A study into the experiences of pre-registration nurses' use of mental simulation.

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the requirements of Sheffield Hallam University
for the degree of Doctor in Education

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Declaration

1. I have not been enrolled for another award of the University or other academic or professional organisation whilst undertaking my research degree.
2. None of the material contained in the thesis has been used in any other submission for an academic award.
3. I am aware of and understand the University's policy on plagiarism and certify that this thesis is my own work. The use of all published or other sources of material consulted have been properly and fully acknowledged.
4. The work undertaken towards the thesis has been conducted in accordance with the SHU Principles of Integrity in Research and the SHU Research Ethics Policy.
5. The main body word count of the thesis is 74,568 words

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Abstract:

Pre-registration nurses (students) must be prepared to be part of a cardiac arrest team at a moment's notice. Basic life-support (BLS), including cardiopulmonary resuscitation (CPR), must be performed proficiently and accurately. Proficient performance relies on repetitive practice, but time without practice results in skill decay, potentially leading to catastrophic memory failure. Annual mandatory BLS updates may not be enough to halt skills decay, nor does it necessarily offer an authentic cardiac arrest experience. Mental simulation offers the opportunity for repetitive, solitary, deliberate practice. Mental simulation is a quasi-sensory or quasi-perceptual experience in the absence of stimuli and overt physical movement (Arora et al., 2011). Mental simulation has been well researched within healthcare education with promising, albeit limited, results.

The study aims are to understand: 1) how participants integrate mental simulation into their lives; 2) how the participants experience imagining a cardiac arrest and what this means to them; 3) whether they see value in experiencing cardiac arrest and life-support education through mental simulation and to, 4) make a judgement as to the benefit of mental simulation as an adjunct to physical simulation in learning life-support. This research study consists of two phases.

Phase-1 is the design of the PETTLEP framework (physical, environment, task, timing, learning, emotion & perspective) mental simulation script and protocol. A tripartite design was used in which four students were interviewed about their experiences of undertaking CPR in a real-world cardiac arrest. These cues taken from the interviews were used as the basis for the cardiac arrest scenario script. The broader protocol included a basic and advanced audio script, a cardiac arrest point-of-view film, scenario overview and introduction, glossary, and resuscitation algorithms. The protocol was engineered to assist the student in creating functionally equivalent, high-fidelity images, as per the PETTLEP framework (Holmes & Collins, 2001). Phase-2 is a qualitative, interpretivist interview study undertaken from an inductive, social constructionist perspective. Eleven pre-registration nurses were asked to use the mental simulation protocol three times per week for 4-weeks. At the end of the four weeks, semi-structured interviews were employed to co-construct an understanding of their experiences. This study was carried out using qualitative inductive thematic analysis to search for commonalities in the participants' experiences. Several themes and sub-themes emerged from their mental simulation journey, which helped answer the research questions.

The findings showed that participants had busy home lives but were motivated to undertake the mental simulations. These motivations created the volition required to problem-solve and make decisions that overcame environmental and time management challenges. The scripts assisted participants in coding images evoked from the language within the script narration. Unique to the participants, these images created individualised, emotionally laden, authentic scenarios high in psychological fidelity. This generated a realistic scenario akin to a real-world practice experience. The mental simulation acted as a reflective tool, and reflective practice allowed the participants to demystify the complexities of cardiac arrest life-support processes. This led to the closing of knowledge gaps, reduced anxiety at the prospect of being part of a cardiac arrest team, and increased self-efficacy. Using mental simulation creates an authentic cardiac arrest learning experience. It creates self-efficacious students who are ready for clinical practice. The author recommends that mental simulation adjuncts physical mandatory BLS training.

In dedication to my beautiful mum's loving memory, grace, and spirit, who is always with me in mind, heart, and soul…

I know you would be proud of me.

Acknowledgements:

I do hope I do not forget anyone! To all the people who have helped me on my journey. They are too numerous to mention.

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To my secondary school teacher, Eileen Heatherington. You always believed in me, even when I did not believe in myself. You always had my back, and my mum always reminded me that I owed you a debt of gratitude for you 'going into bat for me' time and again when I got into trouble.

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Last, but by no means least, to my family! You are all amazing. Specifically, thanks to my two boys, Freddie and Max, for your patience when 'dad is working'. You are now allowed to touch my computer! We can now go and have some fun!!! Thanks so much to Annabel, my beautiful wife. You have the patience of a saint. I promise to now clean the house from top to bottom in every nook and cranny. I could not have done this without you and your support. Thank you!

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A study into the experiences of pre-registration nurses' use of mental simulation

Andrew Flintoff (former England cricketing all-rounder):

"They talk about visualisation, which we used to love as kids! I used to think about my bowling so much that I almost thought that I had practised more than which I had. So, I used to get into a game knowing exactly what I was going to do."

Research participant and pre-registration nurse, Claire, discusses what mental simulation means to her**:**

"It really just prepared me. I will never fail! Whatever it is, even if it's a nurse who falls in front of me, I will do the right thing. So, in practice now, in that sense, I will be qualified!"

Section 1: Study introduction and overview, study context, CPR and chest compression performance, supporting literature review and study aims

Chapter 1 – Introduction to the study: overview

Whilst writing up my thesis, I watched a European Championship (2020) football match between Finland and Denmark. Danish footballer Christian Eriksen collapsed during the match, needing on-field high-quality CPR and early defibrillation. These actions saved Eriksen's life. Whilst watching this unfold, I got "goosebumps", my arm hairs stood on end, and a tear came to my eye. This was not only due to the gravity of the situation but also because of the healthcare professionals' inspirational actions. Training is everything! Training saves lives! If seeing this scene doesn't inspire you to train hard, nothing will!

[Doctoral Journal, Nick White, 2021]

1.1 Introduction

This thesis has a blend of writing from first-person and third-person perspectives. I use the first-person perspective in chapters where the discussion is personal, for example, epistemological positioning and reflexivity discussions. I use the third-person perspective in chapters where it is more conventional to do so, for example, in the literature review chapter.

This chapter explains the study's origins, offering the reader an understanding of the genesis of this research project and insight into my original thinking. This research has been conducted to try and understand how students might experience a four-week programme of mental simulation to learn life-support knowledge and skills. The study was split into two phases. Phase 1 was a tripartite design of a basic and advanced mental simulation script and a broader protocol based on the PETTLEP (physical, environment, task, timing, learning, emotion, and perspective) framework. Pre-registration nurses (sometimes referred to as "students") were asked to undertake the protocol three times per week for 4-weeks. Phase 2 was a qualitative interview study that collected data from their experiences. These phases are introduced below (before a more detailed explanation is offered in subsequent chapters).

A clear overview of the original contributions to knowledge and a summary of each chapter is presented so that the reader can contextualise the thesis as they read the larger document. In the concluding part of this opening chapter, I present a logic narrative and model. This offers an overview of the current study, and it illustrates how my thinking has evolved from the original idea laid out in section 1.2 to the conclusions presented in chapter 15.

Some of the definitions and explanations of the technical language used in chapter 1 are described further in subsequent thesis chapters, as including definitions at this stage could affect the flow and readability of the thesis- they are only presented in this chapter if it is detrimental to understanding not to do so. In the next section, the genesis of the research project is articulated.

1.2 The genesis of the research project: the big idea

I am passionate about patient safety. My patient safety journey began in earnest when a local NHS trust employed me to set up their simulation centre where healthcare practitioners learned through skills rehearsal. I read for an MSc in Medical and Healthcare Simulation during this time, and I am currently the simulation lead for the Nursing and Midwifery Department at my employing university. Furthermore, I have contributed to co-creating a patient safety science curriculum within my department (for a more detailed overview, see White, Clark, Lewis, & Robson, 2016 in the reference list in chapter 16). This curriculum has been delivered through both classroom sessions and simulated practice.

This thesis is about students learning skills relevant to cardiac arrest life-support through the educational technique of mental simulation (see section 1.3 for a definition of mental simulation). For the benefit of this thesis, life-support skills are defined as:

> *The technical and non-technical knowledge, skills, and attitudes required to participate as a team member in providing life-saving measures in a cardiac arrest.*

This definition includes technical and non-technical skills, and a more detailed explanation of this can be seen in section 2.6.

As many research projects do, this study began with an observation in practice. Approximately eight years ago, I taught cardiac arrest simulated exercises in the simulation laboratory. These sessions ran approximately 6 to 8 weeks after their mandatory basic life-support (BLS) sessions. During some of the simulated exercises, many students could not recall the necessary steps to perform cardio-pulmonary resuscitation (CPR) in a timely manner. This observation intrigued me, and as this occurred regularly, I searched for papers on CPR skill learning and skill decay. My observational experience correlated to the search data (presented below and in section 3.3), suggesting that even a short time without practice can lead to skill decay.

Sometime later, I attended a keynote speech from the airline pilot and Clinical Human Factors Group chairperson, Martin Bromiley. Whilst discussing human performance, Mr Bromiley discussed his experience with mental simulation as an airline pilot. He finished the keynote speech by concluding that "the key to safety is mental rehearsal [simulation]" (Bromiley, 2014). It was at that moment that the seed of an idea was formed. Could mental simulation be used to maintain or even enhance CPR skills? Could mental simulation be an answer to providing the repetitive, solitary practice needed to maintain skills? Could mental simulation further create an authentic experience that felt akin to the real thing, and could it perhaps offer an experience beyond what is learned in current BLS mandatory training sessions?

I observed that pre-registration nurses are often poor at reflecting on the proficiency of their life-support skills. Anecdotally, students often suggest to me that in an emergency, they would just "jump into action." This sentiment has also been uncovered empirically, with Neyman and Sihvonen (2000) reporting similar conclusions to my observations. This, therefore, may make it less likely that students will seek further training or updates. This presents a challenge to life-support education delivery.

A mental simulation protocol was developed to enhance the student experience of life-support education to improve their knowledge, skills, and proficiency in cardiac arrest life-support. In the following section, I offer a more detailed thesis synopsis, which begins by presenting data on the prevalence of in-hospital cardiac arrest and current survival rates.

1.3 Study synopsis: background and context

In the previous section, I presented the genesis of my research idea. This section presents current data on cardiac arrest and survival rates to add context to the subject under study. Cardiac arrest is where breathing ceases, and the heart stops circulating oxygenated blood to vital organs (American Heart Association, 2022a). Data suggests that instances of in-hospital cardiac arrest range from 1.0- to 1.5 cardiac arrests per 1000 admissions (National Cardiac Arrest Audit [NCAA] (2021). According to NCAA, most of these cardiac arrests occur on the general wards in patients admitted for medical reasons. Return of spontaneous circulation (ROSC) is achieved in 47.3% (mean) of those treated by a resuscitation team for in-hospital cardiac arrest, and 21.8% survive to hospital discharge. Of those who survive to hospital discharge, 83% have a favourable neurological outcome (Perkins et al., 2021). Healthcare professionals delivering high-quality CPR and other life-support skills are integral to the survival of patients during cardiac arrest.

Basic life-support, including cardiopulmonary resuscitation skills, are integral to students' training, but there is substantial evidence that skills decay with time without use (Kim & Ritter, 2015), and life-support skills are no exception to this rule [see, for example, Madden, 2006; Saad, Favarato, de Paiva, & Nunes, 2019)]. Some specific techniques have been shown to assist life-support skill acquisition and reduce decay [See Hunt, Duval-Arnould, Diener-West, Perretta, & Shilkofski (2014)]. However, these techniques are often resource-intensive as they require repetitive physical practice.

As previously described, mental simulation is presented as an adjunct to physical practice that could help develop life-support skills in pre-registration nurses. Mental simulation is a quasi-sensory or quasi-perceptual experience that exists in the absence of stimuli and overt physical movement (Arora et al., 2011) and is a well-researched in sport-specific skills where using one's imagination creates learning that is functionally equivalent to the actual execution of the same task (Holmes & Collins, 2001).

Mental simulation has been well researched in medical education, specifically surgical skills performance. While some recent nurse education research has been performed, it has not gained as much attention. However, two nursing studies have quantitively investigated the use of mental simulation techniques in enhancing CPR skills in nurse education (Bachman, 1990; Fountouki et al., 2021). Both studies showed that mental simulation had positive effects on CPR skill learning. However, these studies failed to address the end-user's journey. How did they fit mental simulation into their lives? How did they visualise it? What did they visualise? What and how did they learn? How does it make them feel about life-support and clinical practice? This thesis uses an in-depth, inductive qualitative research design to address these knowledge gaps. The study was designed in two phases which are now introduced.

Whilst mixed methods may have helped me answer my research question in part, I felt a more in-depth, focused, qualitative study would assist me in showing how mental simulation was experienced. Qualitative, experiential research offers a unique perspective for mental simulation research in healthcare. As seen above, Fountouki et al. (2021) study showed objectively that mental simulation has a significant positive effect on the performance of CPR skills. However, what Fountouki and colleagues faced to show is the process that occurs when undertaking mental simulation. This process can only be illuminated by understanding the end-user experience. This can only be uncovered through qualitative research methods. This unique understanding will assist nurse educators in implementing mental simulation to future nursing curricula and give a unique inside into exactly how mental simulation functions. This unique understanding will help nurse educators to be able to implement mental simulation in future curricula. The Fountouki et al. (2021) study shows that mental simulation can work for student nurses learning CPR. This study offers some explanation as to how and why mental simulation works.

1.4 Phase 1: mental simulation protocol design phase

The first phase was undertaken over six months after the confirmation stage of the programme. The protocol was based on a functionally equivalent PETTLEP (physical, environment, task, timing, learning, emotion, and perspective) design (Holmes & Collins, 2001). This provided a framework for the mental simulation script and protocol. The protocol consisted of instructions for use, an introductory scenario/ patient background to pre-brief the students, a cardiac arrest film recorded from the first person ("film"), a basic and an advanced script (narrated), a glossary of terms and the basic and advanced life-support algorithms. The protocol elements were added to help the participants visualise the scenario during the mental simulation exercise.

Each protocol element aligns with the theory supporting the PETTLEP framework. For example, the film was recorded as part of 'E' (P***E***TTLEP) or Environment. Holmes and Collins (2001) recommend that mental simulation should be undertaken in an environment where the actual execution of the task would occur. However, photographs or a film should be used if this is not possible. Likewise, the glossary was added to help participants link language and mental representations (Paivio, 1986), thus assisting the students in creating as high fidelity images as possible.

The narrated scripts were designed using a novel tripartite design: 1) 4-students (unrelated to phase 2) were interviewed about their thoughts and feelings about hands-on CPR experiences. These interviews were transcribed and then used to form the basis of the cues within the final scripts. 2) My experience teaching basic and advanced life-support and 3) with the Resuscitation Council's theoretical base (Resuscitation Council, UK, 2015a; Resuscitation Council, UK, 2015b) was further used to develop the script cues and narrative. An actor then narrated and electronically recorded the script.

Eleven (11) participants were asked to undertake the protocol for 10-15 minutes per session, three times per week, for 4-weeks. They were asked to undertake the basic script for 2-weeks and the advanced script for 2-weeks (this related to the 'L' or the learning part of PETT***L***EP, as Holmes and Collins, suggest the tasks become more challenging as the learner learns). The participants were allowed to self-assess, and if they wanted to move from the basic to advanced script sooner, they were encouraged to switch under their own volition. After 4-weeks of undertaking the protocol, they were called back to undertake a semi-structured interview as part of phase 2.

1.5 Phase 2: the research phase

The research questions on which the research design was based were as follows:

- What are pre-registration nurses' experiences (students) who use mental simulation to gain cardiac arrest and life-support experience?
    - How do students modify their behaviour to incorporate mental simulation into their lives?
    - How does mental simulation create an authentic learning experience that prepares students for real-world delivery of life-support skills?
    - What processes make mental simulation a useful technique as an adjunct to physical simulation of BLS and wider life-support knowledge and skills?

This part of the study was a qualitative inductive interview study undertaken from a social constructionist perspective—the study used a qualitative reflexive thematic analysis as the basis of the research design. Below is diagram 1, where I present an overview of the philosophical grounding, using Crotty's (1998) model of the four main elements of research design (with a fifth 'data analysis' element). As described above, no qualitative research explains how mental simulation is experienced and what effects this experience has on learning. This could not be using a quantitative design. This research fills this knowledge gap and contributes significantly to the field of nurse education.

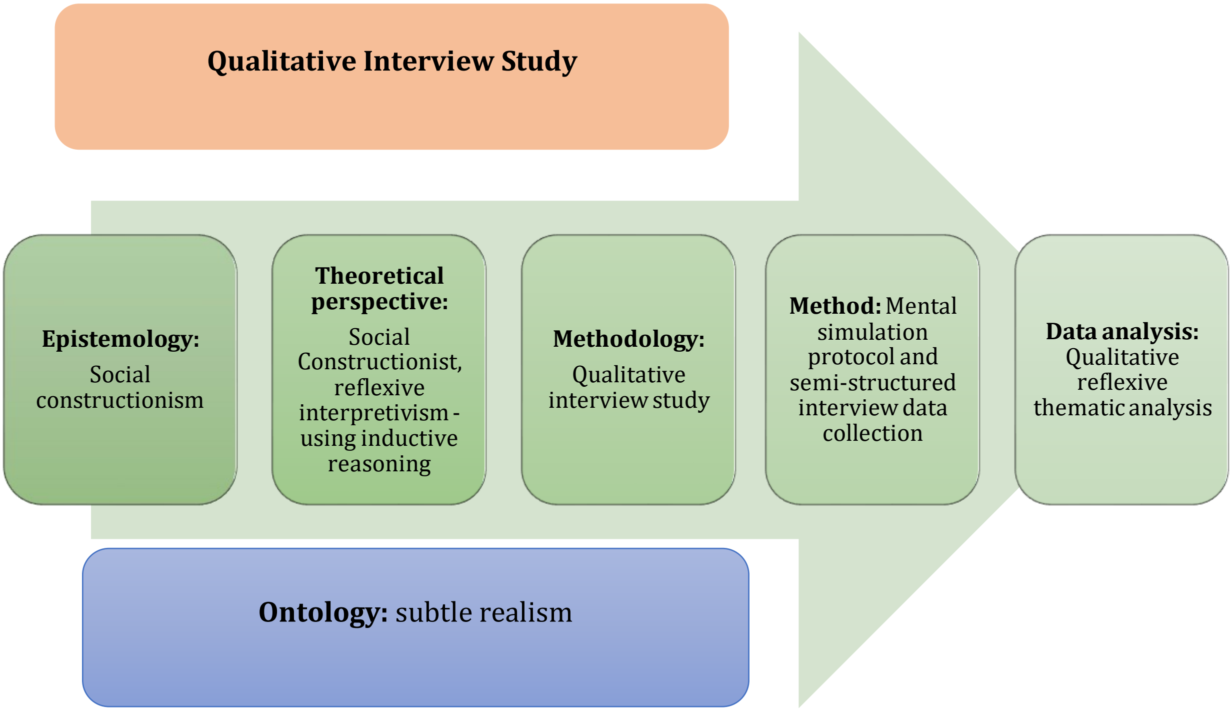


Diagram 1: Theoretical framework of the research design [based on Crotty (1998)]

1.5.1 Theoretical perspective

The overall theoretical perspective of this study is reflective interpretivism, using inductive reasoning. The study was undertaken from the epistemologically social constructionist perspective. This perspective allowed for the co-construction of knowledge between the researcher and the participants and it allowed the participants' voices to be heard. As this was inductive, no literature or theory was used as a perspective through which to analyse the data. Literature and theory were included in the discussion sections to illuminate the participant experiences. The literature searches and reading for the discussion sections were performed post-data analysis. The literature used to illuminate the participants' experiences includes motivation and volition, graduate attributes such as time management, experimentation, problem-solving and decision-making which support the first findings chapter discussion; psychological fidelity, authenticity and dual-code theory, which support the second findings discussion chapter; finally, reflective practice and self-efficacy literature which supports the third findings chapter discussion.

The methodology for this research design aligned with the both study's ontological and epistemological positions. The methodology was designed as the best fit to help me to answer the research question and sub-questions. It was a general qualitative research design and was not grounded in any one particular approach and could be described as 'bricolage' in which one 'uses the means at hand' (Levi-Strauss, 1962 cited in Thomas, 2017, p91). The data were collected using semi-structured interviews that lasted between 1hr, 15 mins, and 2hrs and the data were managed using NVivo data management software. The interview data were analysed using a social constructionist perspective linked to qualitative reflexive thematic analysis (Braun and Clark, 2006; 2013; 2019). Three main themes with several subthemes emerged from the analysis, as shown below in diagram 2.

1.5.2 Findings and discussion

The themes and subthemes helped me tell the story of and give meaning to the participants' journey of learning using mental simulation. The participants' journey

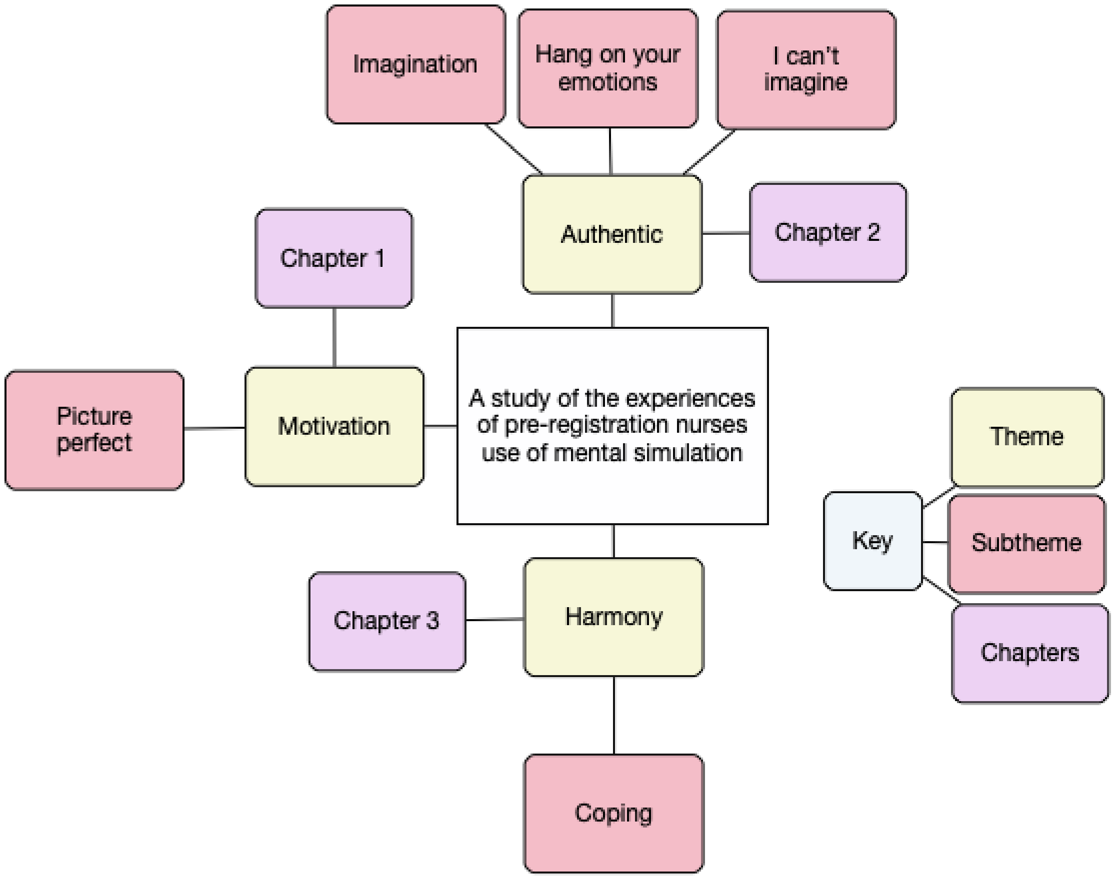


Diagram 2: Themes and sub-themes

began with stress and anxiety about performing real-world life-support as part of a team. The participants had lower self-efficacy beliefs about the prospect of delivering life-support skills in practice. The participants were motivated to act and fit mental simulation into their life routines over the 4-weeks. Success required the participants to employ decision making, problem-solving, experimentation, and time management attributes. When undertaking mental simulation, the participants could 'see' and therefore authentically experience the processes and complexities of providing life-support in clinical practice. The participants used reflective practice skills to bridge knowledge gaps and create a new understanding of the skills sets required to perform life-support. This led to reductions in stress and anxiety and feelings of increased self-efficacy.

1.5.3 Implications for practice

Mental simulation offers a blended approach to learning life-support skills. Mental simulation is less resource-intensive than physical simulation and can provide a repetitive authentic exposure to life-support skills that complement mandatory basic life-support. Mental simulation is mobile and can be used in a self-directed manner. Repetitive practice can reduce skill decay, but as this study suggests, repetitive mental simulation practice can assist students in learning new life-support knowledge and skills and increase self-described self-efficacy. Although students will have to create time in their busy schedules, sharing the participants' experiences and creating new protocols based on the data from this study can help them manage their mental simulation time. This may help with greater uptake and sustained engagement.

The tripartite model for creating mental simulation scripts is replicable and can be used outside of nurse education. It can also be used to create other mental simulation scripts in areas where most students have little or no experience of the skill being learned, meaning they have no way of creating their own mental simulations without educator input.

Mental simulation can potentially reduce stress and anxiety and increase self-efficacy in delivering life-support skills in clinical practice. Mental simulation allows students to experience a realistic cardiac arrest in a safe environment. The increase in self-efficacy can potentially give students a 'dare to' attitude that can help them perform in their role in a cardiac arrest emergency. This is important as nurses are often the first attenders of in-hospital cardiac arrests, so having self-efficacy beliefs are crucial to swift and confident delivery of life-support skills.

In the above section, I have presented and synopsis of the thesis. In the following section, there is an overview of the originality of this research project and thesis. The chapter will conclude with a breakdown of each chapter to prepare the reader for reading the whole document.

1.6 Originality: claims to knowledge

Below are the claims to knowledge that underpin the doctoralness of this thesis:

1. The study uniquely illuminates pre-registration nurses (students) experiences of using mental simulation protocol as a form of solitary, deliberate practice to experience cardiac arrest.
2. The study uniquely examines the mental simulation of a cardiac arrest in the context of healthcare simulation and immersive technologies (SIT)
3. The unique tripartite PETTLEP mental simulation protocol design assists the learner in creating high-fidelity images.
4. Creating high-fidelity images creates an authentic, immersive experience that increases self-efficacy beliefs in life-support knowledge and skills.
5. The study shows the importance of employing certain graduate traits necessary for successfully completing mental simulation.
6. The self-efficacy gained helps students feel able to cope with the thought of real-world BLS and life-support practice.
7. Mental simulation can be used as an adjunct to physical simulation for learning wider life-support skills- this complements BLS skill acquisition.
8. There may be some elements of mental simulation that match or even outperform the authenticity of physical BLS simulation, for example, in exposing learners to stress.
9. These findings are unique as they are presented in the context of Covid-19 pandemic lockdowns and social distancing measures where distance learning measures are fundamental to future education.

The following section presents a summary of each chapter within the main body.

1.7 Summary of the thesis chapters

This section presents a breakdown of each chapter that makes up the main body of the thesis. The breakdown begins with a synopsis of chapter 2.

Chapter 2

This chapter offers a context for the study and gives an overview of pre-registration nursing from the position of graduateness. These graduate attributes include decision making, problem-solving, experimentation, reflective practice and time management. These attributes are identified as being essential for undertaking mental simulation. Chapter 2 further offers the context of a subject-specific attribute of life-support skills that are required for clinical practice.

Chapter 3

This chapter focuses on skill acquisition. The chapter examines skill retention and skill decay through time without practice. This leads to examining skill retention and decay, specifically in life-support education. As well as skill decay, the authenticity of basic life-support education is explored. This is explored from the perspective of recalling skills and performing under pressure. Mental simulation is introduced as an educational technique that could assist students in learning life-support. In the final part of this chapter, mental simulation is explored in the context of healthcare simulation and immersive technologies.

Chapter 4

Chapter 4 is a review of the supporting literature. An overview of the literature search technique is presented (linked to appendix 3, section 17.3) and the guiding review questions. Mental simulation is depicted as a form of deliberate practice with bio-informational theory, dual-code theory and functional equivalence theory offered to explain how people learn using mental simulation. A critical review of mental simulation research in sports (and other domains) and nurse and medical education (mainly surgical skills) is presented. The chapter concludes with an overview of the gaps in knowledge and how this thesis aims to address them.

Chapter 5

This chapter offers an overview of the aims, research question and sub-questions that guide the research project.

Chapter 6

This chapter offers an overview of the PETTLEP mental simulation protocol design. This part of the research is phase 1. The chapter offers a pragmatic and evidence-based justification for how the protocol was conceived. The chapter gives an overview of the unique tripartite method used to create the mental simulation script. An overview of the different protocol elements is presented and how each element links to PETTLEP or mental simulation theory (e.g., dual-code theory).

Chapter 7

This chapter presents the philosophy of the research design. The chapter offers an overview of this qualitative interview study's supporting ontological and epistemological positions underpinning phase 2. Methodological considerations and theoretical perspectives are reviewed. The chapter concludes with an applied examination of reflexivity and its importance to this study.

Chapter 8

This chapter offers the reader an understanding of the research ethics and ethical principles applied throughout the study.

Chapter 9

This chapter discusses the research study design. The first part of the chapter describes participant recruitment and the purposive sampling technique—an overview of how phase 1 was implemented and how it fits with phase 2 of the study. The chapter then describes the semi-structured interviews used to collect data and linked to a social constructionist perspective. In the final part of this chapter, there is an overview of the data collection endpoint and how this was applied.

Chapter 10

This chapter presents a step-by-step overview of the data analysis phase. The research design employs a qualitative reflexive thematic analysis. This chapter offers an overview of the 6-phases and how the phases were applied (combined with the codebook presented in appendix 9, section 17.9). The chapter concludes with a presentation of the research's rigour, quality, and trustworthiness and further discusses the transparency and audit trail of the research processes.

Chapter 11

Chapter 11 is a short chapter that offers an overview of the three findings and discussion chapters, with a short synopsis of how the findings and discussion sections are presented. Braun and Clark’s (2006) thematic analysis suggested that the themes and subthemes are defined, and therefore, this is presented. A mind map is used to show how the themes link, and a narrative road map diagram is presented to show how the overall themes connect to create the participant story.

Chapter 12

Chapter 12 is the first findings chapter. In this chapter, the participants articulated what motivated them to undertake mental simulation to the point of enactment (volition). It was not an easy task to complete, as they had to affect their environment, and this was done by experimenting for their own specific needs. Participants employed their graduate attributes, such as problem-solving and decision-making skills, to help create the time and space to undertake mental simulation and give themselves the best opportunity to succeed and evoke high-fidelity images.

Chapter 13

This chapter discusses what they imagined, how they imagined it and how this helped them learn. There is a discussion of the visual, emotional and kinaesthetic images that were generated (or lack thereof in the case of kinaesthetics). The images created an authentic experience with high-psychological fidelity that created an individualised experience.

Chapter 14

This chapter helps explain how the participants made sense of their experiences and created new knowledge. The participants again used their graduate attributes. In this case, they use meta-cognitive skills. The participants used reflective practice to make sense of their learning, and this process is presented. The process of reflection led to a new understanding of the required knowledge and skills for life-support. This, in turn, acted as an enactive mastery experience and increased the participants' self-efficacy beliefs.

Chapter 15

In this chapter, I conclude the thesis. A summary of the thesis, the research questions and the contributions to knowledge are revisited. The contributions to knowledge are explained in more detail, and general conclusions are drawn. The concluding chapter closes by presenting the recommendations for practice, further research ideas that this thesis generated, and the study's limitations.

The ideas and knowledge generated in this inductive study have evolved during the EdD programme. In the next section, I present a narrative and a logic model displaying the evolution of this study.

1.8 Logic model

In this section, I discuss how the position of this research project has evolved. As an inductive study, I did not overtly predict the participants' experiences. However, I did have some ideas about what might be found as part of this study. These were my early assumptions. After reviewing the mental simulation literature, it was apparent that most studies in the field had only focused on mental simulation outcomes. However, no previous in-depth study had attempted to explain the processes of how the end-user (in this case, pre-registration nurses) experience mental simulation. Only a qualitative interview study could help explain this from students' perspective.

My original assumption was that mental simulation would assist with the technical skill of delivering CPR to patients. However, after I analysed the data (with an open mind and leaving my original assumptions aside), it became apparent that there was much more to the experience than first assumed. For example, the participants learned more than just CPR skills. Amongst other things, they learned about their role within the cardiac arrest team, and they exercised reflective practice skills to help them fill knowledge gaps (see findings and discussion chapters below for more details).

The process of how this research study was designed and how my assumptions and understanding have evolved is presented graphically in a logic model that can be seen in diagram 3 below.

Research into mental simulation for learning life-support skills (logic model)

Context:
- Author teaches pre-registration nurses and observes skill decay in CPR skills
- Reading around the subject shows skills decay quickly
- Considers mental simulation as a potential technique for reducing skill decay

Expected outputs (assumptions):
- Students feel they have learned technical skills of CPR
- Would help with CPR skills
- However, this was an inductive exercise so I was open minded to what I would find

Output: Assumptions and conclusions:
- Original assumptions of only affecting CPR technique were challenged
- Mental simulation appeared to help 'life-support skills' not just CPR
- Mental simulation allowed the participants to experience an authentic cardiac arrest scenario. It give them an experience of feeling as though they were part of a cardiac arrest team
- This experience is a 'step up' from CPR training and allowed them understand their role within during a cardiac arrest
- Through this authentic experience, it allowed participants to understand ALS and BLS processes.
- Mental simulation allowed the participants to reflect on their knowledge and skills and correct practice gaps
- Mental simulation increased the participants cardiac arrest and 'life-support' delivery (self-described) self-efficacy beliefs

Mental simulation research
- Sports and healthcare research suggesting that mental simulation works for increasing performance
- Little qualitative research, with no research that examines the process of undertaking scripted mental simulation
- PETTLEP was the only evidence-based model for mental simulation script design (based on functional equivalence theory [FE])

Resource: a mental simulation protocol design based on PETTLEP which includes
- Basic and advanced scripts (audio recorded/ narrated with sound effects)
- Point-of-view [1-P] film (for E- environment) and to help with visualisation of cardiac arrest [as per P**E**TTLEP (Holmes and Collins, 2001)]
- BLS and ALS algorithms
- Pre-brief scenario
- Glossary to help with cardiac arrest terminology (link images to language)
- To be used 3 times/ week (10 mins or longer)

Script design:
- PETTLEP is meant to be individualised to increase FE, but this is not possible in CPR as not all students experience cardiac arrest in practice
- Therefore, a tripartite design was used, using pre-registration nurse interviews, researcher expertise and theory base from Resuscitation Council and supporting research
- 4-students were interviewed regarding their experience of undertaking CPR in practice
- The mental simulation script was designed using cues from these interviews
- Students undertook 4-weeks of using the mental simulation protocol (2 weeks of the basic script + 2 weeks of advanced script)

Research design:
- Interpretivist, inductive interview study design
- Social constructionist (co-constructed knowledge)
- 11 students volunteered
- Reflexive approach
- 4-weeks of using mental simulation
- Semi-structured interviews (1hr 15 mins- 2hrs)
- Qualitative reflexive thematic analysis used to help analyse the data and create the findings

Output: Coding
- Empirical coding technique
- Eclectic coding (labels)
- Latent (analytical) coding technique employed later in the process (as per Braun and Clark)
- This technique sat with the social constructionist position taken in this study
- This technique assisted in providing an inductive approach to the data and allowing the voices of the participants be heard

Output: Themes
- Theme 1
  - Theme - Motivation
  - Subtheme - Picture perfect
- Theme 2
  - Theme- Hi-fidelity
  - Subtheme – Imagination
  - Subtheme- Hang on to your emotions
  - Subtheme- I can't imagine
- Theme 3
  - Theme- Harmony
  - Subtheme- Coping

Diagram 3: Logic model and the evolution of the study

1.9 Chapter summary

This opening chapter offers an overview of the thesis to allow the reader a broad understanding of the thesis content before reading the larger document as a whole. In this chapter, I have offered a discussion of the genesis of the research project, followed by a short synopsis of the thesis. In this chapter, I have presented the two phases of the research study- the mental simulation protocol design and the qualitative interview design

Furthermore, the study's originality is outlined, with each claim to knowledge articulated to assist in signposting the reader throughout the thesis (see conclusion chapter 15 for a breakdown explanation of how the thesis addresses each claim to knowledge). The chapter concludes with a logic model that presents an overview of how the study was designed and evolved over the thesis phase.

The next chapter offers essential context to the thesis, examining pre-registration nursing from the perspective of graduate attributes, decision making, problem-solving, experimentation, reflective practice and time management. These attributes will be required for successful learning using mental simulation. Life-support is then discussed with an overview of cardiopulmonary (CPR), basic life-support (BLS) and advanced life-support (ALS). The term life-support is then defined based on these initial discussions, and the phrase life-support is used in the thesis where it is appropriate to do so. These sections then lead to a debate of current BLS training and how this is linked to healthcare simulation and immersive technologies (SIT).

Chapter 2 Study Context: pre-registration nursing skills

Graduateness is defined as: '... the successful attainment of a higher education degree. From that educational process, graduates develop key attributes. Those attributes may be common to all graduates, shared among those who have studied related subjects or be subject-specific. These transferrable skills-sets and attitudes are markers of graduate-level performance and/or disposition, contributing to making these individuals desirable to employers.'

[Dr Mike Ramsay]

2.1 Introduction

The previous chapter gave an overview of the thesis. The chapter presented a discussion of the genesis of the research project and a short synopsis of the whole thesis, with a presentation of the two phases of the research study- the mental simulation protocol design and the qualitative interview design. The originality of this study was articulated, with each claim to knowledge expressed. The chapter closed with a logic model that outlined how the study has evolved.

Chapter 2 presents an overview of pre-registration nursing. This chapter provides the reader with the context of the participants' cognitive and psychomotor skills. The following sections present an overview of the pre-registration nursing programme and briefly discuss my relationship with the students. It is important to outline the graduate attributes necessary to complete the 4-weeks of mental simulation. Graduate attributes such as decision making, problem-solving, experimentation, reflective practice and time management will be required. These attributes are developed during their degree programmes and are likely to be required to complete the required number of weeks successfully. This has to be coupled with the motivation to succeed. Motivation alone is not enough, as motivation does not always lead to volition.

As Mike Ramsay (Ramsay, 2020) suggests in the opening quote, graduateness is also related to subject-specific skills. Life-support skills are subject-specific to healthcare practitioners and would fall into this category. Pre-registration nurses must have the basic life-support skills to deploy where necessary. This requires specific cognitive, technical and non-technical skills, which are also presented in this chapter. Current basic life-support (BLS) education provision is discussed in the context of simulation and immersive technologies (SIT). Finally, life-support is defined and is based on the discussions presented in this chapter, as it is necessary to clarify what this key phrase means in terms of the thesis.

2.2 An overview of pre-registration nursing

The research study was performed with pre-registration nurses within a university in a large city in the north of England. I am currently a senior lecturer in adult nursing with 9+ years of experience as an academic, 12+ years as a full-time educator and 25+ years of experience as a registered adult nurse. I primarily teach undergraduate pre-registration nurses. The nursing programme is either a 3-year Bachelor of Science (BSc) or 2-year Master of Science (MSc) in Nursing. The following sections present a description of pre-registration nursing and graduate-level study.

2.2.1 Pre-registration nursing and graduate attributes

A large proportion of the healthcare workforce are pre-registration (student) nurses, with 75,578 accepting places on pre-registration programmes between

2018 and 2020 (Maguire, 2021). Nursing is a 3-year programme studied at either honours (BSc/ level 6) or masters (MSc/ level 7) level. Some routes onto the programme mean only a 2-year university attendance is required, but an extensive portfolio and previous education must be accredited against year-1. These students begin in year-2 of the programme.

Higher-education institutions must design curricula around proficiencies so that students can provide safe and effective care (Nursing and Midwifery Council, 2018b). These proficiencies include metacognitive skills (Chiejina & Ebenebe, 2013), non-technical (teamwork) skills, and clinical skills (Nursing and Midwifery Council, 2018a), such as basic life-support (BLS). Students serve time as an apprentice, where they join their community of practice. Developing the above skills will allow students to be accepted into their community of practice and be empowered as 'legitimate peripheral participants' in which there is "a two-way bridge between the development of knowledgeable skill and identity" (Lave, 1996, p. 68).

With the impetus of the Bologna Process, which aligned academic standards across European Union member states, the Nursing and Midwifery Council (NMC) moved pre-registration nurse education to an all-graduate profession from 2013. There was much debate over post-registration nurses' requirement to acquire an honours degree. Many felt that the cognitive skills or 'graduate attributes' that come with honours and masters level study were necessary skills for future nursing. This is because "'graduateness', [is] the added value of a higher education degree-based outcome [and] is manifest in the graduate attributes the person acquires through the educational journey" (Chief Nursing Officer Directorate, 2017, p.8). These graduate attributes are necessary for the dynamic nature of the evidence-based practice landscape of the profession (Stacey et al., 2014).

Coetzee et al. (2007) argue that graduate attributes consist of a field-specific achievement or the possession of a body of knowledge leading to a strong sense of self-efficacy. Furthermore, cognitive and metacognitive attributes are gained, including critical thinking, problem-solving, synthesising and evaluating knowledge, and the ability to self-assess and be reflective are some of the functional skills of graduateness (Department for Business, Innovation and Skills, 2016). According to Coetzee (2014), the meta-skills and personal attributes of problem-solving and decision-making are required when considering the complexities and initiating the necessary changes to ensure personal and work-life balance and growth. These attributes create an ability to be creative and proactive in learning, offering unique and novel ideas that can help produce new knowledge and insights into a problem or situation (Coetzee, 2012).

Creative problem-solving demands critical thinking and confidence in the decisions that are made (Yamoah, 2010). Smedley (2007, p. 374) discusses critical thinking skills as requiring two distinct functions:

> *Cognitive skills are required to perform a task, while for intelligent functioning, metacognition enables an understanding of how and why that task is performed*

To undertake mental simulation for a sustained period, the participants will require critical thinking. Critical thinking will need to bring creativity to recognise and solve problematic situations. The participants will need to use goal-directed behaviour, efficiently utilising their time and identifying the behavioural and environmental resources required (Coetzee, 2012). The participants will need to be proactive and apply initiative to use mental simulation successfully.

Furthermore, students must be motivated to successfully achieve learning outcomes at a graduate level (Rose, 2011). Motivation is defined as "any sort of general drive or inclination to do something" (Baumeister & Vohs, 2007, p. 116). Students must be self-efficacious in regulating their motivation, thought processes, emotional states, and social environment if they are to influence their behaviour (Bandura, 1982; Bandura, 1997). As Bandura expands here:

> *"Whatever other factors serve as motivators, they are rooted in the course belief that one has the power to produce change by one's actions."*
> (Bandura, 1999, p. 28).

Unless individuals believe that they can produce the desired effect through their actions, they will have little motivation or incentive to persevere.

This motivation must be strong enough to develop into the volition required to enact mental simulation. Volition is defined "as a person's motivation for participating in occupation" (Harel-Katz & Carmeli, 2019, p. 84). Here the operative word is participation. One can be motivated but never follow through with the act. Motivation and volition are required as the students will need to experiment through trial and error and adapt their behaviour accordingly to enact the protocol for the 4-week programme. For example, the participants may have to experiment with time management. Time management is fundamental to both nursing studies and clinical nursing management skills (Nursing and Midwifery

Council, 2018b). However, motivation will still be required to overcome these potential obstacles to completing the mental simulation programme, as employing these attributes will likely be effortful.

As described above, the metacognitive skill of reflective practice is an important aspect of learning from experience in graduate programmes. Therefore, a more detailed examination of reflective practice is warranted below.

2.2.2 Reflective practitioners

The development of reflective behaviour and metacognition are further traits of graduate attributes (Clinton, Murrells, & Robinson, 2005; Jones & Calafell, 2012; Michalsky & Schechter, 2013; Schraw, Crippen, & Hartley, 2006). Pre-registration nurses must use reflective practice throughout their graduate training and beyond. Reflective practice is an essential facet of graduateness and life-long learning within nursing and has recently become a significant component of the re-registration revalidation process. There is now a mandatory requirement to produce five written reflective accounts and hold reflective discussions to maintain registrant status (Nursing and Midwifery Council, 2021).

According to Bryant (2015, p. 3), reflective practice in nurse education is:

> *…a way of considering and examining your own thoughts, actions and reactions, and sometimes those of others, to a given situation or event in order to gain a better understanding of yourself and to identify more effective ways of responding in future. The process can allow you to improve your critical thinking [and] change your approaches to patient care…*

Reflective practice is a continuous process of obtaining new insights through metacognitive self-awareness and critically reflecting on present and prior experiences (Jacobs, 2016). Bryant (2015) argues that reflective practice is concerned with metacognitive processes with a focus on experiences (actions) and the outcomes this produced (reactions). In the case of mental simulation, this is likely to be 'imagined actions.'

Nursing is practice-based, and therefore one must reflect on one's actions. To be able to reflect, nurses must be able to self-assess. According to Levett-Jones (2007), self-assessment involves pre-registration nurses identifying the correct standards to apply to their current proficiency and making judgements about the extent to which they have met those standards. Nurses have a professional responsibility to assess their proficiency levels for practice. Pre-registration nurses should be provided with opportunities to self-assess during their academic programme to develop and refine their abilities (Nursing and Midwifery Council, 2018b). Self-assessment then leads to reflection-on-action.

Reflection-on-action arises retrospectively after the action or experience has occurred. This reflective method is different from reflection-in-action, where the nurse will reflect during the experience, guiding practice in real-time (Schön, 1987). This form of reflection-on-action can be viewed as experiential learning, i.e., using experience as the source of learning and development. Experiential learning was conceptualised by David Kolb (Kolb, 1984). Kolb offers his model for the process of experiential learning that includes 'concrete experience' > 'reflective observation' > 'abstract conceptualisation' > 'active experimentation.' This type of reflection takes an experience that can be used for learning, reviews that experience (what did one know, what did one not know), incorporates theory and finally readjusts their understanding in light of this new knowledge (Tanguay, Hanratty, & Martin, 2020). Using reflective practice in this way can create self-efficacious practitioners.

Self-efficacy beliefs are linked to the confidence that comes with knowledge and understanding. Self-efficacy will affect how the experience of mastering a process contributes to its results (Krogstie & Krogstie, 2016). In the context of this research, the aim is to use graduate attributes alongside practice (rehearsal) to learn life-support skills. In the following section, cardiac arrest and life-support are presented as a subject-specific graduate attribute. The next section begins with looking at the prevalence of in-hospital cardiac arrest.

2.3 Cardiac arrest life-support

This section discusses the epidemiology of cardiac arrest and survival rates as context for the following chapters. I discuss basic life-support (BLS) elements and how this links to cardiopulmonary resuscitation (CPR). A short synopsis of the evidence on which BLS and advanced life-support (ALS) guidelines are presented, as these guidelines are applied to the design of the mental simulation protocol (discussed in detail in chapter 6).

As first introduced in chapter 1, cardiorespiratory arrest ("cardiac arrest") is where breathing ceases, and the heart stops circulating oxygenated blood to vital organs

(American Heart Association, 2022a). Sudden cardiac arrest is a leading cause of premature death (Resuscitation Council, UK, 2015a; Resuscitation Council, UK, 2015b). Key data from the National Cardiac Arrest Audit [NCAA] (2021) suggest that instances of in-hospital cardiac arrest range from 1.0- 1.5 cardiac arrests per 1000 admissions. Most of these cardiac arrests occur on the general wards in patients admitted for medical reasons. Return of spontaneous circulation (ROSC) is achieved in 47.3% (mean) of those treated by a resuscitation team for in-hospital cardiac arrest, and 21.8% survive to hospital discharge. Of those who survive to hospital discharge, 83% have a favourable neurological outcome (Perkins et al., 2021) [data accurate as of 19/12/21]. As can be seen from the data, cardiac arrests do not frequently occur (1.0-1.5/ 1000 admissions). This data suggests that pre-registration nurses may seldom be exposed to either hands-on CPR or working as part of a cardiac arrest team. However, this will depend on where a student is placed, with some placements more likely to see cardiac arrest than others. Therefore, exposure is left to chance and being in the 'right place at the right time.' Consequently, exposure to BLS, CPR delivery and cardiac arrest situations should be provided through simulated exercises.

The first-line response to a cardiac arrest is basic life-support (BLS) which incorporates recognition (assessment) of cardiac arrest, high-quality CPR, airway management, foreign-body airway obstruction, automated external defibrillation skills and rescue breaths (Soar et al., 2021). Positive patient outcomes from cardiac arrest depend on the effective delivery of high-quality CPR (Almeida, Clark, Jones, McConnell, & Williams, 2020). High-quality CPR delivery is associated with improved patient outcomes (Considine et al., 2020; Perkins et al., 2015). However, it has been shown that these skills are not always performed optimally. This issue has been linked to a lack of repetitive practice and poor skill retention (see sections 3.2 and 3.3), stress and anxiety (see section 3.3.1) and low self-efficacy (see section 3.3.2).

It is necessary here to clarify what is meant by CPR, BLS and ALS, and this is presented in table 1 below:

Table 1: Life-support term definitions

Skillset	Definition
CPR (cardiopulmonary resuscitation)	CPR is a specific technique in which manual application of chest compressions and (where possible) artificial ventilation (usually 30:2 ratio). This technique allows end-organs to be perfused [see Considine et al. (2020) and Olasveengen et al. (2020)].
BLS (basic life-support)	BLS incorporates CPR delivery but includes other elements such as cardiac arrest recognition, the use of automated defibrillation skills, foreign-body airway obstruction management and recovery position [see Perkins et al., (2021)].
ALS (advanced life-support)	ALS is a set of life-saving procedures, processes and skills that extend beyond basic BLS. It is used to provide urgent treatment and reverse the causes of cardiac arrest. CPR continues whilst ALS processes are delivered [see Soar et al. (2021)]

These definitions show the differences between the skillsets. However, all three must be delivered to high standards during a cardiac arrest. For this reason, these skillsets are discussed in more detail in the following sections.

2.3.1 Cardiopulmonary resuscitation and basic life-support: evaluation of the evidence

The International Liaison Committee on Resuscitation (ILCOR) was formed in 1992. The ILCOR was created to provide debate and liaison between principal resuscitation organisations worldwide. This multidisciplinary organisation includes groups with a remit for creating resuscitation guidelines and includes organisations such as the European Resuscitation Council and the American Heart Association (ILCOR, 2022a).

The ILCOR provides a Consensus on Science with Treatment Recommendations (CoSTR). According to ILCOR (2022b), a CoSTR is defined as such:

> *ILCOR employs a rigorous strategy to review the current evidence and reach a consensus on the quality of published evidence. This science is summarised as a "consensus on science" statement. The ILCOR community (international experts) then consider this evidence and its potential impact on care to reach a conclusion regarding the best treatment strategy: a treatment recommendation. These Treatment Recommendations are accompanied by a statement regarding the values and preferences that have helped guide the recommendation(s).*
>
> *When evidence is lacking, ILCOR will make recommendations based on expert opinion to guide current treatment strategies, and in some situations, a decision may be made to not make a treatment recommendation. It may be that over time new data emerges that challenges the current assumptions and consensus statements. To address this, ILCOR is moving towards a continuous evidence evaluation process, using dedicated scientific leads to review the current literature and alerting the scientific community if a consensus on when science and treatment recommendation (CoSTR) needs to be revisited and rewritten*

The evidence evaluated by ILCOR for basic life-support is continually reviewed by scoping studies. Systematic reviews and meta-analyses are performed where appropriate, and a CoSTR is written based on the best available evidence. These are then used to create guidelines at the individual Council level. For this thesis, several of these reviews, consensuses and guidelines have been discussed in the following sections (Considine et al., 2020; Olasveengen et al., 2020; Perkins et al., 2015; Perkins et al., 2021; Soar et al., 2021) [the guidelines for the mental simulation script [see chapter 6] were written using the 2015 guidelines, more up to date evidence has been considered when writing this thesis].

