributions as follows:

- design solution for a veterinary e-learning platform.
- the implementation and evaluation of this learning platform
- evidence that such an app would be useful and beneficial to undergraduate veterinary students.

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Appendix A

Participants' information & consent form sheet

Participant Information Sheet

Project title:	Designing a Veterinary CPR Training App
Principal investigator:	Dr Heather Yorston
Researcher collecting data:	Laura Bulloch
Funder (if applicable):	N/A

This study was certified according to the Informatics Research Ethics Process, RT number 7147 . Please take time to read the following information carefully. You should keep this page for your records.

Who are the researchers?

Laura Bulloch (l.bulloch-1@sms.ed.ac.uk), Dr Heather Yorston (Heather.Yorston@ed.ac.uk), Craig Beheney (craig.breheny@ed.ac.uk)

What is the purpose of the study?

The goal of the project is to design a Veterinary CPR App to aid CPR training for all those involved in the care of animals as part of an undergraduate project.

While the goal of this study is to gather feedback on the user interface which has been implemented in the app.

Why have I been asked to take part?

To design a useful app it is imperative to involve users in the design and testing stages. This will lead to the app being more useful for the target end users.

Do I have to take part?

No – participation in this study is entirely up to you. You can withdraw from the study at any time, up until the publication of the project research paper without giving a reason. After this point, personal data will be deleted and anonymised data will be combined such that it is impossible to remove individual information from the analysis. Your rights will not be affected. If you wish to withdraw, contact the PI. We will keep copies of your original consent, and of your withdrawal request.

What will happen if I decide to take part?

We will be designing an app to help train, remind and assist veterinarian students and staff in the act of CPR.

We aim to understand what the prototype does well, what it is lacking, how it could be improved, and if you envisage any other functionality or visualisation that the prototype did not consider.

Participants will be shown an implemented prototype of the CPR app and asked to complete a task. They will be observed while doing this and after asked to complete an online questionnaire related to layout, usability and design. The questions will be a variety of open-ended and strict answer questions, so that we can gather information on specific design elements while also any additional information or ideas which may be useful.

Are there any risks associated with taking part?

There are no significant risks associated with participation.

Are there any benefits associated with taking part?

There are no direct benefits associated. However, if the findings are deemed useful, developers of learning platforms could potentially implement the suggested improvements, and thus result in an improved teaching experience.

What will happen to the results of this study?

The results of this study may be summarised in published articles, reports and presentations. Quotes or key findings will be anonymized: We will remove any information that could, in our assessment, allow anyone to identify you. With your consent, information can also be used for future research. Your data may be archived for a maximum of 4 years. All potentially identifiable data will be deleted within this timeframe if it has not already been deleted as part of anonymization.

Data protection and confidentiality.

Your data will be processed in accordance with Data Protection Law. All information collected about you will be kept strictly confidential. Your data will be referred to by a unique participant number rather than by name. Your data will only be viewed by the

researcher/research team: Laura Bulloch (l.bulloch-1@sms.ed.ac.uk), Dr Heather Yorston (Heather.Yorston@ed.ac.uk), Craig Beheney (craig.breheny@ed.ac.uk)

All electronic data will be stored on a password-protected encrypted computer, on the School of Informatics' secure file servers, or on the University's secure encrypted cloud storage services (Sharepoint) and any paper records will be stored in a locked filing cabinet in the PI's office. Your consent information will be kept separately from your responses in order to minimise risk.

What are my data protection rights?

The University of Edinburgh is a Data Controller for the information you provide. You have the right to access information held about you. Your right of access can be exercised in accordance Data Protection Law. You also have other rights including rights of correction, erasure and objection. For more details, including the right to lodge a complaint with the Information Commissioner's Office, please visit www.ico.org.uk. Questions, comments and requests about your personal data can also be sent to the University Data Protection Officer at dpo@ed.ac.uk.

Who can I contact?

If you have any further questions about the study, please contact the lead researcher, Laura Bulloch (l.bulloch-1@sms.ed.ac.uk) or the PI Dr Heather Yorston (heather.yorston@ed.ac.uk).

If you wish to make a complaint about the study, please contact inf-ethics@inf.ed.ac.uk. When you contact us, please provide the study title and detail the nature of your complaint.

Updated information.

If the research project changes in any way, an updated Participant Information Sheet will be made available on http://web.inf.ed.ac.uk/infweb/research/study-updates.

Consent

By proceeding with the study, I agree to all of the following statements:

- I have read and understood the above information.

- I understand that my participation is voluntary, and I can withdraw at any time.
- I consent to my anonymised data being used in academic publications and presentations.
- I allow my data to be used in future ethically approved research

Appendix B

Low-fidelity Prototype Designs

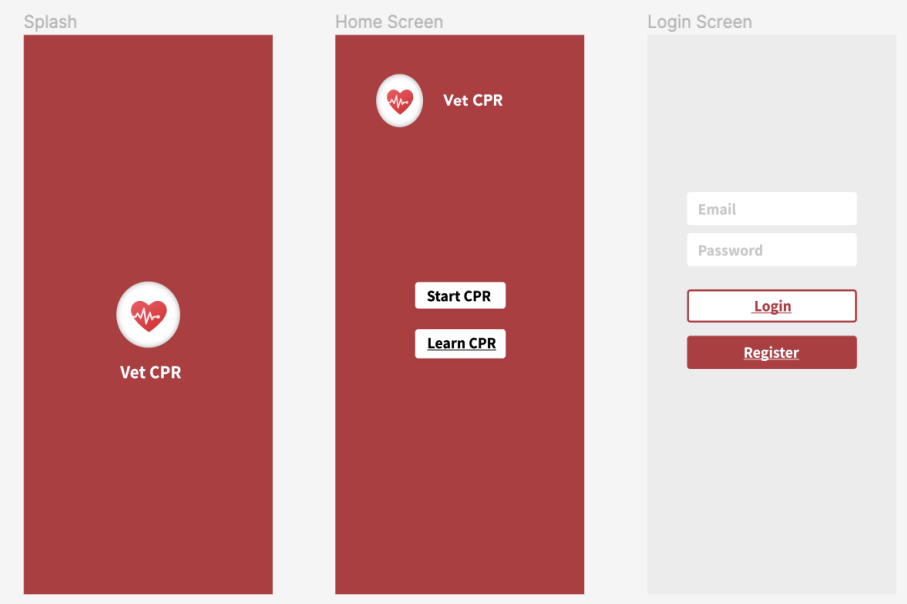

Figure B.1: Low-fidelity Splash, Home and Login screens

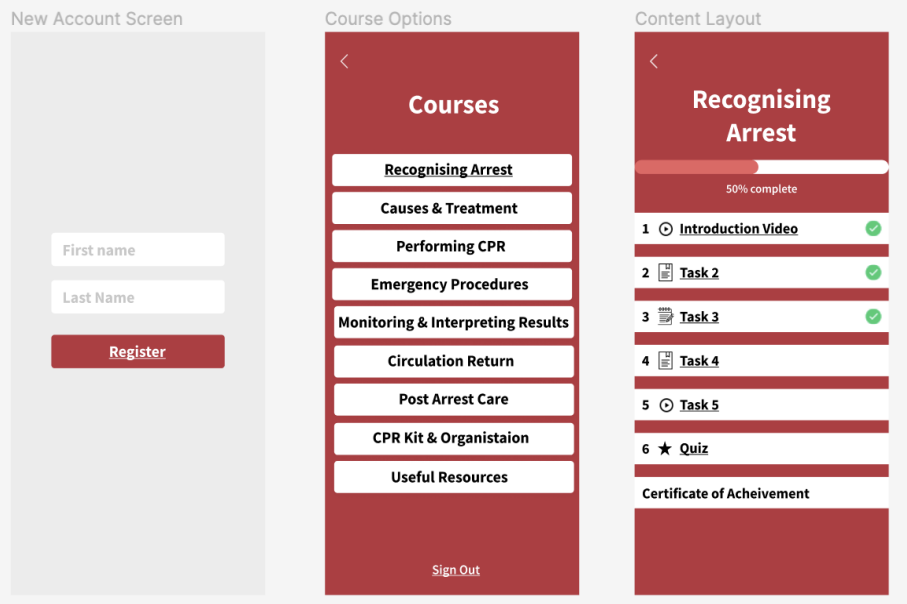

Figure B.2: Low-fidelity New Account, Courses and Course Specific screens

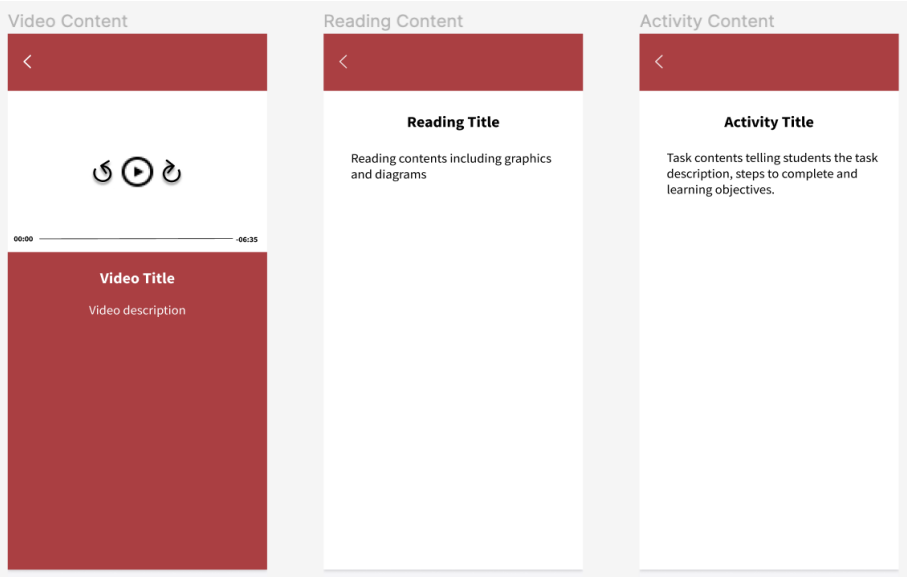

Figure B.3: Low-fidelity Video, Reading and Activity screens

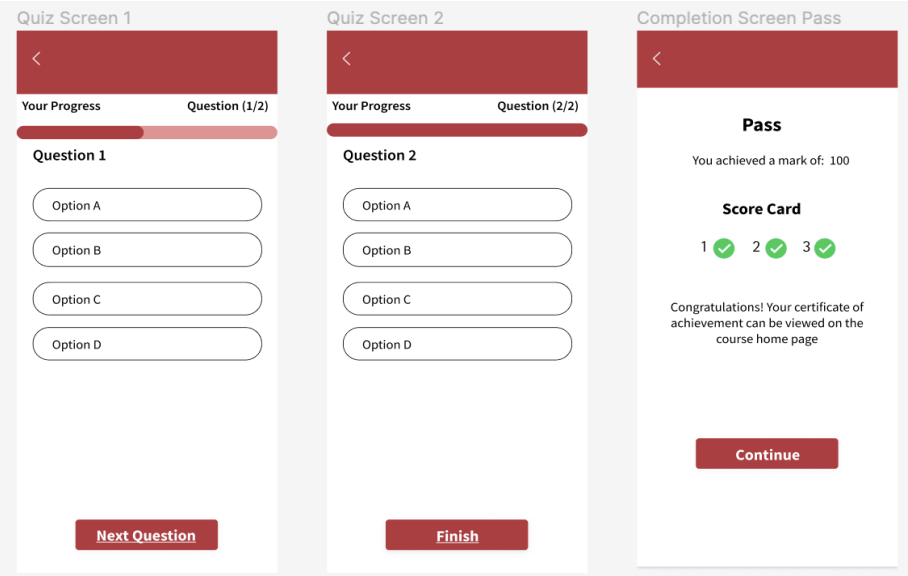

Figure B.4: Low-fidelity Quiz and passing Results screens

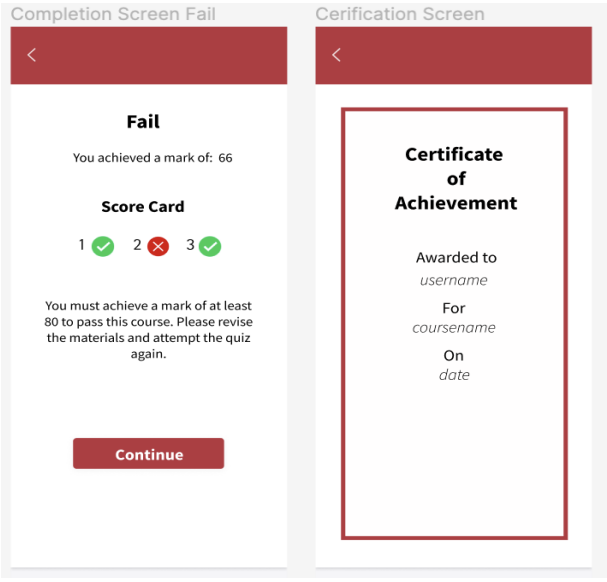

Figure B.5: Low-fidelity failing Results and Certification screens

Appendix C

High-fidelity Prototype Screens

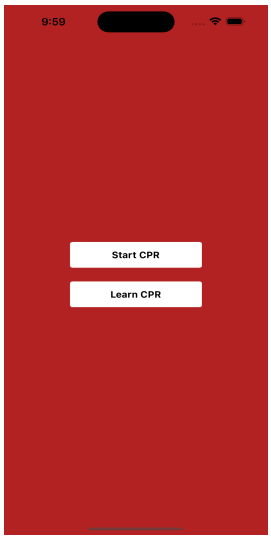

Figure C.1: Implemented Home Screen

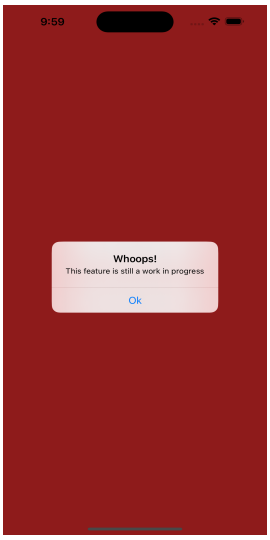

Figure C.2: Implemented Home Start CPR clicked

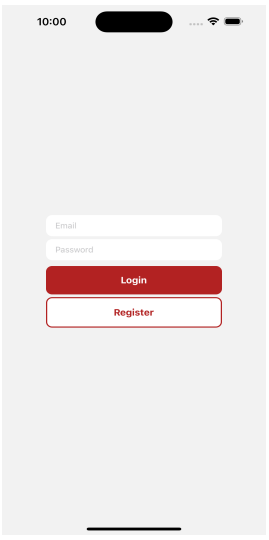

Figure C.3: Implemented Login Screen

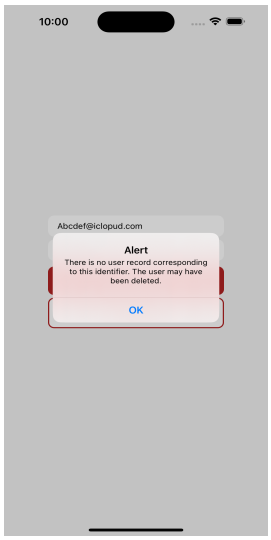

Figure C.4: Implemented Login user not found

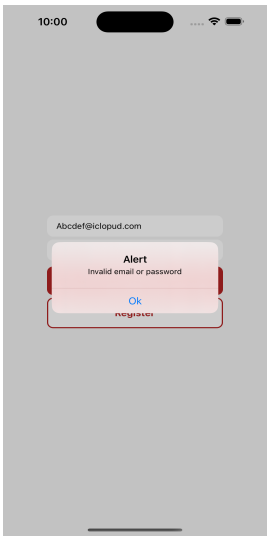

Figure C.5: Implemented Login invalid password

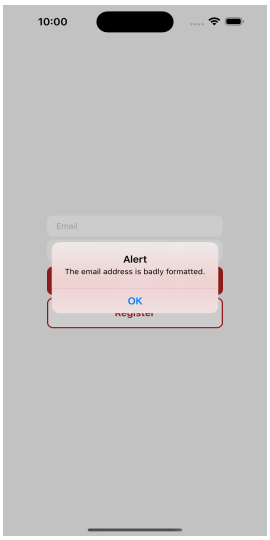

Figure C.6: Implemented Login with missing information

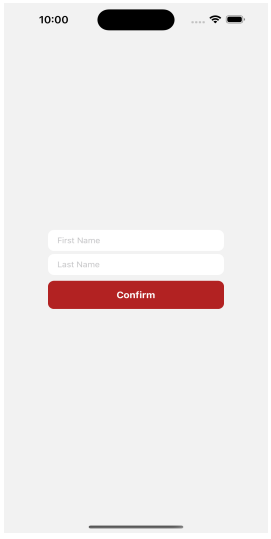

Figure C.7: Implemented New Account Screen

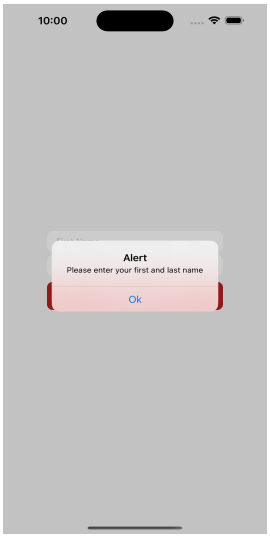

Figure C.8: Implemented New Account Error

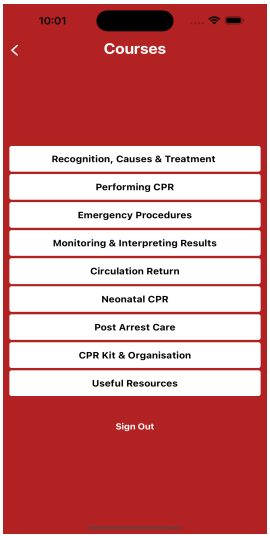

Figure C.9: Implemented Courses Screen

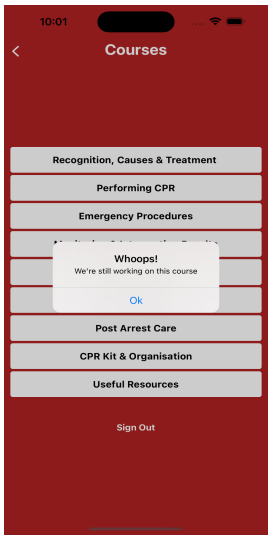

Figure C.10: Implemented work in progress Courses Error

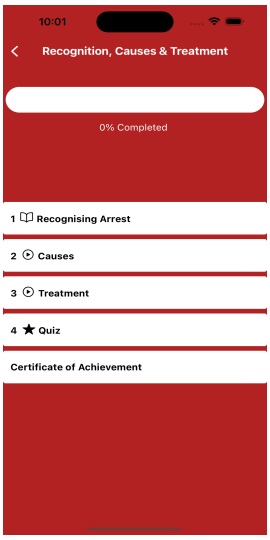

Figure C.11: Implemented Recognition, Causes & Treatment Specific Screen

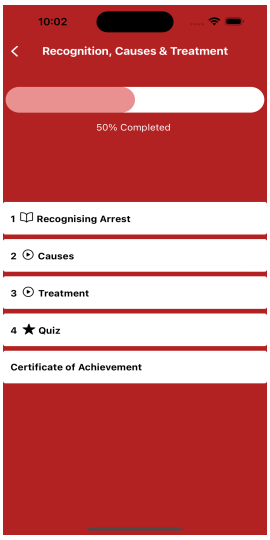

Figure C.12: Implemented Recognition, Causes & Treatment progress bar

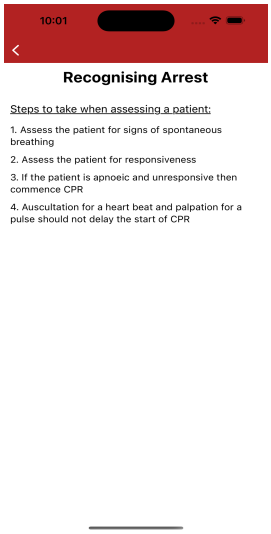

Figure C.13: Implemented Recognising Arrest task screen

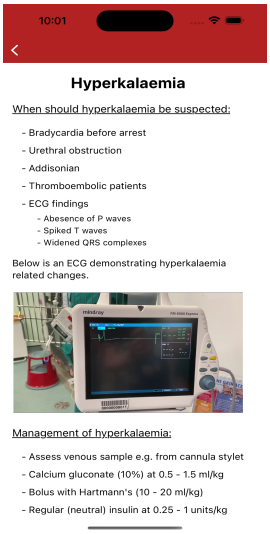

Figure C.14: Implemented Causes task screen

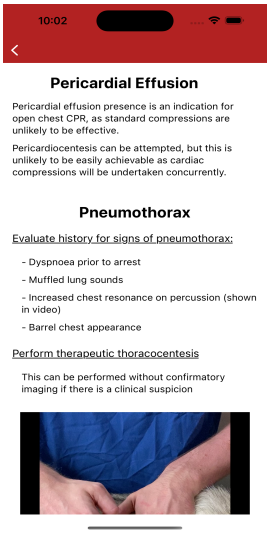

Figure C.15: Implemented Treatment task screen

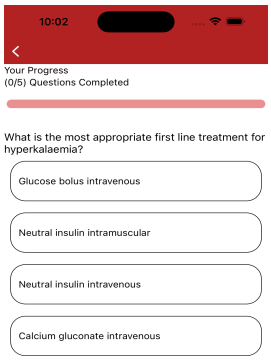

Figure C.16: Implemented First Quiz Screen

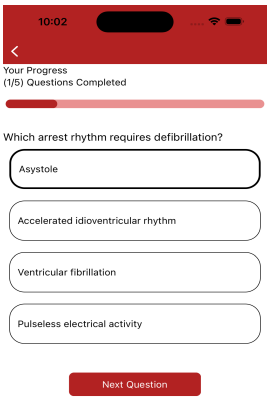

Figure C.17: Implemented Quiz with answer selected

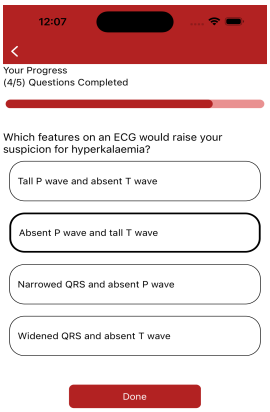

Figure C.18: Implemented Quiz Final Question

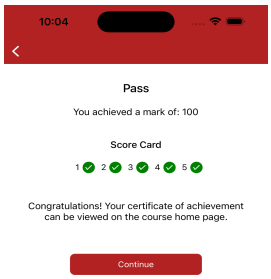

Figure C.19: Implemented Results when Pass achieved

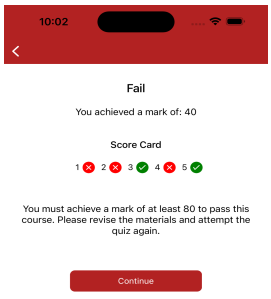

Figure C.20: Implemented Results when Fail achieved

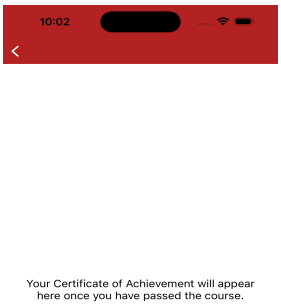

Figure C.21: Implemented Certification not achieved

Figure C.22: Implemented certification Achieved

Appendix D

Pre-Questionnaire Questions

CPA App User Pre-questionaire
Project Title: Developing a Veterinary CPR Training App
Principal Investigator: Dr Heather Yorston
Researcher collecting data: Laura Bulloch

This study was certified according to the Informatics Research Ethics Process, RT number 7147 . Please take time to read the following information carefully. You should keep this page for your records.

Who are the researchers?
Laura Bulloch (l.bulloch-1@sms.ed.ac.uk), Dr Heather Yorston (Heather.Yorston@ed.ac.uk), Craig Beheney (craig.breheny@ed.ac.uk)