Chest compressions are the most critical component of BLS. Chest compressions work by manually 'squeezing' the heart and pushing blood around the body to keep vital organs perfused. For chest compressions to be effective, they must be performed at the correct depth to maximise blood flow (Furst, 2017), with rescuers changing (where possible) every 1-2 minutes to avoid poor quality CPR due to fatigue (Shin et al., 2014). In the next section, a more detailed examination of CPR is presented.

2.3.2 High-quality CPR overview

The above section explains how life-support guidelines are established and how this filters down to practice. As seen in the Resuscitation Council, UK diagram 4 below, high-quality CPR is a vital part of the practice and is the second stage of the chain of survival.

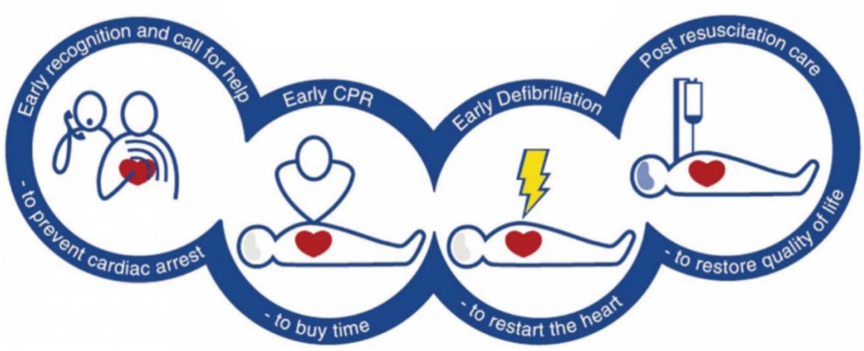


Diagram 4: Chain of survival (Resuscitation Council, UK, 2015b).

Five evidence-based elements make up the CPR sequence, forming the foundation of CPR and BLS skills training (Resuscitation Council, UK, 2015a). The evidenced-based elements that make up high-quality CPR are presented in table 2.

Table 2: High-Quality Chest Compression Criteria (Perkins et al., 2015; Resuscitation Council, UK, 2015a)

Optimal chest compressions (as part of BLS) are defined by compressions of the correct position, depth, and rate, ensuring full release and minimising interruptions to compressions (at the time of writing this thesis): 1. Depth of 50–60mm (5-6cm) 2. Rate of 100–120 compressions min^{-1} 3. Chest wall recoil: allowing the chest to recoil completely after each compression (avoiding 'leaning') 4. The same amount of time for compression and relaxation (50%-50%) 5. Minimise interruptions to chest compression (maximal chest compression fraction)

Table 3 below offers a more detailed overview of high-quality CPR and is presented to provide the reader context around hands-on CPR delivery, how the evidence was evaluated, and the judgements made (for this thesis, it was judged that there is no requirement to present the data in granular detail for each of the reviewed studies, so a condensed overview is presented. For full details of the data, the critical evaluation and the treatment conclusions, please see Perkins et al. (2015), Considine et al. (2020), Olasveengen et al. (2020), and the ILCOR website, which has up to date recommendations).

In 2020, Considine et al. performed a scoping review that identified eight new studies published since the 2015 CoSTR (Perkins et al., 2015). However, none of

Table 3: Detailed overview of CPR elements

Chest compression element	Definition	Rationale	Outcome measures	Recommendation
Chest compression rate.	*Chest compression rate can be defined as the actual rate used during each continuous period of chest compressions over 1min, excluding any pauses. It differs from the number of chest compressions actually delivered in 1 minute, which takes into account any interruptions in chest compressions* (Perkins et al., 2015, p e52).	There appears to be an optimal rate for chest compressions, with evidence suggesting that if compressions are either too fast or too slow, it can have adverse effects on survival. In 2015, Perkins and colleagues (on behalf of the ILCOR) presented evidence from several observational studies reviews that compared low and high compressions rates.	Three observational studies measured a return of spontaneous circulation (ROSC). One observational study measured systolic blood pressure, two studies that measured survival to hospital discharge, two studies that measured EtCO2 (end-tidal carbon dioxide) levels, and one that measured the number of chest compressions per minute.	The conclusion recommended a manual chest compression rate of 100–120/min^{-1} and was classed as a strong recommendation but with very low-quality evidence. The evidence was of low quality due to a risk of bias in the studies reviewed.
Chest compression depth	*Using your body weight (not just your arms), press straight down by 5 to 6cm (2 to 2.5 inches) on their chest. Keeping your hands on their chest, release the compression and allow*	There appears to be an optimal compression depth, and in this case, compression depth can be negatively affected by the rate of compressions. If compressions become too fast, compression depth tends to reduce	Perkins and team (2015) presented evidence from several observational studies that compared chest compression depths. The reviewed research evaluated four studies that measured ROSC, three studies that measured survival to	Perkins et al. (2015). recommended a chest compression depth of approximately 5cm based on best evidence. This was considered a strong recommendation from low-quality evidence.

	the chest to return to its original position. (NHS, 2018 [description of chest compression depth])	(Idris et al., 2015). Therefore compression depth and rate appear to be linked.	hospital discharge, one study that measured survival with good neurologic outcome (CPC 1-2 [Cerebral Performance Category of 2 or less is considered good]) and one study measured patient injury.	However, avoiding excessive chest compression depths greater than 6cm in an average adult during manual CPR was considered a weak recommendation from low-quality evidence. The evidence was considered low quality as it was adjudged to suffer from impreciseness, very serious indirectness and was at risk from bias
Chest wall recoil (leaning)	*Full chest wall recoil is defined as the sternum returning to a neutral position during the decompression phase of CPR. Chest wall leaning is when the rescuer fails to completely release pressure on the chest wall between compressions, preventing full chest wall recoil.* (Considine et al., 2020, p 189)	According to Perkins et al. (2015, p e54), allowing the chest to recoil fully between compressions is: "Critical to hemodynamically effective CPR is blood returning to the chest between compressions. Venous return is influenced by the pressure gradient between extrathoracic and intrathoracic veins. Leaning on the chest wall between compressions, precluding full chest wall	Perkins et al. (2015) evaluated three observational studies that used coronary perfusion pressure, whilst two observational studies measured cardiac output/cardiac index. Three of these studies used animal models, and two used anaesthetised children. These studies (except for one, which suggested no differences were detected) suggested that leaning reduces coronary perfusion and cardiac output/ index.	Based on the best available evidence, Perkins and team recommend that rescuers performing CPR avoid leaning on the chest wall between compressions as this will allow full chest wall recoil. This was considered a weak recommendation, with very low-quality evidence. The evidence was considered weak due to the risk of bias and very serious indirectness. However, it is worth noting that Considine et al. (2020) excluded animal studies

		recoil, could raise intrathoracic pressure and reduce right heart filling, coronary perfusion pressure, and myocardial blood flow".		from their later scoping review because of the impreciseness compared to human studies. However, no new review was deemed necessary by Considine and team.
Minimising pauses to chest compressions	*The minimisation of pauses in chest compressions for cardiac rhythm analysis or ventilations[...].* (Perkins et al., 2015, p e55)	Oxygen and substrate delivery to end-organ tissue is critical to survival in cardiac arrest. Therefore, adequate blood flow must be maintained through high-quality chest compressions. ROSC is dependent on adequate myocardial oxygen delivery and blood flow during CPR (Netherton, 2018a), and both of these are dependent on coronary perfusion pressure (Paradis et al., 1990).	Perkins et al. (2015) reviewed several observational studies and one randomised control trial (RCT). They reviewed one study that measured ROSC, four studies (one RCT and three observational) that measured survival to hospital discharge, one study that measured survival with good neurologic outcome and one observational study that measured shock success. These studies were considered low-quality due to a risk of bias and impreciseness.	Based on the best evidence available, Perkins et al. suggest that in CPR with no advanced airway, the interruption of chest compressions for delivery of 2-breaths should be less than 10 seconds. This was considered a weak recommendation with low-quality evidence. It was further recommended that total pre-shock and post-shock pauses in chest compressions should be as short a time as possible. Perkins and team indicate that pre-shock pauses are as short as possible and no greater than 10 seconds when using a manual defibrillator. This was a strong recommendation with

				low-quality evidence. Finally, Perkins and colleagues recommend that chest compression fraction be as high as possible during CPR, and it should be at least 60%. This is a weak recommendation with low-quality evidence due to the risk of bias and indirectness.
Compression–ventilation ratio (30:2 in adults)	*The compression-ventilation ratio is the ratio between the number of manual chest compressions and the number of manual ventilations [breaths]* (Jackson, 2018).	Combines chest compression and oxygen delivery through ventilations generating oxygen delivery to end-organs (Netherton, 2018b).	Perkins et al. (2015) reviewed several observational studies regarding this ratio. Similar measures of favourable neurological outcomes (two observational studies), survival to hospital discharge (four observational studies), survival to 30-days (one observational study), ROSC (four observational studies) and hands-off time (two observational studies). All of these studies were classed as low-quality when reviewed.	Based on best evidence, the recommendation is a compression–ventilation ratio of 30:2. Again, this was considered a weak recommendation, with low-quality evidence due to the risk of bias and indirectness.

the new studies identified by Considine reported sufficient new evidence to change current BLS treatment recommendations compared to the 2015 data. It was recommended that no new systematic review of BLS evidence was required, and guidelines should remain unchanged. The importance of high-quality CPR and BLS has been described above. These CPR and BLS processes are incorporated into this thesis here as the basis and flow of the mental simulation scripts, as seen in chapter 6.

However, overall, the mental simulation script scenario is based on the advanced life-support (ALS) algorithm. CPR and BLS measures are carried out before and during advanced life-support (ALS) processes. ALS assessments and treatments are advanced procedures provided by practitioners with advanced skills. ALS procedures are complex measures provided to the patient to achieve a return of spontaneous circulation (ROSC). ROSC is where cardiac output returns to autonomic control (Resuscitation Council UK, 2015b). The ALS algorithm can be seen in Appendix 2. Advanced life-support (ALS) is further discussed in the following section.

2.4 Advanced life-support (ALS)

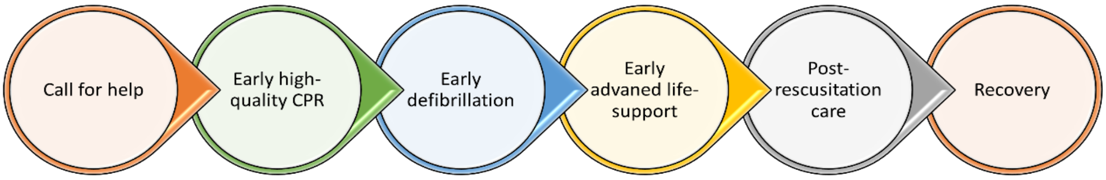


Diagram 5: A six-step process of cardiac life-support based on American Heart Association guidelines (American Heart Association, 2022b)

This section offers a brief overview of ALS processes and procedures. As shown above, in diagram 5, the American Heart Association (2022b) provides a six-stage process to life-support, in contrast to the 4-stages from the Resuscitation Council presented above (Resuscitation Council 2015b). This process includes, amongst other things, early ALS. ALS assessment and treatment are advanced procedures provided by healthcare practitioners with advanced skills. ALS is complex, and it consists of measures provided to achieve a return of spontaneous circulation (ROSC). BLS (including high-quality CPR) continues during ALS processes.

Advanced measures can include (depending on the patient) advanced airway management, capnography, vascular access, vasopressor therapy and anti-arrhythmic drugs (Soar et al., 2021). This is combined with the correction of reversible causes, known as the 4-H's [hypoxia, hypovolaemia, hypothermia, hypo or hyperkalaemia (or other metabolic disorders)] and 4-T's [toxins, tension pneumothorax, tamponade, thrombus (pulmonary or coronary)] (Resuscitation

Council, UK, 2015b). Nevertheless, pre-registration nurses have no mandated requirements to experience ALS processes as part of their basic life-support skills.

However, there is some evidence to support the notion that understanding the processes of advanced life-support readies students for clinical practice. In a mixed-methods questionnaire study (*n*= 149, pre-registration nurses), Gallagher and Traynor (2012) showed that providing students with the opportunity to participate in an immediate life-support (ILS) course enhanced their ability to practice more confidently (felt greater self-efficacious), with 92.6% suggesting the knowledge and skills gained would enhance their clinical practice.

Furthermore, a pilot study by Cook, McAloon, O'Neill, and Beggs (2012) used a novel approach to ALS education, using the PULSE (Platform for Undergraduate Life Support Education) electronic simulation game. This mixed-methods research studied *n*=34 pre-registration nurses and found that understanding the processes of ALS helped to increase self-efficacy, develop their knowledge and decision-making abilities, and improve performance in key resuscitation skills. This evidence suggests that expanding knowledge and skills in a broader understanding of advanced life-support processes can increase self-efficacy and improve performance.

My original assumption was that mental simulation might improve CPR technical skills. However, it could be that a detailed mental simulation script high in descriptive cues could assist students in understanding ALS processes, thus potentially increasing knowledge, helping to understand their role within the cardiac arrest team and increasing self-efficacy.

The above sections have presented an overview of CPR, BLS and ALS. However, life-support skills must be defined as this is a term used in this thesis to describe knowledge and understanding that goes beyond that that might typically be taught in mandatory BLS sessions. In the next section, life-support is defined.

2.5 Life-support skills defined

As seen in previous sections, complex processes must be delivered to cardiac arrest patients, including BLS and ALS provisions. These technical skills are an essential provision for preserving life. However, pre-registration nurses do not work in silos, but they have to work as part of a highly functioning multi-disciplinary team. Hence, there has been a growing focus from the Resuscitation Council on the role of the team delivering resuscitation skills, with a chapter dedicated to teamwork skills in the ALS manual (Resuscitation Council, UK, 2015b; Resuscitation Council, UK, 2021). These skills are known as non-technical skills and are the cognitive, social and interpersonal skills that underpin effective teamwork (Flin, O'Connor, & Crichton, 2008; Resuscitation Council, UK, 2021). Non-technical skills include decision making (when to apply technical skills and in what situation), situation awareness (knowing what is going on around you), and understanding one’s role within the team (teamwork, leadership and followership).

Therefore, it would be prudent to have educational techniques to help students understand both the technical and the non-technical elements of cardiac arrest. It would also be prudent to call these 'life-support skills.' As in section 1.7 above, the author would define life-support skills as:

> *The technical and non-technical knowledge, skills, and attitudes required to participate as a team member in providing life-saving measures in a cardiac arrest.*

Therefore, the term *'life-support skills'* will be used where applicable. Mental simulation has the potential to offer insight into broader life-support skills that pre-registration nurses may not be exposed to from BLS mandatory training alone.

This section presents an overview of high-quality CPR, BLS and ALS guidelines and processes. As described above, pre-registration nurses are taught BLS, including CPR skills, as part of their mandatory training requirements. Therefore, in the next section, BLS training methods are discussed.

2.6 Basic life-support training

BLS training is mandated annually for all healthcare professionals, including pre-registration nurses, in the United Kingdom (White, 2019). BLS training is often undertaken on part-task training manikins such as Resusci-Anne™ in academic-led face-to-face sessions (Yeung, Okamoto, Soar, & Perkins, 2011). See picture 1 below for an example of a BLS part-task trainer. The BLS guidelines and algorithms are the basis for teaching mandatory BLS sessions (see Appendix 2).

Picture 1: Resusci-Anne™ manikin by Laerdal (photo belongs to author)

BLS education uses simulated practice to allow learners the opportunity to rehearse the skills necessary to deliver high-quality CPR. Whilst low-fidelity simulators are good for learning technical skills, they do not capture the authenticity of clinical practice (Girish, Rawekar, Jose, Chaudhari, & Nanoti, 2018). This means that many students will attend clinical practice only having experienced a cardiac arrest in a low fidelity simulation and will not have experienced an authentic cardiac arrest scenario. This discussion is further developed in the section below.

2.6.1 Simulation and immersive technology (SIT): fidelity, immersion and authenticity

One of the main focuses for simulation-based educators is 'replication' or 'realism' (Codreanu, Sommerhoff, Huber, Ufer, & Seidel, 2020). Realism allows students to practice in an environment akin to their real-world clinical environment (Donaldson, 2009). In an attempt to achieve the desired realism, educators must focus on 'fidelity.' In the context of SIT, fidelity is considered to be "as close as is possible reproduction of an object reality" (Bland, Topping, & Tobbell, 2014, p. 1113). In their systematic review, Yuan, Williams, Fang, and Ye (2012) showed that using high-fidelity simulation enhance knowledge and skills in exams as students are allowed to appreciate the effects of their mistakes. To this end, fidelity is a critical consideration in simulated practice. The learners must feel as though they are situated and immersed in the moment (Tun, Alinier, Tang, & Kneebone, 2015). Immersion is a feeling that one is engaged in a 'real experience' or the extent to which the user feels immersed in a 'real' event (Sandars et al., 2019). Immersion, in turn, creates a life-like simulation experience (Lapkin & Levett-Jones, 2011).

A fundamental component of immersion is 'psychological fidelity' (Kozlowski & DeShon, 2004). Psychological fidelity is defined as:

> *[T]he extent to which the training environment prompts the essential underlying psychological processes relevant to key performance characteristics in the real-world setting. In other words, it is an effort to evoke the central psychological constructs and mechanisms responsible for on-the-job performance.*
> (Kozlowski & DeShon, 2004, p. 77)

If the scenario is anchored within work-related activities, it feels real and is valued by the learner. Psychological fidelity can create authenticity in the learners' experience (Rystedt & Sjöblom, 2012).

Authenticity can be defined as a "subjective interpretation/ response to a constructed situation in which the student interacts" (Bland, Topping, & Tobbell, 2014, p. 1113). For example, work-related activities could include 'stress exposure' in which authenticity is created by replicating 'real-world stressors'

(Driskell et al., 2014). The authenticity of a simulated experience is subjective and cannot be pre-prescribed by a simulation-based educator (Barab, Squire, & Dueber, 2000). Authenticity, then, is in the 'eye of the beholder,' and the simulation-based educator can only attempt to influence, but it cannot be controlled. When using mental simulation as an adjunct, life-support training could move from a low-fidelity to a high-fidelity experience, in which students gain an authentic, immersive experience.

2.7 Chapter summary

This chapter has explored some of the contexts of this research project. The chapter began with an overview of pre-registration nursing programmes. Some of the graduate attributes required to undertake mental simulation were explored. These include critical thinking, problem-solving, decision making and reflective practice. As well cognitive skills, subject-specific skills were explored. CPR, BLS and ALS are introduced as the subject being learned. Life-support skills are defined as skills that go beyond what is typically learned in BLS teaching. In the final part of the chapter, current BLS training is described from the perspective of SITs.

In the following chapter, I will explore CPR and chest compression performance. The chapter begins with an overview of skill retention and skill decay, linked to time without practice. High-quality CPR and chest compression performance are then discussed in the context of skill, stress and anxiety and self-efficacy beliefs. Authenticity is then presented in terms of life-support skill education, how authenticity can affect learning, and a discussion of innovative educational techniques is explored. In the final part of the chapter, mental simulation is introduced as a teaching and learning technique for learning life-support skills. The next chapter will be presented in the third person.

Chapter 3 – Basic life-support, CPR and chest compression performance

"Under pressure, you don't rise to the occasion.
You sink to the level of your training!"
[anonymous US Navy Seal]

3.1 Introduction

The previous chapter discussed the pre-registration nurse's (student) graduate qualities. This included recognition of some graduate skills that will be required when learning life-support skills using mental simulation. Some of the graduate attributes required to undertake mental simulation were explored, including critical thinking, problem-solving, decision-making, and reflective practice. An overview of CPR, BLS and ALS skills were introduced as subject-specific skills, and life-support skills were defined. Current BLS training was described from the perspective of simulation and immersive technologies (SIT).

This chapter will begin with a general discussion of how technical and non-technical skills are learned and retained or forgotten with time without practice. This is essential context as it sets out assumptions on repetitive practice on which part of this thesis is based. Furthermore, there is evidence that life-support skills can decay with time without practice, meaning there is a need for educational techniques to help with repetitive skills learning. Several physical practice BLS and CPR education initiatives that are shown to reduce skill decay are presented. However, these initiatives are resource-intensive and rely on repeated physical practice. Therefore, mental simulation is presented as a potential adjunct to mandatory BLS sessions (with a greater discussion of mental simulation can be seen in the literature review in chapter 4). In the first section, skill retention and skill decay are discussed.

3.2 Skill retention and skill decay

"Basic life-support is the foundation for saving lives following cardiac arrest."
[Berg et al., 2010]

In this section, skill retention and skill decay are presented. Deliberate, repetitive practice is required when learning skills of any kind, which is one of the assumptions on which this thesis is based. This first section begins with a review of Kim and colleagues work on skill retention and learning.

Kim and Ritter (2015) suggest learning through continued and sustained practice follows a regularity known as the Power Law of Learning. This law describes the relationship between practice and skill proficiency. The Power Law suggests that as practice trials increase, completion times will decrease, but at a diminishing rate, which results in a Power Law and is described in table 4 below:

Table 4: Learning curve

Time = Trials $^{-\alpha}$ *Where* α *represents the rate at which performance time changes, this learning curve is fundamental to learning CPR skills as it shows a rate to optimal skill proficiency. Undertaking CPR is time-critical.*

This law can be applied to BLS training. As the number of BLS and CPR practice attempts increases, so does learning. Repetitive practice increases the number of memory activations (Ofen et al., 2007). When the sum of the said memory activations is above the retrieval threshold, one can retrieve the memory for the task. Higher activations from repetitive practice can lead to faster and more accurate retrievals (Ritter, Baxter, Kim, & Srinivasmurthy, 2013).

However, time without practice can lead to skill decline. Hands-on, real-world practice is limited due to the relatively low occurrence of cardiac arrest in clinical areas (see NCAA (2021) data in section 2.3). Students may often have long periods without practice, not having the chance to rehearse between yearly mandatory training sessions. This would indicate that CPR and BLS learning is not likely to go past "declarative knowledge." Declarative knowledge is where a learner initially learns a skill. Declarative knowledge is explicit, and it encompasses the acquisition, retention, and retrieval of skills and knowledge and is conscious recollection or "knowing that" (Finn et al., 2016). However, time without practice leads to substantial memory trace decline (Kim & Ritter, 2015), and can lead to increased response times, decreased retention of knowledge and reduced accuracy if unrehearsed (Ka-Chun, Best, Kim, Oleynikov, & Ritter, 2016).

Therefore, declarative skill is performed in a conscious, step-by-step fashion and time without practice, can lead to what Kim et al. (2013) term 'catastrophic memory failure.' Not ideal in resuscitation situations where every second counts (Cheng et al., 2018). This base-level learning supports both a Power Law of Learning and, inversely, a Power Law of Forgetting (Kim et al., 2013), in which skill decay may lead to a loss of speed and accuracy. Skill decay refers to the loss of trained or acquired skills after a period of non-use (Arthur Jr, Bennett Jr, Stanush, & McNelly, 1998).

Bjork and Bjork (1992, cited in Bjork 2011) argue that it is not the memory that decays per se, but it is a *decay of the retrieval process* for reactivating stored memories. Bjork (2011) rejects that loss of skill or knowledge is due to 'decay' per se but suggests that it is more likely linked to retrieval of competing memories. Whether it is a skill that decays, decay of the retrieval process, or competing memories, the outcome is the same. When skills cannot be recalled, the skill cannot be performed promptly and accurately, potentially affecting cardiac arrest survival rates. This phenomenon can be seen in Kim and colleagues' diagram 6 below.

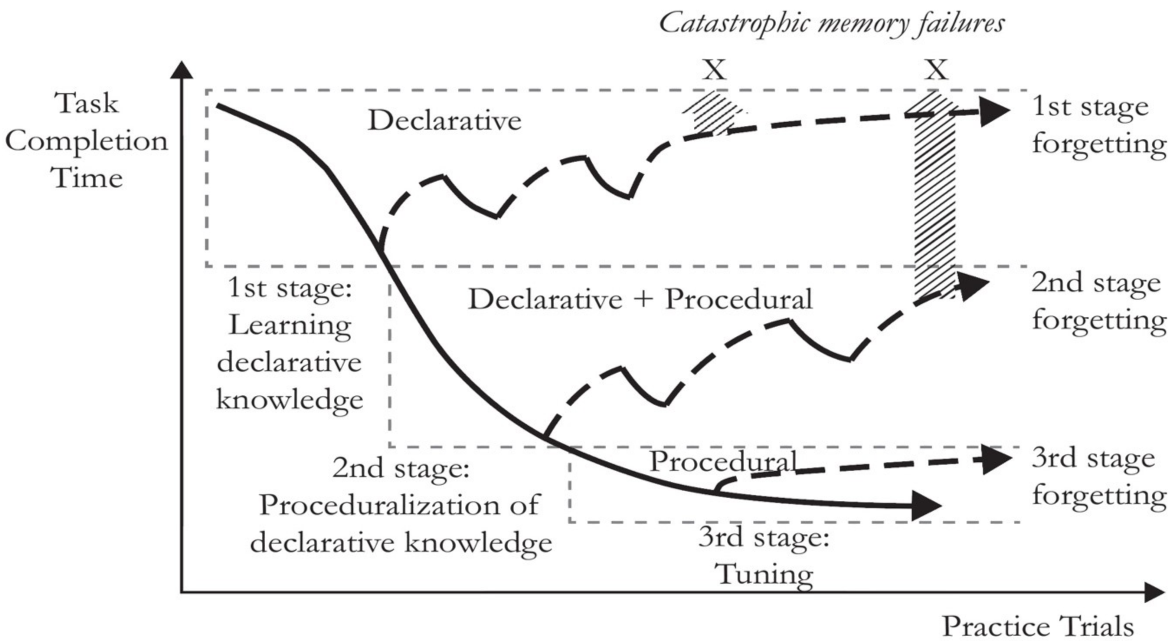


Diagram 6: A graph describing a theory of task knowledge retention, showing the three stages of learning and the effects of forgetting and relearning (Kim et al., 2013).

(Note: The solid lines are the learning and relearning curves. The dashed lines are forgetting curves from each stage. At each stage, the learning and forgetting rates are different.)

Well-rehearsed skills appear to be based on automated control structures. They run primarily outside of declarative attentional control (Beilock & Lyons, 2009). Therefore, it seems logical to train students towards a 'procedural knowledge' state because procedural skills and knowledge are automated and implicit. Procedural knowledge memory traces are so strong that they can be recalled when required, even under stressful conditions (Kirschbaum et al., 1996). They are immune to decay- it is not forgotten with time (Kim & Ritter, 2015). It could then be argued that individuals who cannot perform high-quality CPR and BLS skills when required remain in the declarative learning phase and suffer catastrophic memory failure.

SIT techniques, such as mental simulation, can help with the skill rehearsal that move towards overlearning (Driskell et al., 1992). Driskell and colleagues suggest that overlearning is a pedagogic technique in which there 'is deliberate overtraining of a task, past a set criterion' (p. 615) and requires additional education and training past that necessary for initial competence (Arthur Jr et al., 1998). These are explored in the next section.

3.3 Life-support skills performance

In this section, the author presents evidence that life-support skills, such as BLS can deteriorate quickly with time without practice. The first sections examine nursing-specific students, but this phenomenon is not confined to nurse education only and research in other professions is also presented.

Nyman and Sihvonen (2000) studied (*n*=298) pre-registration nurses undertaking CPR. The CPR skills were considered inadequate in terms of prompt recognition of cardiac arrest and only a 50% success rate ($p < 0.001$) in artificial ventilation and chest compression. The results showed that the best predictors for high-quality skills went to students who had studied resuscitation skills during the previous 6-months showing that time without practice affected performance, and practice trials delayed the decay of skills. Similarly, Madden (2006) retested (*n*=55) students' BLS skills using a quasi-experimental time-series design. Madden showed that students' CPR skill levels were significantly reduced at around 10-weeks, with mean psychomotor performance scores reducing significantly on the retest. According to the correct standard, no student could perform all CPR skill components correctly. However, there was evidence in this study that skills were not learned sufficiently to begin with. Madden contends that:

> *"a lack of CPR competency is often accepted as deterioration in CPR skills, whereas it may instead represent nonacquisition of CPR skills."*
> *(p225).*

Therefore, students must be offered the opportunity to learn life-support skills to a proficient standard.

Niles et al. (2017) suggested that nurse cardiac compression psychomotor skill quality had deteriorated significantly at 6-months after mandatory updates. Furthermore, Roel & Bjørk's (2020) comparative study between two cohorts of students in the bachelor of nursing degree programme showed that initial learning of CPR skills, with no further educational intervention, meant that there was a significant decay in CPR skills, compared to regular repetitive practice ($p < 0.001$).

More recently, Saad, Favarato, de Paiva, & Nunes's (2019) performed a cross-sectional simulation study of medical students' CPR skills. Saad and team mapped the rate of skill decay, and after initial training, the students were retested at regular intervals. The results showed that the mean retention of CPR skills were 90% after 1-month, 74% after 18-months, 62% after 30-months, and 61% after 42-months ($p < 0.001$).

There is further evidence of similar results across other health disciplines (Broomfield, 1996; Na, Sim, Jo, Song, & Song, 2012; Semeraro, Signore, & Cerchiari, 2006), and is not only confined to nursing and medical students. Both Madden (2006) and Charlier, Van Der Stock, & Iserbyt (2020) showed that skill decayed faster than knowledge in students. However, Srivilaithon et al. (2020) showed in their study that knowledge decayed faster than skill; however, both decayed significantly with time without practice. The conclusion drawn here is that time without practice makes recall difficult, and memory failure can ensue (Vlasblom, Pennings, van der Pal, & Oprins, 2020). However, not all BLS skill acquisition studies have produced the same results.

Schmitz et al. (2021) used a cross-sectional design to study CPR skills in emergency physicians tested performing CPR in simulation with $n = 113$ physicians. Overall, 92.9% correctly performed CPR with the proper assessment, compression rate, compression depth and rescue breaths. There was no difference between success rates in physicians who had BLS training within 90-days (91.7%) and physicians who had not had BLS within 90-days (93.1%). There was no difference in the pass rate [p 1.0] of those trained within 90-days (91.7%) to those trained >2 years ago

(90.9%) [p 1.0]. The authors concluded no differences in delivering high-quality CPR in emergency physicians who had recent BLS training and those who did not. It appeared that for this professional group, training did not affect the outcome.

A key limitation of this study is that the authors cannot conclude that practice is not significant. Emergency physicians have high exposure to cardiac arrest emergencies, meaning they are unlikely to have significant time without practice. Emergency physicians may not perform CPR unless they are first responders (Rushton, Drumm, Campion, & O'Hare, 2020; Schmitz et al., 2021); however, this does not rule out learning and maintaining skill through 'mirroring' via 'action observation.' Action observation (part of 'simulation theory') posits that the same neural structures are activated during observation of action as during the actual execution of a task (Jeannerod, 2001). This theory suggests the maintenance of CPR skills through observing others in action.

Other reasons for the performance gaps in CPR skills have been proposed, including stress, anxiety and self-efficacy beliefs. These are discussed in the following sections.

3.3.1 Stress, anxiety, and cardiac arrest performance

There can be many situations that cause stress and anxiety in pre-registration nurses, and cardiac arrests appear to be one of those circumstances. It is essential to understand how and why this may be, as it could be one of the areas in which mental simulation assist the students in their life-support skills learning journey. The following section will discuss stress, anxiety and how this affects performance.

Real-world cardiac arrests can cause stress, which can be tested with biochemical markers and self-reporting (Bong, Lightdale, Fridette, & Weinstock, 2010; Hayes, Rhee, Detsky, Leblanc, & Wax, 2007; Morgan & Westmoreland, 2002; Quilici et al., 2006). It can also cause internal anxiety at the prospect of facing a cardiac arrest in the future (Mäkinen, Castrén, Nurmi, & Niemi-Murola, 2016). Stress and anxiety cause high arousal states that can negatively affect performance, decreasing the chances of high-quality CPR delivery (Frazier, Gabriel, Merians, & Lust, 2019; Jamieson, Peters, Greenwood, & Altose, 2016). Therefore, stress and anxiety should be considered when discussing life-support performance.

Stress and anxiety are two terms often used interchangeably, but it is now well recognised that there are conceptual differences. For example, "stress occurs as a result of external pressure, whereas anxiety occurs as a result of internal pressure (cognitive appraisal)" (Al-Ghareeb, Cooper, & McKenna, 2017, p. 479). Within the workplace, stress evokes:

an appraisal process, in which perceived demands exceed resources, and that results in undesirable physiological, psychological or behavioural outcomes.
(Driskell & Johnston, 1998, p. 192).

Novel events such as cardiac arrest can create this stress. However, anxiety can be created at the prospect of undertaking real-world life-support. Students are acutely aware that real-world BLS and CPR delivery is considered a 'matter of life and death,' and the skills must be delivered accurately and in a time-critical manner

(Vincent et al., 2021). This realisation appears to weigh heavy on some healthcare practitioners.

Stress triggers a cascade of physiological experiences, which includes the secretion of glucocorticoids from the adrenal cortex. Exogenous glucocorticoids impair human declarative memory performance (de Quervain, Roozendaal, Nitsch, McGaugh, & Hock, 2000). However, glucocorticoid secretion during learning has been shown to increase the consolidation of memory traces. According to Roozendaal, Nguyen, Power, & Mcgaugh (1999), post-training activation of hippocampal glucocorticoid receptors facilitates the consolidation of recently acquired information in a dose-dependent relationship. However, too little or too much glucocorticoid can impair consolidation. Reduced performance has been empirically linked to excessive stress hormone release such as glucocorticoid (Kirschbaum, Wolf, May, Wippich, & Hellhammer, 1996; McEwen & Sapolsky, 1995; Mendl, 1999; Roozendaal, 2002). Glucocorticoid has been shown to affect the information-processing systems (de Kloet, Oitzl, & Joels, 1999), thus reducing cognitive ability and thereby reducing performance levels.

Hunziker et al. (2013, p. 1) describe the stress associated with delivering real-world CPR, which cannot be taken lightly in considering performance. Hunziker argues that:

> *"CPR causes significant stress for the rescuers, which may cause deficiencies in attention and increase distractibility. This may lead to misjudgements of priorities and delays in CPR performance, which may further increase mental stress (vicious cycle).*

This negative effect on focus occurs because it impairs attention and recall and increases cognitive overload (Matthews, Wohleber, & Lin, 2019), consequently taking focus away from the task.

These stressors are often powerful enough to be felt after the event, to the point where the stress of cardiac arrest can cause longer-lasting trauma. Spencer, Nolan, Osborn, & Georgiou (2019) performed a cross-sectional study using a 33-item questionnaire survey of *n*=414 doctors, nurses and healthcare support workers working in the emergency department, the acute medical unit and the intensive care unit of a district general hospital. They concluded from the study that 9.6% of staff screened positively for post-traumatic stress disorder due to attending an in-hospital cardia arrest, with junior members of the team being the most vulnerable in developing symptoms.

The Spencer and teams study is interesting as cardiac arrest stress forms part of the narrative of this thesis. A key criticism of the results from this study is that the questionnaire was completed sometime after the cardiac arrest and is, therefore, susceptible to recall bias (Sedgwick, 2012). It holds good face validity that cardiac arrest would cause stress disorder symptoms. Nonetheless, it is difficult to link this directly to the cardiac arrest event itself. The questionnaire responses cannot guarantee causation, especially given the stressful work that healthcare professionals experience in acute areas such as these.

As well as the potential for stress and anxiety to affect life-support performance, self-efficacy beliefs could also play a part. Self-efficacy is explored further in the following section.

3.3.2 Self-efficacy and self-efficacy in life-support skills

Self-efficacy is a belief in one's ability to perform a particular task in various circumstances. It is highly task-specific, and self-efficacy can predict behaviour (Bandura, 1997) and is considered the foundation of human agency (Bandura, 1999). Students are expected to master providing BLS and perform in practice when required, which can be anxiety-provoking and can create doubt in one's ability. Bandura argues that:

> *People who are plagued by acute self-doubts about managing potential threats are more likely to "catastrophise" than those who are self-assured that they can protect themselves against possible hazards.*
> (Bandura, 1978, p. 242)

Self-doubt can affect students thoughts and feelings about delivering BLS in practice. Clinical emergencies such as cardiac arrest can cause feelings of stress and anxiety. Bandura (1977) calls this 'anticipatory self-arousal', where an individual conjures up fear-provoking thoughts that can incite elevated arousal levels at the mere thought of the performance.

Nurses (including students) are often first-responders during a cardiac arrest due to working proximities with patients. However, some nurses still lack the confidence and self-belief to perform BLS in an emergency (Rushton, Drumm, Campion, & O'Hare, 2020). Self-efficacy is an increasingly acknowledged component in education, including BLS training (Turner, Lukkassen, Bakker, Draaisma, & ten Cate, 2009). Resuscitation self-efficacy is defined as a self-judgement of the perceived capability to organise and implement the required knowledge and skill to deliver evidence-based, high-quality care during a cardiac arrest resuscitation (Roh & Issenberg, 2014). Maibach, Schieber, & Carroll (1996, p. 97) argue that even experienced healthcare practitioners are:

> *Less likely to initiate and sustain behaviours for which they lack confidence. This performance-based confidence can be distinguished from both knowledge and skills necessary to perform the behaviour[...]. Even clinicians who are knowledgeable and skilled in resuscitation techniques may fail to apply them successfully unless they have an adequately strong belief in their capability.*

Maisach and colleagues suggest that self-efficacy is integral in delivering life-saving skills. It appears that it is not enough for nurses to have the 'knowledge' (know), 'skills' (able to), and 'attitude' (prepared to). They also need to believe in their ability (dare to) to perform high-quality CPR and life-support under pressure (Turner et al., 2009). Self-efficacy has been shown to correlate with psychomotor skill delivery in students undertaking BLS.

In their study of student nurses' self-efficacy beliefs after BLS training, Roh and Issenberg concluded that:

> *Self-efficacy did correlate with CPR psychomotor skills among nursing students at the time of training in our study, and therefore efforts should be made to boost the self-efficacy of the students through their BLS curriculum*
> (Roh & Issenberg, 2014, p. 678).

Student self-efficacy can be achieved through several sources of experience. These include 1) enactive mastery experience [performance accomplishments], 2) vicarious experience [social learning/ modelling], 3) verbal persuasion [self-talk or discussions], and 4) emotional arousal [desensitisation/ symbolic exposure] (Bandura, 1977; Bandura, 1997).

Two of Bandura's sources of experience for self-efficacy appear to be attuned to mental simulation in learning BLS and life-support skills. These are 'enactive mastery experience' and 'emotional arousal.' According to Bandura (1997):

> *"[Enactive] Mastery experiences are the most influential source of efficacy information because they provide the most authentic evidence of whether one can muster whatever it takes to succeed. Success builds a robust belief in one's personal efficacy. Failures undermine it, especially if failures occur before a sense of efficacy is firmly established."*
> (p. 80)

Pre-registration nurses are unlikely to have had the mastery experiences through repetative practice that can create a sense of BLS efficacy. While Bandura (1997) maintains that real-world experiences are more likely to result in self-efficacy changes, he acknowledges that using mental simulation for mastery experience can approximate a real-world experience.

As previously described, cardiac arrests and the delivery of real-world BLS is a stressful and emotionally laden experience, and Bandura discusses this in the context of self-efficacy beliefs. As Bandura (1998, p. 77) declares:

> *People who believe they can exercise control over potential threats do not engage in apprehensive thinking and are not perturbed by them. But those who believe they cannot manage threatening events that might occur experience high levels of anxiety arousal.*

Mental simulation may act as a form of enactive mastery experience (Bandura, 1977; Bandura, 1991) in helping some students overcome their anxieties of cardiac arrest.

Bandura (1977; 1997) also suggests efficacy experiences in the form of emotional arousal. As previously discussed, feelings of high anxiety can often have debilitating effects on some individuals. Bandura (1997) argues that because people are aware that high stress and anxiety can hamper performance, it is often seen as lowering self-efficacy beliefs as it creates fear-provoking thoughts about ineptitude.

However, exposure to the source of anxiety can often lead to reductions in stress and anxiety through desensitisation (Bandura, 1998). Increasing self-efficacy can positively impact BLS and life-support skill performance, as Roh and Issenberg conclude from their research that the "nursing students who performed correct chest compression skills reported higher self-efficacy" (Roh & Issenberg, 2014, p. 674), which further suggests that self-efficacy would be a desirable outcome of mental simulation. Further analysis of self-efficacy and performance revealed self-efficacy as a highly accurate predictor of behavioural change after complete desensitisation (Bandura & Adams, 1977). According to Bandura (1997), the lower an individual's anxiety, the greater the likelihood of success. Mental simulation could potentially create this exposure to cardiac arrest anxieties and increase desensitisation (Lang, 1979).

Due to the low-fidelity nature of BLS life-support training, it might not currently be possible for a student to be authentically exposed to these stressors to begin desensitisation. In the next section, the authenticity of the current BLS provision is explored.

3.4 Authenticity of current BLS provision

Current mandatory training of BLS skills may not capture these real-world stressors due to the low-fidelity simulation not always capturing the authenticity of the real-world situation (Girish et al., 2018). Therefore, students may not learn to cope with performance during high-aroused states. Mental simulation could be one area that allows students to be exposed to authentic emotions and high-arousal states (Hoppe, Holmes, & Agren, 2020) like those experienced in cardiac arrest.

In Vincent et al.'s (2021, p. 228) narrative literature review, they found that stress generated during a resuscitation:

> *Reduce[d] aspects of general performance, such as narrowing the attention span and impairing retrieval of previously learned information in non-stressful conditions, and protecting performance by enhancing memory and retrieval in affect-laden situations in simulation studies. Also, this review has shown that especially self-reported stress, but also physiological stress, is associated with lower CPR performance.*

The affect-laden simulations recreate higher authenticity in the learning experience (Bjørshol et al., 2011). However, the inexperience of student healthcare professionals and lack of authentic practice may mean that the stress of cardiac arrest negatively impacts their performance (Hunziker et al., 2011). This hypothesis is drawn from Bjørshol and Hunziker papers but also Kirschbaum et al., (1996). Kirschbaum and colleagues formulated a strong case to demonstrate that whilst declarative memory showed impairment under stress, elevated stress levels did not compromise procedural memory.

Ross, Szalma, & Hancock (2004) hypothesise that there is often a difference in the task demands that the individual faces in the real-world context compared to training. For this reason, Ross and colleagues advocate stress exposure training in which the authenticity is created to the level of exposing the learners to the stress felt in the real-world task (Driskell & Johnston, 1998). Due to desensitisation, stress exposure could improve performance under stress (Driskell, Sclafani, & Driskell, 2014). According to Driskell & Johnston (1998), stress exposure training, in which practitioners are exposed to 'normal' environmental stressors, will likely be:

> *[L]ess aroused physiologically, less distracted by task-irrelevant concerns, and more likely to focus attention on the task.*
> (p. 194)

This hypothesis suggests that to ensure adequate performance under stress in real-world environments, one should supplement skill-based training with stress exposure training. As Driskell and colleagues suggest:

> *There is a significant difference in what it takes to perform a specific task in a "classroom" environment and what it takes to perform that task in a stressful or demanding real-world environment.*
> (Driskell, Sclafani, & Driskell, 2014, p. 33)

Mental simulation could be a vehicle for re-creating cardiac arrest emergency stress. For example, Judd, Currie, Dodds, Fethney, & Gordon (2019) show in their study that stress can be recreated in the simulation laboratory and that repeated exposure in simulated practice showed reductions in stress levels between exposures. Lang, Melamed, and Hart (1970) argue that exposure causes desensitisation to performance stress. Desensitisation of heightened arousal included a systematic reduction in heart rate with repeated fear-imagery scene presentations. This desensitisation was, in turn, associated with fewer arousal signals in later tests. It is fundamental to patient safety that students feel confident and are ready to undertake BLS in clinical practice.

While some studies have examined stress and anxiety in BLS, numerous studies have critiqued innovative educational techniques to aid in the retention of CPR and skill. These CPR skill acquisition studies have somehow incorporated deliberate, repetitive practice and mastery learning. Below is an examination of some of these educational methods and the research results that support them.

3.5 CPR skill retention innovations in physical practice

Oermanna et al. (2011) studied the use of monthly CPR training sessions. Pre-registration nursing participants (*n*=606), half of whom were part of an intervention group. The intervention group attended 6-minute-long refresher training sessions each month. Compared to the control group, the intervention group had significantly retained their skills at both 9- and 12-months. Although Oermanna and colleagues suggested that learning with this technique could improve practice over the baseline, whether the participants used procedural or declarative memory when reproducing the skill was not established.

In a further example, Wik, Myklebust, Bjorn and Steen (2002) researched lay participants (*n*=35) who had 20 minutes of CPR training. The control group was assigned a voice advisory manikin (VAM), while the second group was assigned an 'overlearning' intervention. One week after initial training with VAM, the intervention group received a further ten 3-minute training sessions (overlearning). The study showed that CPR skills were retained at 6-months in the group with VAM and overlearning. Wik et al. (2005) concluded from their separate study that using VAM alone is adequate for longer-term skill retention due to the instant feedback mechanism that allows for corrections in technique.

Wayne et al. (2006a) implemented a deliberate practice and mastery learning model to teach resuscitation skills in a further study. After baseline assessment of knowledge and skills, experienced physicians received four 2-hour advanced cardiac life-support (ACLS) simulated sessions. Residents were then retested, and performance improved significantly after simulator training. All doctors met or exceeded the mastery competency standard. The amount of practice time needed to reach the pass score was a strong predictor of post-test performance. They also concluded that setting minimum pass rates meant that mastery was pre-determined.

The longitudinal results from this particular study are exciting and were presented in a separate article. Many other studies show that skill decay can occur between a few weeks (Madden, 2006) and 6-months (Niles et al., 2017). Wayne et al. (2006b) showed that skill did not decay significantly at 14-months, even without further practice after the intervention. This finding could be because of the physicians' high level of resuscitation skill acquisition initially and achieved high skill levels (overlearning toward procedural knowledge).

Furthermore, Hunt, Duval-Arnould, Diener-West, Perretta, & Shilkofski (2014) implemented their "Rapid Cycle Deliberate Practice" (RCDP) training. The training consisted of BLS and advanced life-support (in paediatrics). There was an emphasis on the importance of the 'first-five minutes' (FFM) of a cardiac arrest, and it involved three principles of learning. Firstly, multiple opportunities to practice skills the 'right way.' Secondly, instant expert feedback explores solutions to problems that arrive and correct errors in practice. Thirdly, create an environment of 'psychological safety,' so feedback is not taken defensively. The findings revealed an association between the RCDP-FFM curriculum and marked improvement in BLS and defibrillation quality measures compared to a historical control. However, longitudinally, decay was not measured.

Other approaches to CPR training have been examined by Halm and Crespo (2018) in their review. Some examples include: i) a blended learning approach via HeartCode; ii) use of high-fidelity manikins and; iii) short practice sessions with realistic, in situ, low-fidelity or high-fidelity simulation environments. These mastery learning techniques are very promising. They all show that repetition is key to performance, but they do not negate the issue that time without practice will still lead to skill decay.

Whilst these are very promising techniques, physical simulation is resource-intensive in terms of cost and human resources (Hippe, Umoren, McGee, Bucher, & Bresnahan, 2020; Iglesias-Vázquez et al., 2007; Lapkin & Levett-Jones, 2011; Zendejas, Wang, Brydges, Hamstra, & Cook, 2013). Zendejas and colleagues (2013) highlight the need to consider the cost of SIT faculty, facilities, and sundries such as internet access, lighting, heating, et cetera. This cost is further intensified when attempting to allow for repetitive, deliberate practice required to maintain CPR skill and prevent skill decay (Oermanna, Kardong-Edgrenb, & Odom-Maryonb, 2011; Wik, Myklebust, Bjorn, & Steen, 2002; Wik, Myklebust, Auestad, & Steen, 2005). The cost is prohibitively expensive.

As an example, to illustrate the difficulties, at the author's employer university, there is an extensive department with approximately (c) 630 Bachelor of Science students and (c) 120 Master of Science students (L. Kirkham and S. Morris-Docker, Personal Communication, December 8th, 2020) in one academic year (2020/21) alone, with numbers set to rise in 2021/22. These student numbers make repeated classroom experiences logistically and financially unfeasible. This is due to the number of simulation laboratories available on campus, the number of other skills needed to be practiced and the human resources necessary to run the simulated experience. For example, each simulation session runs with 2-3 educators and smaller class sizes (compared to classroom learning). It is anticipated that mental simulation could assist here. Mental simulation could provide more education for fewer resources.

Higher education and healthcare providers continually look for efficiency savings where necessary, and a 'more for less' ethos has been often espoused (Virtue, 2013; Rider, Hasselberg, & Alexandra, 2013). Therefore, the author would recommend mental simulation for local simulation policy adoption (mental simulation has now been included in the local simulation strategy). Furthermore, it is also unlikely that any of the above mastery BLS and CPR education techniques would allow for learning to cope with the emotional aspects of cardiac arrest.

As can be seen from the discussion of BLS learning, it is not straightforward to learn or maintain the necessary psychomotor skills. Still, life-support skills rely heavily on cognitive skills and decision making in responding to a cardiac arrest emergency. Cook and colleagues suggest why this may be:

> *This can be attributed, in part, to the unpredictability and stressful nature of developing life-support skills in real-life clinical situations. Yet both the cognitive and psychomotor domains must be effectively engaged to develop clinical competence*
> (Cook, McAloon, O'Neill, & Beggs, 2012, p. 714)

Could mental simulation help with this? Mental simulation of a cardiac arrest scenario could potentially assist in learning both the necessary cognitive and psychomotor skills by allowing students to see the bigger picture of the scenario and experience it repetitively. The answer to this can only be uncovered by researching the topic qualitatively and inductively by allowing the participants' voices to be heard and learning from their experiences. The potential benefits of mental simulation are addressed in the next section.

3.6 Mental simulation: background and potential benefits to healthcare

Mental simulation is a quasi-sensory or quasi-perceptual experience that exists in the absence of stimuli and overt physical movement (Arora et al., 2011). It has been described as “seeing in the mind’s eye and hearing through the mind’s ear and so on” (Kosslyn, Ganis, & Thompson, 2001, p. 635), and sports researchers have described mental simulation as “movies of the mind” (Smith, 1990, p215). Mental simulation has been used to supplement the learning of skills in many disciplines, including nursing (e.g., Bachman, 1990), medicine (e.g., Geoffrion et al., 2012), music (e.g., Keller, 2012) and sport (e.g., Cotterill, 2015). A more detailed examination of mental simulation in healthcare research can be seen in sections 4.6- 4.9 below.