What is the purpose of the study?
The goal of the project is to design a Veterinary CPR App to aid CPR training for all those involved in the care of animals as part of an undergraduate project. While the goal of this study is to gather feedback on the user interface which has been implemented in the app.

Why have I been asked to take part?
To design a useful app it is imperative to involve users in the design and testing stages. This will lead to the app being more useful for the target end users.

Do I have to take part?
No – participation in this study is entirely up to you. You can withdraw from the study at any time, up until the publication of the project research paper without giving a reason. After this point, personal data will be deleted and anonymised data will be combined such that it is impossible to remove individual information from the analysis. Your rights will not be affected. If you wish to withdraw, contact the PI. We will keep copies of your original consent, and of your withdrawal request.

What will happen if I decide to take part?
We will be designing an app to help train, remind and assist veterinarian students and staff in the act of CPR. We aim to understand what the prototype does well, what

it is lacking, how it could be improved, and if you envisage any other functionality or visualisation that the prototype did not consider. Participants will be shown an implemented prototype of the CPR app and asked to complete a task. They will be observed while doing this and after asked to complete an online questionnaire related to layout, usability and design. The questions will be a variety of open-ended and strict answer questions, so that we can gather information on specific design elements while also any additional information or ideas which may be useful.

Are there any risks associated with taking part?
There are no significant risks associated with participation.

Are there any benefits associated with taking part?
There are no direct benefits associated. However, if the findings are deemed useful, developers of learning platforms could potentially implement the suggested improvements, and thus result in an improved teaching experience.

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The results of this study may be summarised in published articles, reports and presentations. Quotes or key findings will be anonymized: We will remove any information that could, in our assessment, allow anyone to identify you. With your consent, information can also be used for future research. Your data may be archived for a maximum of 4 years. All potentially identifiable data will be deleted within this timeframe if it has not already been deleted as part of anonymization.

Data protection and confidentiality.
Your data will be processed in accordance with Data Protection Law. All information collected about you will be kept strictly confidential. Your data will be referred to by a unique participant number rather than by name. Your data will only be viewed by the researcher/research team: Laura Bulloch (l.bulloch-1@sms.ed.ac.uk), Dr Heather Yorston (Heather.Yorston@ed.ac.uk), Craig Beheney (craig.breheny@ed.ac.uk)

All electronic data will be stored on a password-protected encrypted computer, on the School of Informatics' secure file servers, or on the University's secure encrypted cloud storage services (Sharepoint) and any paper records will be stored in a locked filing cabinet in the PI's office. Your consent information will be kept separately from your responses in order to minimise risk.

What are my data protection rights?
The University of Edinburgh is a Data Controller for the information you provide. You have the right to access information held about you. Your right of access can be exercised in accordance Data Protection Law. You also have other rights including rights of correction, erasure and objection. For more details, including the right to lodge a complaint with the Information Commissioner's Office, please visit www.ico.org.uk. Questions, comments and requests about your personal data can also be sent to the University Data Protection Officer at dpo@ed.ac.uk. For general information about how we use your data, go to: edin.ac/privacy-research

Who can I contact?
If you have any further questions about the study, please contact the lead researcher, Laura Bulloch (l.bulloch-1@sms.ed.ac.uk) or the PI Dr Heather Yorston

(heather.yorston@ed.ac.uk).

If you wish to make a complaint about the study, please contact inf-ethics@inf.ed.ac.uk. When you contact us, please provide the study title and detail the nature of your complaint.

Updated information
If the research project changes in any way, an updated Participant Information Sheet will be made available on http://web.inf.ed.ac.uk/infweb/research/study-updates.

1. Consent
By proceeding with the study, I agree to all of the following statements:
· I have read and understood the above information.
· I understand that my participation is voluntary, and I can withdraw at any time.
· I consent to my anonymised data being used in academic publications and presentations.
· I allow my data to be used in future ethically approved research.

2. Are you part of the The Royal (Dick) School of Veterinary Studies?

3. Are you a student? If so, enter your year of study. (Enter N/A otherwise)

4. If you are not a student, please enter your role.

5. When learning a new topic, what methods do you use to learn?

6. Do you have experience using online learning tools?

7. If so, what online learning tools have you used?

Appendix E

Observation Questionnaire

1. Was the user able to register successfully?

2. Could the user navigate to the “Recognition, Causes & Treatment” course?

3. Was the user able to complete the “Recognising Arrest” task?

4. Was the user able to complete the “Causes” task?

5. Was the user able to complete the “Treatment” task?

6. Was the user able to complete the quiz?

7. If the user passed the quiz, were they able to see their certificate of achievement?

8. Did the user follow the recommended path for task completion? (Learn CPR, ‘Recognition, Causes & Treatment’, Recognising Arrest, Causes, Treatment, Quiz)