Mental simulation has been used in sports psychology to increase the motivation of elite sports performers. It can be motivational specific [mental simulation of specifics goals and outcomes], motivational general-arousal [mental simulations of arousal and affect], and motivational general-mastery [imagery of cognitions including self-efficacy and mental toughness] (Simonsmeier, Androniea, Buecker, & Frank, 2020). It is possible to draw parallels and similarities between nurse education and sports training regarding the requirement to master a range of motor skills. Therefore, mental simulation training regimes found in sports may also apply to nursing education, and drawing on these techniques could prove valuable. However, few sports have the same life or death implications as cardiac arrest life-support; therefore, using sport mental simulation research to support BLS training should be approached with relative caution and further researched within the healthcare education domains.

Mental simulation could potentially be used in nurse education as a relatively inexpensive simulation and immersive technology (SIT) that is self-directed and can be used by any student with the motivation to learn in their own time. Mental simulation is a deliberate and solitary form of practice. These elements are a fundamental aspect of skill acquisition and the development of expert performance (Ericsson & Pool, 2017). For years, the author has been fascinated with the work of Professor K. Anders Ericsson. The author found Ericsson's work on deliberate practice to be highly relevant to nursing education. Deliberate practice is a highly structured activity with the explicit goal of improving performance (Ericsson & Pool, 2017; Ericsson, 2020).

Deliberate practice techniques require individuals to practice repetitively, with the goal of improvement to the point of mastery (Wayne et al., 2006). Practicing to the point of mastery levels requires solitary practice, where motivated practitioners can learn alone, thus increasing repetition (Ericsson & Pool, 2017). Solitary practice correlates with higher performance in sports (Ericsson & Towne, 2010; Duffy, Baluch, & Ericsson, 2004), music (Macnamara, Hambrick, & Oswald, 2014) and healthcare education (Ericsson, 2004). Solitary practice is the most critical element of mastering a skill as it drives achievement through flexible learning that allows motivated learners to repeat practice in larger doses (Ericsson, 2020).

BLS education is not routinely offered as repetitive practice over several sessions. In the next section, mental simulation is described in terms of healthcare simulation and immersive technologies (SIT) that can be utilised as a repetitive, solitary practice by pre-registration nurses.

3.6.1 The context and significance of mental simulation in nurse education as related to simulation and immersive technologies (SIT) in healthcare

"Simulation is a technique – not a technology…"
[Professor David M. Gaba]

This section offers an overview of the simulation and immersive technology (SIT) discussion and is presented for two main reasons. Firstly, BLS training uses SIT techniques to teach the required life-support skills. As previously described, this is generally accomplished using a low-fidelity, part-task trainer. Secondly, mental simulation should be classified within healthcare education as an SIT training technique and is therefore discussed in this context within this thesis.

SITs within healthcare have been used to teach skills for decades (Wong & Okuda, 2021). An SIT can be defined as:

> *a technique to replace or amplify real experiences with guided experiences, often immersive in nature that evokes or replicates substantial aspects of the real-world in a fully safe, instructive and interactive fashion.*
> (Gaba, 2004, p. i2)

Simulated practice uses various techniques and equipment, such as the aforementioned part-task trainers, to teach technical skills or higher fidelity equipment, environments, and manikins to teach non-technical [teamwork] skills (Shaff & Russell, 2020). Using SITs to avoid patient harm through rehearsal requires simulated tasks that optimally represent the same complex challenges potentially faced in clinical practice (Satish & Steufert, 2002), such as cardiac arrest emergencies.

The principle aim of healthcare simulated practice (simulation) is to protect the public by improving self-efficacy, care quality and increasing patient safety through improvements in human performance (World Health Organization [WHO], 2018). The WHO is clear that practising skills in simulation is ethically and morally essential. Furthermore, in their National Framework for SIT, Health Education England outlines their primary driver for simulation-- they argue that:

Health Education England will ensure the development of a well-trained and engaged multi-professional workforce that is able to deliver safe, effective care by utilising meaningful and cohesive simulation-based education.
(Health Education England, 2018, p. 1)

SITs allow students to rehearse skills away from the front line, with no harmful consequences for patients if errors are made. Studies of simulation training for skills have shown that healthcare practitioners trained in this way tend to make fewer errors (Donaldson, 2009) and feel more self-efficacious in their abilities (Watters, Reedy, Morgan, Handslip, & Jaye, 2015). These are essential aspects of pre-registration nurse training.

Mental simulation can be described as an SIT technique that offers an evidence-based method of improving learning and performance (Cummings & Williams, 2012). The timing of Covid-19 overlapped with the writing of this thesis. The mobility and self-directedness of mental simulation could be viewed as advantageous during the lockdown periods of Covid-19, where remote and blended learning has been thrust upon the student body (Carter Jr, Rice, Yang, & Jackson, 2020). Universities' ability to provide new distance learning methods has become more critical than ever, with students appearing to recognise the importance of a blended learning approach during the pandemic (Mali & Lim, 2021).

Furthermore, the WHO (2018) recommend that simulation be implemented into pre-registration nursing curricula, and Health Education England suggests that:

Simulation and immersive technologies have an important place within this context by offering different approaches to help resolve the impact on education and training arising from the pandemic.
(Health Education England, 2020, p. 4)

While mental simulation would not replace physical practice, it would undoubtedly augment student BLS education. In the case of life-support, this could include face-to-face physical BLS mandatory training, blended with a distance mental simulation approach. Outside of the annual mandatory BLS education sessions, there is no mandated requirement to provide an opportunity for repetitive practice, meaning BLS skills can be prone to decay.

3.7 Chapter summary

BLS skills are practised in the simulation laboratory, using SIT to help students learn the required psychomotor skills, but it appears that there are two challenges to BLS mandatory education in its current form. It is low-fidelity, meaning students may not be exposed to an authentic cardiac arrest simulation or scenario. This means that students may not have the opportunity to learn the broader knowledge of life-support. As presented in this chapter, mental simulation is being explored as a potential technique to overcome these authenticity challenges.

Skill retention and skill decay are introduced to understand knowledge and skill development and how it is retained. Without practice, knowledge and skills are lost with time, leading to catastrophic memory failure. Understanding these principles can assist in understanding specifically how BLS knowledge and skills are learned and maintained. CPR performance research was presented and linked to skill retention theory. Stress, anxiety, and self-efficacy were further presented as potential obstacles to maximum performance during cardiac arrest. An examination of authenticity in BLS training and novel CPR training and education approaches were presented. However, these novel approaches tend to rely on extra physical practice, which is resource-intensive. Mental simulation was offered as a technique that could help bridge educational gaps in life-support. In the final part of the chapter, mental simulation was established in the context of healthcare SITs, and the shared language between physical healthcare simulation and mental simulation was introduced to the reader.

In chapter 4, a review of the literature is offered. An overview of the searches and how the searches were performed is presented (along with appendix 3, section 17.3). The chapter begins by examining mental simulation as a form of deliberate practice. Furthermore, dual-code and bio-informational theories form the basis of the assumptions on which mental simulation and this research are based- a discussion of these theories is presented. An overview of mental simulation in sports is examined, and functional equivalence is introduced as a further assumption on which the PETTLEP framework is based.

Mental simulation in nursing and medical (mainly surgical skills) education is then presented in the subsequent final sections. The research reviewed is primarily positivist and examines measurable outcomes such as skill acquisition, stress and anxiety and self-efficacy. The following chapter presents the gaps in knowledge and justifies employing qualitative techniques in this research project.

Chapter 4 - Review of the literature

Curriculum developments that lack a sound philosophical rationale leave educators at the mercy of the latest educational fads without justification for the appropriateness of the learning process.

[Dewey (1938)]

4.1 Introduction

The previous chapter presented theories on skill retention and skill decay. This was subsequently linked to learning in BLS and CPR knowledge and skills. An examination of research on CPR performance was presented, and this was linked to skill acquisition or lack thereof. Furthermore, stress and anxiety and self-efficacy were explored as potential performance-impairing considerations. Current basic life-support (BLS) provision's fidelity and authenticity were presented, and mental simulation was introduced in the context of simulation and immersive technology.

The first part of this litertaure review chapter presents guiding review questions. These questions shaped the literature review. An overview of deliberate practice, dual-code, bio-informational and functional equivalence theories explains how mental simulation assists in learning. The chapter builds on the ending of the previous chapter by exploring and critiquing mental simulation research from sports, nurse and medical education. The nurse education sections explore and critique two mental simulation and CPR training studies (section 4.7.1). In the final section of this chapter, the author discusses the overall knowledge gaps generated by this literature review and how these gaps will be addressed in this thesis. The chapter begins in the following section with a brief overview of the literature searches.

4.2 Literature search

Two population, intervention, control and outcome (PICO) questions (Brown, 2020) were formulated for sports, and healthcare-specific mental simulation research advanced searches. The databases searched were: 1) CINAHL, 2) PubMed, 3) PschINFO, 4) SPORTDiscus, 5) GoogleScholar. Two main PICO questions were formulated:

1. Does regular use of mental simulation (i) improve skill acquisition (o) in healthcare professionals (p)? (no control was required for this search).

2. Does regular use of mental simulation (i) improve skill acquisition (o) in elite sports (p)? (no control was required for this search).

These questions allowed me to produce alternative search terms, and, using Boolean logic (AND/ OR), these terms were married. Peer-reviewed and English language paper settings were applied along with inclusion and exclusion criteria. The search details can be seen in appendix 3, section 17.3.

Several further basic searches were undertaken as part of the overall subject investigates. The search terms included:

- "Cardiopulmonary resuscitation"
- CPR "skill acquisition"/ "skill decay"
- "graduateness" / "graduate attributes"
- "CPR skill maintenance"
- Mental simulation "nursing," "healthcare", and "surgery."
- "Mental simulation"/ "mental imagery"/ "general principles of mental simulation"
- "PETTLEP"
- "Self-efficacy"
- Plus, method and methodology literature were searched

The author also utilised the reference lists of pertinent articles to source further literature used during this thesis's general writing, and this technique was fruitful.

Several PETTLEP papers were also found using a basic search. These are presented as part of a discussion specific to designing the mental simulation protocol [for example, Holmes and Collins (2001)].

While the PICO question allowed for a systematic search of the databases, review questions were needed to guide the literature review chapter (Greetham, 2021). The following section outlines these review questions before the literature is reviewed in the subsequent sections.

4.3 Guiding review questions

Several overarching questions guided this review. These were:

- What is the evidence for the efficacy of mental simulation in skill learning?
- What are the knowledge gaps from quantitative, qualitative and mixed-method research in mental simulation in nursing education?
- Does mental simulation help reduce stress and anxiety and/ or does it increase self-efficacy?
- Have mental simulation and CPR or BLS (or life-support skills) been researched, and if so, how?
    - Where are the gaps in life-support specific research?

The questions will be answered throughout this chapter, and the chapter conclusion will overtly show the answers to these questions (section 4.11). Understanding the answers to these questions will help articulate knowledge gaps and place this thesis in the context of the current body of knowledge. This will establish the uniqueness of this study and show the significant contributions the thesis makes. The first part of this literature review examines mental simulation as deliberate practice.

4.4 Mental simulation as a form of deliberate practice

As previously described in section 1.3, mental simulation is defined as the cognitive visualisation of a task with a distinct absence of any overt physical movement (Arora et al., 2011). Mental simulation occurs when one imitates actions in an imaged state but does not trigger the action (Jeannerod, 2001; Kosslyn & Moulton, 2009). The mental simulation of hypothetical events can allow students to contemplate events that have not or may never occur. Images are created in the mind's eye. They can relate to visual images [seeing], emotional [emotions, stress or anxiety] (Holmes & Matthews, 2010) and/ or kinaesthetic [haptic/ tactile] imagery (McNeill, Ramsbottom, Toth, & Campbell, 2020).

Mental simulation is known by many different terms that appear to be, at times, used interchangeably. 'Imagery' (Weinberg, 2008), 'mental imagery' (Ribeiro, Dias, Filho, Cruz, & Fonseca, 2019), 'mental practice' (O'Bryan Doheny, 1993), or 'motor imagery' (Abbruzzese, Avanzino, Marchese, & Pelosin, 2015) are all terms used to describe similar imaginal tasks. The author uses the term mental simulation for two main reasons: 1) it is a recognised name for this method of learning, and one used in Holmes and Collins' (2001) seminal paper on PETTLEP imagery, and 2) mental simulation has the potential to be a nurse education SIT (simulation and immersive technology) strategy (Wakefield, Smith, Hogard, Ellis, & Parry, 2020). Therefore, using recognisable cross-cutting language would seem pragmatic in an attempt to gain traction within this nurse education domain.

Mental simulation has been well researched and has shown positive effects on learning skill performance (Smith, Wright, & Cantwell, 2008) and cognitive tasks

(Wright & Smith, 2008). Mental simulation is a well-established method of deliberate practice in sports and exercise sciences. Numerous studies show the benefits of a mental simulation in skill acquisition, with and without physical practice. However, mental simulation is especially effective when combined with physical practice (Björkstrand & Jern, 2013; Chamanian, Rafei, Nezakat, & Salehi, 2018; Kraeutner, MacKenzie, Westwood, & Boe, 2016; Battaglia et al., 2014). This effect occurs because physical practice is thought to generate the internal "feedback necessary to update the motor plan based on an error detection and correction mechanism" (Kraeutner et al., 2016, p. 261). However, Kraeutner et al. (2016) conclude that mental simulation skill acquisition can occur without prior physical practice. This finding suggests that the motor plan necessary to execute a skill [such as BLS] can be generated without physical practice.

It does seem that some form of memory experience is necessary, and these memories get stronger the more they have been experienced. This experience could be described as a dose-response relationship (Paravlic et al., 2008). The more something is seen, felt [emotionally] or touched, the more likely the memory of that thing will be recalled. Beilock and Lyons articulate this when they conclude:

> *Thus, the ability to differentiate action orientations (suggesting one is representing sensorimotor information associated with the objects and individuals they are reading about) is not just a function of general domain knowledge but is dependent on specific experience one has performing the actions and interacting with the objects in question.*
>
> (Beilock & Lyons, 2009, p. 28)

The author used this understanding and incorporated a point-of-view film into the protocol (see chapter 6). The film was created to allow less experienced participants the opportunity to create memories ready for mental simulation.

Mental simulation is based on the 'simulation theory of action' (Jeannerod, 2001). This theory suggests that the observation (of action), imaging, and understanding of motor action, will activate the same neural networks involved in the motor execution of the same action. While these states differ, there is a partial overlap between covert and overt action (Jeannerod, 2001). Neuroimaging studies have revealed that mentally simulated images and actual motor execution shared equivalence in functional neuroanatomy (Zhang et al., 2011). Essentially, imagining the task can have a similar effect on learning as actually executing the task, as it shares neural and behavioural similarities to the actual experience (Cummings & Williams, 2012).

The primary assumption of mental simulation is that the representations stored in memory during mental simulation can later guide the performance of the corresponding real-world activity (Kosslyn & Moulton, 2009). This theory is known as the 'functional equivalence' of mental simulation (Holmes & Collins, 2001). Mental simulation shares:

> *neural networks with major cognitive functions such as language, memory, and movement depending on the nature of the imagery task*
> (Hall, 2002, p. 467).

Dual code theory explains how images are evoked in mental simulation, and is discussed in the next section.

4.4.1 Dual code theory

Dual code theory (DCT) explains how mental simulation script language and cues are turned into the images used in the simulation experience. DCT is based on the empirical work of Allan Paivio and colleagues. As Clark and Paivio (1991) describe here that:

> *The underlying assumptions of DCT concern basic mental structures and processes: the structures are associative networks of verbal and imaginal representations, and the processes concern the development and activation of those structures, including the effects of context on the spread of activation among representations.* (p. 151)

Memory and memory retrieval functions use two systems. These are verbal (logogen/ language) and non-verbal (imagen/ images) memory representational units (Paivio & Csapa, 1973). The imagen system specialises in representing and processing information from nonverbal objects. In comparison, the logogen system specialises in representing and processing information dealing with language. Clark and Paivio (1991) argue that representation and processing within and between the two systems explain knowledge, meaning, and memory. This evocation appeared to activate a network of representational links. The representational link between the two systems is essential for mental simulation. The thoughts and memories (of previous cardiac arrest experiences) have high associative strength to the visual images (Lang, 2014) and are evoked for use in simulation.

Clark and Paivio describe how imagens piece together to build a complete image (scene):

Imagens correspond to natural objects or object parts, or groupings of objects, which can become simultaneously available to build a mental image (of somebody's face, of my living room, of an action, etc.)
(Clark & Paivio, 1991, p. 1420)

This piecing allows the script narration cues to evoke full scenes, such as a cardiac arrest. The corresponding role of two unique but interrelated visual and verbal systems are at the centre of DCT. These two systems are functionally and structurally independent but interconnected (Paivio, 2014; Paivio & Csapa, 1973). DCT is represented in diagram 7 below:

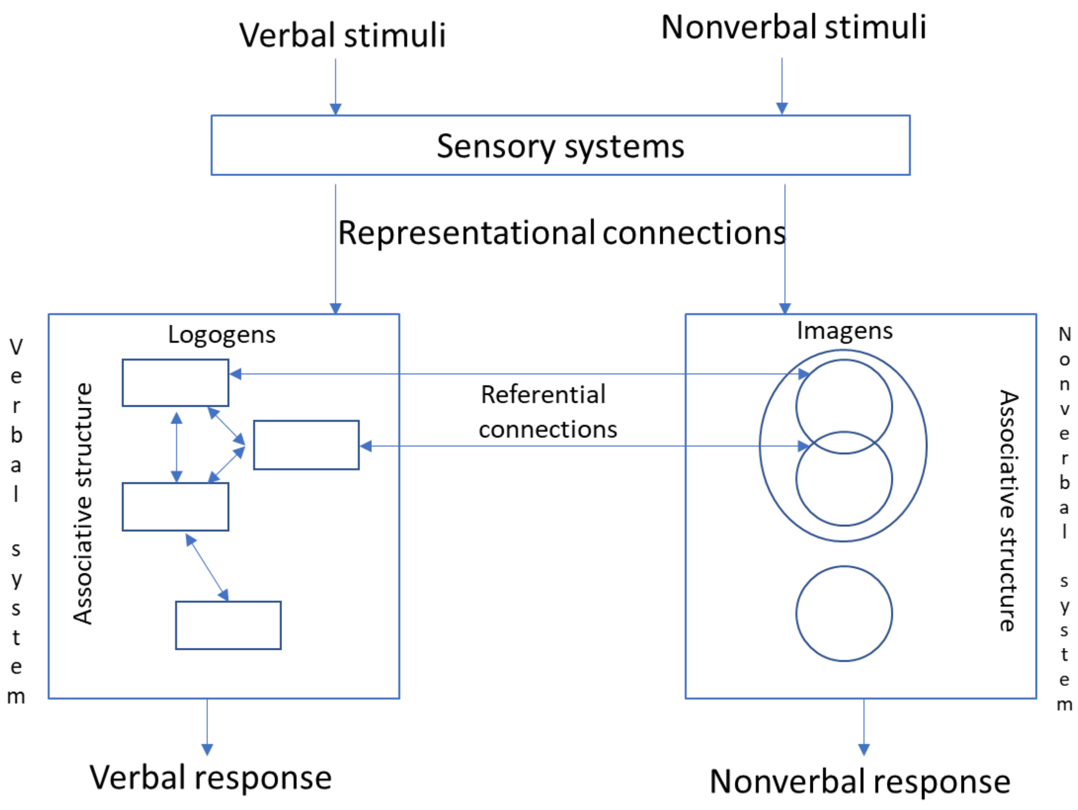


Diagram 7: Dual Code Theory model (Paivio 1986 in Paivio 2006)

Structural model of dual coding theory showing the representational units and their referential and associative interconnections. The referentially unconnected units correspond to abstract-word logogens and "nameless" imagens, respectively
(Paivio, 2006, p34)

As well as creating 'visual images,' mental simulation can also cause higher states of arousal created in the 'mind's emotional eye' (Ji, Heyes, McCloud, & Holmes, 2016). Visual images can evoke an 'emotion-evoking stimulus' (Lang, 2016). As Paivio suggest here:

> *"[T]he language system is peculiar in that it deals directly with linguistic input and output (in the form of speech or writing) while at the same time serving a symbolic function with respect to non-verbal objects, events, and behaviours. Any representational theory must accommodate this dual functionality."*
> (Paivio, 1986, p. 53)

For example, it is:

> *[P]ostulated that a mental imagery representation of an emotionally charged stimulus (e.g., a spider) activates an associative network of stored information that overlaps with that activated during actual experience of the stimulus in reality (e.g., encountering a live spider).*
> (Ji, Heyes, McCloud, & Holmes, 2016, p. 703)

When the script matches the relevant emotional memory trace, and one is instructed to imagine their active participation, the imager captures an equivocal response (Vrana, Cuthbert, & Lang, 1986). For some, this emotional imagery has the potential to be powerful enough to create a 'somatovisceral response' (Ji, Heyes, McCloud, & Holmes, 2016; Roberts & Weerts, 1982), such as sweating or raised heart rate.

Much of the research and literature above has its origins in sports science and sports psychology. In the section below, mental simulation and sports science are further explored.

4.5 Mental simulation: drawing from sport and psychology

In this section, there will be a discussion of mental simulation and sports science.

Several meta-analyses were identified in the search (see appendix 3, section 17.3) and discussed. The section ends with a discussion of mental simulation script/ protocol design framework, PETTLEP, initially designed by sports psychologists for use in the sports performance research paradigms. Mental simulation can be part of a broader set of cognitive techniques. These are known generally as mental rehearsal methods. This section on sports begins with a brief examination of mental rehearsal.

4.5.1 Mental rehearsal in sports

It is necessary to distinguish between mental simulation (as defined above) and mental rehearsal (or mental preparation). Driskell et al. (1994) and Rai (2021) suggest that the outcome of mental rehearsal is to enhance performance, as it is with mental simulation. However, as well as mental simulation, mental rehearsal includes additional techniques such as *psyching up* and/ or *psyching down strategies*, *motivational*, *attention focusing*, *relaxation*, *self-efficacy statements,* and other forms of cognitive or emotional preparation before performing a task. These psychological techniques for improving performance are potentially valuable in future nurse education research. However, the author decided to focus on mental simulation in this research. This technique resembles physical simulation and focuses on learning technical skills instead of cognitive or emotional preparation. However, these are areas of interest to the author for future research projects.

As this research will not incorporate the broader mental rehearsal techniques, it is crucial to provide an overview of the current mental simulation discourse.

4.5.2 Mental simulation in sport and other domains

Mental simulation is one of the most researched topics in sports psychology research (Toth, McNeill, Hayes, Moran, & Campbell, 2020). For this reason, meta-analysis and systematic reviews over the last 5-years were searched, with three found that fit the search criteria (Lindsay, Larkin, Kittel, & Spittle, 2021; Simonsmeier, Androniea, Buecker, & Frank, 2020; Toth et al., 2020). One more paper was obtained (Schuster et al., 2011) that did not fit the specific criteria but was an intriguing paper that examines mental simulation in 5-domains, including healthcare and sport. This paper is referred to in several sections of this thesis. Please see table 5 for an overview of the sport-specific mental simulation reviews.

Overall sport-specific meta-analyses suggest that mental simulation positively affected the performance of sport-specific motor skills, as determined by the outcome and process measures in terms of effect sizes (see the end of table 5 for details of effect sizes). Simonsmeier et al.'s (2020) meta-analysis explored the extent of the current understanding of the effectiveness of mental simulation on any sport-specific outcomes. Simonsmeier and team searched PsycINFO and PubMed databases which yielded *n*=55 publications that matched their criteria. The overall effect of mental simulation interventions was medium in magnitude with an effect size of *d*= 0.431 ($p < 0.05$). It was concluded that across all outcomes, mental simulation, when combined with physical practice, was more effective than physical practice alone, indicating differential effects of mental simulation combined with physical practice. Simonsmeier and team argue that the effectiveness of mental simulation was positively associated with the intensity of the mental simulation training in a dose-response relationship.

Toth et al. (2021) later found similar results in their meta-analysis. Following publication bias analysis, Toth and colleagues' results confirmed that that overall, mental simulation had a small, but significant positive effect on performance (r= 0.131, p= <0.05)). As with Simonsmeier and colleagues, Toth found that mental simulation and physical practice improved performance significantly with an effect size of r= 0.240 (p <0.001). However, they also found that mental simulation alone also had a significant positive effect on performance with a magnitude of r= 0.205 (p <0.001).

Furthermore, Lindsay, Larkin, Kittel, & Spittle (2021) once again showed similar results in terms, with an overall effect sizes g= 0.476 (p <0.05) on the [erformance of sports specific motor skills. In their study, Lindsay and team examined the overall effectiveness of mental simulation programmes for developing sport-specific motor skills. Unique to this study were results suggesting that mental simulation was equally useful for novices and experts. They concluded that mental simulation programmes significantly improve performance across both novice and skilled participants (Novice; g= 0.912; 95% CI [0.600- 1.222] p <0.001 / skilled; g= 0.567; 95% CI [0.329- 0.805] p <0.001).

Lindsay also showed similar results to Simonsmeier and Toth, revealing that there was a significant impact on skill performance following practice using mental simulation combined with physical practice, with an effect size of g= 0.868 (95% CI

[0.603-1.133] $p < 0.001$). As with Toth's study, mental simulation alone showed a significant positive effect on performance with a magnitude of $g= 0.612$ (95% CI [0.317-0.907] $p < 0.001$). This is promising as it suggests a potential for mental simulation to create opportunities for repetitive practice in life-support and cardiac arrest skills in healthcare education where pre-registration nurses do not routinely get the opportunity to undertake extra physical practice outside of mandatory training.

These research findings are encouraging for the potential of mental simulation in learning life-support education. However, it is unclear from these studies if mental simulation can offer pre-registration nurses an authentic experience. The author suggests that the answer may lie in qualitative research studies that examine the end-user's mental simulation journey. Unfortunately, qualitative studies in sports are at a premium. Several qualitative studies appeared during the literature searches, but the focus of these papers was not directly related to this study. For example, the studies included rehabilitation from a sports injury (Driediger, Hall, & Callow, 2006), meta-imagery [thinking or awareness of one's imagery] (MacIntyre & Moran, 2007), or functions of mental simulation in elite sports (Bernier & Fournier, 2010). There were no critical reviews of the qualitative research in sport, perhaps as there appears to be little homogeneity between the qualitative studies. Overall, there is a significant trend towards positivist mental simulation research in sport (this parallels healthcare simulation, as seen below). The next section examines functional equivalence as the basis for the PETTLEP framework, which originated from the sports psychology domain.

Table 5: Sports/ general mental simulation systematic reviews and meta-analysis

First author	Subjects/ numbers/ aims	Methods / data bases	Findings
Lindsay (2021)	*n*= 36 publications with *n*= 1449 participants (sport) The purpose of this paper is to examine the overall effectiveness of mental simulation programmes for developing sport-specific motor skills and investigate programme principles that may moderate the efficacy of mental simulation programmes, such as practice type, skill level, skill complexity, performance measures, duration, practice setting, and session frequency	Systematic review and meta-analysis SPORTDiscus, PubMed, Medline, PsychInfo, and SCOPUS	Mental simulation had an overall significant, positive effect (effect size: *g*= 0.476- medium effect) on the performance of sport-specific motor skills, as measured by the outcome and process measures. Mental simulation delivery type revealed a significant impact on skill performance following practice using mental simulation + physical practice *g*= 0.868 (95% CI [0.603-1.133] p <0.001) and mental simulation alone *g*= 0.612 (95% CI [0.317-0.907] p <0.001). [when corrected for publication bias: Duval and Tweedie's trim-and-fill correction- the overall effect of mental simulation + physical practice was adjusted and becoming small but significant *g*= 0.579 (p <0.001) and mental simulation alone still showed a small significant effect *g*= 0.298 (p <0.001) on performance outcomes. For the moderator variable skill level subgroup analysis revealed that mental simulation programmes significantly improve performance across both novice and skilled participants (Novice; *g*= 0.912; 95% CI [0.600- 1.222] p <0.001) (Skilled; *g*= 0.567; 95% CI [0.329- 0.805] p <0.001).

			Mental simulation has a significant positive effect on sport-specific motor skills for programmes 3 days – 1 week *g*= 0.909; (95% CI [0.249- 1.568] p <0.05), 1–3 weeks *g*= 0.823 (95% CI = [0.547- 1.099] p <0.05), and 4–6 weeks *g*= 0.817 (95% CI = [0.556- 1.077] p <0.05). Mental simulation practice had a significant impact on skill performance when implemented for 2–3 days/ week *g*= 0.840 (95% CI [0.579 - 1.101] p <0.001), 4 – 5 days/ week *g*= 0.697 (95% CI [0.274- 1.119] p <0.001), and 6 + days/ week *g*= 0.660 (95% CI [0.199, 1.121] p <0.001) sessions per week.
Simonsmeier (2020)	*n*=55 publications (sport) This review and meta-analysis aimed to extend the current understanding of the effectiveness of mental simulation in sports on any sport-specific outcome and the relevance of additional variables potentially moderating the effect.	Systematic review and meta-analysis PsycINFO and PubMed	Effects of mental simulation are dosage specific. The results suggest that the more sessions are employed, the more effective the mental simulation intervention. The overall effect of mental simulation interventions was medium in magnitude with *d*= 0.431 (95% CI [0.298- 0.563]). Across all outcomes, mental simulation combined with physical practice was more effective than physical practice alone, indicating differential effects of mental simulation and physical practice. The effectiveness of mental simulation was positively associated with the intensity of the mental simulation training.
Schuster (2016)	*n*=133 publications (sport, music, medicine, psychology, and education)	Systematic review An extended, systematic	The publication gives an overview of successful elements of mental simulation, for example, body position, location, instruction medium and perspective.

	This review aimed to identify the characteristics of a successful mental simulation and compare these for different disciplines, mental simulation session types, task focus, age, gender, and mental simulation modification during the intervention (this study was included due to the frequency that it was discussed in other papers, although it was outside of the publication date inclusion and exclusion criteria).	literature search using 24 databases was performed for five disciplines: Education, Medicine, Music, Psychology and Sports	The analysis considered the differences in specific disciplines (Education, Medicine, Music, Psychology, Sports), mental simulation integration types (added/embedded), session types (individual/group), the focus of the task (motor, cognitive, strength), age, gender groups (female, male, both) and change in content, duration, and dosage. This review aimed to identify the characteristics of a successful mental simulation and compare these for different disciplines, mental simulation session types, task focus, age, gender, and mental simulation modification during the intervention. Body position was task-specific. Participants received acoustic detailed mental simulation instructions, primarily standardised and live. During mental simulation practice, participants kept their eyes closed. Mental simulation training was performed from an internal perspective with a kinaesthetic mode. Changes in mental simulation content, duration and dosage were reported in thirty-one (31) mental simulation interventions. Familiarisation sessions before the start of the mental simulation intervention were mentioned in 17-reports. Mental simulation interventions focused with decreasing relevance on motor-, cognitive- and strength-focused tasks. The average study

			intervention lasted 34-days, with participants practising mental simulation on average three times per week for 17-minutes, with thirty-four (34) mental simulation trials. The average total mental simulation time was 178-minutes, including thirteen (13) mental simulation sessions.
Toth (2021)	*n*= 37 publiations (sports) This publication reports a methodological replication of the methods of Driskell, Cooper, and Moran (1994)	Meta-analysis This study is a meta-analysis that followed the methods of Driskell, Cooper, and Moran (1994) Web of Science, PsycINFO, PsycARTICLES and SportDiscus databases.	Following publication bias analyses, their results confirm that overall, mental simulation has a small but significant positive effect on performance (r = 0.131). Moderators of this beneficial effect were mental simulation duration, type of task and type of mental simulation used. Mental simulation and physical practice were shown to significantly improve performance (r= 0.240, p <0.001) with 86 of the 115 effects analysed (74.8%) Both physical (r= 0.438, p 0.010) and mental (r= 0.205, p <0.001) practice had a significant positive effect on performance While the effect of physical practice on performance was larger than the effect of mental practice, the magnitude of this difference (r = 0.262, 95% CI [-0.084, 0.608]) was not significant (p 0.138) Results indicated that mental practice positively improves performance across the remaining levels of expertise (Novice; r= 0.232, p 0.004) (Intermediate; r=

			0.110, p 0.116) (Advanced; *r*= 0.261, p 0.001) and significantly so for novice and advanced performers The variability between subgroups was not heterogeneous, suggesting that effect sizes were not different (p 0.234). Although mental practice positively increased performance to a greater degree in advanced performers relative to both intermediate (p 0.143) and novice (p 0.780) performers, the differences were not significant

*Some of the results and findings are taken verbatim from the reports for accuracy of reporting and are not intended to plagiarise other peoples' work or take credit for their work- the work is fully referenced

***** (effect size caluculations)***
***d*= Cohen's d**
***r*= Pearson's r**

Effect size	**Cohen's *d***	**Pearson's *r***
Small	0.2	0.1 to 0.3 or -0.1 to -0.3
Medium	0.5	0.3 to 0.5 or -0.3 to -0.5
Large	0.8 or greater	0.5 or greater or -0.5 or less

Cohen's *d* can take on any number between 0.0 and infinity, while Pearson's *r* ranges between -1 and 1 (adapted from Bhandari, 2021). These measures represent the magnitude of the differences measured between groups.

4.5.3 Functional equivalence and PETTLEP (sports psychology and neuroscience origin)

Although initially considered for explaining emotional imagery in cognitive psychology and behavioural therapy, Lang's (1990) seminal work on bio-informational theory of emotional imagery explains some mental simulation mechanisms. Bio-informational theory is a theoretical explanation of how mental simulation can improve performance. According to bio-informational theory, knowledge is symbolised in one's memory as processed abstract units of information regarding objects, relationships, and events (Lang, 1979). This concept is known as 'memory imagery'. Lang proposes that a mental image representation of a stimulus will activate and cause the retrieval of stored memories. Images are created and stored in long-term memory as a set of 'stimulus propositions' linked to 'response propositions' with stronger connections made if 'meaning propositions' are also included (Kent, 2007).

These imagery memories overlap those activated during the experience. Bio-informational theory has the interaction of three different factors that should be included in any mental simulation script design: 1) the environment in which the skill is to be performed [stimulus], 2) what is felt by the performer as the skill is being performed [response] and 3) perceived importance to the learner [meaning] (Hodges & William, 2012). Hodges and Williams further suggest that response to the stimulus is especially significant when undertaking mental simulation. This part reflects how the individual is meant to behave, which will aid in learning. Stimulus> response> meaning cues in mental simulation scripts are crucial for creating high-fidelity imagery (Wakefield et al., 2020). The PETTELP framework for developing mental simulation scripts was created based partly on Lang's (1979) bio-informational theory of emotional imagery.

The PETTLEP model for mental simulation is based on seven factors and considerations (physical, environment, task, timing, learning, emotion, and perspective). PETTLEP is based on the theory and research outcomes of neuroscience (Collins & Carson, 2017) and is grounded in the concept of functional equivalence (Holmes & Collins, 2001) as explained in more detail in section 4.4. PETTLEP is a framework that can develop a mental simulation script. PETTLEP acts as a systematic framework to help build mental simulation scripts high in sensory cues. PETTLEP aims to deliver practitioners with a set of guidelines that can aid in their functionally equivalent imagery (Smith, 2010). See table 6 below for an overview of the features of PETTLEP.

It is argued that for more significant functional equivalence, the end-user should create the script themselves as it creates greater personal meaning (Holmes & Collins, 2001). However, not all students cannot create their own scripts, as life-support and cardiac arrest experiences are, to some degree, dependent on being in the right place at the right time. Many students will not experience a cardiac arrest during their training. For this reason, the author developed the mental simulation script that was theoretically informed and used students' experiences (discussed further in chapter 6). As previously described, 'fidelity' is critical in simulation and immersive technologies (SIT) [see section 3.6.1]. In mental simulation in healthcare, fidelity is equally important, and it refers to how vivid images are in the mind's eye (Wakefield et al., 2020). The fidelity of images can be described as:

Table 6: An overview of the feature of PETTLEP (based on Collins and Holmes, 2001; Smith, 2010)

Acronym	Description
P= Physical	The physical element is arguably the essential PETTLEP component. Here mental simulation is conceptualised as a physical process, and the audio-guided mental simulation script should be as descriptive of the physical elements of the task as possible. Mental simulation is often performed in the location where actual execution is performed, wearing the same clothing worn during actual execution.
E= Environment	The environment element relates to the place where the mental simulation is performed. If this is not possible, then pictures or videos of the environment should help create a mental simulation of the venue.
T= Task	The content of the task being learned should be appropriate for the learner, and this level will likely alter as learning and skill levels increase.
T= Timing	The timing element refers to whether the task is imagined in a slowed down or real-time environment.
L= Learning	The learning element emphasises that the content of the mental simulation exercise should be tailored in response to learning. As the learner learns more, the script's content should alter to offer new challenges.
E= Emotion	The emotional element considers the emotions that go with the task being learned. If the task is laden with emotion, so should the script and the mental simulation.
P= Perspective	Perspective refers to the viewpoint of the performer during mental simulation. This aspect can be in the first-person, i.e., through the performer's eyes (aka internal perspective) or the third-person, i.e., seeing oneself performing as if watching TV [aka external perspective].

an individual's capability of forming vivid, controllable images and retaining them for sufficient time to effect the desired imagery rehearsal
(Morris, Spittle, & Watt, 2005, p. 60).

Image fidelity helps create an immersive and believable experience, and the higher the fidelity of the image in the 'mind's eye', the greater the potential for functional equivalence (Holmes & Collins, 2001). As highlighted above (section 4.4), functional equivalence (FE) is a fundamental aspect of mental simulation. It makes sense then that any mentally simulated event must be as close to being functionally equivalent to actual execution as possible.

Whilst the research for mental simulation in sport-specific motor skills shows a significant positive effect with a medium magnitude, it cannot be assumed that this also applies to healthcare. Therefore, the author will discuss current healthcare mental simulation research in the next section.

4.6 Healthcare mental simulation

There has been much research on mental simulation and the performance of skilled tasks within healthcare education. However, most of this research appears in medical education, primarily in surgical skills training. Over the last three decades, some research has been performed within nurse education. As with sports-specific research, most healthcare studies have been performed within the positivist paradigm, which is explored further below, beginning with mental simulation within nurse education.

4.7 Mental simulation in the nurse education domain

In this section, the author offers a critical review of the mental simulation nurse education research. Despite the apparent potential of mental simulation in nursing, little has been published (Wakefield et al., 2020). Nursing research in mental simulation mainly appears confined to the 1980s and 1990s, with sporadic recently published research. Several nursing mental simulation experiments have been undertaken, but these have shown mixed results, with the research having some methodological limitations. This literature review will begin with two mental simulation studies that focus specifically on CPR skill acquisition as the subject is aligned with this thesis. See table 7 below for an overview of these studies.

4.7.1 Mental simulation and CPR training

Two previous studies have looked at a combination of mental simulation and learning cardiopulmonary resuscitation (CPR) skills, and these are presented below. Bachman (1990) undertook a study of (*n*=22) registered nurses who used mental simulation to learn CPR skills. The study used a mixed-methods approach to determine how interesting and helpful the mental simulation technique was. The study also examined whether mental simulation objectively improved CPR proficiency. Bachman suggested that several elements of CPR skills showed significant improvement compared to the control group. However, there were quantitative methodological limitations within this study. For example, the sample size was likely underpowered [no power calculation was offered (Greenhalgh, 2019)], no effect sizes or p values were offered, meaning that it is difficult to gauge the magnitude of any changes in the intervention groups, so the quantitative results should be viewed with much caution. The qualitative findings suggest that mental simulation was well-perceived as a technique for learning CPR skills, but there were also significant qualitative methodological limitations. For example, there was no discussion of the methods used to analyse the data, and the qualitative data were quantified with no explanation as to why.

In a recent study, Fountouki et al. (2021) performed an objective comparative control study into the use of mental simulation for learning CPR skills. Fifty-two (*n*=52) nursing assistant students were randomly assigned to a mental simulation intervention group or a control group (instructional video). The outcome of this study showed that fewer mistakes were made in the intervention group than the control. Overall the total number of CPR mistakes was 4.2 (mean) for the mental simulation group vs 5.5 (mean) for the control group (all significant with p values < 0.05). Furthermore, students in the intervention group also completed post-intervention training quicker, p <0.05 [intervention= 6.3 mins [95% CI 5.6-6.8 mins] v control 8.5 mins [95% CI= 7.7-9.2 mins]. Although significant, no effect sizes were offered, so it is difficult to gauge the magnitude of this difference. These are encouraging findings for mental simulation in learning CPR skills.

However, the Fountouki study does appear to have some significant limitations. For example, no power calculations were made. It was unclear why mistakes and 'time for completing training' were used as outcome measures. Nor is it clear how mistakes were defined, assessed or who assessed. It is difficult to understand why the accuracy of the technique was not used or whether 'mistakes' and 'accuracy' were categorised as the same thing. Furthermore, specific manikin models can objectively and accurately measure CPR quality. However, it was unclear whether digital assessments were made in this case. There was no attempt to describe how the script was designed or delivered to participants. This makes this study and its results challenging to replicate. The research, whilst promising, does have to be approached with some caution, and this is further explored in relation to future research in section 15.7.

Mental simulation and life-support skills have not been explored in greater depth outside of these two nursing research studies. However, other areas of mental simulation and nurse education have been explored, including skill acquisition of other technical skills, mental simulation for stress management, and whether mental simulation can increase self-efficacy. These are explored in the following sections.

4.8 Skill acquisition, stress management and self-efficacy using mental simulation

4.8.1 Skill acquisition

Further mental simulation research has examined nursing skill acquisition. For example, Bucher (1993) and Wright, Hogard, Ellis, Smith, and Kelly (2008) have shown that mental simulation improved skill acquisition after regular use. Bucher's randomised controlled trial (RCT) randomised participants into a physical practice, mental simulation, or a combined physical practice and mental simulation group. They showed that the mental simulation + physical practice group performed better than mental simulation alone; however, there was no statistical difference ($p > 0.05$) between mental simulation + physical practice and physical practice alone, differing from the results shown in the sport-specific meta-analysis. There were, however, several limitations to this study, with the main concern being that it was likely underpowered, which could have led to a type II error.

Wright et al. (2008) used an experimental design with a control group to examine the effects of a PETTLEP based script for learning blood pressure taking and aseptic techniques. Wright and colleagues could only show that mental simulation enhanced blood pressure monitoring skills ($p < 0.05$), but not the aseptic technique (p 0.69). They used locally-devised OSCEs checklists to measure success. One-way ANOVA showed that the PETTLEP imagery group score was statistically significant on the blood pressure measurement OSCE, $F(1,36) = 4.62$ (p 0.038). Whereas, the one-way ANOVA test revealed that the PETTLEP imagery group did not score significantly higher, $F(1,16) = 0.17$ (p 0.69) in aseptic technique [an F-statistic is the ratio of two variances. Higher variances arise when the individual data points tend to fall further from the mean (Frost, 2022)]. This research was a pilot study, so this data should be interpreted with some caution. This study was likely underpowered, with no discussion of a power calculation. No effect sizes were described for the magnitude of performance differences in blood pressure monitoring. There appeared to be no follow up study yielded from the literature searches.

Ignacio et al. (2017) undertook a further mixed-methods study, looking at mental simulation for clinical emergencies. They compared mental simulation with the pneumonic ‘A, B, C, D, E’ (A to E) assessment. However, there was no significant difference between the intervention and control groups regarding performance and no significant difference in reducing stress levels. The participants did subjectively report being mentally and emotionally prepared for clinical emergencies, which they felt would enhance real-world practice. In contrast, Speck (1990) used a self-reporting anxiety scale on *n*=26 first-year novice nursing students after using a guided mental simulation script to learn an injection technique. The study findings showed that using 'imagery' (mental simulation) reduced anxiety around delivering injections. This measurable reduction in stress could have been down to the relaxation methods included in the protocol and not the mental simulation itself.

Other nurse education studies included O'Bryan Doheny (1993), who undertook a mixed-methods study with an RCT and semi-structured interview design where *n*=95 pre-registration nurses were studied. The RCT design looked at mental simulation ability and the link to learning successfully from mental simulation. The study showed that acceptable performance was more common in higher imagery ability students. Higher fidelity imagers were 20% more likely to have an acceptable performance than low fidelity imagers, although this was only marginally significant (p= 0.51). This stands to reason, as imagery ability is linked to performance through functional equivalence (FE) (Holmes & Collins, 2001) as described in section 4.5.3. The higher the fidelity of the images, the greater the chance of learning through the activation of brain areas, equivalent to learning through physical practice.

As described at the opening of this section, stress, anxiety, and self-efficacy were also measures within nurse education research, explored in the following section.

4.8.2 Stress, anxiety and self-efficacy

Mental simulation helped reduce anxiety around delivering skills (Speck, 1990) and showed that repetition increased the fidelity of images (Eaton & Evans, 1996) which can increase FE (Holmes & Collins, 2001). Saeidikia, Vagharseyyedin, Danaie, & Tabiei (2020) performed a randomised control trial with n= 68 nursing and midwifery students to examine whether mental simulation could increase skill and self-efficacy in a nasogastric tube (NG) placement. The control group practiced a routine nasogastric tube insertion. They concluded that mental simulation enhanced NG insertion skills (a checklist comprised 15 items, the total score ranged between 0 and 10, experimental 8.59 v control 7.22, $p < 0.05$). However, no effect size was offered to show the magnitude of this difference.

However, self-efficacy scores were higher but not statistically significant when compared with the physical practice control. One inference that can be made here is that physical practice and mental simulation scores were similar [(mean scores Learning Self-Efficacy Scale (L-SES), scoring 1-80), experimental 43.65 v control 40.32 (SD 1.7, $p > 0.05$)]. This outcome adds some weight to mental simulation being another form of enactive mastery experience in enhancing self-efficacy (Bandura, 1986) [before intervention score 41.15, although no p-value was offered for this difference]. While measuring mental simulation against physical practice seems intuitive, it is actually counter-intuitive as mental simulation is not designed to replace practice but to augment it. Therefore, having no significant difference between physical practice and mental simulation could be seen as a positive outcome from this study.

Stress levels and mental simulation were researched with contradictory findings. Ignacio and colleagues undertook two mental simulation studies (Ignacio et al., 2016; Ignacio, Scherpbier, Dolmans, Rethans, & Liaw, 2017). In 2016, Ignacio and colleagues undertook a mixed-methods study (observation and focus groups) to study mental simulation and relaxation techniques to improve clinical performance and reduce stress during simulated emergencies. The study included n=18 (n=5 in the focus group) pre-registration students. Paired t-test was used to evaluate any change between pre- and post-test measures. This study objectively showed that both physical and mental simulation positively affected performance. After mental simulation, there was a significant performance improvement, with pre- and post-tests showing significant improvement (t =−2.52, p 0.05), assessed using the Rescuing A Patient In Deteriorating Situations (RAPIDS) tool.

However, there was no significant difference in the objective reduction of stress levels (p 0.484), using blood pressure (t = 0.000, p 1.000) and heart rate (t = 0.715, p 0.484) measures, and the State-Trait Anxiety Inventory (STAI) [STAI results did not show significant differences between pre- and post-test trait anxiety (t= 0.460, p 0.652)]. Disappointingly, there was a significant methodological flaw with no control group to compare the findings. Only pre- and post-test assessments were made on one group. However, despite the objective findings not being statistically significant, some participants subjectively reported lower stress and anxiety levels during the focus groups. Qualitatively understanding why stress and anxiety might be reduced through mental simulation is not addressed in the current suite of nursing research (or medical research below). Stress and anxiety could feel more significant in life-support and cardiac arrest emergencies due to the perceived magnitude of the situation. This knowledge gap is addressed as part of this research study.

The above studies from nurse education showed mixed outcomes, and all of the studies had methodological limitations. The limitations are summarised below in section 4.9.5. The following section offers a critical review of mental simulation in medical education.

4.9 Mental simulation in the medical education domain

In this section, the author offers a critical discussion of mental simulation in medical education. The section begins with an inspection of one of the only qualitative studies (Ibrahim, Richardson, & Nestel, 2015). Then, acquisition of technical and non-technical skills, self-efficacy and stress management measures are presented. See table 8 for an overview of these studies.

4.9.1 Mental simulation research in medical education

In their qualitative research, Ibrahim et al. (2015) found that orthopaedic surgeons tended to build strategies and rehearse procedures using informal mental simulation. Ibrahim and colleagues' research is noteworthy because of their interpretivist research design. Few healthcare studies have examined mental simulation from this position. The researchers examined orthopaedic trauma surgeons' strategy planning, and some of this included mental simulation strategies. All surgeons reported using mental simulation to help them plan for each case.

Furthermore, Skervin & Scott (2021) undertook a mixed-methods survey of (*n*= 153) surgeons informal use of mental simulation in the build-up to undertaking operations. They concluded that informal mental simulation is an often helpful adjunct to optimising surgical training. The participants suggested that informal mental simulation increases clarification of steps, confidence, clear thinking, and anticipation—all critical steps for safe practice in surgery. While this is a valuable examination of how surgeons use mental simulation, these studies looked at informal mental simulation as a warm-up for surgery. These were not script-based mental simulation exercises employed to increase learning.

Overall, the Ibrahim et al. findings showed that all surgeons used mental simulation to create sequencing strategies, surgery plans and rehearse unfamiliar procedures. The surgeons all found quiet spaces (sanctuaries) to undertake mental simulation, to be able to focus. While Ibrahim and team did not overtly discuss self-efficacy, it could be argued that mentally rehearsing procedures and creating mental strategies could increase surgeon confidence and self-belief going into theatre. There appears, however, to be a gap in healthcare mental simulation research. These interesting findings still leave a qualitative gap in knowledge that analyses how end-users (students) experience using formal mental simulation- what they learn and how they learn it. To date, no research has qualitatively tried to understand how self-efficacy is generated by undertaking mental simulation. Therefore, part of this thesis will focus on this gap.

While informal mental simulation appears to be a valuable tool in surgery, more formal script-based mental simulation also appears to be well established. However, as with the nursing studies above, there have been mixed results when testing for efficacy. The use of mental simulation has been shown to improve initial short-term skill learning and surgical performance in various surgical skills. The majority of the experimental designs look at the effects of mental simulation on the acquisition of skills through measuring performance.

Several publications focus on surgical [technical] skill acquisition. For example, undertaking a virginal hysterectomy (Geoffrion et al., 2012), mastoid surgery (Conlin et al., 2016), laparoscopic surgery (Arora et al., 2011; Jungmann et al., 2011; Louridas, Bonrath, Sinclair, Dedy, & Grantcharov, 2015; Mulla et al., 2012; Stefanidis et al., 2017), and suturing (Souiki et al., 2021). There were further studies that objectively measured the effects of mental simulation on non-technical skills (Hayter et al., 2013; Lorello et al., 2018) and studies that measured stress markers after using mental simulation (Anton et al., 2018; Louridas et al., 2015; Stefanidis et al., 2017). These will now be examined in more detail.