9. If no, please specify

10. If the user had any issues during the observation period, detail them below.

Appendix F

Post-Questionnaire Questions

1. Were you able to complete the Recognition, Causes and Treatment course?

2. If yes, please rate how easy you found using the app overall.

3. Did you find the app easy to navigate?

4. Why?

5. Is there anything you would change about navigation through the app?

6. Please rate the app's navigability.

7. Were you able to complete the task without errors?

8. If you encountered any errors, please tell me more about them. (What actions led to this? What error occurred? etc)

9. Did you like the colour scheme of the app? If not, what colours do you think would work better?

10. Did you like the overall layout of the app?

11. Why?

12. Please rate the overall app design.

13. Did you find it easy to sign-in/register for the app?

14. Why?

15. Would you change anything about the 'Courses' page?

16. Would you change anything about the 'Recognition, Causes & Treatment' page?

17. Would you change anything about the 'Recognising Arrest', 'Causes' or 'Treatment' tasks?

18. Each task has an icon next to it e.g. open book, star, play symbol. Did you find this useful?

19. Why?

20. Do you feel any icons would be better suited, if so what?

21. Did you feel the course progress bar was a useful feature?

22. How did you feel about the layout of the ‘Causes’ & ‘Treatment’ tasks where the videos are among text?

23. If you didn’t like the layout of the ‘Causes’ or ‘Treatment’ tasks, what would you change?

24. What did you think of the quiz layout? Anything you would change?

25. Was it clear to see what answer you had selected in the quiz?

26. Did you find the progress bar within the quiz useful?

27. What did you think of the quiz results page? Anything you would change?

28. Please rate the usability of the quiz.

29. Did you try to view your ‘Certificate of Achievement’?

30. If yes, is there anything you would change about this page?

31. Please rate the usability of the ‘Certificate of Achievement’ page.

32. Please rate the overall usability of the app.

33. What additional features would you like to see in the app?

34. Do you think the app would benefit from activity tasks, where instead of reading or watching a video, you would be set a task to complete?

35. If the app was developed further, do you think it would be a useful learning tool?

36. If this app was developed further, would you consider using this app in the future?

37. Any other comments about the app?

Appendix G

Pre-Questionnaire Results

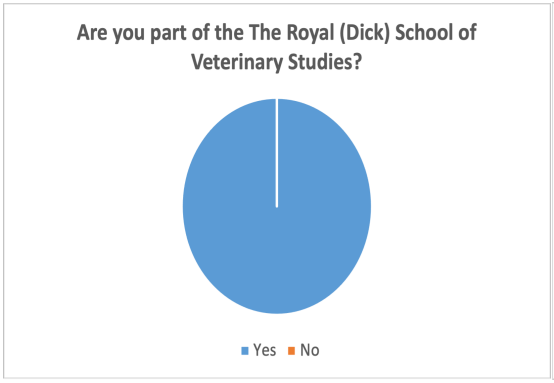

Figure G.1: Question 2 Results

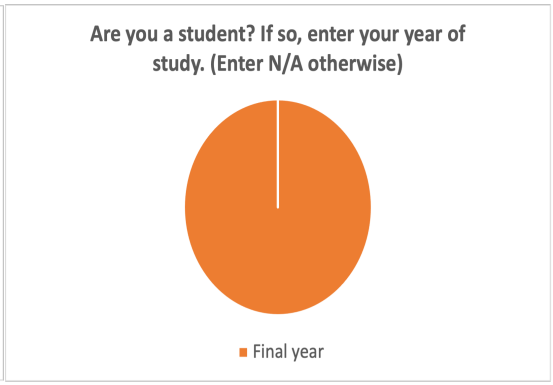

Figure G.2: Question 3 Results

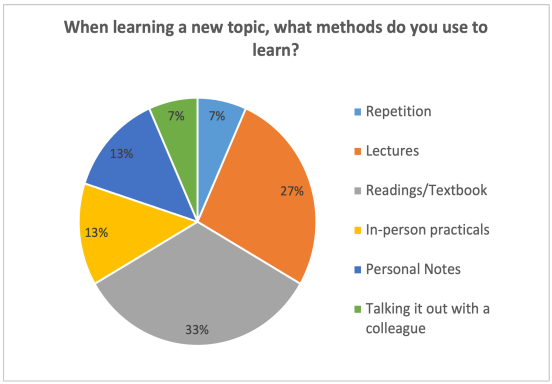

Figure G.3: Question 5 Results

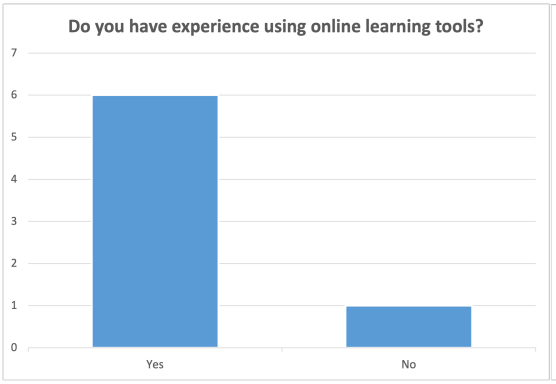

Figure G.4: Question 6 Results

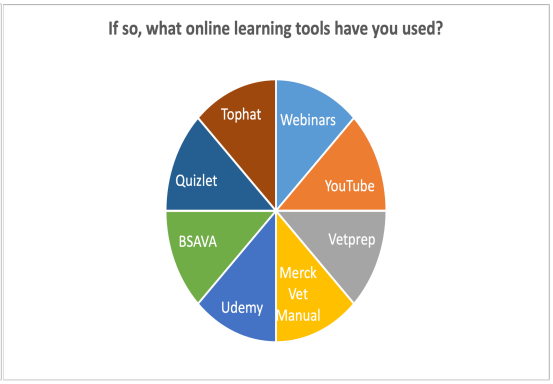

Figure G.5: Question 7 Results

Appendix H

Observation Questionnaire Results

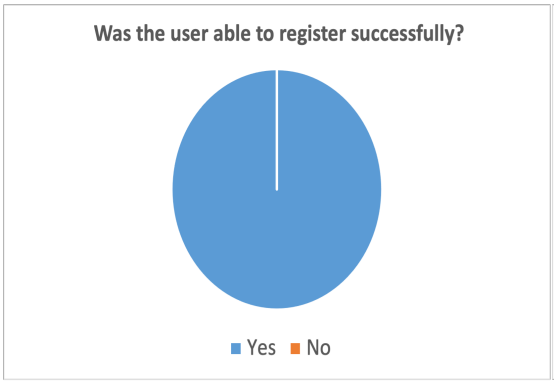

Figure H.1: Question 1 Results

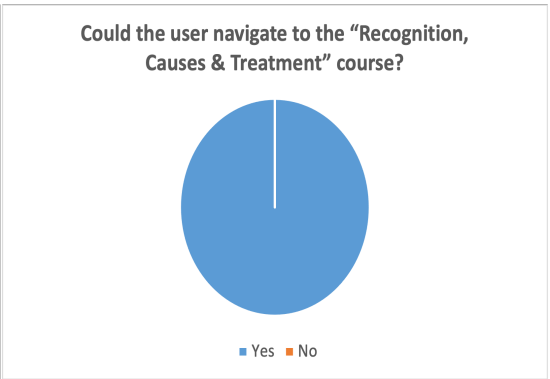

Figure H.2: Question 2 Results

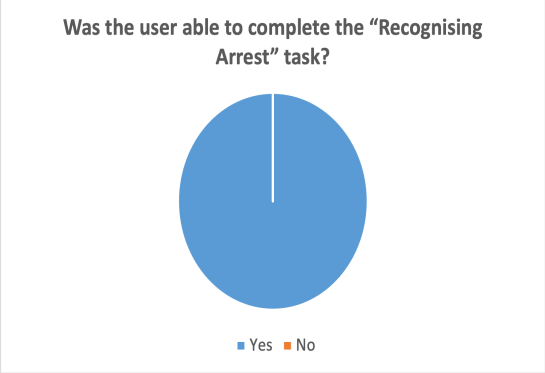

Figure H.3: Question 3 Results

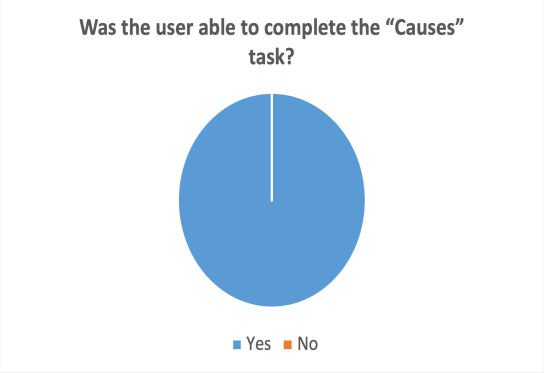

Figure H.4: Question 4 Results

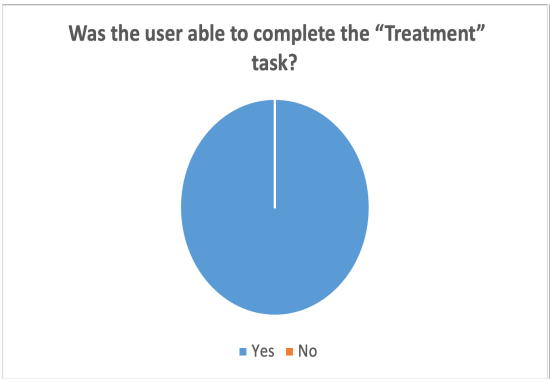

Figure H.5: Question 5 Results

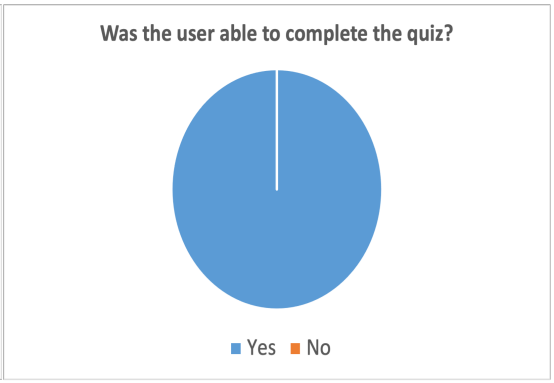

Figure H.6: Question 6 Results

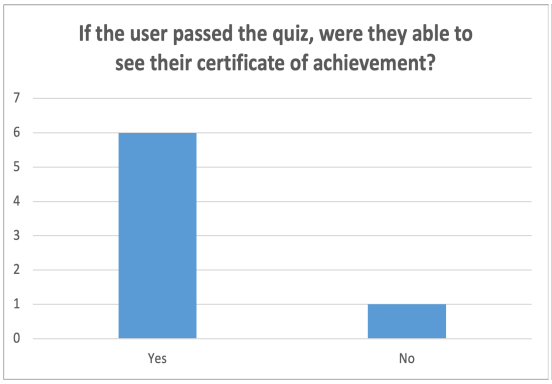

Figure H.7: Question 7 Results

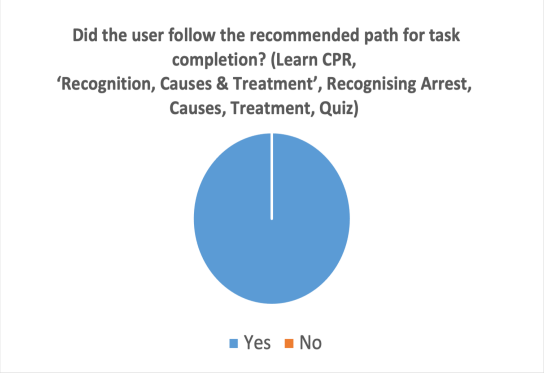

Figure H.8: Question 8 Results

Table H.1: Question 10 Results.

If the user had any issues during the observation period, detail them below.
User swiped off of the app while scrolling.
User did not attempt to view their Certificate of Achievement.
The user thought a quiz question was providing the wrong answer, upon checking the question they thought they were getting wrong was q5 but they were actually getting q4 wrong.

Appendix I

Post-Questionnaire Results

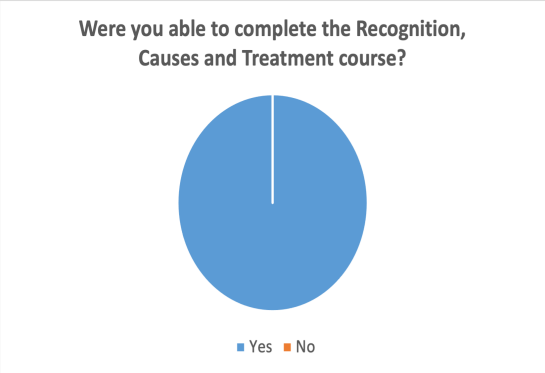

Figure I.1: Question 1 Results

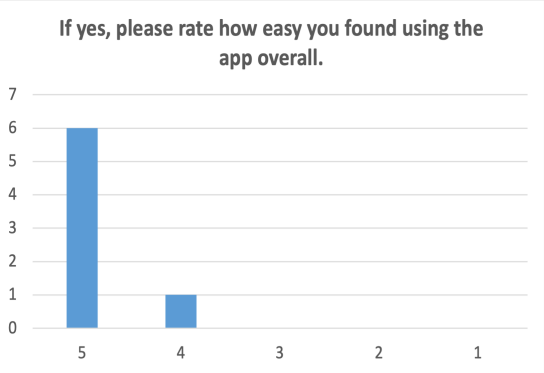

Figure I.2: Question 2 Results

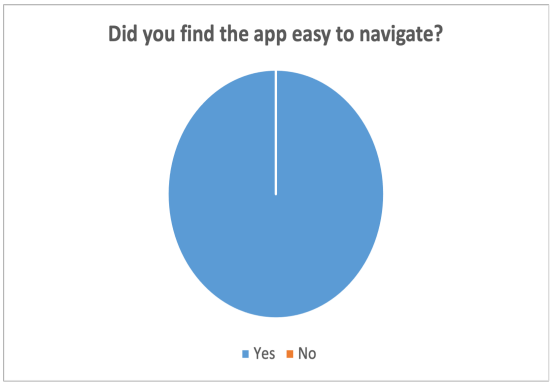

Figure I.3: Question 3 Results

Table I.1: Question 4 Results.