4.9.2 Skill acquisition: technical skills

Arora et al. (2011) undertook a randomised control trial (RCT) that showed that using script-based mental simulation could enhance the quality of laparoscopic cholecystectomy skilled performance on virtual reality simulators in junior surgeons (*n*=18). A blind objective comparison of the quality of performance, using generic Objective Structured Assessment of Technical Skills (OSATS), was made between an intervention (mental simulation) and control (unrelated activity) groups. This assessment revealed that the mental simulation group were significantly superior to the control group in performance. Each arm undertook five separate sessions over five days. Session 1 (median 20.0 vs 15.0, respectively, p 0.005), session 2 (median 20.5 vs 13.5, p 0.001), session 3 (median 24.0 vs 15.5, p 0.001), session 4 (median 25.5 vs 15.5, p <0.001) and session 5 (median 27.5 vs 19.5, p <0.001). While this study may have been underpowered, it was possible to observe significant differences between the control and intervention groups, although the effect size was not calculated. One of the strengths of this study was that it compared mental simulation to an unrelated activity. This meant there was little contamination from informal mental simulation as the control group performed their activity.

For example, contamination may have occurred in Conlin et al.'s (2016) RCT study into mental simulation and mastoid surgery skills. In this, perhaps underpowered study (*n*=12), they compared mental simulation (intervention) to studying from a textbook (control), with no significant differences. Pre-intervention control [standard deviation [SD]) 11.6 (3.3) v mental practice group (SD) 13.1 (1.8), and post-intervention 12.3 (5.0) v 13.6 (3.0) respectively (p 0.395)]. Control arm textbook study may have sparked spontaneous, informal mental simulation, especially if the textbook contained illustrations. Similarly, Geoffrion et al. (2012) used a textbook control and found there was no significant difference in their study

(n=50) when participants were assessed on a Global Rating Score (GRS). There was no difference in GRS score change via blinded assessment from pre-test to post-test evaluation between groups (mean change 13% [Mental simulation] versus 7% [control], p 0.192).

However, compared to a textbook control, Komesu et al. (2008) showed a significant difference between the two groups in their well powered (n=68) RCT trial. There was a significant difference between the two groups. The mental simulation group's surgical assessment scores were 15.9% higher than the controls (p 0.03). The differences between similarly designed studies might have been down to the detail of the scripts and whether the correct stimulus> response> meaning cues (Lang, 1979) were present. However, none of the mental simulation scripts were shared in the publications, making it impossible to make this judgment.

In Stefanidis et al.'s (2017) RCT trial (n=50 junior surgeons), they showed that the mental simulation group demonstrated almost double performance improvement, on the Test of Performance Strategies-2 (TOPS-2) rating, between the transfer and retention tests compared with the control group (17.8% for intervention vs 10.1% for the control, $p < 0.05$), suggesting that mental simulation can impact retention. This is positive; however, a key criticism of this study is that mental simulation may be continued (informally) between transfer and retention tests, with participants replaying the scenario in their minds. This means the control group did not get the same element of repetition. Whilst this may be a form of contamination and a limitation of the study methodology, in reality, the potential (post-formal mental simulation) informal use of mental simulation highlights a major benefit to healthcare education.

While technical skill acquisition is the most frequently researched area, non-technical (teamwork) skills have also been studied. In the next section, studies on non-technical skill acquisition are presented.

4.9.3 Skill acquisition: non-technical skills

As well as technical skills acquisition in surgery, mental simulation was also used to learn non-technical skill acquisition. For example, Hayter et al. (2013) and Lorello et al. (2018) undertook studies examining whether mental simulation could improve team functioning in a crisis. Hayter and colleagues used an RCT design to see if a 20-minutes mental simulation warm-up improved simulated practice of a clinical emergency for n=40 anaesthetic trainees (medical doctors). There was no significant difference on the Ottawa Global Rating Scale (OGRS) (all tests showed $p > 0.05$ throughout) between the intervention group and the (20-minutes of didactic teaching) control group.

However, Lorello and team used a very similar design for a sample of mixed speciality medical doctors (n=78) who showed significant improvements on the Mayo High-Performance Teamwork Scale (MHPTS) between an intervention group (20-minutes of mental simulation) and control group (20-minutes of didactic teaching). The mental simulation group significantly outperformed the control group, having a strong effect favouring mental simulation group on teamwork behaviour. The median score for the mental simulation group was 21.5, and the median score for the control group was 19 (out of 24) (with a large magnitude, r= 0.67 p <0.01).

It is difficult to say why these two similarly designed studies showed differing results. The first difference is the sample size, with Lorello's study being almost double the sample size of Hayter's. Whilst Hayters' study only used doctors (anaesthetists), Lorello's study used a broader range of specialities which is more representative of a team; however, neither used what could be described as an accurate multi-disciplinary team make-up. Both studies used different assessment scales. However, the inter-rater reliability of the MHPTS performs similarly to OGRS when novice-novice raters, expert-expert raters, and novice-expert raters are compared (Iwashita et al., 2014, cited in Lorello et al. 2018). As with the previous studies discussed, the main criticism of both of these publications is that little discussion is had on the content of either the control (didactic lecture) or the mental simulation scripts. This means that it is difficult, if not impossible, to appraise the research completely. In the next section, self-efficacy is discussed.

4.9.4 Self-efficacy

As well as examining skill acquisition, the Geoffrion et al. (2012) study also analysed mental simulation as a tool for increasing self-efficacy beliefs (as with the Saeidikia et al. (2020) study above). Geoffrion and team found that the doctors (n=50) in their study felt more self-confident performing a vaginal hysterectomy (the doctors rated themselves on a self-confidence scale with pre-and post-test vaginal hysterectomy in simulation (mean change 19% [SD 16] mental simulation versus 11% [SD 10] control- textbook reading [p 0.033]. No effect size offered). This is a different outcome to Saeidikia and team's study. As discussed above, this could have been due to the control measures (textbook v physical practice). Furthermore, this could have been down to the detail within the mental simulation script, which was again not accessible for analysis for either study.

Stress management has also been studied within the mendical education domain and this is discussed in the next section.

4.9.5 Stress management

There were mixed results from the research focusing on stress reduction. Anton et al. (2018), Louridas et al. (2015), and Stefanidis et al. (2017) all implemented RCT designs with the six-item State-Trait Anxiety Inventory (STAI-6) to subjectively measure stress pre- and post-intervention. In Anton and colleagues' study (n=23), the STAI-6 scores did not reach statistical significance between groups (p 0.30) and neither did Louridas and team in their study (n=20, p >0.05). These studies were adequately powered (with an α of 0·05 and a power of 0·80) to detect statistically significant differences between the intervention and control group when subjectively measuring stress. Both studies investigated stress in experienced surgeons who may not feel stress like their more junior counterparts. This could mean that a larger sample size is required to detect the more subtle changes in stress levels, or a more sensitive scale may be required to measure the outcomes.

Furthermore, in a more extensive study of (*n*=60) junior surgeons, Stefanidis et al. (2017) found that the participant STAI-6 scores suggested that the mental simulation group experienced less stress than the control group during both the transfer and the retention tests [p 0.05]. However, no effect size is offered, so it is difficult to gauge the magnitude of this difference. Using mental simulation to control stress levels in practice is promising but perhaps not conclusive. Whilst stress levels have been measured in these studies, no study has examined whether mental simulation can reduce anxious thoughts at the prospect of undertaking skills.

There appears to be a gap in the current healthcare research on which this study will focus. Whilst it is beyond the scope of this study to test stress management in practice, it may be possible to understand the process of how anxiety is reduced and the potential for stress control in practice, for pre-registration nurses. Qualitatively researching this will assist in understanding *why* this may happen, giving a deeper understanding of the end-users mental simulation journey- considering how and what they learn. This is currently not particularly well understood within the healthcare education literature.

Whilst there were mixed results from the studies identified, the results from healthcare mental simulation studies overwhelmingly support mental simulation improvements in technical skills, as shown in three recent reviews (Anderson et al., 2021; Gabbott, Tennent, & Snelgrove, 2020; Snelgrove & Gabbott, 2020). Snelgrove and Gabbott's (2020) systematic review concluded that most studies reviewed showed that mental simulation improved technical performance to some degree.

Anderson also concluded that there were notable improvements in surgical performance and increased knowledge compared with traditional learning methods. Gabbott also found that mental simulation can improve technical performance but concluded that the benefits of non-technical skills are less clear. See table 9 for an overview of the studies identified in this review section.

4.10 Reviewed study methodologies critique

Often the research reviewed had methodological limitations. The healthcare studies rarely discussed effect sizes as part of the analysis making it difficult to understand the magnitude of any reported differences. Furthermore, one of the key criticisms of the mental simulation research was that all too often, no detail of the mental simulation script or protocol is provided. This omission may have been due to the authors' feeling that the mental simulation script was their intellectual property that they did not want to share. However, it is not always clear whether a mental simulation script was used, what it comprised of, whether there was a theoretical basis for it (PETTLEP or the like), how the script was developed, and whether or not it was empirically validated. Reproducibility is the cornerstone of experimental research, as it shows the validity and reliability of the research outcomes (Greenhalgh, 2019). It is, therefore, a flaw in the presentation of their research.

Table 7: Nursing mental simulation studies, an overview

First author	Participants/ sample.	Type of mental simulation activity	Study design	Key findings (effect sizes if available and applicable)	Study limitations
1. Bachman (1990)	*n*=22 post-registration nurses	Cardiopulmonary resuscitation (mental simulation script) Skill acquisition and participant experience	Mixed methods approach that looked at whether experienced nurses benefited from mental simulation. There were 2-groups. Control group (no intervention) and treatment group (mental simulation)	• Subjects suggested that mental simulation was useful • The use of mental simulation was well received by the nurses overall. They felt that the use of mental simulation was useful and interesting. • Physical practice was undertaken and augmented with mental simulation • Motivation appeared to be a factor as some participants complained of being bored.	• There is no copy of the questionnaire (it does not outline the data collection method). • No copy or detailed discussion of the mental simulation script is offered • No discussion of how the sample was selected (likely convenience) • No discussion of validation of tools, pilot studies or instruments • The sample size of 22 was too small to see any significant quantitative change, and no power calculation was offered. • No effect size discussion or statistical significance discussion was offered (apart from imagery ability, which was not discussed in the main

					body, only the conclusion) • Dated study, using old guidelines (United States Guidelines)
2. Bucher (1993)	Novice *n*=330 pre-registration female nurses	Glove removal Skill acquisition	A quasi-randomised control trial (RCT) was used A post-test-only control group design The participants were assigned randomly to a physical practice, mental simulation, or a combined mental simulation + physical practice group.	• Mental simulation with physical practice (physical simulation) is found to significantly influence the learning of the skill compared to mental simulation alone. • The mental simulation + physical simulation performed better than the mental simulation alone arm, but not the physical practice alone, • Links the positive effects to dual-code theory learning	• The distribution of scores for the subjects on the Motor Performance Checklist may have been skewed toward the high end of the scale as no tool validation discussion was presented. • No in-depth description of mental simulation script • The study was likely underpowered in each arm. This led to issues rejecting the null hypothesis and the possibility of a type II error • Statistical significance not reached • Dated study
3. Eaton (1986)	*n*=80 pre-registration nurses	Examining imagery ability Enhancement of imagery ability	RCT design Imagery ability was measured, and 2-groups	• Participants with a low imagery ability got better with practice. More practice led to more vivid images	• The study showed that one of the control groups of the study had the same outcomes as the experimental group.

			created 1 x low imagery ability and 1 x higher imagery ability The aim was to see if practice/ repetition would increase image ability Each group received one of two treatments. One group of low imagers received two nonspecific imaging practice sessions; the other group of low imagers and the high imager group received two relaxation practice sessions.	• Subjects with low imagery exposed to imaging practice surpassed the high imagery group (effect size (d) d= 1.00) exposed to relaxation practice in excess of the effect size defined in the hypothesis as the level of significance. • The low imager group exposed to relaxation practice also increased their ability to visualise compared to the similarly treated high imagery group (d= 1.01). • Compared with the high imagers exposed to relaxation, the magnitude of the effect was beyond the 50% level for both low imager groups. However, the effect size was low at only d= 0.04 between the two low imager groups. • The second group of low imagers responded similarly to relaxation practice and showed significant imaging ability gains.	• The definition of low fidelity images was not clear. It appears that what defined the student as a low fidelity imager were scored against each other. This means that all of the imagers could have been high-fidelity imagers or low-fidelity imagers, but some were slightly stronger than others • No description of the mental simulation/ imagery task is offered • Perhaps the practice sessions helped the subjects concentrate. The gains demonstrated by all low imagers may have been due to improved concentration, which was maintained throughout the post-test itself • Dated study

4. Fountouki (2021)	*n*=52 nursing assistant students	CPR and defibrillator skills Skill acquisition	RCT design (Comparative study) Random allocation in two groups. One experimental mental simulation and one control (instructional video) group Measured in terms of undertaking CPR skills training (time to complete) and mistakes made in training	• CPR skill acquisition was stronger in mental simulation group • Students in the intervention group took 6.2 mins to complete training when compared to the control group [8.5 mins] ($p < 0.001$). • Students made fewer mistakes with CPR and defibrillation in the intervention group (p 0.003) • Use of mental simulation is advised when skills need to be learned	• No power calculation was shared, although p values showed statistical significance. • No script was shared to review critically • No description of the video used in the control arm was offered • Unclear why mistakes were used and not an electronic recording of technique through the manikins. • Confusing methods. Unclear when and how long the mental simulation took place. It appears that 'mental simulation' was just recalling the procedure- this would be more akin to rote learning, not mental simulation. • No effect sizes were offered. • Unclear if any of the groups or interviewers were blinded to the study intervention or how the researchers reduced the

					chance of contamination between arms.
5. Ignacio (2016)	*n*=18, year three, pre-registration nurses *n*=5 in the focus group interviews *Pilot study*	Rescue of the deteriorating patient (in simulation) Skill acquisition and participant experience	Mixed methods design: Observation and focus group interviews Rescuing A Patient in Deteriorating Situations (RAPIDS) tool was used to assess performance, post-mental simulation State-Trait Anxiety Inventory (STAI) used to measure of stress/anxiety	• There was a significant improvement in performance after mental simulation: pre- and post-tests revealed that there was a significant improvement in performance (p 0.05), assessed using the RAPIDS tool • No significant difference in the levels of stress pre- and post-test • The participants were better able to assess and manage a deteriorating patient after the mental simulation intervention • Three themes were identified: managing stress, using a mental framework, and using realistic simulations with the mental simulation strategy	• No discussion of analytical methods for the qualitative part of mental simulation was discussed • No discussion of power analysis for the quantitative side of the study • No description of the mental simulation script itself. It is difficult to know if it was designed using an evidence base (for example, PETTLEP, bio-informational theory or dual-code theory). This had a knock-on effect to the Ignacio (2017) study that used this script but found no significant difference between intervention and control • No control, only pre- and post-tests
6. Ignacio (2017)	*n*=32, year three, pre-	Rescue of the deteriorating	Mixed methods design:	• No statistically significant difference between the	• Participants did not appear to be blind to the intervention (raters

	registration nurses *n*=32 individual interviews	patient (in simulation) Comparison between the use of a pneumonic (A to E) and mental simulation Skill acquisition	Observation and semi-structured interviews They were randomly assigned to either a mnemonic or mental simulation group.	pneumonic arm and mental simulation arm of the study • No statistically significant difference between reduction in stress levels • Three themes from the qualitative arm: being mentally and emotionally prepared, recalling and visualising the steps and enhancing actual practice. • Participants found value-added from undertaking mental simulation- it enhanced their learning experience	were, but no discussion of participants) • Tested in simulation, not practice • No power calculation or effect size was offered for the quantitative aspect of the study. • The raters were blinded but only to the participant's identity as the participants wore a cap, gown, and mask. Difficult to know if they were blinded to the group makeup • Little description of the rigour of the coding and theming process shared • Difficult to say that participants using the mnemonic were not visualising as they practiced this aspect • The interview process did not focus at all on the mnemonic – it would have been interesting to understand why this also helped and whether

					informal visualisations were used • No measure for how many times mental simulation was undertaking, meaning the participants could have done it once only- it is difficult to tell
7. O'Bryan Doheny (1993)	Novice *n*=95 Pre-registration nurses	Intramuscular injection (mental simulation script) Skill acquisition and participant experience	Mixed methods study Randomised control-trial (RCT) arm with Students were randomly assigned to one of four groups: control (A), mental practice only (B), relaxation only (C), and combined mental practice and relaxation (D). Quantitative (performance)	• Acceptable performance was more common in higher imagery ability students. Imagery ability (vividness/ fidelity) is linked to performance. • Lower imagery ability students tended to prefer using videos and instructions • In this study, acceptable performance of the injection was more common among high than low imagers regardless of treatment group • Students suggest a combination of physical practice and mental simulation combined is best • Reading about or watching a demonstration enabled them	• No description of the techniques used to create the mental simulation script was offered, and this could have disadvantaged the lower fidelity imagers • No power calculation described • Little discussion of the statistical significance or p-values offered in the paper • No detailed discussion of the mental simulation script • Dated study

			Qualitative looking at perceptions of mental simulation	to use mental simulation more effectively	
8. Saeidikia, (2020)	*n*=68 novice pre-registration nurses	Nasogastric tube insertion Skill acquisition, changes in imagery fidelity, and self-efficacy.	Randomised-control trial (RCT) Intervention group (mental simulation) and a control group (usual nasogastric tube insertion practice) The participants self-assessed as they completed the Revised Movement Imagery Questionnaire (MIQ-R), the Learning Self-Efficacy Scale (L-SES), and a checklist of nasogastric tube insertion skills.	• Using PETTLEP based mental simulation script • The covariance analysis showed that the self-efficacy and its mean difference scores were not significantly different between the groups before and after the intervention ($p > 0.05$). • However, after adjustment, the mean post-intervention scores of nasogastric tube insertion skill and its mean difference were significantly higher in the experimental group than the control group ($p < 0.05$). • After adjustment, the mean score of self-efficacy before and after the intervention and the mean differences were higher in the experimental group. However, the difference was not statistically significant ($p > 0.05$).	• No power calculation discussed • Whilst p-values were offered and statistical significance discussed, there was no discussion of the effect size • The script was not described in detail, but only that it was designed around PETTLEP • Self-efficacy scores are compared to physical practice (control). There is no significant difference, which is positive in this situation- it means one can have the same stress-reducing effect from using mental simulation as from physical practice. This is an enactive mastery experience (Bandura, 1986).

9. Speck (1990)	*n*=26 first-year pre-registration nurses	Injection technique imagery Anxiety reduction in injection techniques	The quasi-experimental post-test design. State-Trait Anxiety Inventory used for self-reporting post-test (post-skill execution) A Kruskal-Wallis on post-treatment and a Biodot stress dot reading was performed. The experimental group received guided imagery instruction by audio cassette tape. The subjects were asked to imagine the injection technique	• Using guided imagery and relaxation techniques reduced anxiety around giving injections • Statistically significant lower anxiety levels by self-reporting (p 0.008) in the experimental group. • No statistically significant differences were found in the Biodot stress dot readings (stress test) (p 0.677), performance times (p 0.130), or performance scores (p 0.774). • Weak evidence for the use of mental simulation to reduce stress levels	• Difficult to understand if the relaxation or the mental simulation that reduced stress. • Low powered study • No discussion of the mental simulation script or how it was created • No discussion of the effect size in the statistically significant aspects • Some evidence that mental simulation does reduce stress, but this evidence is weak • Dated study
10. Wright (2008)	*n*= 56 pre-registration nurses *Pilot study*	Blood pressure (BP) measurement and aseptic technique (AT)	A pilot study, experimental design, with an intervention (mental simulation) vs	• Students who received PETTLEP training for blood pressure measurement performed statistically significantly better than those who did not ($p < 0.05$).	• Pilot study, so limited scope (therefore, no power calculation) • No discussion of the script content (other

		Skill acquisition	control group (training in the normal manner) PETTLEP designed script Measured in Objective Simulated Clinical Assessment (OSCA)	• Enhanced BP measures performance, but not AT ($p > 0.05$). • Results are not conclusive enough to be able to generalise to all nursing (or healthcare) skills • Authors suggest/ hypothesise that BP measurement has a highly skilled motor task (when compared to AT), which could explain the result.	than it is based on PETTLEP) • Little description of the protocol or the control group activity • Some evidence that mental simulation does increase skilled performance, but this evidence is weak
*Some of the results and findings are taken verbatim from the reports for accuracy of reporting and are not intended to plagiarise other peoples' work or take credit for their work- the work is fully referenced					

Table 8: An overview of medical field studies mental simulation studies

First author	**Participants/ sample**	**Type of mental simulation activity**	**Study design**	**Key findings (effect sizes if available and applicable)**	**Study limitations**
11. Anton (2018)	*n*=23 experienced surgeons	Laparoscopic suturing Stress management using mental simulation	RCT design- a control group (no mental simulation) and intervention group (mental simulation) Eight training sessions over a period of approximately 3-months. Mental simulation included arousal and attention management techniques 6-item state-trait anxiety inventory (STAI-6) measured anxiety levels (self-reporting)	• The intervention group performed better than the control group under stressful conditions in simulation (p 0.005) • The mental simulation group performed significantly better than the control group when stressors were first introduced (p 0.005). • Indication that comprehensive mental simulation is effective at diminishing the deterioration of surgical performance under unexpected stressful conditions compared to controls • Regarding physiological stress, there were no differences in heart rate (HR) between or within groups for any of the repetitions for repetition 1 or 2. Still, the control group's average HR was significantly higher than the mental simulation group for repetition 3. • STAI-6 scores did not reach statistical significance between groups (p 0.30)	• Several outcomes were not statistically significant • Self-reporting is not always reliable (although the tool was valid). • While the study was adequately powered (beta= 0.8) to detect a 30% difference amongst groups, the sample size may not have been large enough to detect statistically significant differences between or within groups on other related variables like mental skills, workload, and perceived stress.

			Self-reporting using a Test of Performance Strategies Version 3 (TOPS-3) scores		
12. Anton (2020)	n=21 experienced surgeons	Impact of group mental simulation v individual mental simulation	A pilot study of small group vs individualized training programme (learner engagement with the curriculum)	• Delivering mental skills training individually facilitates greater participant engagement than small group training. Given that there were no significant differences between groups regarding their mental skills use and laparoscopic suturing skill at post-test, the authors conclude that mental skills can be effectively taught in individual or group sessions. • Local resources and trainer availability should dictate the choice of delivery approach.	• A pilot study, so not possible to generalise • No discussion of the script or the curriculum content • Unclear why teams and groups were being tested
13. Arora (2010)	n=10 novice and n=10 experienced surgeons	Laparoscopic cholecystectomy (LC) Mental simulation script validation	Pre- and post-test experimental design Mental imagery questionnaire (MIQ) used as pre- and post-test Validation of mental simulation script was made by assessing	• After mental simulation training, the median MIQ scores of the novice surgeons had improved significantly after mental simulation (p 0.005). This improvement was present for every item/aspect of mental simulation assessed by the questionnaire. • After mental simulation training, experienced surgeons also showed improved median MIQ scores (p 0.007). However, this improvement	• Did not look at technical performance, only look at self-reporting of a broad range of elements, including confidence, the fidelity of the images and whether mental simulation energised the end-users. • No effect sizes were calculated, so difficult to know the magnitude of changes

			whether MIQ scores had increased Offered a detailed look at the mental simulation script design	was significant only in confidence and kinaesthetic imagery. • This study developed and validated a mental simulation script for novel training for laparoscopic surgery. Mental simulation may be a time- and cost-effective strategy that improves surgeons' ability to visualize themselves performing an LC, increasing their knowledge and self-confidence.	
14. Arora (2011)	*n*=18 novice surgeons	Laparoscopic cholecystectomy Skill acquisition	RCT design Two arms, one intervention of mental simulation (*n*=9) and one unrelated activity (*n*=9) Assessed in a virtual reality simulator (VRS) Video recordings were blindly assessed by 2-experienced laparoscopic surgeons and trained raters	• This study shows that mental simulation enhances the quality of performance based on virtual reality laparoscopic cholecystectomy • The use of sensory cues in the scripts is fundamental (in the design). Mental simulation improves with practice • A comparison of the quality of performance (using OSATS) between groups revealed that the mental simulation group were significantly superior to the control group for session 1 (p 0.005), session 2 (p 0.001), session 3 (p 0.001), session 4 (p <0.001), and session 5 (p <0.001). • Successfully demonstrated superior psychomotor performance through the use of a scientifically developed and validated script	• Undertaking mental simulation just before the procedure does not necessarily give you evidence of long-term learning per se. • Assessed in simulation, not in practice • Small sample size • No specific power calculation, only based on previous VRS studies • No effect sizes were offered to show the magnitude of the effect

			using the generic Objective Structured Assessment of Technical Skills (OSATS)-based global rating scale.		
15. Conlin (2016)	*n*=12 senior surgeons from Canadian training programmes	Mastoidectomy surgery Skill acquisition	RCT design They were randomised into two groups. Mental simulation v textbook (control) Changes in pre- and post-test scores using validated expert ratings, the Task Specific Evaluation of Mastoidectomy and the Global Evaluation of Mastoidectomy, were statistically analysed	• On total Task-Specific Evaluation for Mastoidectomy score (primary outcome), subjects in the mental simulation group had a higher post-intervention total score than the Textbook Study group. Still, they did not reach statistical significance (p 0.736). Each group had a non-statistically significant higher total score post-intervention than preintervention (p 0.182). • The authors could not demonstrate a significant difference in the benefits of mental simulation in mastoidectomy, possibly due to the sample size. However, the authors concluded that mental simulation is a surgical education tool that is portable, accessible, inexpensive, and safe.	• Whilst a description of the mental simulation script design was described, no script or mental simulation protocol was presented • Whilst improvements were seen in both arms of the trial, no statistical significance was observed between the two arms of the trial • Study was likely underpowered

16. Eldred-Evans (2013)	n=64 medical students	Laparoscopic surgery training Skill acquisition The following four assessment criteria: time, accuracy, precision, and overall performance were measured on both the box-trainer and virtual reality simulator (VRS)	RCT design Four arms to the trial: Group-1 received box training; group-2 received additional VRS training. Group-3 received mental simulation training, and group-4 were trained on VRS with additional mental simulation. Mental simulation/ relaxation independent mental simulation from a script) One week after the initial training session, a crossover assessment was conducted, with all participants	• The mental simulation–enhanced group had the best overall performance score with 90.4% (p <0.05) when assessed with a box trainer. • There was no significant difference between the VRS–enhanced and control groups (p <0.05). The box-free group had the poorest performance. In summary, the mental simulation group performed best across all the domains when assessed on the box trainer. • In the VRS assessment, the VRS-enhanced group scored highest with 91.7%, followed by the mental simulation–enhanced group with 87.3%. The box-free group had the lowest overall performance, with 73.9%. In summary, when assessed on the virtual reality simulator, the VRS group performed best across all the domains. • The findings of this study provide evidence for the use of mental training in developing basic laparoscopic skills.	• Whilst an explanation of the mental simulation script design was offered, no script or mental simulation protocol was presented • Assessed in simulation, not assessed in practice. • It appears that only two mental simulations were offered, but this is not best evidence. It is quite possible that no long-term learning occurred • No effect sizes were offered to show the magnitude of the effect

			given a maximum of 15 minutes to perform the task on the box trainer and VRS.		
17. Geoffrion (2012)	*n*=50 junior surgeons (less than five vaginal hysterectomies (VH) performed)	Vaginal hysterectomy performance Skill acquisition and self-confidence	RCT design- two arms, intervention, and control After performing a pre=test VH, junior gynaecology residents were randomised to standard mental simulation versus textbook reading (no mental simulation) and then performed a test VH. Surgeons blinded to group evaluated resident performance on the pre-test and post-test VH via global rating scales, procedure-specific scales,	• There was no significant difference in GRS score change via blinded assessment from pre-test to test evaluation between groups (mean change 13% [Mental simulation] versus 7% [control]- p 0.192). There was no difference in a procedure-specific score change. • Residents also felt more confident performing a VH (mean change 19% [mental simulation] vs 11% [control] p 0.033).	• Whilst a description of the mental simulation script design was described, no script or mental simulation protocol was presented • Appears to be a lack of response- and meaning-cues in the mental simulation script • No effect sizes were offered to show the magnitude of the effect of significant differences • Tested in simulation, not in clinical practice • Potential for contamination between closely working surgeons

			and intraoperative parameters. Residents evaluated their own performance.		
18. Hayter (2013)	*n*=40 anaesthetists (doctors)	Crew Resource Management (CRM) skills in a simulated cardiac arrest Warm-up technique Non-technical skill acquisition	RCT design Non-technical skill acquisition and performance Intervention group and control group. The intervention group performed 20-mins of mental simulation of a script based on CRM principles. The control group received a 20-mins didactic teaching session on an unrelated topic.	• There was no significant difference between the intervention and control groups • Contrary to the study hypothesis, it was found that 20-minutes of mental simulation does not significantly improve the crew resource management performance of anaesthetist performance of a simulated cardiac arrest (all tests showed $p > 0.05$ throughout)	• This was a warm-up technique and not a 'learning' technique per se • A single dose of (20 mins) mental simulation may not have been enough to show any effect. This may be especially so with non-technical skills (CRM) • All participants knew prior to the investigation that they were going to participate in a simulation session- this could have led to some of the control participants using informal mental simulation • Not clear the level of cardiac arrest experience of the participants. The more skilled a participant is, the smaller the effect of training (learning curve distribution)

			Ottawa (Global Rating Scale) GRS. The time to start chest compressions, administer epinephrine, and give blood was recorded.		• Whilst a power calculation was offered, it is still possible that the study was underpowered to observe a significant difference • Other professions/ members of the team were omitted. This may limit the generalisability of their results
19. Ibrahim (2015)	*n*=9 orthopaedic surgeons	Identification of informal (ad hoc) mental simulation components of preoperative preparation in orthopaedic trauma surgery	Semi-structured interviews Qualitative interpretivist study to identify the mental simulation components of preoperative preparation in orthopaedic trauma surgery and to locate these practices in existing socio-material theory to produce a model that is useful for surgical skills training	• Analysis revealed that surgeons interact intensively with multiple colleagues and materials during their preparatory activities. Such interactions stimulate mental simulation to build strategy and rehearse procedures, which, in turn, stimulate preparatory interactions. • Participants identified the discussion of a preoperative 'plan' as a critical engagement tool for junior training surgeons and as a form of currency by which a trainee may increase their participation in a procedure.	• Despite the title of the paper (Mental mental simulation and learning: a qualitative study in orthopaedic trauma surgery), it appears that mental imagery/ simulation is only a small part of the findings and one of the emerging themes, rather than the researchers set out to investigate mental imagery/ simulation. • Little discussion of the qualitative data analysis technique. • Some evidence that there were some positivist tendencies from the researchers- for example,

					there was rightly a concern about bias. Still, there was no discussion of how the authors approached the data reflexively.
20. Jungmann (2011)	*n*=40 medical students	Laparoscopic basic surgery Skill acquisition	RCT design Two arms were randomly assigned. The variables time and tip trajectory (total path length of the instrument tip trajectory) were used to assess the performance of the intracorporeal knot-tying task using a laparoscopic Nissen fundoplication model. The experimental group completed additional mental	• All participants achieved an improvement in time ($p <0.001$) and tip trajectory ($p <0.001$) in the second training session. • High scores on the visuospatial test correlated with faster performance ($p < 0.001$) and more precise movements (p 0.016). • Comparison of the two groups did not show any statistically significant differences in the parameters time and tip trajectory time (p 0.588), tip trajectory (p 0.984), and time of instrument collision (p 0.829)	• No description of the mental simulation script or protocol • No description of how the mental simulation script or protocol was designed • Both arms of the trial showed improvement in skill acquisition, but there was no difference between the groups. This does not discount mental simulation as an appropriate method of learning • Novice surgeons/ medical students with fewer images and kinaesthetic memories could have affected the results. One could think about giving them the experiences to help navigate this • Video used in the control group could have the same

			simulation during the interval between the two training sessions		effect as mental simulation (simulation theory)
21. Komesu (2009)	*n*=68 resident surgeons (having performed <3 procedures)	Cystoscopy performance Skill acquisition	RCT design The 68 residents were randomised into a mental simulation group (33) and control groups [textbook] (35). Groups did not differ in experience or seniority level. The primary outcome was a comparison of groups' surgical performance scores, with the secondary outcomes measurements being operative times and resident ratings of the	• The 68 residents were randomised: 33 to mental simulation and 35 to control groups. Groups did not differ in age, cystoscopic experience, residency level, or sex. • The mental simulation group's surgical assessment scores were 15.9% higher than the controls (p 0.03). • Operative times did not differ between groups. • Mental simulation surgeons rated mental simulation preparation as more helpful than controls (p 0.0001). • Surgeons considered mental simulation to be a more useful preoperative preparation. The mental simulation group's surgical performance was superior to controls. • The mental simulation group was more prepared for the procedure (p 0.03), and the mental simulation residents again rated their preoperative preparation's	• No detail of the mental simulation script or protocol was offered, only how it was it was designed • No effect size was offered to show the magnitude of change • Tested in simulation, not in clinical practice

			helpfulness to their preparation.	usefulness higher than controls (p 0.0001)	
22. Lorello (2016)	*n*=78 medical doctors (anaesthetists, emergency medicine, and surgery physicians)	Trauma resuscitation – team-based Non-technical skill acquisition	RCT design Two-member teams were randomly assigned to either a mental simulation or a control group. The mental simulation group engaged in 20-minutes of mental simulation, and the control group received 20-minutes of Advanced Trauma Life-Support (ATLS) (classroom) training.	• Seventy-eight residents provided informed written consent and were recruited. The mental simulation group outperformed the control group with a significant effect on teamwork behaviour as assessed using the Mayo High-Performance Teamwork Scale ($p < 0.01$) • Mental simulation improves team-based skills compared to traditional simulation-based trauma instruction. The authors feel that mental simulation may be a valuable and inexpensive tool for improving non-technical skills instruction effectiveness for team-based trauma care	• Some participants may have had a greater capacity to partake in mental simulation than others (imagery fidelity could have been greater in some than others). The study did not control for mental simulation capacity • No description of the simulation script or protocol makes it difficult to replicate the research • Other professions/ members of the team were omitted. This may limit the generalisability of the results
23. Louridas (2015)	Experienced *n*=20 senior surgical trainees	Porcine laparoscopic jejunojejun-ostomy in a trauma scenario	RCT design Skills were assessed while undertaking a porcine	• Scripts developed by senior surgeons • Mental simulation with scripts and accompanying voice-over instructional videos improved both mental simulation ability and	• Script designed by experts, not by the end-users • Assessed in simulation using porcine models. However, stressors were

		Skill acquisition and stress management	laparoscopic jejunojejunostomy as part of a crisis scenario in a simulated operating room, using the Objective Structured Assessment of Technical Skill (OSATS) and bariatric OSATS (BOSATS) instruments. Objective and subjective stress, using the six-item State-Trait Anxiety Inventory (STAI-6) parameters were measured, as well as non-technical skills using the Non-Technical Skills for Surgeons rating, also	improved advanced laparoscopic technical skills. • There was an improvement in OSATS (p 0·003) and BOSATS (p 0·003) scores in the mental practice group compared with the conventional training group. Seven of ten trainees improved their technical performance during the crisis scenario, whereas four of the ten conventionally trained participants deteriorated. • Imagery ability improved significantly following mental practice training (p 0·011), but not in the conventional group (p 0·083). • No differences in objective or subjective stress levels or non-technical skills were evident.	added to create authenticity • Mental practice had no effect on measured stress level or non-technical skills- this aspect appears to be far more challenging for mental simulation. Perhaps a design that specifically looked at this might have helped. • No effect size was offered to show the magnitude of change

24. Mulla (2011)	n=41 medical students	Simulated laparoscopic surgery Skill acquisition	RCT design n=41 medical students were included in the study. After randomization, they were divided into five groups. Group 1 was the control group without training; group 2 was box trained (BT); group 3 was also box trained with an additional practice session; group 4 was VRS trained; and group 5 was solely trained using mental simulation. The task was to cut out a circle marked on a stretchable material. All groups were assessed after one	• Time: On BT assessment, the box-trained group with additional practice (group 3) was the fastest, and the mental trained group 5 was the slowest. On VRS assessment, the time difference between group 3 and the control group 1 was statistically significant (p 0.023). • Precision: On BT assessment, the box trained groups (2 and 3) scored high, and mental trained were low on precision. On VRS assessment, the VRS-trained group ranked at the top, and the mental simulation group was at the bottom on precision. • Accuracy: On BT assessment, the box-trained (group 3) was best (p 0.001), and the mental-trained group was last. On VRS assessment, the VRS-trained group 4 scored high closely followed by box-trained groups (2 and 3) (p 0.005). • Performance: On BT assessment, the box-trained (group 3) ranked above the other groups, and the mental-trained group ranked last. On VRS assessment, the VRS (group 4) scored best, followed closely by box-trained groups (2 and 3). • Mental simulation alone cannot replace conventional training.	• There is no discussion of the mental simulation script content- because of this, there is no way of telling if the correct cues are present in the script. Therefore, results could be down to the script design instead of the mental simulation itself. • No discussion of power calculation or effect size was made. • Tested in simulation, not in practice • Each student was instructed and agreed to further practice these exercises daily for 15 minutes at home- there is no discussion about how this was checked.

			week on both BT and VRS, with the main parameters were assessed, namely time, precision, accuracy, and performance.		
25. Skervin (2021)	*n*= 147 general surgical core trainees, registrars, fellows and consultant surgeons	Use of informal mental simulation Warm-up technique	Survey research Mixed methods (statistical survey and free text data)	• When mental simulation occurs, it is predominately for complex cases (complex cases = 55.8% vs all cases = 44.2%). Of the consultants and trainees who use mental simulation before operating, 59.7% and 51.4%, respectively, do so for complex cases only. • Performing mental simulation with others was more frequently performed amongst consultants than trainees (24.7% vs 22.9%, respectively). However, this difference did not reach statistical significance (p 0.63). • The COVID-19 pandemic is a prime example of how alternative training methods in the form of simulation are needed to maintain surgical competency when operative exposure is reduced.	• Unsure why statistical significance was necessary for finding two as no comparisons were being made • The qualitative research was not analytical, and it tended just to report the data without offering meaning • Not a particularly deep research survey study (although it was an interesting study)

26. Souiki (2018)	*n*=17 junior surgeons	Perform intestinal hand-sewn anastomosis on bovine intestine. Skill acquisition	RCT design- a control group and intervention group (Pilot study) Mental simulation volunteers (*n*= 9) benefited from a mental simulation exercises before physical practice, while the control group (*n*= 8) did not undergo any mental simulation process before surgery practice.	• The mental simulation technique group performed significantly better than the control group (p 0.001). • The mean overall score is significantly higher in the mental simulation group (17.78; SD = 2.42) compared to the control group (10.63, SD = 2.85). • However, advanced analysis of individual assessment items showed a significant statistical difference between both groups only in 6 out of 14 assessed items.	• It was assumed that because none of the subjects had been undertaking formal mental simulation, they were all at the same baseline. This is a flawed assumption, and they are unlikely to be at the same baseline • A pilot study, so cannot be generalised • Small sample size (likely underpowered) • No discussion of the mental simulation script/ protocol content
27. Stefanidis (2017)	*n*=60 junior surgeons	Laparoscopic surgery. Skill acquisition and stress management	RCT design All participants received Fundamentals of Laparoscopic Surgery (FLS) training while the intervention group also participated in mental simulation.	• There were no statistically significant differences between the mental simulation and control groups in laparoscopic suturing performance during the transfer and retention tests. • However, the mental simulation group demonstrated almost double performance improvement between the transfer and retention tests compared with the control group ($p < 0.05$).	• No discussion of the mental simulation script/ protocol content • No effect sizes were offered in the discussion, so it is not possible to see the magnitude of change • Tested in simulation, not in clinical practice

			Performance was assessed using the Test of Performance Strategies-2 (TOPS-2) for mental skills, FLS metrics for laparoscopic performance, and the State-Trait Anxiety Inventory (STAI-6) and heart rate (HR) for stress.	• Participant STAI-6 scores indicated that the mental simulation group experienced less stress than the control group during both the transfer and the retention tests (p 0.05). • There were no significant differences between groups in average HR at baseline (p 0.17), post-test (p 0.27), or during the transfer test (p 0.16), the control group had a significantly lower average HR during the retention test than the mental simulation group (p 0.04).	
*Some of the results and findings are taken verbatim from the reports for accuracy of reporting and are not intended to plagiarise other peoples' work or take credit for their work- the work is fully referenced					

Table 9: Surgical mental simulation systematic reviews

First author	Subjects/ numbers	Methods / databases	Findings
28. Anderson (2020)	*n*= 11 publications with *n*= 213 participants	A systematic review of orthopaedic surgery PubMed and Embase databases were systematically reviewed for articles related to cognitive training in orthopaedic surgery.	• The most common forms of cognitive training identified cognitive task analysis and mental rehearsal. • All 11 publications supported the use of cognitive training in orthopaedic surgery training. • In the six randomized controlled trials, the utilization of cognitive training was associated with notably improved surgical performance and increased knowledge compared with traditional methods of learning. • No effect sizes offered
29. Gabbott (2020)	Eight studies that used *n*=268 participants	A systematic review of surgical skills and teamwork MEDLINE, Embase, British Educational Index, CINAHL, Web of Science, PsycInfo and Cochrane databases were searched	• Mental simulation can improve technical performance, but the benefits of non-technical skills are less clear. • Future research should look at longitudinal mixed-method evaluation designs and focus on real clinical teams. • No effect sizes offered
30. Snelgrove (2020)	*n*=6 publications	A systematic review of systematic reviews Medline, Embase, British Educational Index, CINAHL, Web	• The majority of studies demonstrate the benefits of mental simulation for technical performance. Overall, the systematic reviews were of medium to high quality. However, studies lacked a sufficiently articulated evaluation methodology to examine impacts beyond the immediate experimentations. • Future research should look at longitudinal mixed-method evaluation designs and focus on real clinical teams.

		of Science PsycINFO, Cochrane databased were searched	• The impacts on transfer to simulation and the long-term acquisition of skills and personal uptake of mental simulation routines were not reported. • No effect sizes offered
*Some of the results and findings are taken verbatim from the reports for accuracy of reporting and are not intended to plagiarise other peoples' work or take credit for their work- the work is fully referenced			

Overall, there are some encouraging signs for mental simulation for learning skills, with some support for mental simulation increasing self-efficacy, decreasing stress levels, and potentially decreasing anxiety at the prospect of performing during a cardiac arrest in practice. This review has uncovered knowledge gaps, which are discussed in section 4.11.2. The following section will overtly explain how the review questions were answered.

4.11 Answering the review questions

This chapter concludes by revisiting the review questions and briefly discusses how they have been answered:

- What is the evidence for the efficacy of mental simulation in skill learning?
- What are the knowledge gaps from quantitative, qualitative and mixed-method research in mental simulation in nursing education?
- Does mental simulation help reduce stress, anxiety or does it increase self-efficacy?
- Have mental simulation and CPR, wider BLS and/ or life-support skills been researched, and if so, how?
    - Where are the gaps in this specific research?

4.11.1 What is the evidence for the efficacy of mental simulation in skill learning?

The majority of the studies reviewed were quantitative research. Different skills were tested, from sports-specific skillsets to surgical and nursing skills. Different outcomes were measured in these studies. For example, most studies investigated skill acquisition between an intervention and control group. However, some studies assessed self-efficacy while other studies measured stress responses. The outcomes of the studies identified for this review were mixed, with some reporting no significant differences between control and intervention. However, most studies showed a significant difference in the mental simulation intervention group, but all studies outside of sport failed to discuss the magnitude of any statistically significant differences.

There were methodological limitations identified for all of these studies, with the most significant being that the mental simulation scripts were seldom shared. As described, these limitations affect the research's reproducibility, meaning other researchers cannot reproduce the same results as they cannot replicate the methodology. See sections 4.5- 4.9.5 for a more detailed overview.

4.11.2 What are the knowledge gaps from quantitative, qualitative and mixed-method research in mental simulation in nursing education?

The literature review suggested that an in-depth qualitative interview study could unveil new knowledge and significantly contribute to nurse education. There is currently no dedicated qualitative research on formal mental simulation or mental simulation for learning life-support skills. There are several mixed-methods studies; however, the qualitative side of the studies do not explore mental simulation in great depth. Therefore, a significant in-depth qualitative study on mental simulation (and life-support) is long overdue. Previous studies have not dealt with the journey of those undertaking mental simulation as researchers have not treated the experience of mental simulation in much detail. This omission occurs because most studies in the field of mental simulation have only focused on the quantitative aspects of performance, stress management and self-efficacy.

Such approaches have failed to successfully address what it takes to undertake mental simulation during a busy training programme. Much less is known about what might drive students to undertake mental simulation to learn life-support. It is still unknown what pre-registration nurses see in their mind’s eye and how this relates to their education. What is less clear from the current research is precisely what is learned and how is it learned. If there is an increase in self-described self-efficacy, a qualitative study will help undercover *why* this occurs. An in-depth, focused qualitative design is required to understand these concepts more thoroughly. Understanding this from the end-user's perspective would help to implement future life-support mental simulation programmes and lead to other research strands.

As part of this study, a mental simulation protocol needed to be designed. While the author was not looking to create a reproducible study due to its interpretivist nature, the protocol's design must be transparent. Therefore, the justification for the script and protocol design is discussed in chapter 6. The script is presented in appendix 8, section 17.8 and the protocol is stored electronically on the university database with this thesis.

4.11.3 Does mental simulation help reduce stress, anxiety or does it increase self-efficacy?

Although limited, there is some evidence that mental simulation can reduce stress and increase self-efficacy when undertaking skills in various settings. However, there is limited evidence as to whether mental simulation can reduce anxiety at the prospect of delivering a skill. This is a gap addressed in this thesis. See sections 4.8.2, 4.9.4 and 4.9.5 above for a more detailed overview.

4.11.4 Has mental simulation and CPR skills been researched, and if so, how? And, where are the gaps in this specific research?

Fountouki et al. (2021) objectively tested mental simulation in learning CPR skills. While this study had some methodological limitations, the authors concluded that mental simulation reduced error when delivering basic life-support (BLS). Furthermore, Bachman (1990) suggested that several elements of learning CPR skills showed significant improvement compared to the control group. However, there were significant quantitative methodological limitations within this study too. Bachman undertook a mixed-methods study, so there was a qualitative element to the study. However, this part of the research was limited to how participants accepted it as an educational technique. However, it is much less clear how mental simulation was experienced and the learning journey that nurses go on when learning life-support. This qualitative design can potentially help to explain how and why the Fountouki study had significant positive outcomes. A quantitative design can unpack the experience of mental simulation from the end user's perspective. A more detailed review can be seen in section 4.7.1.

4.12 Chapter summary

This chapter has presented a review of the current sports and healthcare mental simulation discourse. The chapter began with an overview of the search strategy and an overview of the review questions that guided the literature review. The chapter then reviewed theories that explain mental simulation, including dual-code, bio-informational and functional equivalence (FE). An evaluation of sport-specific reviews showed that mental simulation (with or without physical practice) had a medium effect size.

Nursing and medical education research showed mixed results regarding performance, self-efficacy, and stress management measures. Much less is known about anxiety management. The review questions were overtly answered based on the literature review findings, including a detailed overview of the current knowledge gaps and how this thesis intends to address them.

Now that the first four chapters have established the study context, current discourse and gaps in knowledge, it is important to establish the study aims, research outcomes and research questions based on the secondary data accumulated in these opening chapters. These are addressed in the following chapter.

Chapter 5 - Study aims, outcomes and research questions

The first steps of any study are developing the research question, aim and objective. Subsequent steps develop from these, and they govern the researchers' choice of population, setting, data to be collected and time period for the study. Clear, succinctly posed research questions, aims and objectives are essential if studies are to be successful

[Doody & Bailey, 2015]

5.1 Introduction

The previous chapter outlined current thinking in mental simulation research. The gaps in knowledge pointed towards undertaking an in-depth qualitative enquiry. As the grounding for this enquiry, it is important to present the aims, outcomes and questions. This will then lead to the methodology section beginning with the next chapter. The aim, research outcomes and research questions are presented in the following sections.

5.1.1 Aims

In this section, the author will highlight the study's aims, research outcomes and research questions. The author is interested in understanding: 1) how participants integrate mental simulation into their lives; 2) how the participants experience imagining a cardiac arrest and what this means to them; 3) whether they see value in experiencing cardiac arrest and life-support education through mental simulation and 4) make a judgement as to the benefit of mental simulation as an adjunct to physical simulation in learning life-support. Based on these overall aims, the below outcomes were created.

5.1.2 Research outcomes

Several research outcomes were developed to help achieve these aims and answer the research questions. These were:

- To undertake a search of the literature to gain a better understanding of the research context and research problem
- To perform semi-structured interviews of pre-registration nurses (students) about their experiences of using mental simulation
- To use a tripartite design to construct a mental simulation protocol based on the PETTLEP framework.
- To use social constructionist qualitative reflexive thematic analysis to analyse the data
- To conclude the findings and make a judgment on the benefit of mental simulation as an adjunct to physical simulation in learning life-support.
- To make recommendations for future practice.

In the section below, the research questions are articulated.

5.1.3 Questions/ sub-questions

- What are the experiences of pre-registration nurses (students) who use mental simulation to gain cardiac arrest and life-support experience?
    - How do students modify their behaviour to incorporate mental simulation into their lives?
    - How does mental simulation create an authentic learning experience that prepares students for real-world delivery of life-support skills?
    - What processes make mental simulation a worthwhile technique to use as an adjunct to physical simulation of BLS and wider life-support knowledge and skills?

Experience will be defined by both the participants and a reflexive interpretation of the data (Brinkman & Kvale, 2015). These questions formed the basis for the research data collection and data analysis and directed the research approaches. The research questions drive the research design (Clough & Nutbrown, 2012), and the research design can be seen in chapter 9.

5.2 Chapter summary

This chapter has presented the aims, outcomes, and research questions based on the context, literature review, and identified knowledge gaps. In the following chapter, the design of the mental simulation protocol is described. In table 12, there is a justification offered for the protocol design.

Section 2: Design of mental simulation protocol

Chapter 6 - Mental Simulation Protocol Design: Phase 1

"Mental practice is the simulation centre of the mind."
[Charles Sanders]

6.1 Introduction

The previous chapter outlined the aim, outcomes and questions. These were based on the current mental simulation research discourse. In this chapter, the mental simulation protocol design is reviewed. It begins with a description of the protocol concept, and then table 12 justifies the elements of the protocol. The mental simulation protocol is based on the PETTLEP framework conceptualised by Holmes and Collins (2001) and is based on functional equivalence (FE) theory described in the previous chapters. Each item of the protocol is added to help improve the FE of the mental simulation, by giving the participant the best chance of creating high-fidelity images. The section begins with an overview of the protocol.

6.2 Mental simulation protocol

The mental simulation protocol was designed in phase-1 of the research project. The mental simulation protocol design was based on both pragmatic and evidence-based elements. As described in chapter 1, the protocol is based on the PETTLEP (physical, emotional, task, timing, learning, environment and perspective) framework. PETTLEP has been well researched in sports (Post, Young, & Simpson, 2018; Smith, Wright, Allsopp, & Westhead, 2007). For example, Smith et al.'s (2007) two-stage randomised control trial compared conventional (control) and PETTLEP mental simulation. The study conclusions suggest a significant difference in assessed hockey flick techniques in the PETTLEP mental simulation group compared to control, supporting the efficacy of PETTLEP-based imagery over more traditional imagery interventions.