Why did you feel this way about the navigation?
It was easy to move back and forth between the screens.
Categories were clear, going back was easy
Easy to transition between sections, each section is well laid out
Clear titles easily directed to the next page
Clear labels for sections
Back buttons were clear, pages flowed
The layout was really straightforward and I liked how clear the subheadings were

Table I.2: Question 5 Results

Is there anything you would change about navigation through the app?
It might be nice to be able to move straight from one into the next, rather than having to go backwards and forwards.
Perhaps a ”menu” button that shows up from any page
No I like it, the videos especially are very helpful when trying to picture the clinical signs/treatment acuity
No
way to scroll between sections rather than clicking out of each to enter the next one
being able to access the next task without going back
maybe add a search bar - so in an emergency you could find the exact issue you’re having

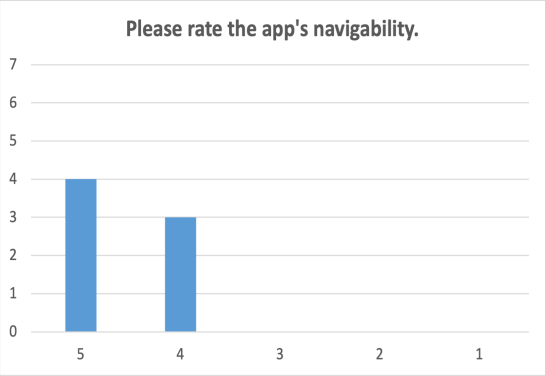

Figure I.4: Question 6 Results

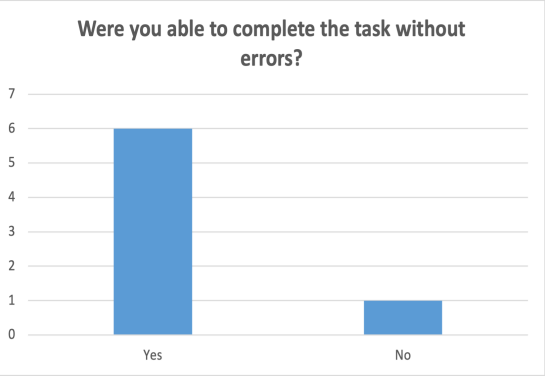

Figure I.5: Question 7 Results

Table I.3: Question 8 Results

If you encountered any errors, please tell me more about them. (What actions led to this? What error occurred? etc)
The answer for one of the quiz questions was incorrect, the answer to the ECG findings for hyperkalaemia was incorrect.

Table I.4: Question 9 Results

Did you like the colour scheme of the app? If not, what colours do you think would work better?
I liked the colour scheme of the app, it is easy to read.
Yes
Red and White works well, they pop against each other and I think are pretty universal for ECC/CPR type info.
Yes
I like the red
yes, good contrast
yes - the red suits car

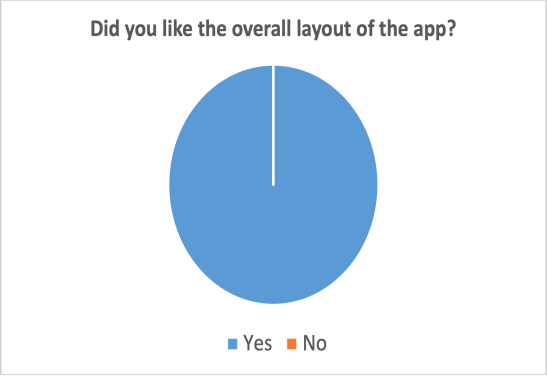

Figure I.6: Question 10 Results

Table I.5: Question 11 Results

Why did you feel this way about the layout?
It was straightforward and concise. It would be very easy to study from.
Liked the categories, liked having videos, quiz was easy to complete, certificate was accurate
See previous answers
Very well summarised and highlighted the important and relevant information for emergency procedures.
Easy to use
Everything was sectioned well
So easy to understand and not distracting

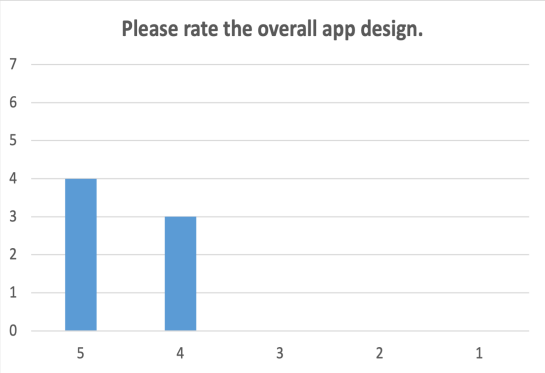

Figure I.7: Question 12 Results

Figure I.8: Question 13 Results

Table I.6: Question 14 Results

Why did you feel this way about sign-in/registration?
I just put my email and password in. It was very easy to use.
Didn't require a lot of information
Was able to just put in an email and password and go!
Very simple and just one or two steps.
Very straightforward and simple
Normal registration system
The registration and login being the same place makes it super easy to create an account without having to reenter email

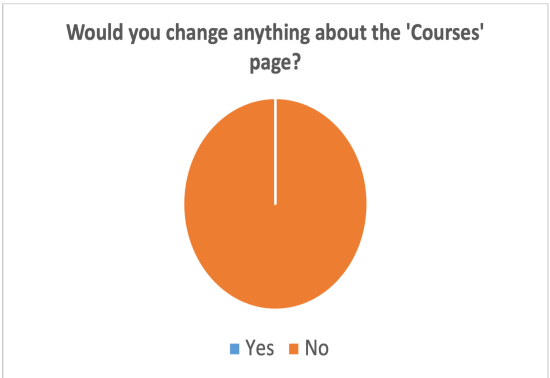

Figure I.9: Question 15 Results

Table I.7: Question 16 Results

Would you change anything about the 'Recognition, Causes & Treatment' page?
Maybe make it easier to move forward from one course into the next? And have the completed bar reach 100% once you finish the quiz.
Maybe a "jump to" section if it is particularly long, otherwise not necessary
Nope
No
No
No
No

Table I.8: Question 17 Results

Would you change anything about the 'Recognising Arrest', 'Causes' or 'Treatment' tasks?
No.
No
yes, some of the treatments were under the causes page like the treatments for hyperkalaemia treatments. Some of the videos could use a label. Like the video for the glide sign I wasn't sure if that was showing an absence of a glide sign or a glide sign.
more clear separation between the topics covered in each, maybe like separate tabs for them?
No
No
No

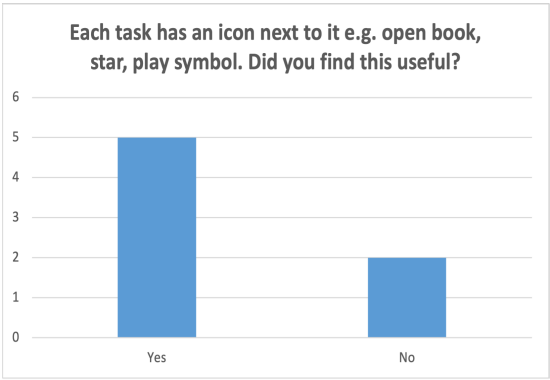

Figure I.10: Question 18 Results

Table I.9: Question 19 Results

Why did you feel this way about the icons used?
So I knew if there were videos to watch on the task.
I don't think I noticed the icon and didn't use
Easy to see where I could play the videos and scroll through the info.
Labeled well and easy to navigate
they didn't add anything that wasn't already stated in words
Helped me know what content to expects
the visuals help to show what you're doing