Some healthcare research has used PETTLEP as the basis for their mental simulation scripts [for example, Wright, Hogard, Ellis, Smith, & Kelly (2008), see section 4.8.1]. However, it is not as well established as it is for sport-specific motor skills. The mental simulation protocol designed for this research consisted of 6-items that can be seen in table 10 below. Below is a description of how and why the protocol was designed with these items.

Table 10: Mental simulation protocol

Mental simulation protocol (based on PETTLEP)
1) instructions for use
2) basic and an advanced script
3) a point-of-view (first-person) film of a cardiac arrest
4) the (2015) BLS and ALS algorithms
5) a glossary of terms
6) a patient handover script

The mental simulation protocol design

Lang (1979) argues that three main input variables are required for stimulating images and performing mental simulation. Lang suggests that these are: 1) the image cues, 2) the image orthesis (such as a script or video), and 3) instruction for active participation in the imagined event. These cues are a fundamental part of assisting the evocation of mental simulation images (Lang, 1979; Rao, Tait, & Alijani, 2015; Schuster et al., 2011).

Furthermore, in their seminal paper introducing PETTLEP, Holmes and Collins (2001) argue that mental simulation exercises may need supporting resources to help the learner execute mental simulation with high-fidelity images. For example, they suggest for that 'E' [Environment], the learner undertakes mental simulation in the environment where they would execute the real-world task as this improves FE. If this is not possible, Holme and Collins suggest that a picture or film of the environment will improve the fidelity of images created and thus improve FE. The author used a point-of-view (first-person) film [film hereafter] to help stimulate images in the participants. This same principle supports each protocol item (see table 12 below for more detail).

Each item of the protocol is designed to assist the student in increasing their imagery ability and creating clearer/ higher fidelity images. This is done to increase the functional equivalence of their mental simulation experience.

6.2.1 The script

The author employed a tripartite design for the two mental simulation scripts. The scripts were designed between 1) the author, 2) the current CPR, BLS and ALS guidelines (Resuscitation Council, UK, 2015a; Resuscitation Council, UK, 2015b) [described in chapter 4] and 3) pre-registration nurses (students) as the end-users. As an advanced life-support instructor, the author had experience and expertise in basic and advanced life-support, and this expertise was used to formulate the script. The essential script stimulus> response> meaning cues (Lang, 1979) were taken from four semi-structured interviews with pre-registration nurses who had experienced performing BLS during a cardiac arrest in practice.

The four student nurses were not included in phase-2. The participants were chosen from year-three students. After several classroom discussions, the author invited the four students. Below is an example of the questions and answers from the semi-structured interviews #2 and #3:

Interview #2:

Nick: *Who was on the crash team? Can you remember, was it obvious, or...?*
#2*: No, just doctors, anaesthetist came—'cause he just took over the-- well, I didn't fully, but just because he took over the airway and I, yeah, I just assumed 'cause he put the airway in [inaudible)*
Nick: *Was he in scrubs?*
#2: *yeah*
Nick: *Yeah, and was it, so it was easy to-- so was it easy to see who's in charge or was it...?*
#2: *so the sister was coordinating it, it was like talking to us and like if anything needed doing the doctors tell her, and she'd like, pass that on*
Nick White*: So, she knew the team, so she knew, who to-- what skills people haad?*
#2: *I remember just being able to like, hear her voice, and then we stopped. Because the doctor said, "everyone stop a minute," and then he said, does anyone else want to carry on, but at this point, it was like agonal breathing ... thought like, oh like he might be coming back to life... so we carried on for a bit longer*

Interview #3:

Nick White: *who was giving direction about that?*
#3: *the guy that came from the errrm, the cardiac team-- crash team-- and like they'd say right we want to give him some of this, the sister go 'right you can get that', and someone get that drug and then put it up... run it through... and I think it might-- were scribing, what was being given so they could prescribe afterwards. Remember like, all the, think that there are only seven beds in that bay and someone had shut all the curtains around all they the other patients. I think it must have been*

distressing for the other patients cause they're all like in the same position, but there's no way around that, is there?

The interviews aimed to understand cardiac arrest from the perspective of potential mental simulation end-users. Part of this information was used to create an authentic feeling mental simulation script. This data was then coded using part of Braun and Clark's (2006) thematic analysis method (see chapter 10 for an overview of this method). There was no requirement to theme the data as this was not research per se. Coding using NVivo data management software allowed easy access to the required data extracts. An example of codes can be seen in table 11 below (see appendix 8, section 17.8, for an overview of the script and how this was pieced together using this tripartite method).

Table 11: Phase 1 code and data extract examples

Code	**Example of data**	**Participant**
Organised chaos	*I am quite an emotional person, and I used to find it really upsetting, but I don't anymore. I find it's like organised chaos. I sort of thrive off of it now, and I love it*	#1
Physical effects	*The force of it and I could only do it for a minute at a time, and then I would have to say, "Can someone else step in," and the gentleman was really large as well, a massive belly* *Definitely heart rate, and I noticed how much it hurt my hand.*	#3
Internal distractions	*He was an elderly gentleman as well, so compared to A&E, I were having to hold back the tears whilst I were doing it in A&E on the 42-year-old chap because his wife was stood there and she was shouting, and she were just-- oh god, it was horrible.* *So, we had to start doing CPR at this point, and I was thinking about what his daughter is going to say because obviously, DNAR agreed that we kind*	#2

	of went against the will. So, it was a mixture, to be honest	
Questioning CPR skills	*You are watching what everybody else is doing and thinking, "What should I be doing because nobody ever says to you in those events what to do. Just start chest compressions. So, you are thinking about, "Have I got enough depth? Am I in the right place?*	#4

The same ethical principles and permissions as phase-2 were sought and granted through the university research ethics committee. The ethics application is stored on the university's Converis electronic ethics system (see appendix 5, 17.5 and section 8.2 below for full ethical discussions).

Once the script had been written using the described tripartite method, an experienced medical colleague with expertise in advanced life-support was asked to review the script to check for inaccuracies of the content. The next step was to break the script down into smaller chunks to record it, and a colleague volunteered to be the voice actor. Sound effects were recorded in the simulation suites, and they were added to the scripts by the audio-visual (AV) department team. A metronome sound set at 120bpm was also added to help with the chest compression rate.

Once the scripts were recorded, it was uploaded to GoogleDrive so the participants could access them. As part of the PETTLEP framework design, the POV film was recorded in a simulation laboratory using a Go-pro™ camera. The film was again recorded using colleagues and was edited and kindly produced by the AV team. Permissions to use the Resuscitation Council algorithms were gained (see appendix 1, section 17.1), and instructions on using the mental simulation protocol were written. A glossary of terms was devised to help students understand the technical

Table 12: Design framework for the mental simulation protocol

Mental simulation protocol element	Description	Justification
First-person perspective [1-P/ internal imagery perspective]	Perform mental simulation using a 1-P perspective. It has been described as seeing: *"*the event from the visual perspective you had when the event was originally occurring. In other words, you can see your surroundings in the event looking through your own eyes." (Libby & Eibach, 2011, p. 189).	Schuster et al.'s (2011) systematic review into the best practice for mental simulation in five disciplines found certain common features. Amongst other things, it was established that the most effective behavioural outcomes were based on a 1-P perspective that incorporated kinaesthetic (haptic) parameters.
Point of view film of a cardiac arrest	This film was recorded in the 1-P perspective and was part of the mental simulation protocol to assist the participants' in creating high-fidelity images (Holmes and Collins, 2001).	The film was created to produce an experience that imitated real-world and mental simulation experiences (Jackson, Meltzoff, & Decety, 2006). This way, students can 'fill in the gaps' missing from their own, often limited, experiences. In a 2014 study, Battaglia and colleagues studied 72 rhythmic gymnasts, half of whom were asked to use video observation before using mental simulation. The study results showed that using a video action observation technique before using mental simulation, increased their imagery fidelity (Battaglia et al., 2014).
Timing	The mental simulation was evoked and 'run' in real-time (instead of slowed down or freeze-frame).	This element suggests a temporal accuracy is required in training and therefore in the mental simulation protocol: "Real-time execution speed is the ultimate temporal goal of physical task learning and performance thus, it makes sense that athletes [in this case, students] would choose to employ images that predominantly unfold at real-time speed" (O & Hall, 2009, pp. 25-27).

		It is also fundamental that the protocol attempts as much as possible to stay as true as possible to PETTLEP's FE philosophy (Holmes & Collins, 2001), especially considering the time-sensitive nature of a cardiac arrest.
Audio sound effects	During the narration, authentic cardiac arrest sound effects played in the background to create an element of realism	Here the sound effects have a dual purpose. Firstly, the participant engages in auditory processing and will use a host of sensory and perceptual skills previously learned through experience; these sound effects afford iconic meaning to the narrative (Rodero, 2012). Here the students will obtain meaningful information from the sound effect(s) (Kraus & Banai, 2007), which stimulate emotional images in conjunction with the narration as it embodies the coding, processing and evocation of real-world experiences in their memory (Babin & Burns, 1998). This phenomenon has been described as 'auditory fidelity' (Sandars et al., 2019). Sanders and colleagues argue that background noise in simulation can increase immersion and authenticity, creating escalating stress levels akin to practice. Furthermore, as Lang and colleagues describe here in behaviourist terms: *Our understanding of the brain's defence circuitry comes primarily from neuroscience research with animals […]. In this work, a nociceptive event (e.g., electric shock) is paired with a previously innocuous […] tone over repeated trials until a connection is formed.* (Lang & McTeague, 2009, p. 6)

		The participants may create high arousal connections between the industrial sounds of a cardiac arrest and their meaning. The primary effect of adding the audio to the narration is increased participant emotional arousal (Potter & Choi, 2006). This element was developed in line with the 'emotion' [E] aspect of PETTLEP (Holmes & Collins, 2001).
Basic audio-guided mental simulation script (stage 1) **Advanced audio-guided mental simulation script (stage 2)**	(stage 1) Based on PETTELP, this part of the protocol is performed for a maximum of 2-weeks. Can move on to advanced script under own direction. They can also move back to the basic script if they need to. Or the basic script can be used in conjunction with the advanced. (stage 2) Based on PETTLEP, this part of the protocol is used for the rest of the four-week intervention period. Students can go back to the basic script if required. The emotional levels in this script are intensified, and it was created to replicate a full cardiac arrest.	Holmes and Collins (2001, p. 72) suggest in their seminal PETTLEP article that: "[Mental simulation] should [...] be personalised through full, multisensory involvement of the performer in the generation of the motor image content. Suggesting environmental "as if" situations that are novel to the performer." It was felt that the script could not be personalised to the student group as many will not have cardiac arrest experiences to draw upon. Therefore, *n*=4 students were interviewed in the initial phase of this doctoral research. These interviews were used to create the PETTLEP script narrative, and the final product can be seen on the database stored with this thesis. Basic and advanced scripts were developed to align with the learning ['L'] element of PETTLEP. It is suggested that the content of the mental simulation exercise should be tailored in response to learning. As the learner learns more, the script's content should alter to offer new challenges (Holmes & Collins, 2001; Smith, 2010).

Use of guided-audio script	The script was narrated using an audio recording, with a voice actor taking the user through the scenario in real-time	It is well recognised that affective descriptive text or narration can evoke visual images and that those visual images can, in turn, create arousal evocation (Vrana, Cuthbert, & Lang, 1986). Emotional responses in most, such as those linked to emergencies, have been shown to increase emotional arousal (Driskell & Johnston, 1998). Smith and Holmes (2004), in their study of (*n*=40) golfers' putting, found a significant difference in performance after using audio scripts compared to written scripts. This narration was used instead of the user reading through a paper script. The narration was developed to help create a communication-evoked mental simulation process, and so doing it will generate "a theatre of the mind and one that will paint pictures in the imagination of listeners" [Adapted from Bolls (2002, p. 527)]
Time spent undertaking the protocol	4-week duration, 10 minutes per day. 3-times per week (12- attempts in total) The first 2-weeks on the basic script, second two weeks on the advanced (however, they could move from basic to advanced when they felt ready)	This design was chosen because the protocol required substantial time and effort on the participants' part. Schuster et al. (2011) performed a meta-analysis of best practice for mental simulation. The average duration was 17-minutes, at 3-times a week, with 34 trials overall in a positive outcome (significant differences in the learning of skills compared to control). So, there does appear to be a dose-response relationship to learning through mental simulation. However, I was genuinely concerned about attrition even when designing the study before recruitment [attrition was 26.3%]. Therefore, some elements (e.g. undertaking 3-times/ week) were evidence-based, but the others were pragmatically created (e.g. undertaking for 10-15 minutes & 12-trials). This

		element was set to a time that the author judged to be manageable for the participants.
Body position	The protocol user is encouraged to take a position similar to one they take in a real-world cardiac arrest (standing or kneeling). However, this is left for the participant to decide, and the user can autonomously take a more comfortable body position should they wish.	The protocol user was encouraged to take a position similar to one they take in a real-world cardiac arrest (Holmes & Collins, 2001), in this case, standing or kneeling. This element is in line with the physical element of PETTLEP. However, the executive decision was left with the user to decide.
Physical practice	It was not possible to design physical practice into the protocol due to the nature of the skill being learned and the resources required to make this happen. (There was no budget for this research)	Numerous studies show the benefits of combining physical practice and mental simulation (for example, Chamanian, Rafei, Nezakat, & Salehi, 2018; Kraeutner, MacKenzie, Westwood, & Boe, 2016; Battaglia et al., 2014). Due to the nature of the BLS tasks being learned, the practicalities of using physical practice as part of this protocol are prohibitive. In addition, the resources required to use simulated physical practice, or the 'luck' required to undertake real-world BLS, are out of reach of most students.
Glossary of terms	A glossary of terms available to help with (mis)understanding of medical language	The glossary was included so that participants would be able to fully understand the language being used in the mental simulation script and the algorithms
Algorithm (basic and advanced life-support)	Resuscitation Council UK, Basic life-support and advanced life-support algorithms are available as part of the mental simulation protocol	The algorithm was included for visual clarity. Participants may have wanted to use it to make sense of the language used during the narration.
Emotions and kinaesthetics	Deep descriptions and visual images may expose students to the emotions involved in a cardiac arrest	As most participants have not been involved in a cardiac arrest, their kinaesthetic (haptic) memories may be lacking. It is argued that kinaesthetic imagery ability is not fixed and can be developed (Williams, Cooley, & Cumming, 2013).

	It is hoped that participants will be able to 'feel' the scenario through the kinaesthetic cues in the script	Individual differences in imagery ability relate to the observable effectiveness of mental simulation in terms of measurable learning (Zabicki et al., 2019). This means the higher-fidelity the images, the greater the behavioural outcomes. Therefore, mental simulation training could potentially be incorporated into future protocols. This mental simulation training would be based around "Layered Stimulus Response Training" (LSRT) as this has been shown to improve kinaesthetic imagery ability and actual movement execution (Williams, Cooley, & Cumming, 2013). LSRT is a 4-stage technique is based on Lang's (1979) bio-informational theory. The script cues work by creating a stimulus [specific details of the cardiac arrest environment or BLS and CPR task]. The response propositions ['you push firmly on the chest' or 'you feel your blood pressure increase'] and meaning ['you feel your blood pressure go up because you are stressed']. These are layered to increase in detail in each session (Williams, Cooley, & Cumming, 2013). Williams and colleagues' study showed improvement in kinaesthetic ability after LSRT training. LSRT could be added to future protocol design where required.

language, and a mock patient case was written as a pre-brief to the scenario. Please see table 12 for a justification of these decisions.

The participants were allowed to move from one script to the other once they felt ready, but they were told not to use the basic script for more than 2-weeks. This technique was used to avoid script use becoming stale- the concern was that this might reduce attention spans. The participants were allowed to use the protocol's other resources (film, etc.) as little or as much as they needed to assist them in creating high-fidelity images. There was no requirement to test the script due to the qualitative nature of the study. This is explained in more detail in the section below.

6.3 Intervention pilot study

No pilot study was performed on the mental simulation protocol designed in phase-1. The author judged that there was no requirement to do an official pilot testing of the script in this study as the protocol was not being objectively researched. Therefore validity and reliability did not form part of the research design, as this has positivist undertones. However, the author did ask a pre-registration nurse to listen to the two scripts. The feedback was that it made sense and was easy to follow.

Overall, the process of undertaking phase-1 interviews, writing the two scripts, recording the first-person film, recording the sound effects and scripts and waiting for them to be edited and produced lasted for approximately seven months. I was approximately 3-years into the EdD programme before I began phase-2 of the research. I could not begin phase-2 data collection until phase-1 was completed.

6.4 Chapter summary

This chapter gives an overview of the process undertaken to design the mental simulation protocol. The tripartite technique of protocol design appears to be unique. The use of semi-structured interviews and coding to help design mental simulation scripts offers a unique perspective. It allows the script cues to be written using the voice of potential end-users. The chapter describes how the participants were asked to undertake the protocol and further describes the 6-items of the protocol in table 10, and the protocol makeup is justified in table 12.

The research questions and the mental simulation protocol items have now been generated. It is time to turn the thesis focus to phase-2 and the research design. The foundation of a research design is the research philosophy, which is presented in the next chapter. Therefore, this next chapter is personal and written in the first person.

Section 3: Methodology

Chapter 7 – The research philosophy: Phase 2

Qualitative inquiry seeks to discover and to describe narratively what particular people do in their everyday lives and what their actions mean to them. It identifies meaning-relevant kinds of things in the world—kinds of people, kinds of actions, kinds of beliefs and interests— focusing on differences in forms of things that make a difference for meaning
[Erikson, 2018]

7.1 Introduction

The previous chapter outlines the mental simulation script design and the protocol. The chapter describes the participants' expectations and justifies each of the items. The tripartite design of the script appears to be a unique method of designing mental simulation scenarios.

This chapter offers a reflective and reflexive account of the philosophical underpinnings of the study, outlining my personal ontological and epistemological grapple, shifting from a positivist stance to a social constructionist position. I will share my reflexive approach to the research design (presented in chapter 9) and data analysis (presented in chapter 10). This chapter discusses my theoretical perspective and the theories that underpin the study discussions. The data analysis was performed using an inductive, theory-free (atheoretical) reflexive process, so the literature and the theories used in the discussion sections were included after data analysis was completed. The theories are used to illuminate the data analysis. The chapter begins with a presentation of the research philosophy

7.2 Philosophy of the research design

As described in the previous chapter, the knowledge gaps in the current mental simulation discourse pointed towards a qualitative (semi-structured) interview approach. This approach to the research design was the most appropriate to address the study's aims and answer the research questions. Individual in-depth interviews are likely to afford the best context for eliciting pre-registration nurses (students) perceptions of their mental simulation experience. I will critically articulate and justify this position in the sections below by reflexively discussing my evolving epistemological 'grapple'.

7.2.1 Ontology and Epistemology

Epistemology is the theory of knowledge; it defines how we know what we know (Crotty, 1998). Whilst ontology is the study of being, the nature of existence and what constitutes reality. Both encompass what determines and what constitutes valid knowledge within a certain reality (Gray, 2014). It is unlikely that I will fully arrive at a set of ontological and epistemological positions. This is because the nuances of my perspectives will likely continue to evolve through experience, reflection, reading and further academic engagement (Kofer, 2001). However, this must be articulated as part of the philosophical underpinnings of any research design.

I began my doctoral studies as a novice researcher, feeling that 'only other people do research.' My original understanding of the interpretive research process was limited. As I read, reflected, and joined in with classroom discussions, my understanding expanded. I began to appreciate a broader epistemological outlook on the world of research methods and methodologies.

In the next section, I discuss how I approach my research reflexively. I begin with a discussion of the influences of nursing and medical research.

7.2.2 The influence of nursing and medicine

Scholarship within nursing has a long tradition of using interpretive, qualitative knowledge creation (Braun & Clarke, 2014). However, in particular, a critical care medicine career draws knowledge primarily from the biomedical domains. Much of the research in critical care medicine is from a (post-)positivist perspective and utilises quantitative research design and knowledge creation (Duncan & Nicol, 2004). My bachelor's nursing degree, for example, is a Bachelor of *Medical* Science (BMed Sci). Here, the word 'medical' is an interesting term for describing a nursing degree and has no doubt tacitly influenced my early epistemological assumptions!

I was first introduced to the hierarchy of evidence on my BMed Sci and Master of Science programmes. This hierarchy shows that when a research question fits a positivist research design, there is a hierarchy of evidence based on the risk of bias in different types of research and these study types tend to be based on the strength and precision of their research methods (European Centre for Disease Prevention and Control, 2011; Harris et al., 2001). This type of knowledge creation is based on an objectivist epistemology (Mills & Birks, 2014). Objectivism or positivism is founded on the assumption that an absolute observable reality can be measured, studied, and understood (Braun & Clarke, 2013; Duncan & Nicol, 2004). Observed objects have an existence that is independent of the observer (Flick, 2015). The object imposes itself on the observer's conscience 'from without' (Cohen, Manion, & Morrison, 2011, p. 5). A further assumption is that only a systematic collection of sense-data through unbiased researcher observation will create knowledge (King & Horrocks, 2010). It is based on a value-neutral view of knowledge creation.

This positivist perspective would help me identify whether mental simulation helped students learn basic life-support (BLS) skills effectively against set numerical criteria. However, it would fail to assist me in understanding how the participants' experiences of using mental simulation. To answer questions around student experience, I needed to look at alternative paradigms. As I began to understand the social sciences, I found it challenging to place my worldview. As my understanding of social science research continued, I questioned my early ontological and epistemological assumptions. I began to see the research process in a new light, which led me to see *my* research in a new light. I share this journey further in the following sections below.

7.2.3 Research direction: my evolving worldview

While not entirely anti-positivist, social sciences are often based on constructionist, constructivist or subjectivist epistemologies (Crotty, 1998; Denzin & Lincoln, 2017; Kvale, 2007). Throughout my doctoral journey, I have had my eyes opened to the social sciences, the varying qualitative epistemologies and methodologies and the potential for what it may mean for my journey as an early career researcher. I used my doctoral journal to consider this epistemological grapple. In my doctoral journal, I wrote:

Due to my nursing [bio-medical] background, I initially had a realist ontology. This is because I tended to see objects as having an independent existence that is independent of the observer and needed to be statistically "proven" for interventions to be considered for practice. My personal epistemological view had always been objectivism- I didn't know anything else. I did not even know there were varying views.

I saw the nature of knowledge as tangible, hard and objective when free from researcher bias. This is how I'd been 'brought up' to understand the world, based on my critical care nursing and masters education, and this had been, unbeknown to be me, my worldview at the start of my doctoral journey. Things have slowly started to evolve…

[Doctorate Journal, 20/05/2017]

From my doctoral journey has emerged new thoughts, theories, understandings, research, and knowledge creation possibilities. As a result, my epistemological and ontological positions evolved, influencing this research design.

I no longer truly believe that the positivist notion of objective reality is the *only* way to consider knowledge and reality. This shift was helped by reading Gergen's (2011; 2015) work, making understanding social constructionism accessible and enjoyable. In my doctoral journal, I noted:

…on the one hand, I agree with an external reality independent of our minds. Still, on the other hand, I am starting to feel like the truth around reality cannot be fully determined but is experienced independently by individuals. Through interaction, knowledge is created. For this reason, it would seem that there are times where socially constructed data is required. Perhaps there are times when a more pragmatic view of research design is required, and the philosophy of 'the best tools for the job' must be employed. I believe this is where my perspective lies.

[20/06/2017]

My worldview had shifted, and as Kuhn (1962) suggested, the researcher with a new paradigm now sees the world very differently from the way they had before (cited in Gergen, 2015). This is how I saw myself, and my research idea evolved. Would understanding students' experiences using mental simulation be enlightening for nurse education? Would understanding experience help with implementing mental simulation with my local organisation? If this learning method could be introduced to learn and maintain BLS skills, it would be pragmatic to give meaning and understanding to participant experience. This would still be evidence-based practice, just not how I initially anticipated it. To answer these questions, I turned to social constructionism and interpretivism.

7.2.4 The social construction of knowledge

Social constructionists see knowledge as co-constructed, conversational, narrative, linguistic, contextual and interrelational (Kvale, 2007). Kvale describes the social constructionist researcher using a traveller metaphor:

> *"the traveller wanders the landscape, entering into conversations, asking questions, and listening to stories from local inhabitants. The potentialities of meanings in the original stories are differentiated and unfolded through the traveller's interpretations in the narratives he or she brings back to home audiences."*
> (Kvale, 2007, pp. 19-20).

In the social constructionist worldview, "meaning is not discovered but constructed… [therefore], we do not create meaning, [w]e construct meaning" (Crotty, 1998, pp. 42-44). Crotty argues that the meaning we hold for 'our' constructed world is co-constructed through social interactions, relationships, and cultural traditions. Furthermore, as Gergen (2015) contends, it is out of these interactions, relationships, and traditions that we adopt our vocabularies, assumptions, and theories from which we form our worldview. This interaction is a crucial aspect of the research design.

At this point, it is worth distinguishing between *constructivism* and *social constructionism* in relation to my research study. These terms are often used interchangeably but do have different philosophical traditions. These concepts hold true that knowledge is subjective of the experiencing person. Constructivists believe that knowledge and reality are constructed *within* the individual. In contrast, socially constructed knowledge is created through discourse and conversation (Crotty, 1998). So, rather than viewing the participant experience of using mental simulation as already existing independently from the participants' conscious interpretation of it, the participants will *co-construct* meaning with me as the researcher (King & Horrocks, 2010). This co-construction will occur through discourse and professional conversation in the form of semi-structured interviews.

As my epistemological worldview has evolved, so too did my ontological position. This evolution occurred because "ontological and epistemological issues tend to emerge together" (Crotty, 1998, p. 10). Logically, creating meaningful construction of knowledge through the interview process must mean the construction of meaningful reality. However, social constructionism, per se, lays no claim to reality. It only lay claims to the social construction of knowledge (Andrews, 2012). Ontologically, social constructionism is at once both realist *and* relativist. Reality is not viewed as containing objects and structures. It is viewed as a product of how individuals engage (King, Horrocks, & Brooks, 2019). '[T]o say that meaningful reality is socially constructed, is not to say it is not real' (Crotty, 1998, p. 63). Hammersley offers a solution to this quandary.

Hammersley's (1991) solution is to adopt neither a realist nor a relativist position but adopt a position midway between the two. This ontological position is known as 'subtle realism.' This perspective recognises the existence of an independent reality. This world has an existence independent of our observation of it. However, according to Hammersley, subtle realism denies that there can be direct access to this reality, and it emphasises instead representation, not a reproduction of social phenomena. It is this 'representation' of an independent reality that I seek to uncover using semi-structured interview methods. According to this ontological perspective, I cannot directly measure my participants' experiences. However, this 'representation' can be socially constructed through the interview process. This interpretation symbolises reality rather than attaining the truth (Mays & Pope, 2000). An important distinction to make for this research project.

Now that social constructionism has been explored, in the following section, interpretivist enquiry is presented as part of the theoretical perspective of this research project.

7.2.5 Qualitative interpretivist enquiry and inductive reasoning

I want to understand and interpret the complexities of students' behaviour when using mental simulation to learn BLS and life-support skills in their everyday lives. Qualitative enquiry is appropriate for this type of exploration (Liamputtong, 2019). Inductive reasoning and exploratory methods were applied as this was the most appropriate method to answer the research question (Guest, MacQueen, & Namey, 2012). My reasons for applying inductive reasoning are firmly linked to my epistemological position.

In inductive research, meanings are exchanged and produced in interpretive processes (Flick, 2015) and should be studied in a *bottom-up* data analysis process. Inductive reasoning *begins with the particular and moves to the general*, whereas deductive approaches are a *top-down* process where one *begins with the general and moves to the particular* (Harding, 2013). My analysis should not begin with what is already known about the subject to be truly inductive. The essence of this research study is discovery (Jebb, Parringon, & Woo, 2017). Inductive reasoning allows my participants' voices to be heard, which was important in answering the research questions. In this case, their experiences of learning life-support through mental simulation.

The data was grounded in the co-constructed interpretation of the interview data, therefore, developing a co-constructed *a posteriori* conclusion (Bryman, 2004). Before writing the thesis, I researched mental simulation (and other related topics). I began developing underlying knowledge and assumptions about physical and mental simulation. I, therefore, ceased reading around the key mental simulation theoretical subjects after my initial literature review module, thus adding rigour to my inductive methods. Ceasing reading reduced the influence of 'what is already known' (Charmaz, 2014) about mental simulation and allowed the inductive process to occur.

As the data interpretation will be co-constructed, it was not desirable to completely bracket out my preconceived knowledge. If I co-construct meaning with my participants, I will have to use my own (reflexive) experiences, outlining my assumptions or humanness (Dean, 2017). I am, therefore, actively involved in the meaning-making and interpretation process of study (Brinkman & Kvale, 2015). My experiences as both a basic and advanced life-support instructor and my prior reading of mental simulation literature are essential as they will help me interpret the data. This means that I likely sit on a spectrum somewhere between induction and deduction.

However, I positioned myself much closer to induction through the practice of open-mindedness and methodological self-consciousness. Methodological self-consciousness is where I turned a deep reflexive gaze back onto myself to better understand my position within the interpretive process (Charmaz, 2017). As part of this reflexive gaze, I ensured that I did not *impose* my interpretation from past knowledge, expertise, and preconceived ideas (biases). A more detailed explanation of my reflexive approach is offered below in the reflexivity section (section 7.4).

The overall methodology of this study has been designed as a general qualitative study and is not grounded in a particular approach. I pragmatically designed the research to fit the needs of the study. This approach could be described as bricolage in which one:

> *uses the means at hand, that is, the instruments he [sic] finds at his disposition around him, those which are already there, which had not been especially conceived with an eye to the operation for which they are to be used*
> (Levi-Strauss, 1962 cited in Thomas, 2017, p. 191)

The research design is made from a range of available philosophies, methods and techniques gained from studying, and I pieced them together to create the study design described in this thesis. For example, I used methodological self-consciousness (above) as part of my research design (see section 7.2.4), which has its origins in a constructivist ground theory approach. Importantly, the research design will help me to answer my research questions.

7.2.6

7.2.7 Methodological considerations

This section offers an overview of some of the methodological considerations embarked on as part of the research design processes undertaken in the early stages of the EdD programme. Interpretive phenomenological analysis (IPA) methodology was considered in these early stages. IPA is a methodology that has a relatively rigorous but rigid philosophical framework. The premise is hermeneutics, the theory and practice of interpretation (Braun & Clarke, 2013) and a type of linguistic analysis based in phenomenology, and is described by Kvale as:

> *Hermeneutical interpretation seeks to arrive at valid interpretations of the meaning of a text or conversation*
> (2007, p147)

Here, the researcher attempts to interpret the participants' own interpretation in what is known as double hermeneutics (Smith & Osborn, 2007). However, this did not sit with my social constructionist perspective because IPA assumes that what participants say in an interview situation reflects their actual lived experience, not its co-construction between researcher and participants (Smith, Flowers, & Larkin, 2009) [this is further explained in table 13, below].

Social constructionists base their beliefs on the assumption that language is not always an accurate reflection of the world, but there are multiple descriptions, with each of these descriptions being constructed with the researcher. It is argued that research can never be value-free as it is always situated in a specific context (King, Horrocks, & Brooks, 2019). This philosophy is true of the experiences of the participants in this study. They bring their 'baggage,' life experiences, placement and work experiences, family experiences, and aspirations. Social constructionism champions relationships between the researcher and participants and where knowledge is created in unison (Gergen, 2015). This position is one that I take in this research. It will adequately allow me to answer my research questions. Therefore, using a social constructionist informed QRTA was the adopted analytical method.

Using a qualitative reflexive thematical analysis (QRTA) design assisted with creating an inductive study as QRTA acts as a 'blank canvas,' so to speak. QRTA is a method and not a methodology. QRTA allowed me to create a research design based on my social constructionist, interpretivist and reflexive position. As described above, this allowed participants' voices to be heard throughout the process. Social constructionist QRTA allows me to analyse what is said, not how it is said.

Several other 'off-the shelf' methodologies were considered but were ultimately not employed for various reasons, which are shared in table 13 below.

Table 13: Other qualitative methodologies and the reasons for discounting them

Qualitative Methodology/ theoretical perspective	Overview	Advantages	Reason for discounting the methodology (limitations)
Phenomenography	Phenomenography is a research design approach that specifically attempts to answer questions about thinking and learning in education settings- phenomenography explores the qualitatively diverse ways in which people experience or think about various phenomena (Marton, 1986)	Specifically designed for use in education, research phenomenography is concerned with the content of thinking and the various ways people think about phenomena (Svensson, 1997)	In phenomenographic research, the researcher chooses to study how people experience a given phenomenon, not to study a given phenomenon (Marton, 1986). I set out to research both. The author is exploring education as a phenomenon, but I want to examine the different ways in which people experience a phenomenon. I want to examine common themes (shared meaning) (Marton, 1986; Svensson, 1997). It does not appear to be a step-by-step methodology. Poor range of literature to support its use.

Qualitative Methodology	Overview	Advantages	Reason for discounting the methodology (limitations)
Phenomenology	Phenomenology is about understanding the world from the perspectives of the individual. It is about understanding their life world (O'Reilly & Kiyimba, 2015). Phenomenology is about understanding how people sense the world around them, and the researcher must bracket out preconceptions that they may have about the world (Bryman, 2004).	I wanted the participants' data to 'speak for itself', and I wanted the participants voice to 'come through,' so in this respect, it would have fit with my research design	As a researcher, I wanted to highlight my involvement with constructing the data and analysis. My research is co-constructed. I did not want to maintain pure bracketing I did not want to be held to a particular viewpoint when looking at my data. I would have constantly been examining my data through a phenomenological lens
Interpretative Phenomenological Analysis (IPA)	IPA is a variant of phenomenology that investigates an individual's insights and experiences. Using an idiographic approach emphasises individuals' cognitive, linguistic, affective, and physical existence (Pringle, Drummond, McLafferty, & Hendry, 2011). IPA is concerned with how meaning is constructed by an individual within both a social and a personal world (Smith & Osborn, 2007)	IPA offers a non-prescriptive, adaptable methodology. Exploratory methodology that allows the researcher to investigate and give meaning to the lived experiences of its participants (Smith, Flowers, & Larkin, 2009)	As above (phenomenology) Based on double-hermeneutics, the analysis of linguistics. This methodology and theoretical perspective would not have helped me to answer my research question as it is trying to interpret the participant's own interpretation

Qualitative Methodology	Overview	Advantages	Reason for discounting the methodology (limitations)
Grounded Theory (GT)	Grounded Theory endeavours to understand, interpret, and explain the complex social phenomenon by characterising its concrete and structured guidelines. This understanding comes through an inductive reasoning process (El Hussein, Hirst, Salyers, & Osuji, 2014). A rigorous analysis might develop theoretical analysis and scrutinise the data until theory emerges (Charmaz, 2014).	Provides for intuitive appeal Fosters creativity Potential to conceptualise A systematic approach to data analysis Provides for data depth & richness (Charmaz, 2014; El Hussein et al., 2014)	Theoretical sampling and exhaustive nature of the GT (El Hussein et al., 2014) would have been challenging to manage with a 4-week protocol running within the time frame of my doctoral studies Theoretically constructivist, not constructionist, it does not fit my epistemological position. I do not want or need to produce a theory for this study as part of this was to inform future practice There are multiple approaches to GT, making this a complex method to use, therefore increasing the potential for methodological errors

Action Research (AR)	Broadly, AR can be described as a research method in which an agent/ stakeholder collaborates to identify an issue and form a solution based on this diagnosis. The data collection tends to form part of the diagnosis of the problem and the evaluation of the problem (Bryman, 2004)	Work very closely in collaboration with participants as stakeholders to find solutions to problems	I did consider AR research as a potential methodology at the start of the project. I wanted to use AR to help design the mental simulation script and protocol. However, it was ruled out because my research went further than AR allowed. I wanted to study the experience of the end-users. As has been previously discussed, I wanted to examine the experiences of the participants, the further opportunities and new research streams in nursing and mental simulation and Life-support mental simulation

:

This section has articulated the methodological considerations undertaken in the early stages of the research design. As Crotty (1998) described in chapter 1, diagram 1, the study's theoretical perspective is important for the research design. The theoretical perspective described in diagram 1 is reflexive interpretivism and inductive reasoning. As outlined above, the inductive lens meant that I did not attempt to impose theory on the data but allowed the data to 'speak for themselves.' However, literature and theory were applied to the findings post-analysis. This formed part of the opening chapters and was later married to the data in the discussion sections. This approach is detailed below.

7.3 Theoretical perspectives

As described above, it is not possible to fully induce the findings of this study before analysis. Therefore, no single theory is used as a lens to view the generated data, as it is not possible to find a 'one size fits all' discourse. As Dean (2017) argues, one must not 'narrow their gaze' when looking at the theory to explain one's findings. While mental simulation theory has, in part, been used to explain some of the findings, I also looked outside the mental simulation research literature. For example, parts of the discussion sections draw on motivational, graduate attribute discourse, and self-efficacy literature (e.g., Bandura, 1994). Other academic discourse, such as communities of practice (e.g., Lave, 1996) and fidelity and authenticity (e.g., Bland, Topping, & Tobbell, 2014), have been applied to illuminate the findings further, and these have been synthesised as a lens with which to view the finding and discussion chapters.

The data itself was analysed "atheorectically." The academic discourse and theories used in the findings and discussion chapters have been driven by the data analysis, not vice versa. The data was analysed from my (the researcher's) position as a lecturer with knowledge of nurse education and healthcare simulation and immersive technologies (Braun & Clarke, 2013). The literature used to support the discussion sections were added *a posteriori* to the thesis. As previously described, I paused reading to approach the data inductively, so the data analysis was not influenced by the literature cited in the discussion sections.

Above, I use the term "atheoretically" to emphasise the approach taken to this research, but the reality is that no data can be analysed completely atheoretically. For this reason, I approached the data reflexively, meaning that I am transparent about the influences of the interpretative processes. This is presented in the following sections.

7.4 Reflexivity and thematic analysis

This section will outline the importance of reflexivity in qualitative research Reflexivity is a fundamental aspect of the qualitative research process and qualitative reflexive thematic analysis (QRTA) (Braun & Clarke, 2013; King & Horrocks, 2010). I reflexively research as I am not claiming to be objective in my interpretation of the data. I will always bring my subjective values to the research process (Gergen, 2011). Reflexivity reflects the multi-directional correlation between me, as the researcher, and the research itself (King et al., 2019), and being transparent about this is a fundamental aspect of this research project (Jenson &

Laurie, 2016). The eventual themes (see chapter 11) created as part of the QRTA are created and interpreted stories developed at the intersection of my theoretical and methodological assumptions, worldview, the research questions and data itself (Braun & Clarke, 2019). In the next section, I will reflectively and reflexively illuminate my assumptions.

7.4.1 Reflexive practice: engaging a reflex approach to research

I reflected on my changing epistemological and methodological assumptions in the first sections of this chapter. In this section, I reflect on some of my theoretical assumptions. I am a critical care [registered] nurse, academic, educationalist and early career researcher. As a Doctorate in Education (EdD) candidate, I undertook four (level 8) modules, one of which was a Literature Review module. Undertaking this literature review helped with the subject knowledge required to pass this module. However, before the data analysis phase of the main research project, it had meant that I had to research and engage with some of the core mental simulation discourse.

There was a potential conflict here, so I approached the co-constructed data with an open mind. Dey's (1999, p251) oft-cited words are apt here. Dey suggests that "there is a difference between an open mind and an empty head" (cited in Charmaz, 2014). I tried to apply this concept throughout my research, approaching with an open mind, reflecting where necessary, and questioning why I was doing what I was doing. More focused reading occurs when data analysis is developed sufficiently to allow the broader literature to be used as additional data (Heath & Cowley, 2004), and this is the position that I adopted for this research project. I left the reading for the thesis introduction, literature review, and the findings and discussion chapters until I had sufficiently developed the data analysis process. This method was extremely time consuming, but the findings suggest that it was time well spent. In the next section, I reflexively discuss the influences of my simulation and immersive technology (SIT) background.

7.4.2 Influences of simulation and immersive technology

My most recent educational background is healthcare [physical] simulation and facilitated debriefing. I set up a simulation centre from its inception at a local NHS Foundation Trust in a previous role. Furthermore, I am the simulation lead in my current role within the department where I reside. I am the module leader for the Simulation-based Education module within my department, teaching simulation education and debriefing skills. As an advocate of simulation, I see a potential 'gap' for using mental simulation as an adjunct to 'mainstream' healthcare simulation techniques.

Therefore, the thesis is written in a language that cross-cuts between mental simulation and physical simulation theories, as described in the work of Wakefield et al. (2020). It seems pragmatic that if both physical and mental simulation share a common language, it may become an accepted method within the healthcare simulation community. Being transparent about this was a fundamental aspect of the reflexive processes. I did not look to shoehorn this language into the study. I let the data influence the language used.

7.5 Chapter summary

This chapter has presented the philosophical grounding of phase-2 of the research study. The chapter commenced with a discussion of my epistemological grapple and the influence of nursing and medical science. The chapter continued with a debate of my evolving worldview, and excerpts from my doctoral journal supported the debate. An overview of potential methodologies was presented; however, this study was not grounded in a particular approach but was perhaps designed with the best tools for the job, which I have described as a bricolage approach. An overview of the theoretical perspectives was considered, further discussing the employed reflexive practices and where I had cross-cut the data, in part, with the language of healthcare SIT.

In the next chapter, the ethical considerations are introduced. I will outline how the participants were safeguarded and how I minimised psychological risk from thinking about and discussing cardiac arrest and death. The chapter concludes with a discussion of anonymity and data protection.

Chapter 8 - Ethics and Ethical Considerations

Although codes, policies, and principles are very important and useful, like any set of rules, they do not cover every situation, often conflict, and require considerable interpretation. Therefore, it is important for researchers to learn how to interpret, assess, and apply various research rules and how to make decisions and act ethically in various situations.

[Dr David B. Resnik]

8.1 Introduction

In the previous chapter, the philosophical grounding of the research design was discussed. In this, my ontological and epistemological journey is considered. The theoretical perspectives and the reflexive positions are described in the context of healthcare simulation and immersive technologies (SIT).

Ethics is an important aspect of all research projects. While this qualitative interview study may seem ethically innocuous, there are many things to consider to protect the participants. This chapter will describe the safeguarding measures against psychological stress, including a debrief and signposting to counselling services. Anonymity and data protection considerations are articulated by discussing the encrypted databases on which the data was stored. These ethical principles and the ethical permissions were sought to cover both phase-1 and phase 2 of the study- both phases were present on the Converis, Univerity Research Ethics Committee (UREC) ethics application undertaken at the beginning of the study.

8.2 Ethics and Ethical Considerations

Before beginning data collection, this study gained ethics approval from the University Research Ethics Committee (UREC). The ethical framework sets out the moral rules and principles that guided my research (Denzin & Lincoln, 2017). The ethical framework designed for this study was primarily based on UREC policies. The UREC is based on the principles of respect for the person, knowledge, democratic values, the quality of educational research and academic freedom (British Educational Research Association (BERA), 2011). These BERA guidelines on which this study is based incorporate *voluntary participation*, *openness and disclosure*, *the right to withdraw*, *the right to privacy* and *full disclosure*.

The following section will overview the main ethical principles of caring for the participants and myself as the researcher.

8.2.1 Safeguarding participants from the harmful effects of emotion

As a researcher, I must take the necessary steps to safeguard all participants. The research participants must understand the process in which they are engaged. It could be argued that participants cannot agree to participate in this study with complete knowledge of what it is. There will always be hidden elements- this is a consequence of the semi-structured nature of my interview method and the interpretive process (Swain, 2017). However, it is crucial to inform the participants as thoroughly and accurately as possible. The information must include why they may want to participate, how the data will be used and how it will be reported (BERA, 2011). The process began with explaining the study and providing an overview of what to expect. This allowed the participants to make an informed decision.

I presented the participants with a written overview of the study. It was necessary to gain written (informed) consent as per UREC rules (these documents can be seen in appendix 5). According to BERA (2011), I must recognise the right of my participants to withdraw from the study for 'any or no reason' and 'at any time.' I informed the participants of this right. However, I was faced with an ethical dilemma. I planned to begin my initial analysis soon after each interview was completed. This is because I wanted to use the data to inform subsequent iterations of the topic guide (Charmaz, 2006) [see appendix 6].

Therefore, the participants were informed of their right to withdraw. However, the caveat was added, limiting withdrawal to 72-hours after completing their interview. UREC rules suggest that:

> *Potential participants must be informed that they are free to withdraw consent to participation at any time during the study and* ***up to a specified date after the data has been collected*** *unless data collection is anonymous.*
> (Sheffield Hallam Univerisity, 2016, p. 3)

This ethical dilemma is a contentious issue. After deliberation and discussion with the university lead for ethics, this decision was taken. The consensus was that providing the participants were aware of this before being interviewed, then they could make an informed decision.

There was a concern about the potential stress of thinking about cardiac arrest and death. The following section will discuss the potential psychological stress of discussing this emotive subject.

8.2.2 Psychological stress on topics of death and dying

As educational and social research involves people, there is a potential for the participants to suffer research induced stress, anxiety, and even physical harm (Swain, 2017). BLS and cardiac arrest are sensitive topics for some. Critical incident stress was a concern for me as an educator and researcher. However, as a registered nurse, I have a duty of care to my participants. One of my first objectives as a researcher and nurse is to 'do no harm' (non-maleficence) (Mertens, 2012; Nursing and Midwifery Council, 2018c) and to inflict no unnecessary pain on the participants (Hennink, Hutter, & Bailey, 2011; Kavanaugh & Ayres, 1998). To try and mitigate this, I was open about these potential risks during our first meetings, and I allowed the participants to remove themselves should they wish to.

However, this study has potential societal benefits (beneficence), and the research is not just being performed for academic benefit (Hennink et al., 2011). It has practical applications and aims to show whether mental simulation could improve life-support knowledge and skills. This could potentially save lives. It is not always possible to eliminate risks, so they must be identified and managed. I was vigilant to some potential study sensitivities (Kavanaugh & Ayres, 1998), which are outlined below.

As identified in the previous chapters, cardiac arrests are potentially psychologically stressful, and so too is evoking these memories. Despite this research being non-experimental, I was mindful of causing harm to the participants, as Thomas articulates here:

"Administration of any questions or procedures that may cause mental[…] discomfort during or after the research. This includes questions that at first sight appear to be straightforward."
(Thomas, 2017, p. 44)

This quote is significant in the light of Laws (2001) research on cardiac arrest. Laws found that post-BLS performance often caused 'critical incident stress.' Laws found that side effects include restlessness, irritability, excessive fatigue, sleep disturbances, anxiety, startle reactions, depression, moodiness, muscle tremors, difficulties concentrating. As previously described, the stress of cardiac arrest can cause longer-lasting trauma, with up to 10% of healthcare practitioners potentially showing signs of post-traumatic stress disorder following involvement (Spencer, Nolan, Osborn, & Georgiou, 2019).

The concern lay with the idea that in-depth reflection of BLS incidence may manifest with some of the above symptoms. Therefore, my UREC application reads as such:

Suppose the study causes an overt negative change in emotions (crying, loss of concentration, perceived anxiety, change in mood). In that case, the study will stop, and a debrief would be offered to the participants. This stoppage would allow them to talk about their past experiences and how it has made them feel. University counselling will also be offered if required, and details of the service will be given to all participants.
[Nick White, UREC submission form]

I offered the students the information for the university counselling team, should they require it. BERA (2011) considered it good practice for researchers to debrief participants at the interview's close. I debriefed the students at the end of their interview [see appendix 7 for the debrief overview]. As I am not qualified to undertake a psychological debrief, the main aim of the debrief was to ensure participants felt emotionally well and that the participants were signposted to support services. No participants relayed any ill-effect from the research protocol or from being interviewed.

8.2.3 Anonymity and data protection

Interview transcripts and identifying data are kept on the university's Q-Drive to maintain anonymity and protect participants' data [General Data Protection Regulation: GDPR] (Data Protection Act, 2018). This storage is an encrypted drive that has been designed to store the university's research data. It is fully encrypted to the specific encryption policy recommendation of FIPS 140-2 level. Participants can only be identified from a pseudonym (see demographics table in section 9.3, table 14), and identifying features are stored on the encrypted drive. Identifying features cannot be identified from the recordings or transcriptions themselves.

8.3 Chapter summary

In this chapter, the ethical framework has been discussed. This began with an overview of the ethical principles based on BERA guidelines. An overview of the psychological considerations and safeguards that were put into place were outlined, and these included debriefing and signposting to counselling should it be required. These are significant considerations, given the topic of death and cardiac arrest. The chapter concludes with how anonymity and data protection and a description of the Q-drive university set-up for encrypted data storage was discussed.

The next section presents the research study design and offers an overview of the data collection methods and considerations. The participants are introduced, and the sampling technique is described. The data collection method was semi-structured interviews. There is a short discussion on how the participants were put at ease by building rapport, and the endpoint of data collection is described.

Chapter 9 - Research study design: data collection

A well-planned research design helps ensure that your methods match your research aims and that you use the right kind of analysis for your data
[Shona McCombs and Pritha Bhandari]

9.1 Introduction

The previous chapter tackled the important ethical considerations of the study design. These considerations were based mainly on the welfare of the participants, especially considering the topic of death and cardiac arrest and outlined how these sensitive and emotive topics were managed. Anonymity and data protection were also discussed in the context of secure encrypted drives.

This chapter will discuss the data collection methods. The chapter opens with an introduction to the participants. This includes how they were recruited and the purposive sampling technique utilised. There is a discussion of how the two phases of the study and how they combined. Phase-2 of the study is a qualitative interview study that utilises a semi-structured interview method linked to the study's social constructionist epistemological perspective. The chapter concludes with a discussion on rapport and how the participants were put at ease. Some 11-participants were interviewed for phase-2 of the study, and the final part of the chapter addresses the data collection end-point and how this was decided. The chapter begins with discussing the EdD pilot modules and what these meant for the study overall.

9.2 Pilot study

There was no official pilot study conducted as part of this research. As a taught doctorate, this EdD programme was designed with pilot study style modules. These modules were conducted in year-2 of the programme, but no official data analysis was conducted. Research methodology (module 3) and the data analysis methods (module 4) were considered. As part of module-3, I had the chance to practice using semi-structured interviewing techniques. The interview questions were more aligned to phase-1 of the study and were based on pre-registration nurses' experiences undertaking CPR in practice. This part of the course also allowed me to practice using NVivo data management software before the thesis phase of the programme (see section 9.4.1 for more detail on NVivo).

As there was no chance to pilot the phase-2 questions, an in-depth discussion of the topic guide was undertaken with both supervisors. Here I used their experience to help focus the questions, look at the wording of the questions and design some of the follow-up questions that were ultimately used. As shown in more detail in appendix 6, section 17.6, the questions were also re-worded as the data was collected and the data analysis commenced.

9.3 The participants and recruitment

As I primarily teach pre-registation nurses, I wanted to study this population to make a difference within my practice area. Recruitment was based on several factors, which will be discussed and justified. I will not use the term ‘sample’ to describe the study participants. I claim to create an original contribution that is transferable to practice. However, I do not claim the results to be generalisable. The terms 'sample' and 'sample-size' have positivistic undertones (Thomas, 2013), so it does not fit my epistemological position. 'Participant' is a more appropriate term in an interpretivist paradigm. I use the term 'participant(s)' throughout.

Year-2 and year-3 adult field students from the Nursing and Midwifery department within a large UK university were invited to become participants. Recruitment was undertaken using e-posters that were sent in bulk to relevant students via email, and I conducted face-to-face invites at induction lectures. Year-1 students were not recruited due to being at the start of their nursing journey and the recruitment being very early in the academic year.

Sixteen participants began the study, but five withdrew for personal reasons, leaving 11 (eleven) participants (the participant demographics below in table 14 see section 15.8 for discussion of how attrition affected the study). Only 3-participants had delivered hands-on BLS, whilst a further 4-participants had observed a cardiac arrest from afar. All the participants had experienced CPR in a low-fidelity situation (mandatory training), but only 6-participants had experienced CPR in a high-fidelity simulation in the simulation laboratory. Participants were selected using a purposive sampling technique discussed in the next section.

Table 14: Demographics and experience of the participants

Name	Age	M/F/B	Ethnicity	Year/ Course	Hands-on CPR	Cardiac arrest observed	ALS Simulation
Sarah	18-25	F	White British	2/ BSc Nursing	Yes	Yes	No

Mandy	26-35	F	White British	3/ BSc Nursing	No	Yes	Yes
Ralph	18-25	M	White British	3/ BSc Nursing	No	No	Yes
Jack	18-25	M	White-European	3/ BSc Nursing	Yes	Yes	Yes
Claire	46-55	F	Black African	2/ BSc Nursing	Yes	Yes	No
Lucy	18-25	F	White British	3/ BSc Nursing	No	No	Yes
Amy	46-55	F	White British	3/ BSc Nursing	No	No	Yes
John	18-25	M	White British	2/ MSc Nursing	No	Yes	No
Emerald	18-25	F	White British	3/ BSc Nursing	No	Yes	Yes
Paula	26-35	F	White British	3/ BSc Nursing	No	Yes	No
Wendy	26-35	F	White British	3/ BSc Nursing	No	No	No

9.3.1 Purposive sampling technique

The participants were chosen using a purposive sampling technique, as they were selected based on particular characteristics (Walliman, 2016) of being the pre-registration (student) nurses that I teach. Purposive sampling is a non-random or non-probability sample where the target population meet specific criteria (Etikan, Abubakar, & Rukayya, 2016). In this case, it was a deliberate selection of specific individuals from a specific setting. The participants were accessed for their personal perspective. In this case, the students' unique perspective of using mental simulation to learn life-support skills while being a pre-registration nurse. They were, therefore, chosen because they are specifically homogenous (Cohen, Manion, & Morrison, 2011) and "information-rich cases" (Patton, 2015, p. 264). The homogeneity, in this case, is that all the participants are pre-registration nurses in their second or third year of study.

Overall, the participants were invited and chosen based on their accessibility (Braun & Clarke, 2013). This sampling method was chosen as the research does not seek to represent any group other than itself (Cohen et al., 2011). A purposive sampling strategy emphasises depth and similarity, and this sampling technique appeared better suited for examining commonalities (Palinkas et al., 2015) when using thematic analysis.

A limitation of using purposive sampling is that the researcher can often exclude several groups, potentially leading to skewed research findings. When using purposive sampling, the researcher is subjective, and there is a risk bias when choosing the participants (Etikan et al., 2016). While it is not easy to overcome this, I gave everyone in years two and three of the nursing programme an equal opportunity to participate. All the students who approached me to be included were invited to participate in the study.

9.4 Using the mental simulation protocol

The participants were met before undertaking the 4-week mental simulation protocol described in chapter 6. Access to the mental simulation protocol was granted, and an explanation of what was required of them was discussed. Information sheets (see appendix 4, section 17) were given to participants so they were fully informed. We exchanged phone numbers so that participants could contact me should they need further clarification. I asked permission to send one text message in the middle of their 4-weeks, to which they all agreed. At 2-weeks, I sent a message asking how they were progressing.

At 4-weeks, the participants were contacted once again, by email, to arrange the semi-structured interview, which was agreed upon based on the availability of both parties. Face to face interviews were then conducted and recorded on an electronic dictaphone and then downloaded to the university's Q-Drive (encrypted drive). The semi-structured interview protocol was designed using the philosophy laid out in the next section.

9.5 Semi-structured interview protocol

I utilised the semi-structured interview to ask open-ended questions, probing the participants on the meaning of their experiences. Semi-structured qualitative interviews relied on developing a list of open-ended and follow-up questions (Jenson & Laurie, 2016). The semi-structured interview also allowed me the opportunity to ask questions out of sequence or ask probing questions that were not pre-planned. This method is based on the underlying assumption that given the right conditions, the semi-structured interview will allow participants to 'answer freely based on personal reflection, knowledge and experience' (Jenson & Laurie, 2016, p. 173). Semi-structured interview methods allow participants to freely present their situations in their own words (Bryman, 2004). The knowledge conveyed through conversation will be brought into being through socially constructed meaning (Gray, 2014; King & Horrocks, 2010; Kvale, 2006). In creating meaning, people do not just act with one another but *interact* (Flick, von Kardoff, &

Steinke, 2004)- from a social constructionist perspective, this interaction is essential. The semi-structured interviews afforded me the privilege of this interaction.

The research protocol is the topic guide (research question guide) and is an essential and central component of the data collection methods (Rabionet, 2011). I developed the topic guide and follow-up probes (see appendix 6, section 17.6 for the first and last iterations of research questions). No closed format questions were written, as I did not want to limit the participant responses. Using open-ended semi-structured questions was in keeping with my epistemological and ontological positions (Walliman, 2016). The semi-structured nature of the interview allowed me to ask ad hoc questions to help co-construct meaning further (Jenson & Laurie, 2016).

I paid very close attention to the relationship between the main study questions and the questions devised for the interview, ensuring that they helped me understand the phenomenon under scrutiny (Clough & Nutbrown, 2012; Roulston, 2010). I further categorised the topic guide into subsets with subject headings. I essentially translated the abstract research questions into a more colloquial topic guide (Hennink, Hutter, & Bailey, 2011). As described above, the questions were then discussed in detail with my supervisory team.

My interview questions were iterative and evolved throughout the data collection phase as data analysis began. I reflectively examined the relationship between the questions I asked in the interview and the answers given by the participants

(Rabionet, 2011), which helped gauge participant understanding. Some questions were difficult for the participants to understand. Some of this confusion came from me trying to ask the questions in a conversational style format as I tried to put them at ease. When this occurred, I reverted to the formal wording of the guide, which appeared to help. I often reworded the questions in new iterations of the interview protocol if they appeared challenging to grasp. I listened to the interview tapes post-interview to reword or dismiss questions that no longer seemed appropriate (Gray, 2014), and this allowed me to streamline the interview process, but this did not always work out, as I had more than one interview on the same day due to time constraints and participant availability. I also attempted to write the questions so as not to be leading. I did not want to bias the data collected (Hsiung, 2008) nor irritate the participants (Roulston, 2010). But how is this linked to social constructionism?

9.5.1 Link to social constructionism

As previously described, a social constructionist position encourages the co-construction of the meaning between researcher and participant. It will offer a more rounded understanding of participant experiences (King, Horrocks, & Brooks, 2019) of using mental simulation. The participants themselves are the only people who can illuminate the factors that influence their own experiences (Thomas, 2013) and semi-structured interviews allow this to occur. To show this construction of knowledge, I sometimes present two-way conversation extracts in the findings and discussion chapters.

The semi-structured nature creates interaction, which is interpretive and reciprocal, and this makes it a fundamental act in facilitating co-constructed meaning with research. Individuals construct a perceived reality based on their perceptions of their world (Benzies & Allen, 2001). Joen (2004) suggests that participant experiences are best understood through interpretation and meaning. These are the major foundations in understanding human behaviour- this is the position I take for this research. However, making the participants feel at ease is important. This is so they can speak freely and give me honest answers, even if they feel that I may not 'like' the answers. The next section describes this rapport building.

9.5.2 Putting the participants at ease: building rapport

A semi-structured interview is a specific form of professional conversation within this research design. However, there is a clear power-asymmetry between myself as a researcher and the students as participants; my role is to ask questions, and the participant's role is to answer (Brinkman & Kvale, 2015). This asymmetry raises epistemological issues regarding knowledge production from interviews and raises ethical issues about how one deals with this power asymmetry. It was necessary to put the participants 'at ease' so they might open up to me to give an 'accurate' description of their experiences (Mills & Birks, 2014). This is a critical aspect of this research design.

As an insider researcher, I had a tutor/ student relationship with the participants. While I tried to put the participants at ease, the semi-structured interview should not be regarded as an open and free dialogue between two egalitarian partners (Kvale, 2007). Power asymmetry can never entirely be eliminated, but developing a trusting and warm relationship with the participants helped me in 'acquiring the fullest, most accurate disclosure a respondent can make' (Gleshne & Peshkin, 2005, p. 87). It is possible to have constructive, open dialogue, and by spending time building a rapport, I feel that I reduced the power asymmetry as much as I might.

Rapport is part of the quality process (Gray, 2014) and is designed to generate an environment that can evoke 'reflection and truthful comments from the interviewee' (Rabionet, 2011, p. 564), thus [theoretically] allowing the participants to express themselves (Gray, 2014). Both King and Horrocks (2010) and Cohen, Manion, & Morrison (2011) argue that rapport is about gaining and maintaining an element of 'trust.' Likewise, Bryman (2004) suggests that a researcher/ participant relationship must be quickly established. For this reason, I designed into my research method a period where I could build a rapport with the participants. At the beginning of the phase-1 research period, I spent some time 'getting to know' the participants. I attempted to *level the playing field* by talking to the participants about my studies and referring to myself as a student (Brinkman & Kvale, 2015; Gleshne & Peshkin, 2005). I discussed the stress of undertaking an assignment based programme, to which they could easily relate and would see me in a less 'powerful' light.

Now that data collection has commenced, and data analysis has begun, it is important to consider when the data collection endpoint is. There are several factors to consider, and these are presented in the final section.

9.6 The endpoint of data collection

The number of participants was established *a posteriori*, which is often the case in qualitative research (Sim, Saunders, Waterfield, & Kingstone, 2018). Each interview lasted between 1-hour 15 minutes, and 2-hours. However, this kind of assessment of data collection focuses on quantity over quality, which does not fit the research design. In interpretive studies, it is often challenging to anticipate 'how much is enough.' This is because the required number of participants is emergent as the data analysis is undertaken (Braun & Clarke, 2016). On reflection, I find it problematic to consider qualitative research in terms of quantitative measures. I thought long and hard about 'using' data saturation. Data saturation is based on information redundancy (Sadowski, 2008). As Grady (1998, cited in Sanders et al., 2018) argues here:

> *New data tend to be redundant of data already collected. In interviews, when the researcher begins to hear the same comments again and again, data saturation is being reached[…]. It is then time to stop collecting information and to start analysing what has been collected.*
> *(p.26)*

Data saturation methods are not atheoretical. It appears to have positivist undertones regarding quantity over quality, and this position did not sit with my social constructionist position. As Low (2019, p. 131) suggests here, interpretivist research saturation is a:

> *[L]ogical fallacy, as there are always new theoretical insights to be made as long as data continues to be collected and analysed.*

A recent Braun and Clarke (2021, p. 207) article on data saturation helps explain my position in this research:

> *In [qualitative] reflexive thematic analysis, codes are never finally fixed. They can evolve, expand, contract, be renamed, split apart into several codes, collapse together*

with other codes, and even be abandoned. Coding can and often does become more interpretive and conceptual across an analysis, moving beyond surface and explicit meaning to interrogate implicit (latent) meaning. Such developments and refinements reflect the researcher's deepening engagement with their data and their evolving, situated, reflexive, interpretation of them. They also demonstrate a key point for [qualitative] reflexive thematic analysis: codes are conceptual tools in the developing analysis and should not be reified into ontologically real things.

So, the question is, 'what is the endpoint?' Again, Braun and Clarke (2021) articulately argue the adopted position in this study. They suggest that I ask myself: *does the data tell a compelling, coherent and valuable story about the data in relation to the research questions*? Coding and deeper analysis do not reach a fixed endpoint, but I made a considered and interpretive judgement about when to stop coding and move on to theme generation and then on to mapping and so forth. This study occurred when the boundaries of each theme were clear and the themes and sub-themes easily defined (Braun & Clarke, 2006). Smaller numbers of participants can often be applied when the participants are relatively homogenous.

As described in section 9.3.1, homogeneity is associated with purposive sampling (Patton, 2015). Furthermore, the study area is narrow, and the research question is focused, meaning that smaller numbers will often reach 'endpoints' sooner (Braun & Clarke, 2013; Braun, Clarke, Hayfield, & Terry, 2019). Furthermore, Sim et al. (2018) argue that interpretive research is pragmatic. One must consider time and resources, and this was certainly a consideration on an EdD programme where time to completion and resources are finite. Sim and colleagues conclude that the endpoint to data collection is determined by interpretive, situated [in the data analysis] and pragmatic judgement. This position guided my data collection 'endpoint' and guided how I decided on ending data collection.

9.7 Chapter summary

This chapter has outlined the data collection methods. The chapter began with a discussion of how the final two assessed modules of the EdD programme acted as pilot study style modules, but they fell short of full pilot data analysis. The purposive sample design was discussed, and the recruitment strategy was explained. The links between phase-1 and -2 of the research were made clear, and an overview of how the two phases interconnected. In line with the study's epistemological lens, a rapport was built with the participants before data were collected through semi-structured interviews. This allowed for the co-construction of data and knowledge. The method for judging the endpoint of data collection was described and is based on Braun and Clark's (2021) work described in the sections above.

The following chapter discusses the data analysis phase of the research. Qualitative reflexive thematic analysis was used to theme the data in this phase. Each of the six phases of thematic analysis and how each of these were applied is presented. The final parts of the next chapter discuss the research process's rigour, quality, and trustworthiness as these are essential aspects of qualitative research processes.

Chapter 10 – Study design: data analysis and quality

A pattern-based analysis allows you to systematically identify, interrogate, interpret, and report on salient features of the data. These data patterns are united by a central organising concept that develops from the interpretive process following coding.
(Braun & Clarke, 2006; 2013)

The previous chapter outlined the methods for data collection through semi-structured interviews and how this phase (phase-2) of the research links with phase-1. The pre-registration nurse participants were introduced, along with recruitment strategies and the purposive sampling techniques were described. The importance of rapport building in qualitative research was addressed and how this was applied was outlined and justified. The final section discussed the endpoint of data collection and how this was employed.

The current chapter is set into two main areas: the data analysis phase and a presentation of the research process's trustworthiness, quality, and rigour. As previously described, the research project employed a qualitative reflexive thematic analysis (QRTA) method. QRTA is recognised as a method of analysis in its own right and has been demarcated and proceduralised by Braun & Clarke (2006). Each phase of the analytical methods and the operationalisation in this study, will be conveyed throughout. Each phase of QRTA are utilised as subheadings to offer structure to outline the processes involved in the in-depth data analysis. Finally, saliency analysis is discussed as the final part of the data analysis methods- this method focuses on using data, based on its saliency to the research questions.

In the rigour and quality sections of the chapter, I use Braun and Clark's (2006) 15-point checklist for good thematic analysis and Tracy's (2010) 8-Big Tent criteria as a guide to help show the study’s trustworthiness. The NVivo data management system also helps show the study's rigour, which is presented. NVivo helped create an audit trail of the coding and theming processes (see appendix 9, section 17.9 for the NVivo codebook). Finally, there is a short discussion of the publication and conference outputs from the perspective of quality. The first section offers an overview of QRTA.

10.1 Qualitative reflexive thematic analysis

QRTA, according to Braun and Clarke (2006, p79), is a method for “identifying, analysing and reporting patterns (themes) within data.”   Themes reflect a pattern of shared meaning across a dataset, and they are arranged around an organising central concept (Braun et al., 2019). Using QRTA will help organise and describe my dataset and create a narrative, allowing me to ‘tell a story’ in relation to the research questions (Braun & Clarke, 2021). Codes and themes attempt to generalise the data through common labels to compare and contrast certain aspects (Harding, 2013). QRTA is finding common threads across the dataset (De Santis & Noel, 2000), and it will help me find patterned responses. QRTA is about “what is said, not how it is said” (Bryman, 2004, p. 412). The interpretation of meaning in ‘what is said’ will help me answer my research questions and unpick the participants' experiences.

QRTA is a method and not a methodology, and for this reason, it has no theoretical framework (Braun et al., 2019). QRTA is atheoretical and methodologically flexible, which was why it was adopted in this study. It is compatible with a social constructionist paradigm in that it allows experience and meaning to be socially produced through conversation (Braun & Clarke, 2006; 2013). Braun and Clarke (2006, p.85) further suggest that a social constructionist QRTA:

> *seeks to theorise the sociocultural contexts and structural conditions that enable the individual accounts provided.*

This perspective certainly supported my research question and my epistemological position. To be inductive, I needed to analyse the data using a method that did not impose a worldview. Other 'off-the-shelf' methodologies (for example, constructivist grounded theory or interpretive phenomenological analysis) tend to impose a lens with which to view the data (see table 13, section 7.2.6). In the section, QRTA is examined in more detail.

10.2 What is a qualitative reflexive thematic analysis?

The Braun and Clark (2006) and Braun et al. (2019) QRTA method follows a 6-stepped procedure. QRTA is a method that allows the categorisation and labelling of qualitative data. This allows the researcher to "make sense of meaningful patterns" within the data and create a dataset (King et al., 2019, p. 309). As the QRTA researcher, I will be the storyteller (Braun et al., 2019; Gibson & Brown, 2009). QRTA provides me with the foundation for establishing and understanding the participants thinking, feelings and behaviour in relation to their experience (Joffe, 2012). I will also observe both commonalities and contrasts within the dataset (Tuckett, 2005). In essence, generating and interpreting themes will allow me to analyse and understand my participants' representation of their independent reality (Hammersely, 1991). As previously discussed, I approached the data analysis with initial ideas and skills; therefore, I needed to be open-minded during the analysis and interpretation phase. I consequently questioned how I arrived at each code and theme. I approach my data analysis with both this understanding and a reflexive lens.

The following subsections discuss the stages of QRTA approaches, the adaptations employed, and [most importantly] I will offer justifications and reflections as I go.

10.2.1 QRTA Phase-1- Familiarising yourself with your data:

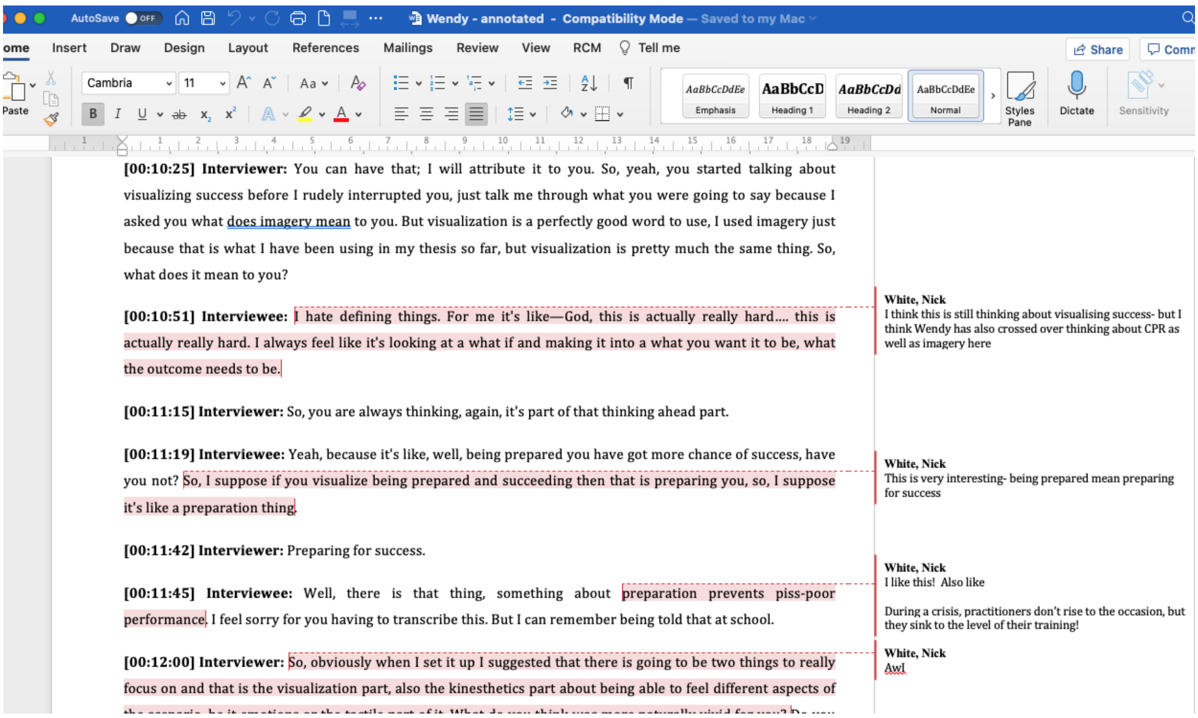
Table 15: QRTA Phase-1, Braun and Clark (2006, p. 87)

Phase 1	**Description**
Familiarising yourself with your data:	Transcribing data (if necessary), reading and re-reading the data, noting down any initial ideas that you have about the data and your initial interpretations

The first stage of the data analysis phase starts with immersing oneself in the data to familiarise. This allows the researcher to begin to get to know that data (Braun & Clarke, 2006). See table 15 (above) for an overview of phase-1. This section begins with an examination of transcribing as part of the familiarisation of the data.

Transcription of interviews involves close observation of one's data through constant listening and can be the first step in data analysis (Bailey, 2008). Bailey suggests that this familiarity with the dataset and close attention to what is said rather than expected can facilitate realisations and ideas that emerge during analysis. It was, therefore, not without careful consideration that the decision was made not to transcribe my own interviews. I paid for a transcription service to transcribe the data to Microsoft Word documents on my behalf.

To ensure quality and begin familiarisation, I listened to each interview recording and checked them against the transcripts (Easton et al., 2000). This action served two purposes. Errors can occur with punctuation, such as a misplaced or forgotten question mark or comma, and these inaccuracies can change the meaning or implication of a phrase (Easton et al., 2000). This process also allowed me to make an in-depth first impression of the transcripts and create annotations on the transcription documents as memos. I documented initial analytical ideas during this phase (Charmaz, 2014). These memos were created to note my initial thoughts about the data and marked the beginning of the written analysis phase. See below in picture 2 for an example of an annotated memo.



[00:10:25] Interviewer: You can have that; I will attribute it to you. So, yeah, you started talking about visualizing success before I rudely interrupted you, just talk me through what you were going to say because I asked you what does imagery mean to you. But visualization is a perfectly good word to use, I used imagery just because that is what I have been using in my thesis so far, but visualization is pretty much the same thing. So, what does it mean to you?

[00:10:51] Interviewee: I hate defining things. For me it's like—God, this is actually really hard.... this is actually really hard. I always feel like it's looking at a what if and making it into a what you want it to be, what the outcome needs to be.

White, Nick
I think this is still thinking about visualising success- but I think Wendy has also crossed over thinking about CPR as well as imagery here

[00:11:15] Interviewer: So, you are always thinking, again, it's part of that thinking ahead part.

[00:11:19] Interviewee: Yeah, because it's like, well, being prepared you have got more chance of success, have you not? So, I suppose if you visualize being prepared and succeeding then that is preparing you, so, I suppose it's like a preparation thing.

White, Nick
This is very interesting- being prepared mean preparing for success

[00:11:42] Interviewer: Preparing for success.

[00:11:45] Interviewee: Well, there is that thing, something about preparation prevents piss-poor performance. I feel sorry for you having to transcribe this. But I can remember being told that at school.

White, Nick
I like this! Also like

During a crisis, practitioners don't rise to the occasion, but they sink to the level of their training!

[00:12:00] Interviewer: So, obviously when I set it up I suggested that there is going to be two things to really focus on and that is the visualization part, also the kinesthetics part about being able to feel different aspects of

White, Nick
Awl

Picture 2: initial memo annotations

Memos are descriptive summaries and are used to synthesise higher analytical meaning (Miles and Saldaña, 2014). Memos help examine thought processes by helping to analyse associations, potential codes and themes, and initial ideas. Memos assist with developing theoretical and conceptual links by supporting the analysis of these relationships within the data (Grbich, 2013). Grbich further suggests that ideally, a memo should be made each time coding of the data ensues. I did this using the notes section in each code in NVivo (NVivo is further described in section 10.4.1). Essentially, this is a way of recording and capturing a route map for how the data analysis unfolds, making it easier to reanalyse and reinterpret the data later (Charmaz, 2014), and this proved to be the case as my data analysis progressed – see codebook in appendix 9 for the notes for each initial code.

During the initial checking of the transcripts, many errors required correction. By initially immersing myself, I started to engage with the data. An understanding of the meaning behind what the participants were describing began. Once completed, I felt confident moving to phase-2, where codes were created for the corpus data, described in the section below.

10.2.2 QRTA Phase-2: Generating initial codes

Table 16: QRTA Phase-2, Braun & Clarke (2006, p. 87)

Phase 2	Description
Generating initial codes:	Coding interesting features of the data in a systematic fashion across the entire dataset and collating data relevant to each code.

Coding the data categorises [labels] and sorts the data (Charmaz 2014). Coding creates a category that describes a general feature and captures one interpreted idea within the data (Braun & Clarke, 2013; Gibson & Brown, 2009) [See table 16 for an overview of phase-2]. I began using eclectic coding (Saldaña, 2016), where I mixed and matched various coding methods. I was unfamiliar with the data, and ideas about the deeper analytical meaning were not yet apparent. This process mainly involved in-vivo coding [where I used the participants own language as a label] and descriptive coding [where I used surface meaning of the codes as a label] (Saldaña, 2016). These techniques might be described as semantic (Braun & Clarke, 2006) as I was not looking for latent or 'hidden' meaning at this time. As the process continued (see phase-4), I interpreted a deeper latent meaning. At this point, the names changed to be more analytical in meaning (Braun & Clarke, 2013). See the phase-2 codebook in appendix 9 for an overview of the process taken during this phase.

As noted, my coding methods drew attention to interesting features within my data. Joen (2004) suggests that coding is performed to draw attention to *commonalities* within a dataset. These codes then act as the building blocks that shape my understanding and the meaning-making of participant experiences. These codes always relate to my research question(s) [I had the research questions pinned to my office wall within my eyeline]. Coding was performed systematically across all the data of the eleven interviews (Braun & Clarke, 2006). I employed a coding method that left very little of the corpus data uncoded in at least some way. It was better to over-code and discard than risk failing to code an idea that could become an important feature later in the analytical process (Gibson & Brown, 2009). This process was by no means an arbitrary exercise but was performed to be thorough in the coding and analytical processes, but it was time-consuming. However, I did not want any ideas or interpretations of the data to be missed.

In line with inductive reasoning, I employed the use of empirical codes. Empirical coding means that the codes (and eventually the themes) are strongly linked directly to the data themselves and not to preconceived ideas or theories. Empirical codes *emerge* through the evaluation and interpretation of the data (Gibson & Brown, 2009). It is worth highlighting here that the term 'emerge' is perhaps misleading. *Emerge,* or *emergence*, suggests that the codes reside within the data, just waiting to be discovered. It fails to consider the researcher's active role in the interpretive process (Braun & Clarke, 2006; Braun et al., 2019).

However, as an interpretivist researcher, I take an active role in systematically and constantly comparing the dataset, recognising and categorising patterns and theming, before selecting which data are of interest and using these to build up a picture of my participants' experience and about the research questions (Braun & Clarke, 2006; LeCompte, 2000; Thomas, 2013). From a social constructionist position, themes are made, shaped, or conceived from the dataset (Sandelowski & Barroso, 2003). Therefore, for the benefit of this thesis, I would define emerge/emerging as:

the conception, shaping, recognition and categorisation of patterns within the dataset as reflexively interpreted by the researcher.

I was mindful that codes are often looked at as a poor substitute for researching experience. Code extracts can decontextualise a contextually specific aspect of the participants' experiences (Gibson & Brown, 2009). Contextualising sections of the dataset can often be bracketed out, potentially impoverishing the participants' experience. However, this does not mean that categorising data into themes is not valuable. I was mindful of this whilst I was coding, and I was careful to try and take extra text from around the coded lines to keep some of the contexts of the original conversation. I was also able to instantly return to the full text in the interview using NVivo. This way, I was careful to keep some of the context of the conversations. I will use some examples to describe how codes emerged from my data in the next section.

10.2.3 Emerging codes

After immersing myself in the initial parts of the analysis, many codes emerged from the interview data. These codes were identified not by prevalence but concerning my research questions (Gibson & Brown, 2009; Saldaña, 2016). As described above, I employed an empirical coding technique. Using empirical coding is in contrast to employing *apriori* codes. If I had employed an *apriori* code technique, I would have created my codes before analysing them. Utilising an *apriori* technique is often used for exploring particular areas of interest (Thomas, 2017). These codes are developed through prior reading and research interest in the study area (Male, 2016), and *apriori* coding is a deductive approach to research design and has positivistic undertones (Braun et al., 2019). I had "hypothesised" about some of the participants' experiences as this is human nature. I could, therefore, have potentially used *apriori* codes in my study. However, using *apriori* codes may have led me to miss much of the complexity of the discussions that inductively emerged from the participants (see chapters 12-14). Therefore, using empirical codes allowed me to be open-minded and consider factors that were not previously visible to me from reading the literature or from my own experiences.

The next step was to find ways in which the codes relate to each other in a coherent, study-important way. The codes now need to be conceptually and structurally unified (Miles et al., 2014). As coding progressed and data analysis ensued, I employed the interpretive, analytical method, known as the constant comparative analytical method (CCAM). CCAM is an iterative technique undertaken in the tradition of inductive reasoning. It is a process of reducing the data through constant coding and re-coding (Charmaz, 2014). The codes are compared and re-compared to other codes within the dataset (Kolb, 2012), adding rigour to the analytical process. I employed this technique, comparing each incident to other incidents, and I used this method to compare similar incidents within the interview text (Fram, 2013). CCAM allowed me to connect some codes into initial ideas for (candidate) themes. This is further discussed in the next section.

10.2.4 QRTA Phase- 3: Searching for themes

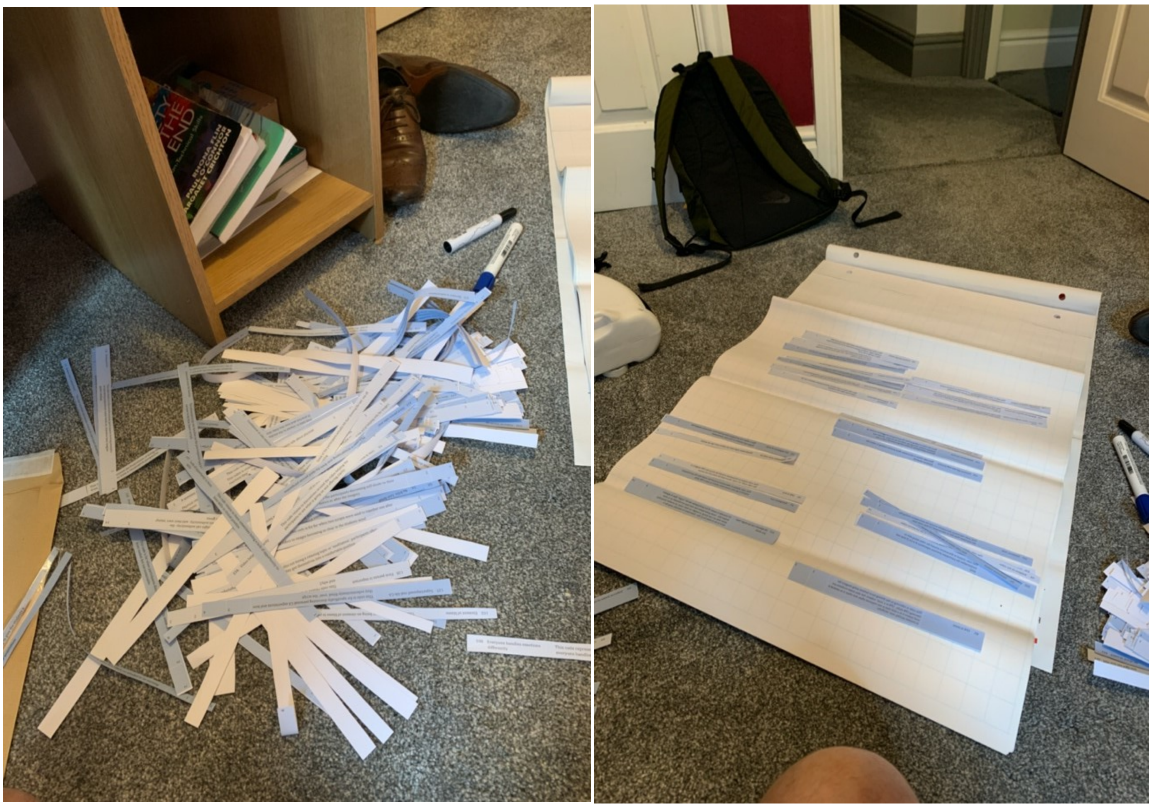
Table 17: QRTA Phase-3, Braun and Clark (2006, p. 87)

Phase 3	**Description**
Searching for themes:	Collating these codes and putting them into potential themes. This is done by gathering all the data relevant to each potential theme.

This phase occurs when the data has been initially coded and somewhat refocuses the data analysis aims at a much broader level of themes and is defined in table 17 above. This phase involves collating the data extracts within 'candidate themes,' so-called because these themes are, for now, temporary (Braun & Clarke, 2006). According to Braun and Clark (2013), a theme is defined as:

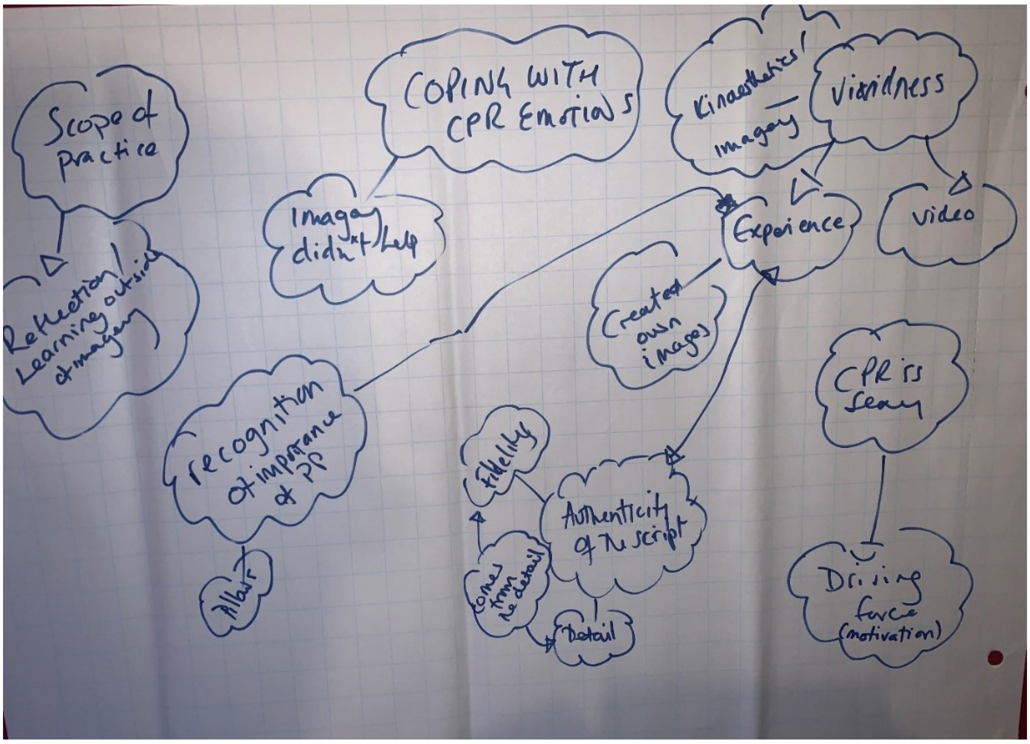
> *A patterned meaning across the dataset that captures something important about the data in relation to the research question, organised around a central organising concept*
> (p. 337).

These 'important' and 'meaningful' aspects come from interpretation with the research question in mind. See the phase-3 codebook in Appendix 9 (section 17.9) to overview the candidate themes. I undertook this phase by cutting out each code and grouping them with initial thematic titles. See picture 3 below for an example of this process.



Picture 3: The theming process in action

The *central organising concept* is the essence of the theme. The central organising concept is an idea that encapsulates a logical, significant, and unifying pattern from the codes and provides a succinct element toward answering the research question (Braun & Clarke, 2013). At this stage, I began to analyse my codes in further detail. I started to interpret which codes would combine to form an overarching theme (Gibson & Brown, 2009). I further used the suggested mind map technique advocated by Braun and Clark (2006) to visualise and conceptualise the codes that might be linked together to create the candidate themes. See picture 4 below for a mindmap created at the very early stages of the analysis.



Picture 4: A very early attempt at theming the coded data

At the end of this phase, I was left with 11-candidate themes. I was left unsure if this was too many. However, as they were candidate themes, I left any necessary refinement until phase-4, which can be seen below.

10.2.5 QRTA Phase-4: Reviewing themes

Table 18: QRTA Phase-4, Braun and Clark (2006, p. 87)

Phase 4	Description
Reviewing themes	Checking if the themes work in relation to the coded extracts (Level 1) and the entire dataset (Level 2), generating a thematic 'map' of the analysis

Once the set of candidate themes had been devised, I set about refining them- this is akin to quality control of the dataset. At this phase, I must begin to tell a story that 'rings true' and is faithful to the data (Braun & Clarke, 2013) [see table 18 above]. I went back through the codes to ensure they were coherent. I renamed some of the themes at this stage. In the second part of phase-4, I re-read the corpus data from the beginning, re-reading each interview afresh (Braun & Clarke, 2006). See phase-4 codebook in appendix 9 for an overview. Furthermore, in appendix 9, I offer an example of each theme, presented with each code and an example of a data extract from that code. This will allow the reader to observe the boundaries of each theme and subtheme.

After refining the codes and strengthening the themes and subthemes, I was left with a miscellaneous folder of codes that did not fit the final, more refined themes. As I refined my themes, it emerged that some of them shared the boundaries of their central organising concept. For this reason, I created several subthemes (Braun & Clarke, 2006; Braun & Clarke, 2013). See diagram 8 in the next chapter for an overview of the themes and subthemes. In the next section, phases 5 and 6 are discussed.

10.2.6 QTRA Phase-5 and -6: Defining and naming themes and producing a report

Table 19: QRTA Phases-5 and 6, Braun and Clark (2006, p. 87)

Phase 5	**Description**
Defining and naming themes:	Ongoing analysis is then used to refine the specifics of each theme generated and the overall story that the analysis tells- this will help to generate a clear definition and should produce names for each theme
Phase 6	**Description**
Producing a report	The final opportunity for analysis. Selection of high-fidelity, compelling extract examples, the final analysis of selected extracts, relating back of the analysis to the research question and literature, producing a scholarly report of the analysis.

In this phase (see table 19 above for definitions of phases 5 and 6), the themes are defined and named according to the central organising concept. See table 22 in the next chapter for the theme definitions. The themes were defined using a maximum of two sentences as Braun and Clark (2006) argue that the theme is perhaps too large if you require more than two sentences.

At this stage, the names of the themes were long and cumbersome and so were shortened and eventually renamed. As Braun and Clarke (2013) suggest, the naming of the theme should be creative, catchy, evocative, concise, informative, and reflect the theme content. I named the themes after song titles, as this allowed me some creativity and allowed me to put my 'take' and interpretive stamp on the themes. I often listened to music with my mum as I grew up, and I felt that this was a fitting tribute to my mum, who lost her battle with breast cancer as I was undertaking this doctorate.

I applied Braun and Clarke's (2006) 15-checkpoint criteria throughout the process, as seen in table 20 below. This checklist was created so researchers could create "good thematic analysis" (p.96).

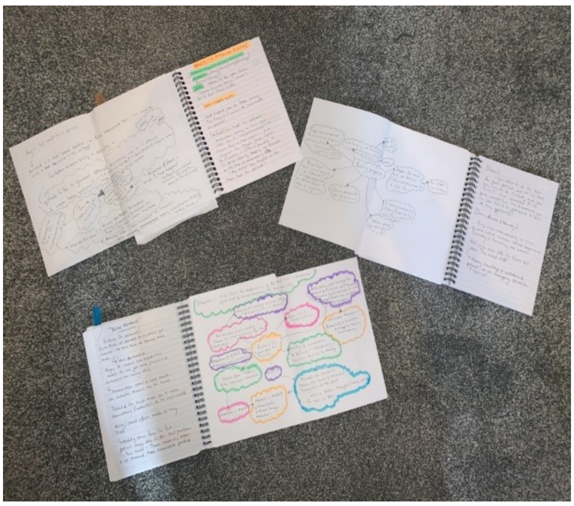
Table 20: 15-point checkpoint criteria for good thematic analysis (Braun and Clark, 2006)

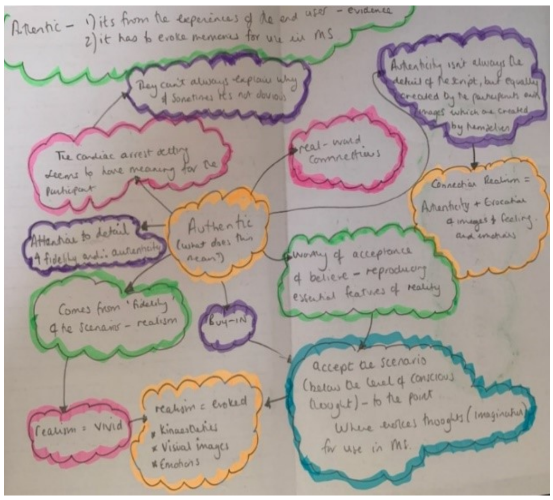
Process	No.	Criteria and how I met said criteria
Transcription	1	The data was transcribed professionally by a third party. However, I checked the transcription for accuracy, and it had been transcribed to an appropriate level of detail.
Coding	2	I initially gave each part of the data an equal amount of my attention in the coding process. I made annotation notes (memos) as I coded.
	3	Themes were not formed at this point. I needed to keep an open mind about the coding process.
	4	All relevant extracts linked to relevant themes were extracted. See phase-2 output in the codebook (appendix 9).
	5	Initial candidate themes were checked against each other and themselves. I checked the themes against the original dataset.
	6	The produced themes were internally coherent, consistent and distinctive whilst having overlapping boundaries that would allow a narrative to be produced during the writing phase.
Analysis	7	I began to interpret the data, past the point of paraphrasing (I found this part of the process challenging (!) But rewarding). I asked myself, "what is the participant *really* saying here?" This question helped me to get deeper into the analytical process.
	8	I began to question whether the analysis and the data matched each other- I looked to see if the extracts matched the initial claim being made.
	9	The analysis started to tell a convincing story. However, I did not get to the entire narrative until I had written a significant amount about the data (I was now into my third iteration of the findings chapters).
	10	I checked to see if there was a good balance between extracts and data analysis interpretation. Again, this was an iterative process that continued under multiple versions of the same chapters. I experimented with different amounts of data and interpretation. I settled on what is presented in

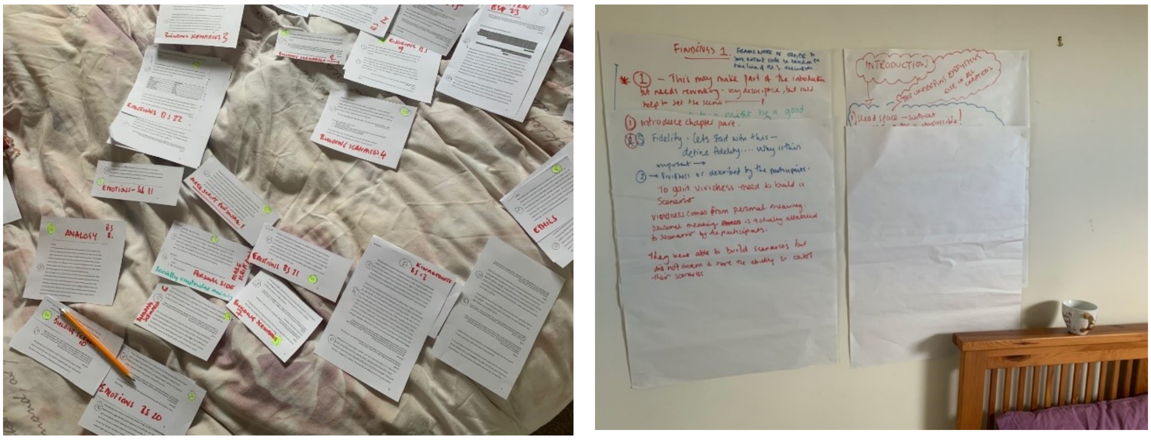
		this thesis, as I feel that it is balanced between extract (which is rich and informative) and my interpretation.
Overall	11	Enough time was allocated to this process. This process was far more time consuming than I had imagined it would be. The process from transcription checking to completion of the findings chapters was approximately 24-months.
Written report	12	The assumptions were clearly outlined in the methodology section. Thematic analysis is theoretically flexible, so the underlying methodological assumptions were articulated.
	13	The methods that I had undertaken were clearly articulated. Some of this can be seen in the codebook (appendix 9).
	14	The language used in the thesis is consistent with my social constructionist epistemological position.
	15	It is made clear that the themes do not emerge. I am active in the research process, made clear throughout the thesis.

The bulk of the initial data analysis was performed. However, writing *is* analysis (Thompson & Kamler, 2016). The writing stage allowed me to hone my analytical ideas, and it eventually allowed me to synthesise my interpretation of the dataset with the broader literature (Clough & Nutbrown, 2012). To help with creativity at this stage, I also used a 'storyboarding' technique suggested by Thompson & Kamler (2016).

The storyboarding method allowed me to write about chunks of data from each theme. This can be seen in pictorial form in picture 5 below:







Picture 5: Storyboarding of themes

Rather than writing into chapters, I worked out the structure as though I was a movie director. This structure came together to resemble the initial iterations of the findings, and discussion chapters (chapters 12-14), which were the foundations of the final chapters included today. In the next section, I discuss salience analysis, an adjunct to thematic analysis (Buetow, 2010; Braun & Clarke, 2013).

10.2.7 Saliency analysis

As articulated above, a pattern-based analysis, such as QRTA, allows one to systematically identify and report the salient features of the data and rests on the assumption that patterns across the data offer something meaningful (Braun & Clarke, 2013). Saliency analysis is a fundamental aspect of this research study. Overall, the saliency of the dataset is linked to the research questions, i.e. is it of high importance to help answer the research questions? According to Buetow, saliency is governed by importance, and data is essential when “they are new and advance understanding, and useful in addressing problems or do both” (2010, p. 124). I used Buetow’s (2010) guide to help me consider the saliency of the codes if they were: 1) highly important and recurrent, and/ or 2) highly important but not recurrent. This consideration meant that whilst recurrence of data within a code could signify saliency, it also meant that codes that were not recurrent, but deemed significant, would also be included.

In qualitative research, rigour, quality, and trustworthiness are essential components, and transparency is critical. In the final section, I offer an overview of these elements.

10.3 Rigour, quality, and trustworthiness of the research findings

Overall, quality in qualitative studies is part of a larger but often disputed and contested debate about the *nature of the knowledge* produced by qualitative research (Mays & Pope, 2000). Mays & Pope question whether the subjective and constructed nature of qualitative research quality can legitimately be judged and if so, they ask, 'how can it be judged?' Purest relativists (believing in multiple realities) argue that qualitative and quantitative investigation are very different paradigms for knowledge creation. It is, therefore, impossible to judge qualitative research using conventional standards such as *reliability, validity*, and *generalisability* (Mays & Pope, 2000). Whilst these terms are often linked to more (post)positivist research methods, validity and reliability are argued to be useful even in qualitative interviews (Brinkman & Kvale, 2015). Reliability relates to the consistency and trustworthiness of the research findings. As Gray (2014) submits, this might arise from a sound methodology (a well-designed research project, with appropriate ways of constructing knowledge, appropriate analysis techniques and open and justifiable epistemological conceptions). I have been transparent about this in the opening parts of the methodology section.

As a doctoral researcher, part of this quality process is the support and feedback received from experienced supervisors, critical friends, course faculty and cohort student colleagues. Kvale (2007) calls this 'dialogical intersubjectivity.' This refers to the 'agreement through rational discourse and reciprocal criticism between those involved in the research process' (p121). Supervisor support via Zoom and WhatsApp group chats with EdD cohort student colleagues have been invaluable in helping to shape my thinking through communicative validation. Especially during the Covid-19 lockdown period, when the invaluable colleague 'corridor conversations' have all but disappeared.

Whilst informal quality processes are a vital part of the quality process, so are more formal aspects. The next section offers a more detailed look at these processes.

10.3.1 Quality processes and transparency

As part of the quality process, I used a combination of Tracy's (2010) and Braun and Clarke (2006) checklists [see above in table 20 criteria for quality in qualitative and thematic analysis research]. Tracy's Eight "Big tent" is a well-recognised set of criteria in qualitative research and is a rationalised and conceptualised guide to undertaking trustworthy and rigorous research. At the heart of the "Big tent" criteria are: i) worthy topic, ii) rich rigour, iii) sincerity, iv) credibility, v) resonance, vi) significant contribution, vii) ethics, and viii) meaningful coherence. I have outlined these criteria for my research process in table 21 below.

Table 21: Eight "Big Tent" Criteria applied to this research (Tracy, 2010)

Criteria for quality	The methods by which this was achieved
Worthy Topic	In the opening chapters, I outlined the topic relevance to nurse education (potentially the wider simulation community). It was outlined that mental simulation was potentially important to life-support learning, allowing for solitary, deliberate practice and increasing self-efficacy beliefs.
Rich rigour	See table 20 above for a 15-point checklist for adding rich rigour to qualitative reflexive thematic analysis (QRTA). There is also rich rigour in each chapter's theoretical and evidence-based synthesis. There was appropriate rigour in the thesis writing phases, as each chapter had several iterations. This provided a more profound analysis with each iteration. *Analysis is writing*, and iterative processes are fundamental to quality, rigour and trustworthiness in qualitative research (Braun & Clarke, 2006; Thompson & Kamler, 2016).
Sincerity	I offered a self-reflexive gaze at my work. I kept asking myself questions such as "what are the participants trying to say" and on my office wall, I had written in big letters, "why have you interpreted it like this?!" I wanted to move from the semantic to the latent in line with the epistemological position but needed to be reflexive and reflective as I did so. I was constantly learning and reflecting on my practice. This has been especially so regarding my methodological grapple, where I have presented my reflections to later EdD cohorts. I have presented my mental simulation work at conferences to try and shape the research through discussion. I have constantly contacted my supervisory team for feedback and advice. I found the EdD research and writing processes extremely challenging, intellectually and emotionally, but I have learned so much about the research process. Overall, I have given an honest account of my inductive interpretation of the data. I have been fully transparent with my methods and analysis and kept an audit trail within the NVivo data management software.
Credibility	In my analysis, I have given a 'think description' and have attempted to offer a deep interpretation, past the semantic meaning of the data. As discussed above and below (section 10.3.2), I have used NVivo to keep an audit trail of my data analysis and provided NVivo generated codebooks in appendix (9) to show my thought

	processes. Again, see table 20 above regarding the undertaking of the phases of QRTA. I have produced a rigorous, plausible, trustworthy thesis with applicable, practical findings. See the following chapters
Resonance	This research will resonate with several groups/ communities. Nurses educators/ resuscitation educators and simulation-based educators may find this work interesting and applicable to their teaching methods. This work is not generalisable per se. However, it will still be significant and transferrable to practice and may influence thinking past the immediate setting in which the study was conducted.
Significant contribution	This work makes a theoretical and practical contribution to nursing education and simulation and immersive technologies-based education. The specific contributions are articulated in detail in chapter 1 and chapter 15.
Ethical	As described in the ethics section above, I approached this research as ethically as possible. I always approach ethical issues in the same manner. I always ask myself, 'how would I want my family members to be treated?' This is an invaluably helpful gauge. As a nurse and a researcher, I apply the four pillars of ethics to my practice: beneficence, non-maleficence, justice and respect. My ideals of being in a caring profession have not changed during my research. I have applied my 'duty of care' throughout the research process. See the ethics section above for a more detailed explanation of the specific ethical findings.
Meaningful coherence	The narrative across the thesis is coherent. I have answered the research questions, creating and researching something practical with practical applications. The methods and the procedures fit with the stated goals of the research project. I have meaningfully interconnected the research questions, literature, methodological and theoretical lens, findings, reflexive interpretations, and conclusions. This is shown as a narrative thread that runs through the core of the thesis.