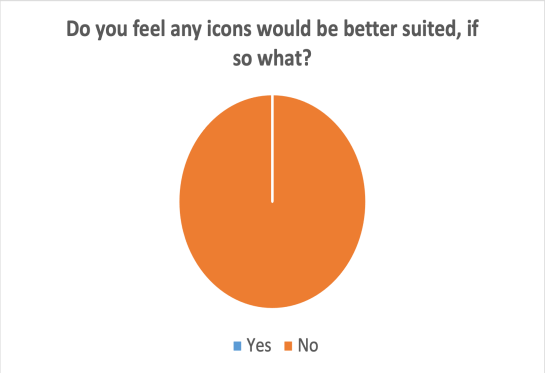

Figure I.11: Question 20 Results

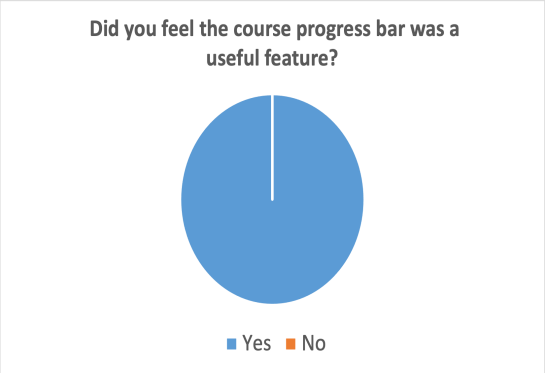

Figure I.12: Question 21 Results

Table I.10: Question 22 Results

How did you feel about the layout of the 'Causes' & 'Treatment' tasks where the videos are among text?
I liked that you have a video or picture to accompany the task. It is nice to see the example.
Videos in the spot relevant to the paragraphs were nice, I wasn't questioning what video I was seeing
It was well condensed and the topics were all relevant and useful
I found it useful
Everything was split up well. Liked the videos next to the text they were relative to.
I liked it - this meant that I definitely watched them

Table I.11: Question 24 Results

What did you think of the quiz layout? Anything you would change?
I thought the quiz layout was easy to navigate. I would not change anything.
No
Good 5 questions, needed knowledge. Maybe make it clearer that calcium should be given first, in the treatments for hyperkalemia, perhaps use numbers instead of bullets
There was one error on the quiz the ECG findings for hyperkalaemia had an incorrect answer.
I liked it
No, I liked it.
loved the layout of the quiz - liked that it was multiple choice

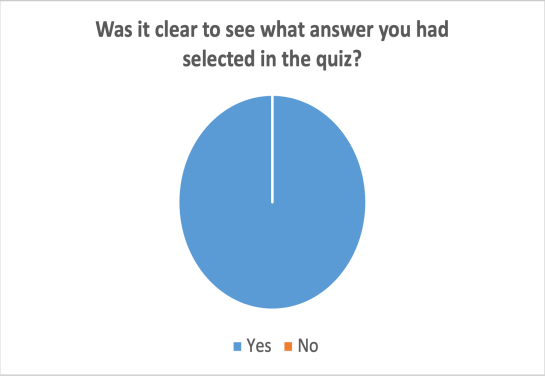

Figure I.13: Question 25 Results

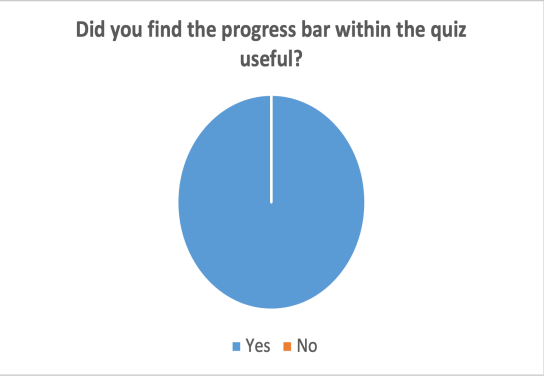

Figure I.14: Question 26 Results

Table I.12: Question 27 Results

What did you think of the quiz results page? Anything you would change?
If you got the answer wrong it might be nice to provide the answer.
No
Nope, all good
No
show correct answer if you got it incorrect
results page was infomative
loved it - showing what question I got wrong really helped

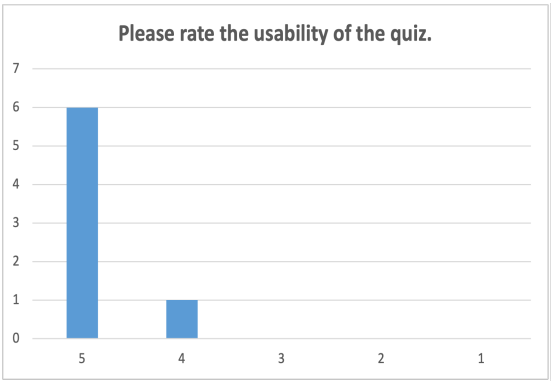

Figure I.15: Question 28 Results

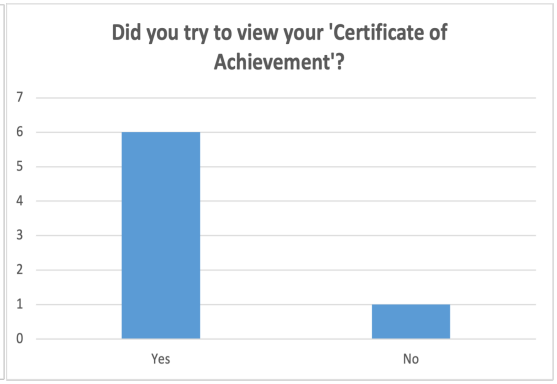

Figure I.16: Question 29 Results

Table I.13: Question 30 Results

If yes, is there anything you would change about this page?
No
No
Just brought me back to the beginning
No
n/a
looks very basic so could improve on the visual aspect/aesthetic of it ?

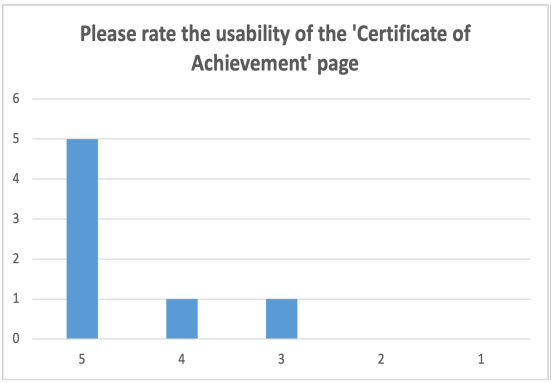

Figure I.17: Question 31 Results

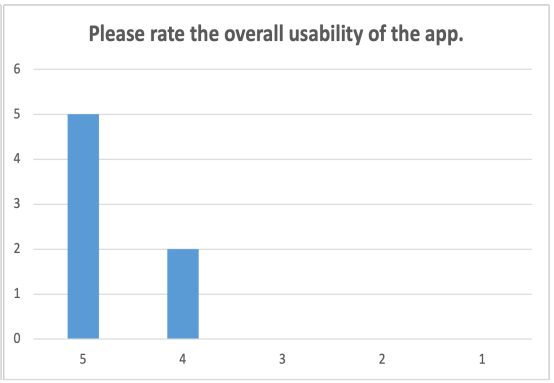

Figure I.18: Question 32 Results

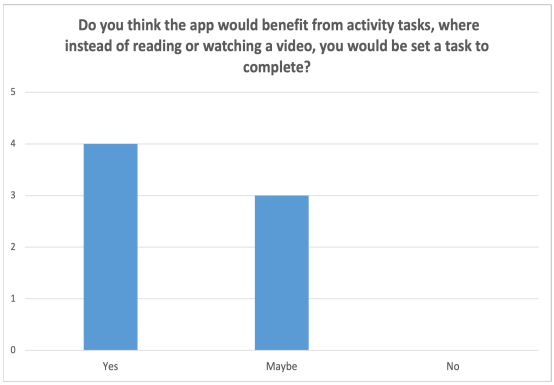

Figure I.19: Question 34 Results