10.3.2 Data management: Using NVivo adds trustworthiness

I coded and themed the dataset using NVivo data management software. NVivo does not analyse the dataset per se, but it is designed to organise and manage unstructured qualitative data. Qualitative data analysis brings order, structure, and meaning to a large volume of collected data. This is not an easy process to manage. Data management systems, where the data can be brought up at 'the click of a button,' allows for ease of constant comparison of data, codes and themes (Hilal & Albari, 2013). I attended a two-day workshop on NVivo, run by QRS International- see picture 6 below:

qdatraining.eu

Certificate of Completion

QSR International

Awarded to

Nick White

For having successfully completed

Two Day - NVivo Training Workshop up to Intermediate Level- in:
Computer Aided Qualitative Data Analysis Systems

Course Date & Location:

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This: 8th Day of January 2020

Awarded by: Ben Meehan, qdatraining.eu, QSR Registered Nvivo Trainer

Picture 6: Certificate of completion for NVivo training

NVivo was used to work more efficiently through effective and systematic management of the data. NVivo helped me quickly organise, store, and retrieve the data in a node (code) and theme form (QSR International, 2021). I have organised my data on NVivo into the 6 phases of QRTA to offer an "audit" trail for transparency and help in evidencing that I engaged in a rigorous process. See codebook in appendix 9 and see picture 7 below to view the audit process captured in NVivo. As previously described, using NVivo also assisted with keeping the context of the conversation as I could return to the interview section instantly, should I want to read the data extract in the whole conversation context, which I often did.

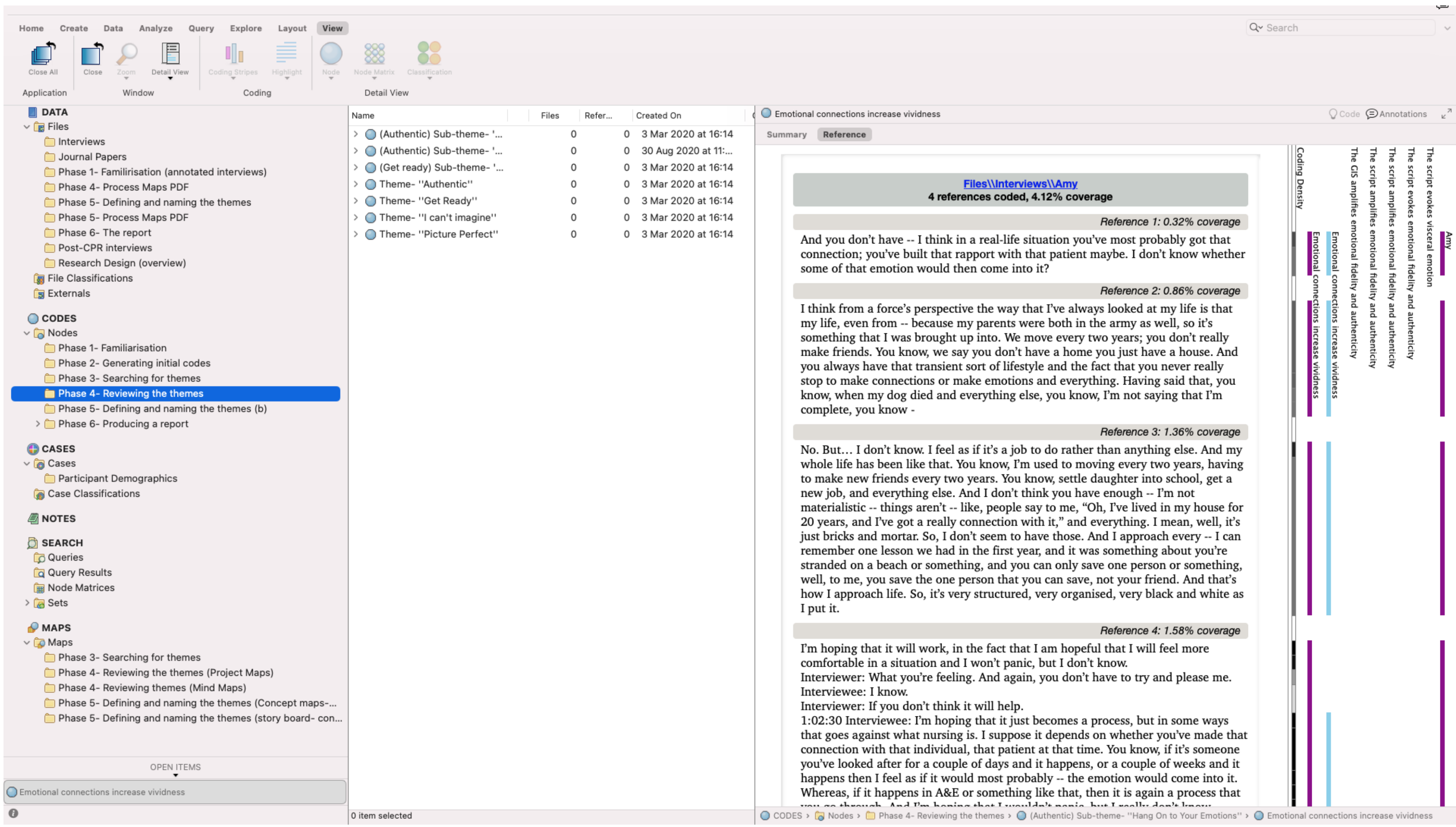
I had several outputs during the EdD programme, which are shared below.

10.3.3 Publications and outputs related to mental simulation and life-support

I have had several outputs from this research. This item is included in the quality section of the chapter as it shows that the community accepts (after scrutiny) elements of my research and mental simulation as an emerging area of simulation and immersive technologies. These outputs can be seen below:

- *Comment piece*

  White, N. (2019). *Use of mental imagery to learn CPR skills in pre-registration nurse education*. British Journal of Nursing, 28(7) https://doi.org/10.12968/bjon.2019.28.7.468



Picture 7: Coding within the themes- NVivo audit trail shows stages of analysis

- *Peer-reviewed abstract and conference oral presentation:*

White, N. (2019). *OP14 Understanding the experiences of pre-registration nurses, after using a mental simulation audio script for learning CPR*, 5(supp1), https://dx.doi.org/10.1136/bmjstel-2019-heeconf.14

- *CAE simulation conference oral presentation:*

White, N., Rumbold, J. & Garner, I. (2019). *Understanding the experiences of pre-registration nurses after using a mental simulation audio script for learning CPR* (10-minute oral presentation)

- *HE Yorkshire and the Humber Simulation Network Meeting:*

White, N., Rumbold, J. & Garner, I. (2019). *Understanding the experiences of pre-registration nurses after using a mental simulation audio script for learning CPR* (20-minute oral presentation).

10.4 Chapter summary

QRTA is used as a systematic method to analyse the interview data. The data analysed is grounded in the research philosophy identified in chapter 7. To this end, analysis is conducted using a social constructionist inductive approach, where the data is co-constructed between the researcher and the participant. Each phase of the data analysis cycle was outlined, and there was a discussion justifying my actions in each phase. The research rigour, quality and trustworthiness were presented. This was presented using Braun and Clark's (2006) 15-point checklist for good thematic analysis and Tracy's (2010) "8-Big Tent" criteria as a guide to help show the study's rigour and trustworthiness. NVivo data management system was employed during this study. This helped keep an audit trail of each phase of the data analysis for transparency, presented in the codebook in appendix 9.

I offer a short synopsis of the study findings in the next chapter. The study finding and discussion chapters are chapters 12, 13 and 14. Chapter 11 presents the theme and subtheme definitions and a mind map of how the themes and subthemes connect. A road map of the themes and subthemes presents an overview of the findings narrative. This allows the reader to visualise the bigger picture of the story created using QRTA.

Section 4: Findings, discussion and conclusions

Chapter 11 - Findings overview

"Pictures are worth a thousand words," and so are mental images.
(Clark & Paivio, 1991)

11.1 Introduction

The previous chapter outlined this study's qualitative reflexive thematic analysis (QRTA) approach. Each phase was described, and a discussion of how this was operationalised was presented. The rigour, quality, and trustworthiness were presented using Braun and Clark's 15-point checklist and Tracy's (2010) "8-big tent" criteria. The chapter concludes by examining NVivo data management to describe how an audit trail of the phases was created.

This chapter presents an overview of each of the findings and discussion chapters. The chapter begins with an overview of each theme. Each theme and subtheme is presented with its definitions. A synopsis of each chapter is then presented to offer an overview of what is to come in chapters 12-14. This chapter begins with an overview of the findings chapters and a presentation of themes and subthemes.

11.2 Findings Chapters: an overview

Three main themes are identified, with each theme having subtheme(s). The author will interpret the themes and subthemes that emerged from the dataset. Below in table 22 are the emergent theme definitions interpreted from the participants' experiences. This was performed in accordance with QRTA (Braun and Clark, 2006). See diagram 8 for a visual overview of how the themes and subthemes connect. See diagram 9 for a road map of how the themes and subthemes interconnect to create a story of the participants' mental simulation journey.

Table 22: Theme and subtheme definitions

Theme/ subthemes	Definition
Chapter 1	
"Motivation"	Participants were underconfident about undertaking real-world BLS and life-support, creating strong motivational drivers. These motivational drivers (along with others) were strong enough for participants to enact mental simulation.
"Picture perfect." (subtheme)	The participants had to fit mental simulation into their busy life schedules, creating the time and space necessary to undertake it.
Chapter 2	
"Hi-fidelity" (theme)	The script narration and cues of the audio-guided mental simulation script (script) created the basis for creating a high-fidelity simulated experience.
"Imagination" (subtheme)	The participants tended to produce visual images evoked by the language within a script, but they significantly individualised them. The participant created these images from past and memories unique to them.
"Hang on to your emotions" (subtheme)	The narration and the sound effects within the script evoked high-arousal states that are akin to those felt in a real-world cardiac arrest.
"I can't imagine." (subtheme)	The majority of participants found the kinaesthetic (haptic) imagery challenging. The script did not tend to evoke high-fidelity kinaesthetic images, perhaps due to a lack of real-world experience.
Chapter 3	
"Harmony" (theme)	Mental simulation created periods of reflective practice, which illuminated gaps in skill and knowledge, demystifying the cardiac arrest structure and processes. This reflective period helped to fill in skill and knowledge gaps.
"Coping" (sub-theme)	Mental simulation gave participants greater self-efficacy towards their ability to perform clinically, meaning they felt ready to cope with real-world life-support practice.

It is worth offering a reminder of the research question(s) as these guided the interpretation of these data from the following three chapters:

- What are pre-registration nurses' experiences (students) who use mental simulation to gain cardiac arrest and life-support experience?
    - How do students modify their behaviour to incorporate mental simulation into their lives?
    - How does mental simulation create an authentic learning experience that prepares students for real-world delivery of life-support skills?
    - What processes make mental simulation a useful technique as an adjunct to physical simulation of BLS and wider life-support knowledge and skills?

Below is an overview of the three findings and discussion chapters that follow.

11.2.1 Overview: Chapter 12- Motivation and preparing to undertake mental simulation

This chapter describes the preparation part of the mental simulation experience. The participants were motivated to undertake mental simulation. Amongst other things, the participants were motivated by BLS performance anxiety- driven by anticipatory self-arousal, imposter syndrome or past experiences of failure. A further motivation was their career aspiration and viewing BLS and life-support proficiency as a 'badge of honour' that may allow them to be legitimate peripheral participants in their career aspiration communities of practice. This motivation was enough for the mental simulation protocol to be enacted.

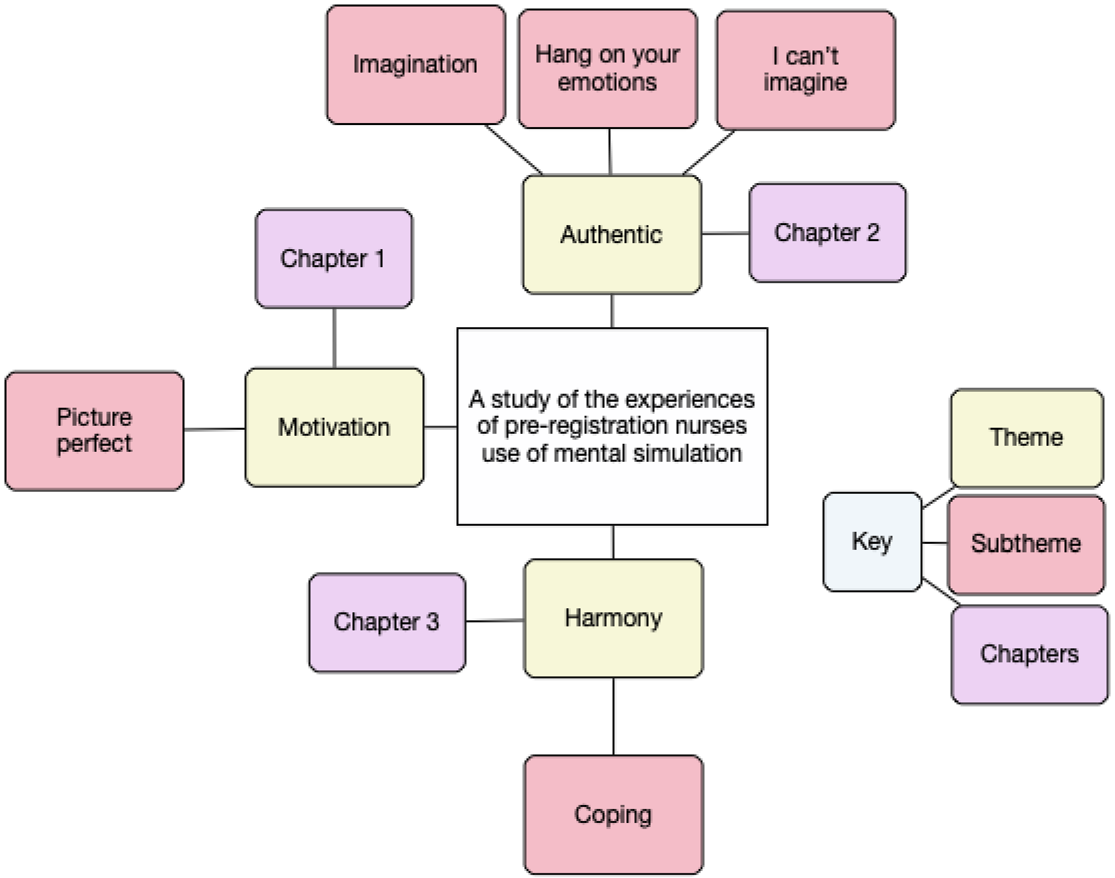
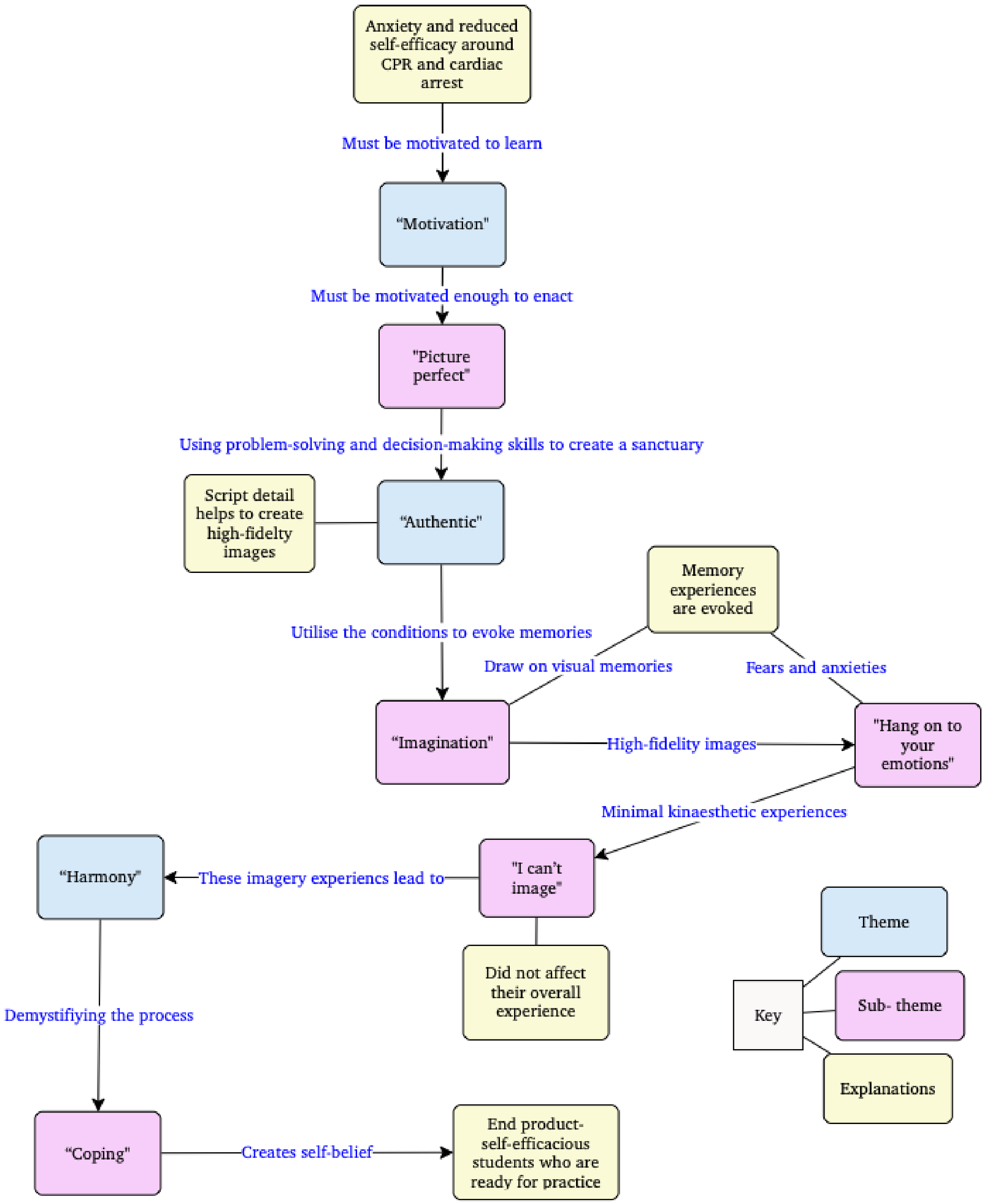


Diagram 8: Basic overview of how the themes and subthemes link to each other and the chapters



The flow of the narrative

Explanation points

Diagram 9: The flow of the narrative from top to bottom

The participants had to work hard to experiment with time. The participants had to modify their behaviour and environment to create a sanctuary, allowing them to focus and create higher fidelity images. It would not have been possible to undertake the four-week protocol without doing so. Nor would it have been possible to create high-fidelity images. How the participants created these images is explored in chapter 13.

11.2.2 Overview: Chapter 13- Buying into the simulation scenario

This chapter describes how mental simulation was experienced and performed. The detail in the audio-guided mental simulation script provided the content and cues. Images were evoked from personal meaning when listening to the script—visual images created from real-world, simulated, or audio-visual experiences. Emotional images were evoked, and listening to the audio script caused arousal such as stress and anxiety, which led to some participants feeling somatic responses, such as high heart rate and sweaty palms, and is akin to stress response training. Due to a lack of real-world cardiac arrest experience, the participants' kinaesthetic image experiences were not as high fidelity as their visual or emotional images. Some suggested that they could not 'feel' at all. However, this did not affect their overall experience of learning life-support using mental simulation.

Visual and emotional images combined like pieces of a jigsaw to create a scenario high in psychological fidelity, which created an authentic cardiac arrest experience. The participants felt as though they were situated ‘in the moment.’ Authenticity is an essential sequence of events for creating an experience as close to practice as possible. Creating a situation akin to the real-world experience increases the functional equivalence (FE) of the experience and increases the chances of increasing performance levels. Creating authentic mental simulation allowed for reflective learning, essentially filling gaps in skill and knowledge. This created higher self-efficacy beliefs, which was the focus of chapter 13.

11.2.3 Overview: Chapter 13- Reflective practice and self-efficacy

This chapter is the reflective practice part of the mental simulation experience. Most participants self-assessed their knowledge and skill against proficiency criteria in the script. As the participants used mental simulation more, it illuminated the BLS, CPR and advanced life-support (ALS) processes. The participants were able to see the 'structure' and sequences of how a cardiac arrest unfolds.

The participants self-assessed their current knowledge and skill against the mental simulation protocol, highlighting some knowledge and skill gaps. It illuminated gaps in understanding their scope of practice and their roles in the cardiac arrest team (and the role of others). It emphasised gaps in skillset proficiencies (self-assessed against past practice). The protocol also illustrated implicit cardiac arrest knowledge (such as pulling out the bed, dropping the bed flat, or changing rescuers). Through internal feedback mechanisms, new knowledge was created.

This was an enactive mastery experience. Through engagement in the mental simulation process, self-efficacy increased. Increased self-efficacy meant that high-arousal states diminished, and the participants felt prepared for clinical practice. The layout of the findings and discussion chapters is presented in the next section.

11.3 The layout of the findings and discussion chapters

The following chapters present a detailed narrative of the participants' mental simulation experience. The story was constructed through writing and editing of four iterations. Writing and editing are the cruces of data analysis (Braun & Clarke, 2006) and doctoral-level work (Thompson & Kamler, 2016). In these three chapters, the analysis of the participants' mental simulation journey is told. Each chapter is laid out the same.

Each chapter begins with a detailed exploration of the students' experiences, as co-constructed with the researcher during the research process. As with all chapters in this thesis, an opening quote sums up the chapter. A participant quote is also used at the beginning of each section in the findings and discussion chapters to help illuminate the narrative further and help to offer richness to the presentation of the analysis.

Each of the three findings and discussion chapters has a separate discussion section where literature illuminates the participants' experiences. As described in chapter 7, these data have been analysed inductively. Therefore, the literature, discourse and theory used to support the discussion has been synthesised and included *a* *posteriori*. As this is an applied research study, a theory to practice section has been added to each chapter discussion.

11.4 Chapter summary

This chapter outlines a brief overview of the findings and discussion chapters. The themes and subthemes were established and presented. How the themes and subthemes connect were presented in diagrammatic form. Furthermore, the participants' journey was presented as a road map diagram. The chapter concluded with a description of how each findings and discussion chapter is presented.

The following chapter is the first of the findings and discussion chapters. The chapter outlines what motivated participants to undertake a mental simulation programme over 4-weeks and why motivation was strong enough to create their volitional state. The chapter reveals how the participants experimented with their surroundings and managed their time to create a sanctuary that would allow them to have the best chance of creating high-fidelity images.

Chapter 12 – Motivation and preparating to undertake mental simulation

Even if it's just small, there is nothing going on, and I am just in my room by myself. There is nothing going on. There is no TV, there are no clocks or anything! It's literally just a computer. Anything small, and your attention will just go, and it's hard to focus in on the immediate task at hand.
[Ralph]

12.1 Introduction

The previous chapter outlined the themes, subthemes and their definitions in accordance with Braun and Clark (2006). The theme definitions were presented, and these definitions assist the reader in being able to observe the boundaries of each theme. A synopsis of the three findings and discussion chapters was offered, concluding with a brief discussion of how each chapter will be presented.

This chapter is about how the participants managed themselves in preparation to undertake mental simulation. Motivation is required to undertake mental simulation. This motivation comes from several sources, including anxiety about decaying skills, lack of experience, past experiences, being valued team members, and patient safety. However, motivation must be strong enough to move the learner into a volitional state, where the protocol is actively incorporated into their daily routines, and this requires commitment. To undertake mental simulation requires concentration and focus, and therefore creating a sanctuary free from internal thoughts and external distractions is critical for enacting mental simulation. Therefore, there is a need to find an optimal, distraction-free environment to undertake mental simulation- the participants share this part of their journey.

Creating this space is effortful and complicated, and it requires determination to succeed. Students have busy life schedules that often conflict with self-directed activity, and overall, this made mental simulation a time- and energy-consuming task. There was a clear need to create a learn-life balance. The chapter 'road map' is laid out in diagram 10 below.

12.2 The motivation to learn

> *Yes, I would say so. I think CPR is the one, I don't know if it's just me or if it is everyone, but it's the one thing that makes you think, "Oh god, it's CPR" -- anything else is less stressful-- but I think this is like you say 'higher end'. I think that is the one thing you want to be prepared for if there is ever an emergency, so you are more driven to learn it.*
>
> [John]

12.2.1 The driving forces

As John alludes to in the opening excerpt, there appears to be a drive or motivation to use mental simulation to learn life-support. These motivations are essential to understand—these motivational elements are the bedrock that pushes students from motivation into action. Without motivation, mental simulation is unlikely to be prioritised into a busy, daily life routine. This first section explores the nuances of these motivations so that educators can use this information to inspire future protocol users.

Participant assessment of knowledge and skills revealed a lack of self-efficacy in cardiac arrest skills. This lack of self-efficacy was due to insufficient opportunities for repetitive practice, which created anxieties. Mandatory training sessions alone did not suffice or fully increase efficacy levels and self-belief. Paula discusses her

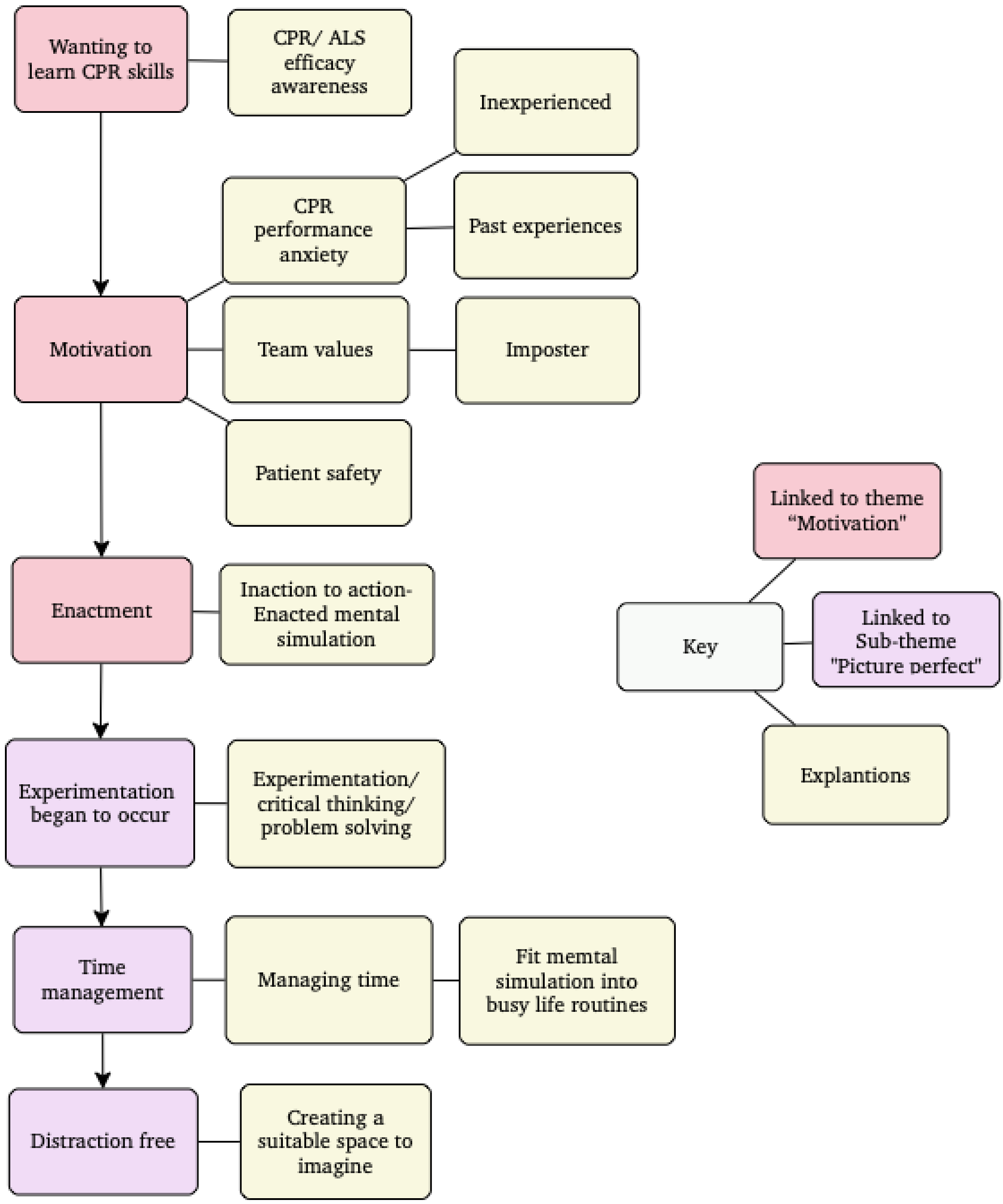


Diagram 10: Overview of chapter 12: Findings and Discussion

take on the current mandatory training regime:

> *Yeah, it didn't, because the mandatory training-- I think it also depends on keeping up with that as well, like if I just do it once, and then [for the skills to] actually just stay there-- because if you don't use something, you're not going to actually maintain that. So, yeah, I don't know about the mandatory training. I'm like, I know I'm definitely more of a visual learner. When it comes to learning, I like things like images and anything visual because I do use my imagination a lot to picture those sorts of things.*
>
> *[Later in the conversation] Because I think once a year, mandatory training is not [enough]. Again, on the cardiology ward, when they're constantly doing [life-support]– like they know what to do because they're constantly doing it. But if you're on a ward where you don't see that very often, it's like being able to use something like this [mental simulation] helps.*
>
> [Paula]

Recognising skill decay may create clinical performance anxieties. As Paula articulately recognises, mandatory training alone is not enough for BLS and CPR skills to 'stick.' Further to a lack of classroom simulation experience, students may get overlooked during real-world practice due to the time-sensitive nature of a cardiac arrest. As Emerald describes here, she was pushed to one side during her only real-world cardiac arrest experience:

> *Yeah, I was a bit like, "Oh no, what about if--?" You know, obviously, I know it's not every time, but a lot of the time the leader is a consultant or a doctor, but if they ask me to do something and I do not know what I am allowed to do, what if I do something I am not meant to and this person dies, it's my fault. The person is not real [in simulation], but, you know, that is just what I was thinking.*
>
> *[Later in the conversation] Cardiac arrest is something-- as I discussed with you-- is something I've seen but I have not been involved with because I kind of got a little bit pushed out of the way, so it gave me a lot of anxiety, the thought of it.*
>
> [Emerald]

Being superfluous creates a lack of real-world exposure and creates a sense of angst and self-doubt about their ability to perform when the time comes.

John further describes his feelings when he thinks about his involvement in a cardiac arrest. He alludes to why he was motivated to undertake mental simulation and how mental simulation helped overcome some of these anxieties:

> ***John:*** *Like that bit [in the mental simulation script] that I don't know what to do with my hands or for a second you forget what to do, and I thought that is right, that is how you would feel or how I did feel when I saw it. So yes.*
> ***Nick****: How do you think that might help you in practice?*
> ***John****: I think it would mean that when that did happen to you, you would think it's okay that this is happening. It will go in a second. I think it was good rather than-- if you had never heard that I don't know what to do and then you were in a situation, and you didn't know what to do, you would panic and think, "Oh god, I'm the only one that doesn't know what I'm doing" or "Why don't I know what I'm doing?". But hearing someone say actually that happens to all of us is useful.*
> [John]

In suggesting that he could think in his panicked state, "am I the only one…." John compares his BLS skills to that of the practitioners he will work with within clinical practice. It is right to do so in this instance. Students are afforded a period of apprenticeship, but this is not the case with clinical skills, especially BLS skills, where they have to be delivered accurately, whatever your professional status.

Student status can make some feel like an imposter, with their role in a cardiac arrest. This element can create performance anxiety. Lack of experience in either simulation or real-world cardiac arrest can create this as the student has little or no experience rehearsing or implementing their skills within the cardiac arrest team. This further supports low efficacy beliefs. Wendy describes such troubling feelings and concludes that she does not want to perform poorly in front of her team:

> *I don't know, I think it was just the anxiety thing, it was like-- because seeing it is really exciting, and they're like, "Right, you're doing it now." You almost feel-- you know, it's the first time you're going to do it. It's in front of a group of people who've-- the only person I knew was one of the nurses I'd worked with the day before. So, it's that-- it's almost like stage fright, I suppose. "I've got to perform in front of all these people." And*

it's like you don't want to mess it up. You don't want to be, like, "Them compressions are crap, get off," you know.
[Wendy]

Students are training to be part of a nursing team and the broader healthcare practitioner community. Creating a feeling of 'dare to' is clearly important to some participants and creates motivation for seeking out mental simulation. Acceptance by the wider community of practice is important to most students, and they appear to view learning BLS skills as one of the fundamentals to this acceptance. For example, Jack was motivated by the reward of his aspiration to make his career in the "cardiac cath-lab" (often where stents are inserted post-heart-attack). Paula's incentive was an aspiration to be a cardiology nurse. Wendy's desire was motivated to work in the Emergency Department. As Sarah suggests here, her mental simulation driver was a career in the Emergency Department or critical care (both acute areas of clinical practice):

Sarah: *Yes, because it [life-support/ cardiac arrest] does intrigue me. It's that sort of work I like.*
Nick: *Is that the sort of thing you want to go into?*
Sarah: *Yeah. A&E, critical care, something like that, yeah.*
[Sarah]

This longer-term goal aspiration of working in acute areas is a driver and creates life-support skills as 'esteem' and further creates a 'marketing tool' to appeal to future students who may take up mental simulation to learn life-support.

Mental simulation was seen to help with being a valued member of the team. Teamworking and functioning in their community of practice are fundamental goals. Paula articulates that being skilled in life-support is critical to her practice.

As students, they want to be valued members of the team, but also they want to be skilled for their patients:

It's a big deal to me being able to help the team [and] help the patient; I think it's because I've been in those scenarios where there have been cardiac arrests and not knowing what I'm doing as well, which has just made me [think]. That's why I was really, really wanting to engage with this stuff [mental simulation] ... It helped me to visualise being there, kind of with the team and with the patient.
[Paula]

Paula articulates very nicely that nurse education training is essentially about helping the patient. Being a highly skilled individual is central to 'helping patients.' Accurate skill delivery is linked to patient safety, and the participants were striving for excellence. Some of this anxiety came from real-world clinical experiences.

Real-world experiences also create a motivating factor. As Claire describes here, her anxieties and arousal states are driven by a clinical experience that did not go to plan:

Claire: *[B]ecause when the doctor came we just saw the bed and I went on top of the bed and started with the chest. We never tilted her head, and maybe when we're doing this, her head is down there, and the situation stopped. Yeah.*
Nick: *I think a lot of people probably do that. I think a lot of people miss out the assessment part.*
Claire: *Yes, because we did not do that one.*
Nick: *Why do you think you missed out the assessment part?*
Claire: *I don't know, and I was with a doctor. Even the doctor himself did not-- He just talked to the lady, the lady was unconscious, he did not check the mouth, he did not tilt the head, we just started the CPR from the wrong place.*
Nick: *That is really interesting, actually. I don't think you are the only one that has done that. I think there is maybe an element of panic as well and an element of--*
Claire: *Yes, we just start the CPR with the chest. Even the chest compression without giving oxygen or something, it would be useless.*
[Claire]

Firsthand experience of skill decay can potentially drive motivation to undertake mental simulation. Despite being taught to assess the patient during mandatory training, a lack of deliberate, repetitive practice was experienced firsthand. This aspect failed her under the pressure of a cardiac arrest, creating catastrophic memory failure.

Moving from being motivated to undertake mental simulation to enacting mental simulation within busy lives is also fundamental for educators to understand. This motivation was significant enough to 'push' the participants into a volitional state and enact mental simulation. Volitional acts are explored in the next section.

12.2.2 Volition

One of my experiences was when the emergency buzzer went off, my mentor last year was a sister of the ward, and she had literally just got off the ward to go have her jacket- potato and beans. The emergency buzzer went off, and it was the far end of the ward, and she ran back onto the ward with a spoon with jacket potato and beans in her mouth, shoved it in her mouth, dumped it on the nurse's station and ran the length of the ward. I was like, "This is amazing. I want to be that person."
[Wendy]

Students face many competing demands and must overcome them to engage in mental simulation. This cannot be taken for granted by nurse educators. As Claire suggests here, it is not always easy to make being a student nurse a priority when at home, especially when others depend on you:

Yes, when I am busy, and I have got assignments at night and sleeping late and children coming in between, I just cannot do it when I am with other things, you know? When my head is telling me it's time to iron or time to do this. I have to do it [mental simulation] when I am relaxed.
[Claire]

Being motivated does not always mean one will perform mental simulation when competing time demands are met [this was perhaps highlighted by the five participants that began using mental simulation (motivated) but failed to complete the full 4-weeks (did not cross over to a volitional state)].

Following through with performing mental simulation requires control. Participants exerted critical thinking, problem-solving and decision-making skills to manage time and their environment, allowing for the exertion of control in their busy schedules and life demands- they worked out what worked and what did not work for their particular situation. For example, Jack suggests if one is motivated to do something, one should strive for control, and this control will maintain volition:

> ***Jack:*** *No, I am a believer that if you want to do something, you will do it. I do not like thinking that you are too busy to do anything, realistically. I did fit it in, and I think doing nursing with the course time management is key with everything.*
> ***Nick:*** *But you feel like you need some time management to get through it?*
> ***Jack:*** *Yes. I think it would be very difficult to do without a decent level of time management. Otherwise, you would forget about it, or you would miss one day, you would miss the next day, and you would miss the next day, and then you would just give up, wouldn't you.*
> [Jack]

Here, Jack suggests that he moves from motivation into a volitional state as he exerts self-control which suggests that students must control their behaviour if they commit to mental simulation. For example, using aid memoirs such as documentation may also help maintain volition. Some participants journaled their experience, and Paula describes 'using a diary' to timetable and document mental simulation sessions to further maintain her behaviour:

> *I just made sure I allocated time, that's all. I actually had my trusted diary on the top, the day[...] But like in here, just like, right, this day, I looked at my plan for the week. I looked at what lessons I had, because of course, with nursing, you are in prison every day anyway [laughter]! I actually have a timetable [for imagery]. This is going to sound really sad, but I had a timetable for my study, like how much I was going to study to do for my assignment, two hours here. So, I just made sure I looked there and just put it in.*
> [Paula]

This manipulation of behaviour helped adjust performance processes strategically allowed Paula to fit mental simulation into her busy routine and course commitments. Educators can assist this by creating time in the curriculum where students have time invested. Timetabling mental simulation into the curriculum could help this. This may increase uptake, showing the student body the value placed on mental simulation and life-support skills. Manipulation and experimentation are discussed in more detail below.

12.2.3 Manipulation and experimentation: strategies for success

> *Errrm, I tend to do it in bed before I go to sleep. So, I'm sat up in bed. I find I have to close my eyes and sort of block out all distractions. Because I did try it a couple of times at the very beginning downstairs. There were too many distractions going on, whether it just was the dog barking or whatever. So, I found that I needed to be in my own space with no distractions, and I found it easier if I closed my eyes.*
> [Amy]

The novelty of mental simulation means experimenting with 'what works, and what does not work' is a significant factor. Emerald articulates some of her early experimentation with where she performed her mental simulation. She needed to 'play around' to find the optimal outcomes:

> *Yeah, I tried it at around 1[pm] o'clock after my dinner once because I was in the house by myself, my parents were out, and I had got a day off university, and I tried it then, and I found it quite hard. I think it's maybe because it was bright, and I could hear my dogs walking around in front of me. I think I really need nothing around me to distract me to listen.*
> [Emerald]

All of the participants proactively manipulated their environment to suit their learning needs. For example, Emerald further discusses how she overcame her initial distractions by finding a quiet room with darkness, so her mind can be freed to create mental simulation 'images':

> *"God, I can't get into this, I can't think," because my sister has got the telly on, and my brother is shouting upstairs, and I cannot think what I am doing. So, I decided to do it just before I was going to bed. I tend to not try to go to bed tired. I am never tired*

when I go to bed. I am somebody who has to take ages just to drift off, so I am still quite alert. So, I decided to do it in bed with my curtains closed. Everyone was downstairs out of my way; I needed a quiet area to do it, and then I also remembered the thought of a touch, like I could actually maybe press on my bed, and maybe that will help-- I know personally visually; I have a short attention span. If I see something, I am like, "Ooh," so, if I shut out-- Yeah, then I have nothing else to concentrate on-- darkness! Then your mind can run wild
[Emerald]

Further, Wendy's experience shows how easy it is to become distracted without a sanctuary:

Nick: *Did you have your headphones on?*
Wendy: *Yeah.*
Nick: *Did you? How was that?*
Wendy: *Well, I was going to a job interview actually, and I got there really early, and I thought, "Oh, I'll just squeeze this in here because I've got nothing else to do." It was weird because it was one of those things that every other time I have kind of closed my eyes to do it, and I was like, "You can't just sit in a cafe with headphones on and your eyes closed, you'd look a bit nuts," kind of thing. So, I was trying to listen to it and still look normal.*
Nick: *You had your eyes open?*
Wendy: *Yeah. So, it was weird because it was almost like taking a backseat kind of thing. I was kind of visualising it in my head, but then I was also dealing with all the information that was coming through from me looking around this cafe, so it was difficult. What day was it when I did that?*
I found it easier because I had watched the point of view video as well. That is what you do when you have got a lot of free time before your interview, so it was kind of easier to drop into it, but then it was like, "Oh no, people might be looking at me weird because I am sat here with my headphones on."
[Wendy]

Performing mental simulation requires a sanctuary or haven, which will be made explicit in future protocols. This could help with volition as students would not have to spend their time experimenting.

Solving the problem of distraction elimination was necessary as all participants suggested that they had to 'relax' to focus. As Claire argues here:

Claire: *Maybe when I am relaxed on the sofa or when I go to bed like this, and I think about it.*
Nick: *So, were you laying down on the sofa?*

***Claire:** Yes, I was just relaxing.*
***Nick:** Did you try any different positions, or were you just laid down when you did it?*
***Claire:** No, I have never thought about it, you know, like, when I am busy, but when I relax like that, I feel--*
***Nick:** Did you feel like you needed to relax to actually--?*
***Claire:** Yes, to visualise.*

Finding a sanctuary where one can relax appears to assist with the thoughts, emotions, and cognitive arousal levels that enable optimal mental simulation performance, as Wendy described the routine that she developed:

When I did it at night, it was pretty much a dark room-- just lay in your bed kind of thing-- but that was just because I was going to bed straight after [laughter]. But other times, I have done it in, like, well-lit places, and I think I probably felt like it worked better at night.

Later in the conversation, Wendy describes trying to keep her eyes open:

Yeah, it was just very much like you are trying to focus on what you are visualising, but then your eyes are open, so you are focusing on what you are looking at anyway, so it's kind of hard to make the two merge together.
[Wendy]

This experience can be further seen in Amy's routine, as she felt that she needed to relax to get the best out of her mental simulation. Furthermore, as Amy describes here, there is a requirement for creating a quiet space to avoid 'external' [environmental] distractions. "[E]veryday life" [Amy] tended to obstruct focus. Claire suggested that if there were distractions, she would think to herself: *"God, I can't think, I can't get into this",* and Jack suggested needing: *"No other thought… no, nothing!".* This focused time enabled the participants to create the necessary images for the phase of performing the mental simulation, which is presented in the next chapter.

In the next section, the author will discuss both the theoretical underpinning and what the findings in this chapter mean for practice.

12.3 Chapter discussion

This chapter's central position is that students must engage in motivational learning to fulfil the required time and effort to undertake mental simulation. As educators attempting to influence current practice, there must be an understanding of how mental simulation is integrated into students' lives, and this chapter outlines this. In this initial preparation for mental simulation phase, individuals motivated themselves as the participants set their goals to be 'better at cardiopulmonary resuscitation (CPR) and basic life-support (BLS)' [which will be examined further in chapters 13 and 14].

One must be motivated to succeed as mental simulation requires a process by which the student must seek to accomplish learning goals through self-direction and modification of specific strategies, which were evident in the successful completion of the protocol. Being motivated can determine the success of self-directed learning (Khiat, 2015). This is because, with powerful motivation comes a drive for students to achieve their 'self-set goals' and move into an enacted state (Semmar, 2006). These processes are critical determinants in creating the conditions for undertaking deliberate practice and increasing knowledge and skill acquisition (Ericsson & Pool, 2017). These are important steps for student life-support knowledge and skill development.

There has been motivation sport-specific specific research examining how mental simulation might promote motivation and winning mindsets in athletes (Di Corrado, Guarnera, Vitali, Quartiroli, & Coco, 2019; Hall & Fishburne, 2010; Simonsmeier, Androniea, Buecker, & Frank, 2020). However, previous healthcare research has not dealt with how individuals motivate themselves to undertake a programme of mental simulation. This is a critical factor when implementing a new self-directed learning technique. Understanding this can help educators implement mental simulation programmes, discussed in further detail in section 12.6.1 below. Participants were motivated by a lack of experience and performance anxiety. Novel or threatening events cause stress (Driskell & Johnston, 1998), and cardiac arrests would undoubtedly be classified as novel and threatening (Spencer, Nolan, Osborn, & Georgiou, 2019). Lee and Cha (2018) describe CPR performance anxiety as common, even among experienced post-registration nurses. Lee and Cha suggest that this anxiety is caused by awareness of the stakes involved. This is a driving factor for participants wanting to improve.

As described in section 3.3.1, Mäkinen and colleagues found that most nurses felt their BLS training was inadequate for real-world practice. The majority questioned were underconfident about the nurses' role in a cardiac arrest situation (Mäkinen, Castrén, Nurmi, & Niemi-Murola, 2016). This phenomenon also appears to hold some truth for some of the participants. The participants highlighted their initial self-appraisal of efficacy for performing real-world BLS and concluded they were underconfident. This motivation to learn appeared, in part, to be anxiety-driven. Lang (1979) argues that emotions are motivators. For this reason, mental simulation was embraced by all the participants. The motivation to succeed and increase skill and experience must be enough to move into a volitional state (Harel-Katz & Carmeli, 2019). The participants felt that mental simulation could help them increase their self-efficacy beliefs.

The participants moved from committing to undertake mental simulation to the actual action of undertaking it. This action was perhaps not as easy as it may first appear, as students have busy life schedules that they needed to navigate. To do this, they had to manipulate their behaviour to push themselves to undertake mental simulation when perhaps there were more pressing activities that participants felt they needed to undertake. Nevertheless, these commitments to their motivational driving forces are often enough to create a volitional responses (Corno, 1993). Because movement from motivation to volition is effortful, the outcomes of these efforts must be sufficiently attractive. This links to personal causation, or the awareness of the effects of one's acting and doing, and includes a sense of personal capacity, which is, amongst other things, an evaluation of one's self-efficacy (Harel-Katz & Carmeli, 2019), and this appeared to be the case with mental simulation. However, this volitional action still had some practical hurdles to overcome.

The participants appeared to employ their graduate attributes in helping them at this stage of using mental simulation. All participants experienced strategic planning, so they successfully completed the 4-week protocol. This strategic planning positively impacted their protocol performance and allowed them to take control and 'fit it into their daily lives.' Time must be dedicated to learning if learning is effective because effective learning is deliberate, repetitive, and requires (internal or external) feedback (Ericsson, 2004). Mental simulation is no different.

Therefore, time management was observed throughout, as the participants successfully discussed how they achieved their goal of completing the protocol. As previously described, time manageent is an important graduate attribute and practicing time management is an essential aspect of nursing practice (Grimssom, Loeb, & Matani, 2015; Nursing and Midwifery Council, 2018b). Participants' decision making and problem-solving in finding ways to succeed in performing mental simulation further suggests that participants were motivated to succeed (Baumeister, Muraven, & Tice, 2000), allowing for the exertion of executive control (Kuiper & Pesut, 2004). In the story of the study's participants, this began by creating a positive time attitude. It would appear that the participants' success was down to prioritising mental simulation within other life demands.

Regulation of life demands led to the participants striving to find a 'learn-life balance,' as it was not always easy to find the time around their other, often more pressing, commitments. In this research, the critical thinking and problem-solving behaviour shown relied on choosing alternative courses of action. Choosing courses of action often requires experimentation to get this 'just right' for the situation and directly engages their graduate attributes. As mental simulation was novel to the participants, they experimented with their environment as they found quiet spaces (sanctuaries), akin to Ibrahim et al.'s (2015) findings in their qualitative research into orthopaedic trauma surgeons' use of mental simulation.

The experimentation occurring throughout the initial process led, by implication, to self-evaluation and reflective practice. Here the participants looked at the value of the outcome of their experimentation. They reflected on what worked and did not work for them, and they either repeated or abandoned it. Examples of this can be seen throughout this first chapter. Eventually, the participants found elements of the mental simulation process that worked for them, and they began to repeat these measures and develop a routine that continued throughout the protocol. The findings in this chapter could only have been uncovered by a qualitative research design as this was the story the participants told.

Whilst extensive research has been carried out on mental simulation, no studies have uncovered the preparation required to undertake life-support mental simulation from the end-user's perspective (in this case, pre-registration nurses). The next section moves to practical implications of the research findings in the next section.

12.3.1 Theory to practice

Understanding students' motivations are helpful for educators to understand as it assists in creating an education provision with a broader uptake. Students must find their motivation to learn, especially for sustained, self-directed learning. Understanding student fears and motivations allow nurse educators to tailor provision to meet students' needs. The participants clearly recognised their own needs and shortfalls, which created some anxieties as there is currently no provision that allows for deliberate, repetitive practice of BLS or wider life-support skills. The anxiety created a “positive” pressure and created a short term motivational goal to seek out learning opportunities to remedy these feelings. Mental simulation was seen as a vehicle to reduce their ‘hang-ups.’

The participants appear to recognise that the current provision is unlikely to be enough on its own. They sought out mental simulation and carried it through for the 4-weeks as they were motivated for themselves, their teams, and their patients’ safety. If students have anxieties and are motivated to learn, nurse educators have a duty to provide education that ‘fills these gaps,’ and mental simulation is one such educational technique. Outlining to students the potential evidence-based benefits of learning life-support through mental simulation may create extrinsic motivation.

Creating a sanctuary, increased combinations of thoughts, emotions, and cognitive arousal levels to enable optimal mental simulation performance (Kamata, Tenenbaum, & Hanin, 2002). Finding a sanctuary will help create the necessary high-fidelity images experienced in real-world cardiac arrests as it allows the student to concentrate their learning efforts (Hunziker et al., 2013) and it allows students to create clearly, higher fielity images. Finding a sanctuary may help with maintaining volition for the required periods of time and could help to avoid frustration due to increased levels of focus.

Suggestions of relaxation, earphones etc., will be added to future protocols. Strategies to enhance the experience might involve providing eye masks (see picture 8 below) and earphone sets which could create sensory deprivation and create a 'manufactured' sanctuary for those students who cannot find the required quiet space. This could be a reasonable approach to assist with the engagement of more students. Healthcare researchers have not previously considered the 'sanctuary issue,' which further supports this thesis as adding to the body of knowledge within nurse education.

Picture 8: Eye mask

As these data show, internal motivation is essential. However, perhaps educators can do more. For example, creating time within the curriculum could help show commitment to mental simulation, further assisting with enactment. Furthermore, asking future protocol users to evaluate their life-support knowledge, skill, and self-efficacy, creating a feeling of inspiration, thus creating the required motivation to undertake mental simulation.

There is a clear requirement for participants to control their mental simulation exercises and find times and environments suitable for their life circumstances- this should be made clear in future protocols. Finding the right environment, time management and creating the distraction-free sanctuary is required. Independently experimenting takes commitment. However, sharing the participants' experiences with future users could help cut the experimentation time and keep users in the enactment phase through to completion.

These are 'hurdles' to get through to undertake mental simulation successfully. These are the hard yards that take commitment. This is the crux of the volitional state for mental simulation. There can be no full engagement in mental simulation without climbing these hurdles. It seems that mental simulation is hard work, and students must recognise this and recognise that commitment is required. While some students will undoubtedly be motivated and inspired to undertake mental simulation, some will not. However, even if a small number undertake mental simulation, this could function as a marginal gain and potentially increase the pre-registered nurses' knowledge, skill, and self-efficacy in undertaking life-support.

12.4 Chapter summary

In this chapter, the participants described how they adapted their learn-life balance to accommodate mental simulation. This was effortful, requiring enough motivation to create a tipping point into volition. This volition was not just about performing mental simulation but about being motivated enough to employ their graduate attribute skills to think critically, problem-solve and make decisions about what worked best and what did not work for their particular life circumstances. This chapter outlines what motivated the participants to learn life-support skills using mental simulation. This motivation created enough impetus for the participants to experiment with their environment, manage their time, thus creating a sanctuary for mental simulation, where they could focus when performing mental simulation.

The chapter concludes with a link to the literature presented in the opening chapters to illuminate the participants' experiences, and the concluding part links the findings to practice. As this is applied research, the findings from this chapter must be applied to practice, and this was presented as part of the discussion section.

Whilst the preparation for undertaking mental simulation has now been created, the participants now share their experience of undertaking mental simulation. The next chapter begins with an overview of how the detail of the script created the necessary visual images to 'see the scenario.' The script and wider protocol helped create emotions in some participants akin to real-world emotions. While most participants were unable to 'feel' the mental simulation's kinaesthetic elements, it did not affect their overall experience, and the participants reported mental simulation as feeling authentic, which created an individualised experience.

Chapter 13 - Buying into the mental simulation scenario

You will hear a lot of little noises but at the same time, when you compare the film and the script to real life- it was real! The person who was doing the CPR in the script had no idea what was actually happening… especially at the beginning. It felt like that when I was doing it. I had no idea what anyone was saying to me.
[Jack]

13.1 Introduction

The previous chapter explored motivation and volition, examining what drives students to undertake a course of mental simulation. The chapter above explored how participants engaged their critical thinking, problem-solving, and decision-making skills regarding the best times and the most effective places to focus on undertaking mental simulation and creating high-fidelity images. This occurred through manipulation and experimentation, meaning that they created an optimal environment or sanctuary, without which the participants would not be able to create high-fidelity images. The next chapter explores these high-fidelity images.

This chapter explores how the participants executed mental simulation. The chapter begins with an examination of how participants engaged with the detail of the script and how the detail assisted in creating authentic images that created high psychological fidelity. These data suggest that the script language was interpreted to evoke visual, emotional and (for some) kinaesthetic images.

However, lack of kinaesthetic BLS and CPR experience meant that the fidelity of kinaesthetic imagery was not as strong as visual and emotional imagery, and this is explored in the sections below. Overall, engagement with the script and broader mental simulation protocol allowed the participants to create high-fidelity, authentic, and immersive mental simulations. The chapter concludes with the discussion section, where a theoretical and literary underpinning illuminates the participant experience. The participants' experiences are illuminated using dual-code theory, which is further linked to psychological fidelity and authenticity in helping to create a scenario that feels realistic. A theory to practice section is offered to help future practice. The chapter 'road map' is laid out in diagram 11 below.

13.2 Detail of the script and visual images

Yes. I think towards the end, when they are talking about where they are in a shockable rhythm or if you have to give adrenaline, I think I could imagine that more. Because it was a bit different from the advanced script, but I felt then like I was stood listening to a conversation between different people. Whereas the first bit, when you are just doing the CPR, I felt like I was there less. I think I imagine the end more, and then I think at the end they say about 'you go off to phone the family' or something, and I could imagine myself walking to the desk
[John]

In this first section, the experiences of how the participants engaged with the script and how they evoked images are explored.

The narration script detail was pivotal in creating high-fidelity images for all participants. The participants could relate to the story being narrated. Participants found that the scripts were relatable. As Ralph describes here, higher fidelity visual images were evoked more readily because the scripts (especially the advanced script) were high in descriptive cues:

Ralph: *The advanced script helped a lot, really.*
Nick: *In what way did that help, do you think?*

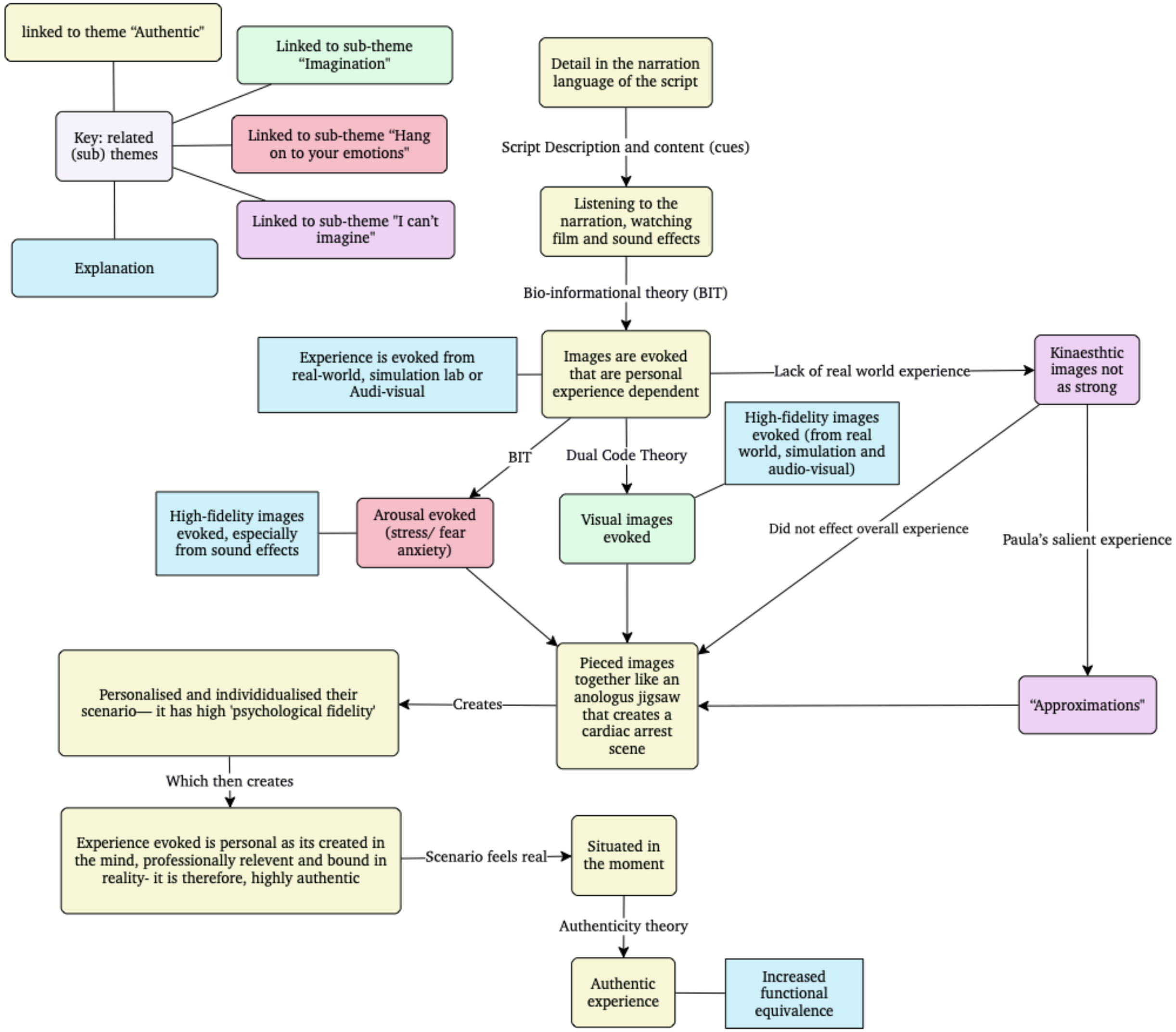


Diagram 11: Overview of chapter 13: Findings and Discussion

Ralph: *It's a lot more descriptive. It sets the scene a little better, and it talked about pupils dilating, blood pressure rising, and then it talks you through what you are doing a bit better, it says you put your knees on the bed to help this, and you can go, "Right, knees are on the bed. I'm now feeling things in my legs."*
[Ralph]

The script was constructed to direct the participants' imagination through each action within the described scenario. The detail of the script meant that relatable images were evoked. As Jack describes here, the visual images evoked in his mind's eye were of his previous relatable experience of delivering real-world CPR:

Jack: *Obviously, I used my past experience. So, when I was on the ward, which was in ***** [name of hospital removed] on a GI ward, where I had the CPR. So, kind of hold the environment-- I don't just feel the small details, but I also feel the people in there as well*
Nick: *Right, so which people did you visualise being there?*
Jack: *Well, I kind of-- well, obviously, I knew my mentor was there and also too, the health care assistant. I knew their faces. I knew their names. They came straight away. I also imagined the tools that we used, where the resus' trolley was, where the notes were. Where to find out the DNAR status? Where is the defib? So, I felt all these details of how long there are when all these things are brought to the patient. Sometimes I filled in some noises as well, like the way they are dragging the IV stand because obviously, they always.*
Nick*: So, you pictured those yourself?*
Jack: *Yes. Yes. Because obviously, they are loud, especially at night, because obviously, for me, it happened at night. So, that might be-- I don't know, that might be something with me as well.*
Nick*: So, you pictured-- you fitted-- you can tell me if I'm wrong here. This is what I'm getting. You pictured the scenario from when you had a-- when you were involved in your cardiac arrest, and you kind of superimposed that onto this scenario?*
Jack: *Yes. And there were times when I did that, but there were times when I pictured in the "cat flap" because of my interest. I kind of fill in the whole saying, if this person tells me to get there. Where do I have to go or who are the people? So, I tried to imagine two scenarios within the same script, not simultaneously, of course. I tried it on the different days but kind of tried to imagine how it would look like if I didn't experience it, but then I tried to imagine how the script would fit in with my experience as well.*
[Jack]

There was a clear link between the language used in the script and the images evoked. This link suggests that the PETTLEP/ student experience designed script was relatable to the participants. The importance of understanding the language and narration within the script was highlighted in John's salient experience. John describes not fully understanding the script narration until he read the glossary of terms. Once it was made clear, it illuminated the mental simulation and the experience:

About a week ago, I actually sat down properly and looked through the glossary of terms, and once I had done that, I then found the advanced script a lot better and more interesting, and I felt like I was more with it. I think something I would say to someone else doing it would be to read the glossary terms right from the beginning and get to know all of the words and understand the process because once I'd done that, the advanced script was much more interesting and as I said about the shockable rhythm and the adrenaline. That kind of went over my head a bit at the start, but once I'd learned that, I then thought, "Oh, okay". So yes, I found the advanced script more interesting and easier-- easier to visualise and to feel and all the things relevant to it.
[John]

Whilst not all of the participants experienced using the glossary (most felt comfortable with the language used), it highlights three positive aspects and considerations for nurse educators: 1) the glossary of terms is a valuable aspect of the protocol as it creates links between and the newly understood glossary language, and previously known language, which then evokes clearer images; 2) the glossary appeared to help inexperienced students relate to the script suggesting mental simulation could be tailored to benefit new starters and; 3) language and cardiac arrest images appear to be very closely related. The images are evoked from previous experiences, but these appear to come in different forms of experience.

For some, substitute experiences were evoked because of a lack of real-world cardiac arrest experience. These experiences also included simulated practice and different audio-visual experiences as Amy, Claire, and Sarah describe here:

[C]rash trolley-- I think it has to be from simulation. Because other than that, I have never seen a crash trolley, I've never audited a crash trolley. I've never seen it without the cover on-off. So, the only time I've seen a crash trolley is in simulation. [Amy]

I can see, and I have been visualising when I am doing it, but after I saw this video, I watched on YouTube about the suggestion; now, I always see that person doing it. [Claire]

I definitely think it helped. Like I say, I watched it about three times, and it does help: 1) with seeing it from the first person and 2) just actually being in that situation. If somebody had never actually been in one where people are coming in with the crash trolley, people are kind of everywhere, leaning over, putting the pads on. If they had not seen that before when they had done CPR, I think that would be quite-- Or trying to imagine and you cannot because you cannot imagine all that happening, whereas the video you could see it happening, so it did help [Sarah]

These data suggest many experiences are drawn on, but it also implies that the film can help create images to be evoked during mental simulation exercises. In line with participant experiences of the film, it further implies that simulation-based educators can somewhat manipulate some of the cardiac arrest images evoked.

This is a positive finding as it would allow for engagement from more junior students. It further indicates that the film is a valuable aspect of the protocol, even for more experienced students. The main aim of the script was to create an experience that was as close to reality as possible (authentic). This appears to have occurred. This indicates that the scripts (especially the advanced script) functioned as was intended. As well as visual images being evoked, the mental simulation script also evoked emotional images, which is discussed in the next section.

13.3 Emotional imagery evocation

Yeah, so there was a medical emergency on that [ward], so I wonder whether the – even though it wasn't that scenario because I could see that patient there, there was that link with an emotional component or something. Really strange how your mind just [does that].
[Paula]

For some, the script evoked emotional experiences akin to real-world experiences. As Paula and Jack both describe below, these feelings of arousal are created when cardiac arrest visual images are evoked:

Yeah, there was adrenaline. Well, panic at first. But again, it was on the inside. It wasn't externally or anything. So, inside, it felt like, oh God, what do I do? But that started to, again, teeter off. And then started again in the other [advanced] script.
[Paula]

And as was seen in Jack's experience of the mental simulation is akin to his real-world experience:

[W]hen it says that you're washing a patient and then you go to another patient who is unconscious. The same feeling came again because that's when your mind goes into a bit of chaos, but then you still know what to do. And yes, you get that-- I don't know what the term for it is when your heart skips a beat. You get a feeling that like-- which had happened to be at the beginning when I started to watch [listen to] the basic and the advanced script.
[Jack]

Later in the conversation, Jack discusses some of the powerful physical responses felt whilst imaging the scene:

Yes. When you go to the patient. When you hear the-- when you go to the patient, and you are just about to assess, the adrenaline rush because I also have very sweaty hands. So, my biggest problem is putting the gloves on in an emergency. That's not going to happen. Cause my hands to go straight into sweating, and there is no way I can do like, simple tasks, to put the gloves on. So, when I watched it for the first time, I felt my hand become straight away sweaty and yes.
[Jack]

As Claire describes here, the script sound effects evoked a strong emotional response. Claire experienced heightened arousal when simultaneously hearing the sound effects and visually imagining the scene:

It gives me the urgency-- the buzzer-- everything that is there is what a real scene would be. So, it gives me the image of the real thing, that is what we should do in our practical, they should put everything in because when you hear that buzzer, I think you even first panic before you act but in the advanced [script] it is giving us the real scene how it should look like, so, I think it's good.
[Claire]

The 'emergency buzzer' and the 'bed dropping flat' are specifically associated with an emergency and patients *in extremis,* and this played out in the experience of Paula, who articulated:

But that's the thing. In terms of like learning, the sounds are amazing because it's really helped you to be – it makes you – you can imagine yourself being in the situation, especially if you have heard that sound before, and you have— it projects you there.

A little later in the conversation, Paula further conveys that she thinks that:

[T]he anxiety of the situation and thinking like that person could die or something. The emergency, you just know that emergency is like something serious-- I feel like it's an emotional connection with people! So, even without the information about the patient, it's that desire. That need to help that person, sort of thing.
[Paula]

These again are positive findings for the use of mental simulation. Mandatory basic life-support (BLS) training simulation is unlikely to evoke these emotions in students. Therefore, students are not experiencing these emotions until they reach clinical practice and are involved in a cardiac arrest, perhaps only then striving to cope with acting proficiently while fighting feelings of stress and anxiety.

Mental simulation offers students a 'realist and authentic' experience akin to real-world practice and acts as a stress-exposure exercise described in section 3.4. However, authenticity cannot stop at equipment or the environment. To be genuinely authentic and offer a 'real experience,' it is fundamental that students experience and learn to deal with their emotions. Mental simulation is one such teaching method that offers this.

13.4 Kinaesthetic imagery

> *When I think about it, it is when I am going to sleep and, "Oh, I can't, I didn't think about it. But more, I visualise myself doing it but not-- is it called kinaesthetics? The feeling of it really does not come. I can see myself doing it- I do not feel it! [T]hat feeling like I am touching the person or whatever, I do not really get it. It's visual, yes-- Yes, I can see, and I have been visualising when I am doing it.*
> [Claire]

Overall, kinaesthetic imagery did not appear to create the same level of high-fidelity experiences, as Claire articulates above. For most, it felt more challenging to evoke kinaesthetic images than visual and emotional images. However, just as visual and emotional imagery were evoked from experiences, so it seems are some kinaesthetic images, as Lucy describes here:

> *Definitely seeing, visualising the scene. I find it really hard to feel things. I think the reoccurring theme throughout these sessions was because I'd not actually done it before. I don't know what a person's chest feels like. I don't know what that sensation feels like, so that was quite hard in my head. Often, I would think about doing it on the mannequin with the clicking sound to help me. I definitely found it easier to see things for sure.*
> [Lucy]

John's experience also shows this, as he maintains that it is more likely that he will hold kinaesthetic images from repetitive memories, with this repetition allowing him to retain them:

> *I feel like that is just the sort of person I am, but I can imagine what something feels like when it's cold, or I think there is a question in that questionnaire thing where you feel yourself opening a door or whatever, and I've opened doors thousands of times, so I know what it feels like. But to see yourself in first-person [performing BLS], I think, is something I do less if that makes sense?*
> [John]

This experience could be described as a dose-response relationship. As described in section 2.3, hands-on, real-world practice is limited due to the relatively low occurrence of cardiac arrest in some clinical areas. However, no participant experiences are the same in this situation.

Paula was similar to John and Lucy, having never enacted real-world BLS skills or performed CPR. Nevertheless, Paula's experience is salient and insightful as much can be learned for future protocol design. Paula also found it difficult to draw on kinaesthetic images from the script initially, but she began to find this easier after some time. Paula articulates her experience here:

> *At first, I couldn't really feel that, but then eventually, I start to feel. I could feel my fingers-- I haven't had that actual experience of doing it. But the descriptions were – it might have been a memory that's retrieved. You're washing them or something. I can feel the ribs because you're washing them, and all sorts of this is going on*
>
> *[Later in the conversation] At first, it was [visual] imagery [that was the strongest]. I think visual imagery was the most vivid, yeah, but then the kinaesthetics wasn't. I was actually able to, by the end, develop that quite a bit[...]. I think it just came on. I think just gradually. I think the more and more I did it. The skills developed over time.*
> [Paula]

Paula used an 'approximation' of real-world experiences. Paula purposefully created the feel of the chest from other relevant but not directly related experiences, essentially implanting her own 'false memories' into the simulation.

Paula's mental simulation experience is salient in the study because it offers an insight into a potentially exciting and valuable way to approach future protocol design and future research. As shown in the following chapter, this lack of kinaesthetic experience did not stop participants from suggesting that mental simulation increased their self-efficacy. However, this should not stop educators from striving to help users gain a more authentic kinaesthetic experience. Therefore, educators could include substitutes as part of their protocols to increase kinaesthetic ability- creating these approximations. For example, educators could ask students to feel their own chest, the chest of a significant other (with express permission) or use previous clinical practice memories, as Paula suggested. Overall, the above experiences led to an authentic, individualised experience, discussed next.

13.5 Authentic, individualised experience

> *[T]he first time I listened to the basic script, because I hadn't listened to the advanced one yet, it felt stressful and real, and I felt on edge listening to it the first time… [then, the advanced script] felt more frantic and that there was a lot more going on, but that was good, because that is what real CPR is like, so it did feel more real.*
> [John]

The scenarios were made up of 'pieces' of participant experiences as described above. These were akin to jigsaw pieces. These image 'pieces' were constructed experiences as Sarah, who imaged the team members, alludes to here:

> *So, you had the crash team, and then the other nurse left. I remember rightly because I think some nurses came originally to help, and then when the team came, they went back. Then there was the test; somebody took charge-- Yes, I could imagine their faces…*
> [Sarah]

Or Lucy, who imaged her environment:

> *It changed. I think the first few times I did it, for some reason, my brain chose a first year, first placement on a stroke ward and a particular bay and a particular bed, and I don't know why that's the image that came to mind. Other times it was on a placement in my second year, but I don't know why. Maybe it's more recent in my mind*
> [Lucy]

This experience created a personalised, authentic experience that created a feeling of immersion because it belonged to them- it was their own, individualised scene.

The participants felt that they were immersed in a 'real' event. The participants often defined the mental simulation experience as being immersive and authentic.

Most participants described mental simulation as: "real" [Emerald, Sarah & Ralph], "real-life" [Amy, Jack, Mandy & Paula], like a "real scenario/ situation" [Claire & John], or "true to an actual scenario" [Wendy]. For example, Emerald describes how she was immersed in mental simulation. However, she suggests that one does not get the same authenticity from simulated, basic life-support (mandatory training) practice:

> ***Emerald****: Noise. Very much noise. Real noises-- what would happen [in the real-world]. Also, the description of the feeling of your hands, how you are feeling, your mind goes blank, you forget things because that might really happen to you. But where a simulation, kind of a lot of the time the teachers or lecturers just say beforehand, "It's not real, no-one is gonna die."*
> ***Nick:*** *That is the whole point of simulation.*
> ***Emerald****: Yeah, but I think that is what made it [mental simulation] more real.*
> ***Nick:*** *Yeah, the whole point of simulation is it's safe for the patient. So you do not get those emotions?*
> ***Emerald:*** *But Yeah, like you say, you do not get the real emotions along with it and the feeling along with it because they just say to you, "It's all right, its only practice. No-one's gonna die." But in the script, they really are going to die.*
> [Emerald]

This authentic experience 'situated' the participants as though they were there delivering life-support as part of a cardiac arrest team, as Lucy describes here:

> *They really helped. It would start off with the buzzer going off in the advanced script that helped to situate me on the ward. That sound instantly goes to your heart. It puts you in fight or flight mode. That really helped. Then the bed noise, the CPR handle going. I think because it's really loud in the script. That really evoked all the feelings that you need to be in that situation. Then there's a bed squeaking noise when you're doing the CPR. That was useful. More of that would be good. I think there's a noise when the crash team comes, possibly.*
> [Lucy]

This suggests that the authentic nature of the mental simulation experience made it feel as though they had actually experienced the cardiac arrest situation. It had placed them at the scene of a cardiac arrest and given them an immersive learning experience in the safety of their home (or suchlike).

In the next section, the author will discuss both the theoretical underpinning and what the findings in this chapter mean for practice.

13.6 Chapter Discussion

The mental simulation script featured as being critical to the participants' experiences. The script direction, within the narration, were primarily based on 'bio-informational' cues (Lang, 1979) created from the student experience constructed in phase-1 of the study (see appendix 8, section 17.8). These created 'memory images' in the participants from a previous event or occasion (simulation, real-world or audio-visual experiences). The cues create a representational link between language and images (Lewis, O'Rielly, Khuu, & Pearson, 2013; Lui & Wang, 2007). Dual code theory can help to explain how the images were created from the narrative in the script and experiential memories.

The script cues in the narration represented the 'logogens' or the verbal aspect of mental simulation (Clark & Paivio, 1991). The participants recognised the verbally described tasks in the narration. The 'imagens' were then constructed from previously relatable experiences (Paivio, 2014), creating authentic, immersive visual, emotional and (perhaps weakened) kinaesthetic images. These personalised higher fidelity images would further increase the prospect of transfer from mental simulation to real-world practice (Hardwick, Caspers, Eickhoff, & Swinnen, 2018).

This was a unique finding as no healthcare research had dealt with this understanding regarding life-support education. In contrast, most quantitative research has dealt with the 'what' (outcomes). This chapter uniquely uncovers 'why' and 'how' the quantitative outcomes may occur.

As described in section 3.4, stress can negatively affect performance. Reduced cognitive performance has been empirically linked to the excessive release of stress hormones, corticosteroids and catecholamines that cause arousal (Kirschbaum, Wolf, May, Wippich, & Hellhammer, 1996; McEwen & Sapolsky, 1995; Mendl, 1999; Roozendaal, 2002). This also occurred during the mental simulation exercise and appeared to be caused by the task's emotional relevance (Michiels, Poels, & van't Hof, 2017). The emotional relevance meant that the imagery narration in the script held enough propositional content that matched the represented memory concepts—creating high fidelity images that caused arousal. In some cases this has also been shown to trigger a 'somatovisceral response' (Ji, Heyes, McCloud, & Holmes, 2016; Roberts & Weerts, 1982). The autonomic nervous system increases heart rate and endocrine responses (Lang & McTeague, 2009) and this was the case for some participants in this study, for example it resulted in elevated heart rates or sweaty palms.

While the script text evoked arousal by creating high-fidelity visual images, there appeared to be an even stronger emotional imagery response to the sound effects embedded within the audio script. The embedded sound effects further created emotional imagery. In addition, the embedded sound effects were influential in creating stress exposure (Driskell et al., 2014). 'Industrial sounds' were added for effect, significantly affecting participants' arousal levels. These increased arousal levels are a type of auditory fidelity and were strived for in the protocol's design. This increase in arousal was primarily based on the sound effects explicitly linked to emergencies. It can once again be explained by dual-code theory, but in this case, a non-verbal *sound* to a non-verbal *emotion* (see diagram 7, specifically ‘associative structures’). This emotional arousal is a type of symbolic exposure and creates emotions that help to desensitise (Bandura, 1997) the student. The sound effects were a further success of the mental simulation protocol and should remain in future protocol designs.

Mental simulations are created by piecing together images from past memories (Newman & Lyndsay, 2009). It would appear that the imagens evoked from the script are analogous to jigsaw pieces that fit together, making a bigger picture of a cardiac arrest scene (Clark & Paivio, 1991). Emotions, kinaesthetics, and visual images are unique to each person (Smith, Wright, Allsopp, & Westhead, 2007). This, indeed, appeared to be the case for the participants. The uniqueness of the participants’ experience means that they evoked scenarios high in ‘psychological fidelity.’ This psychological fidelity creates an immersive experience, creating the perception of being physically present in a non-physical world (Radianti, Majchrzak, Fromm, & Wohlgenannt, 2020).

The authentic experience and ensuing immersion came from the participants believing the mental simulation to be professionally and clinically relevant to real-world practice (Rystedt & Sjöblom, 2012). Authenticity is in the eye of the beholder and, in this case, the “mind’s eye” of the beholder. Mental simulation is bound in the confines of reality (Kahnemann & Miller, 1986), which makes mental simulation of a cardiac arrest an authentic experience.

The script 'situated' the participants as though they were part of a cardiac arrest team and delivering life-support, and this is an essential factor as the authenticity of simulation can increase the chances of transfer to practice. The participants can conceive that the mental simulation is about their role as students undertaking real-world life-support (Rystedt & Sjöblom, 2012). A crucial prerequisite of mental simulation practice is that learners can comprehend the simulation (Holmes & Collins, 2001), meaning that they imagine a scenario as an appropriately relevant representation (Tun, Alinier, Tang, & Kneebone, 2015). Creating images as close to the 'as if' as possible is essential to learning from mental simulation. It creates an experience that is functionally equivalent (FE) to real-world experience. As described in the literature review chapter, functional equivalence is the underlying theoretical assumption of PETTLEP (Holmes & Collins, 2001). Therefore, making the experience as close to the 'real deal' as possible is critical.

This chapter contributes to the body of knowledge as most studies have only focused on understanding these elements from a quantitative perspective. For example, Fountouki et al. (2021) showed that mental simulation produced students who made fewer mistakes when delivering CPR. However, this qualitative study helps to create an understanding of some of the processes that occurred for the Fountouki participants whilst they imagined CPR. One theory generated by the findings of this thesis is that life-support mental simulation improved performance under stress by producing high psychological fidelity. This creates positive performance benefits from the higher authentic learning experience (Bjørshol et al., 2011) that physical BLS training may not have the capacity to capture. This study begins to understand why and how the participants experienced an authentic situation. This study also uniquely uses the perspective of healthcare (physical) simulation to help to illuminate the participant experience and helping to cross-cut mental simulation with physical simulation language, commonly used by the community.

13.6.1 Theory to practice

The script and broader protocol had effects beyond the author's expectations. BLS trains students in the technical skills required to perform BLS, but with time without practice, these skills decay. Mental simulation would appear to be a powerful adjunct to physical practice. Not only does it allow students the opportunity for deliberate, solitary practice, but it also creates a feeling of reality—feelings of being there during a cardiac arrest (situated). It offers a much more authentic cardiac arrest experience than other low fidelity experiences may offer (including mandatory training). This is not to suggest replacing mandatory training but to use mental simulation to complement it.

There were several features of the protocol that stood out. The point-of-view film helped less experienced participants create images, and therefore, the film should be part of future protocols. Creating various videos or using pictures of labelled equipment may assist evocation of high-fidelity images. Mental simulation ability is not fixed and can be developed (Williams, Cooley, & Cumming, 2013), and this may help. There is much the nurse educator can do to help stimulate images. Future protocol design could incorporate physical haptic elements to assist with kinaesthetic imagery. Elements such as handling the required equipment or putting knees on a spongy bed could increase the chances of evoking the associated kinaesthetic memories.

As previously described, kinaesthetic imagery was not as high-fidelity for most participants. It is argued that kinaesthetic imagery ability is not fixed but can be developed (Williams, Cooley, & Cumming, 2013). Individual differences in imagery ability relate to the observable effectiveness of mental simulation in terms of measurable learning (Zabicki et al., 2019). This means the higher-fidelity the images, the greater the behavioural outcomes. Therefore, mental simulation training should be incorporated into future protocols. This mental simulation training would be based around “Layered Stimulus Response Training” (LSRT) (see chapter 6, table 12) as this has been shown to improve both kinaesthetic imagery ability and, therefore, actual movement execution (Williams, Cooley, & Cumming, 2013). Perhaps these are important next steps for future mental simulation development.

13.7 Chapter summary

This chapter has presented how participants execute their mental simulation. Using the detail of the mental simulation scripts, the participants could visualise their involvement in a cardiac arrest. The participants were able to evoke detailed visual images of the scenario evoked from past experiences of cardiac arrest or other types of emergencies. Emotional images were also evoked, with the script sound effects playing a key role in evoking these feelings. Most participants could not evoke kinaesthetic images, attributed to a lack of exposure to hands-on CPR. This meant that kinaesthetic memories had not been formed, so they could not be evoked. However, it does appear that it might be possible to evoke kinaesthetic images that are an approximation to the real thing. Overall, the mental simulation was high in psychological fidelity, which creates an individualised experience. Again, the chapter was linked to theory and literature to help to ground the participant experience. Dual-code, psychological fidelity and authenticity theory were used to help explain the participants' journey. The chapter concludes once again with an application to practice.

In the next chapter, the participants describe how they make sense of their learning and their journey's endpoint. The participants make sense of their learning by employing reflective practice skills and creating new knowledge using the mental simulation script to self-assess and benchmarking their knowledge against the content of scenario. Creating new knowledge and skills creates a sense of self-efficacy and feeling prepared for practice.

Chapter 14 – Reflective practice and self-efficacy

The script prepares you for the physical [real-world practice]. Because what I felt, listening to the narrator-- you kind of hear the voice like I can still hear that voice in my head which I believe that is the voice I will probably hear when I do CPR. Like I can still hear it, like 30:2, 5 to 6 centimetres-- 30:2, 5 to 6 centimetres. So, yes, that's one way it could help. And also, to lower your adrenaline, I think
[Jack]

14.1 Introduction

The previous chapter describes how mental simulation was executed and experienced. Importantly the chapter presented why it was experienced in this way. Both visual and emotional images were experienced, and high psychological fidelity created an authentic, individualised experience that felt akin to real-world practice. While kinaesthetic images were not as easy to evoke, this did not deter from the participants' overall experience.

The authentic experience described in the previous chapter allowed the participants to experience cardiopulmonary resuscitation (CPR), basic life-support (BLS) and advanced life-support (ALS) sequences and processes. These processes were demystified by mental simulation, and participant/ student roles within the team were illuminated. Learning was consolidated through reflective practice, presented in this final findings and discussion chapter. The experience illuminated their scope of practice, teamwork, technical skills and implicit knowledge. Reflective practice brought an understanding to their learning journey. The learning gained from using mental simulation acted as an enactive mastery experience, creating a feeling of coping and self-efficacy—the participants felt ready for practice. The participants'

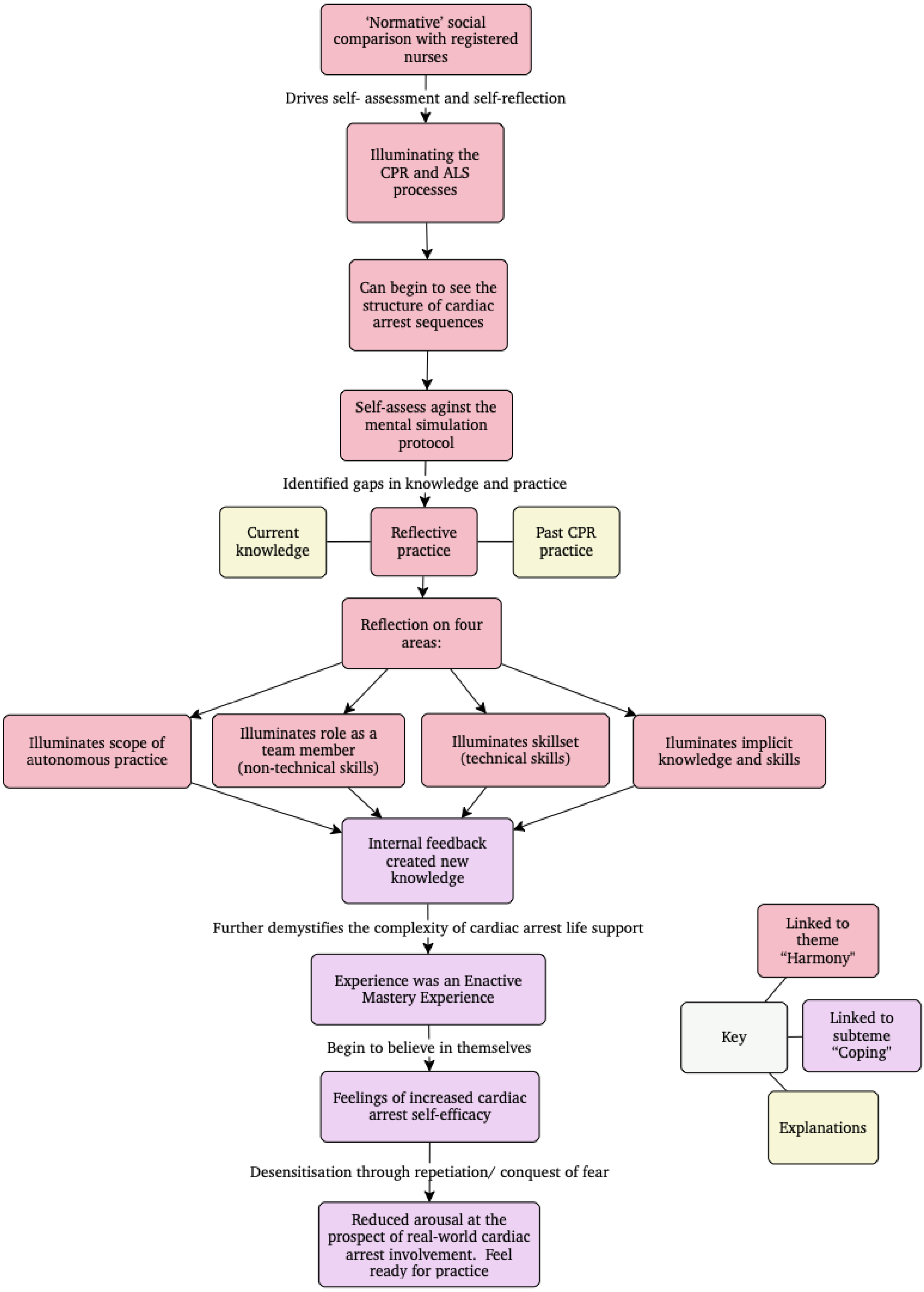


Diagram 12: Overview of chapter 14: Findings and Discussion

experience is shared in the findings and discussion chapter below. The chapter 'road map' is laid out in diagram 12 below.

14.2 Reflection and internal feedback phase of mental simulation

No, I did not even think. I know it sounds stupid, but even as a student nurse with this basic life-support, if you have not seen a cardiac arrest, you do not even think of all the things that come along with it, you just think of compressions and defibrillator and airways, that is about it. You do not think about timekeeping, you do not think about all these different things, and I think it [mental simulation] has helped that. Actually, being able to see it in my head because now I am like, "Right, I've seen this before, I'm into it. Let's go," kind of thing.
[Emerald]

The following section outlines the different aspects of practice the participants reflected on. As suggested in section 2.2.2, central to learning in nursing is the metacognitive skill of reflective practice. Participants engaged this graduate attribute to self-assess and reflect to create a new understanding of life-support. The participants tended to benchmark their knowledge and skills against the protocol. As Jack alludes to when he discusses using the protocol to self-assess against his own experiences and an experience in practice:

Because obviously, when I reflected [on] myself, and when I was in the CPR situation, my emotions took over me, especially when I have seen it for the first time, so that's why I just observed for the first time to see what's happening because I didn't know what to do. Even though I know what I should have done, it-- obviously-- I just froze. So, the script helped to give me a structure and, as we talked about before, for my actions to become automated.
[Jack]

This experience allowed Jack to understand where he was in his life-support learning process. This experience occurred for most participants. Mental simulation illuminated the CPR, BLS and ALS "process(es)" [Amy, Jack, John, Mandy, Paula, Ralph & Sarah]. Mental simulation allowed them to see and understand the "structure" [Amy, Emerald & Jack] of ALS, which was unbeknown to them before using the protocol—undertaking the protocol demystified elements of cardiac arrest practice that mandatory BLS training does not. This demystification came from engagement with the script and had reflective practice at its core.

Several cardiac arrest practices were reflected on, including technical skills, team roles, autonomous practice, and implicit knowledge. Gaining knowledge in these elements increased self-efficacy (shown in section 14.3). Claire highlighted that she failed to execute the correct sequence in real-world practice. Claire used the protocol to reflect on her technical skills. Claire compared the script to a cardiac arrest that did not go according to theory:

> *So, that is what I used to visualise, but that one, the visualising, has given me the-- you know, the depth of it. Because I do remember when we resuscitated this patient in the stroke unit, we just put the bed in the CPR position. I do not remember checking her mouth. I cannot even remember tilting her head. I just went to her chest.*
>
> *[Later in the conversarion] [I]t's [mantal simulation] like a refresher. You have to know the basics before you go to the-- It's refreshing what I knew, you know? It makes me do it properly-- has that knowledge. You visualise the right thing. So, before, I could have just visualised myself just wait for compression, but not before anything. I will first talk to the patient and open his airway. So, that is the basic-- starting from the basic, that is how we are going to save the patient's life. So, it refreshes my mind of what I had. It added-- It polished what I had.*
> [Claire]

Emerald admits that the protocol highlighted gaps in her knowledge around the scope of practice of pre-registration nurses:

> *It sounds ridiculous, but I only thought of adrenaline in that situation, and now I am thinking of different things that I could add! Can I give medication? Can I not give medication? What is expected of me? I did do a little "Googling" around it and stuff like that… Yeah, it has. It got me thinking.*
> [Emerald]

Furthermore, some participants described the 'implicit' aspects of BLS and ALS. These are elements of practice that are not in the algorithm(s) but are critical aspects of a real-world cardiac arrest. These elements allow for the delivery of high-quality CPR, BLS and ALS techniques to take place. For example, John describes beginning to understand the implicit elements of life-support:

John: *I think it is just where I was, who was there. I think I thought about things like when they say about pulling the CPR handle, and the bed folds flat, and I thought about things like, "Oh, what if the sides of the beds are up? Do you put them down? Is that wasting time?" I thought about little details like that.*
Nick: *Yes, because that wasn't in the script, was it?*
John: *Or the patients have tables over their beds. Things like that, do you take time to move them when someone is needing CPR? Do you know what I mean? I thought about the side of the beds quite a lot.*
Nick: *It's good though, isn't it? Because it does get you thinking about-- even things like that-- that you probably wouldn't have thought about before?*
John: *Yes.*
[John]

Additionally, the mental simulation illuminated their role within the cardiac arrest team, alleviating some of the 'imposter' feelings highlighted in section 12.2.1.

Emerald reflects here on the realisation that there is a role for the student to play, including a leadership role when first on the scene to the patient, as nurses often are:

I mean, the practical, like I said, it did quite well to replicate what I had seen, so, them two put together I can now see what the team was, someone needed a leader, everyone had a role, and since I did actually ask yesterday like I mentioned to you, I was thinking to myself, "Oh God, what can I do? What if I don't know how to do something?" The lady yesterday who taught my lesson actually said to me, "If you can't do something, they'll give you another job. Just say, 'I can't do it' it's more dangerous for you to try and do something you don't know how to do," so that helped

[Later in the conversation] Because I was thinking in the first person-- I was trying to think in first person-- I was trying to think in first person what I was doing, and up until the leader arriving and the crash team arriving, it's you, you are doing it, you are in charge.
[Emerald]

Mental simulation illuminates their role and shows their position within the team, but it also shows the *importance* of the student role within the team- students are not surplus to requirements despite what they may assume. This new reflective understanding will perhaps reduce feelings of being an imposter in future mental simulation users.

Reflecting on these elements means students can see the ALS 'jigsaw' pieces together as one big scene. Importantly for self-efficacy, where they fitted into that scene, as Wendy alludes to here:

> *[T]his was like, "Oh yeah, this is happening, and then this person is coming [as part of the cardiac arrest team], and this is gonna happen," you know-- I cannot think of how to describe it. It just made me think of all those-- I feel like I would know what everybody else was doing. I think that is the stuff that is quite anxiety-inducing for students is, "I kinda know what I'm doing, but I've got to fit in within with what everybody else is doing." So, it's like knowing that prepares you a bit better*
> [Wendy]

It appeared here that fulfilling a particular role helped the participants visualise success. These elements are not practiced in mandatory BLS training. Reflecting on these elements appeared to increase cardiac arrest self-efficacy, discussed further in the next section.

14.3 Self-efficacy in delivering real-world life-support

> *Because you know, in the beginning, I mentioned, with how they diagnose and everything. So, I felt like I was more confident in doing what I am doing because I've seen-- because I heard many times how to check for the pulse, how to check for breathing, bilateral movement, and all of these words stayed in my head, and when I went to do it myself, the same words came into my mind without actually putting much effort to think about it if that makes sense. So, my actions kind of brought-- my brain followed my actions, rather than my actions follow my brain [...]. It has increased. It has definitely increased. It [mental simulation] gives me more confidence by giving structure, by putting the narrator's voice in my head, that has-- that will definitely stay with me. Yeah.*
> [Jack]

The participants began to believe that they could exercise control and function as a valued member of the cardiac arrest team and deliver life-support. In addition, as

Claire alluded to here, mental simulation allowed her to understand the processes, giving her confidence to the point where she felt able to teach someone else if necessary:

> *Yes, through my imagination, I am able to train someone because now it has become so clear to me I would be able to guide somebody; when this happens, you can say that and that and that. Like I was now in the video explaining to my children, "You see what happens, there" I could even tell them the next step that is coming in. So, it's more clear, and I [would] be able to save a life and also help somebody else who needs that knowledge of CPR*
> [Claire]

Most participants suggested that exposure to mental simulation would likely increase their real-world life-support proficiency levels. For example, as can be seen here, Paula discusses that undertaking mental simulation has given her self-belief in her ability to perform real-world BLS:

> ***Paula:*** *No, I think it was better. Yeah, I think it's – certainly, by the end of it now, like with all that, I actually feel like a lot more confident.*
> ***Nick:*** *So, you feel overall better for you that you did it in the first person than the third person?*
> ***Paula:*** *Yeah, because you can actually see yourself performing the action like you would do in real life, so it's more authentic that way.*
> [Paula]

This engagement with mental simulation reduced their initial anxieties described at the start of their learning journey. For example, here, Emerald discusses growing in her life-support self-belief as the four weeks progressed to its conclusion:

> *I definitely am a massive supporter of this. I am very much like I think it's so important, and it has reduced my anxiety, massively regarding cardiac arrest now. Nobody likes cardiac arrest, it worries everyone, but I was physically frightened of it, thinking, "Oh my God, I might runoff. I'm that scared." But now, I can see myself doing it. I can see what is happening. I can see the team. I can think about that time.*
> [Emerald]

Paula and Emerald's experiences stem from the mental simulation experience feeling 'real' and being authentic, as described in more detail in the previous chapter.

This imaginal 'conquest of fear' produced an anxiety reduction through repetition and desensitisation. As Paula further alludes here, she manages to control her arousal after using the protocol for some time:

> **Paula:** *Yeah. But again, that was initially, when I was first starting, that was anxiety because I didn't know exactly what I was doing. But by the end, it wasn't that – I know that my emotion is actually starting to level out.*
> **Nick:** *So, it helped you control your emotion, do you think?*
> **Paula:** *Control it, yeah. So, still there, but they were managed feelings. I think it's managing the emotion-- I don't think you're, like, immune from the emotion of it. I think that you just manage the emotional reaction to that stimuli rather than eliminate it altogether*
> [Paula]

Overall, being motivated, creating a sanctuary, enacting the protocol, creating an authentic mental simulation and reflecting on learning made the participants feel they could cope with real-world practice if the time came. Mental simulation left the participants feeling ready for clinical practice. As Claire describes the overall impact of mental simulation:

> *It really just prepared me. I will never fail. Whatever it is, even if it's a nurse who falls in front of me, I will do the right thing. So, in practice now, in that sense of CPR, I will be qualified. I will be able to explain why I did this, why I checked the airway first and why I did that, and I will be able to instruct the others, "Can you call for help? Can you go and get the defibrillator." So, I will do it properly. I will do it properly in my practice.*
> [Claire]

The feeling of readiness and coping was a significant outcome of their engagement in mental simulation. This outcome was more significant than the mere learning of the technical skills initially anticipated by the author, and mental simulation is an exciting prospect for the broader learning of 'life-support' and self-efficacy beliefs.

In the next section, the author will discuss both the theoretical illumination and what the findings in this chapter mean for practice.

14.4 Chapter discussion

The participants monitored their progress towards their goal of BLS and cardiac arrest knowledge, skill and self-efficacy beliefs. They did this in tandem with self-assessment and reflective practice. Reflective practice allowed the participant to evaluate their learning. Reflective practice led to the participants comparing current knowledge and performance against previous performance levels (Bandura, 1997). Participants self-assessed and benchmarked their learning progress against clear criteria within the protocol. The protocol closed the knowledge and skill gap and illuminated the correct procedure. The protocol allowed them to see the bigger picture of:

> *The technical and non-technical knowledge, skills, and attitudes required to participate as a team member in providing life-saving measures in a cardiac arrest.*

Seeing the bigger picture of life support knowledge and skills is an important aspect of mental simulation and is a unique conclusion of this research.

The participants closed the knowledge gap by creating internal feedback mechanisms where new knowledge was created (Nicol, 2020) from either the protocol or outside sources. This was a form of reflection-on-action (Schön, 1987) and appeared to follow the experiential learning processes as identified in section 2.1.3. The above experiences can be further explained through the experiential learning cycle (Kolb, 1984; Kolb & Kolb, 2009), in which the mental simulation created an experience. The participants appeared to go through the processes of ‘concrete experience’ > ‘reflective observation’ > ‘abstract conceptualisation’ > ‘active experimentation’ during their protocol use.

The concrete experience of mental simulation was followed by reflective observation, where gaps in knowledge and performance were identified. Furthermore, cardiac arrest concepts were identified from the protocol and other independent research and reading, which helped fill in their knowledge and performance gaps. Finally, the new knowledge was actively tested in further mental simulations. As discussed in section 2.1.3, Bryant (2015, p. 3) argues that reflective practice in nurse education is:

> *…a way of considering and examining your own thoughts, actions and reactions, to a given situation or event in order to gain a better understanding of yourself and to identify more effective ways of responding in future…*

This description certainly appeared to be a process that occurred during mental simulation. This notion can be modified more simply: the participants self-assessed their knowledge against the protocol, which acted as a criterion or standard (benchmark) to test their knowledge and skill levels. The participants used reflective practice to judge what this meant to their learning.

As identified in sections 4.7- 4.9.5 and section 4.11.2, most healthcare studies have focused on the output of the mental simulation in terms of performance, stress management and/ or self-efficacy. However, they have not treated the learning processes in much detail. This chapter offers insights into the mental simulation protocol's learning processes.

The participant reaction to the mental simulation appeared to function as an "as-if real" template for rehearsing and modifying their emotional and behavioural responses (Ji, Heyes, McCloud, & Holmes, 2016). This imaginal 'conquest of fear' created fear extinction through repetition and desensitisation (Bandura, 1982). This desensitisation appeared to be the case for the participants. For the participants who did feel emotions whilst imaging, these emotions tended to waiver after repeated exposure. Past performance has a strong relationship to self-efficacy (Sitzmann & Teo, 2013), and it gave participants the experience of completing life-support measures successfully. Mental simulation, therefore, controls anticipatory self-arousal, and exposure to the images of a cardiac arrest reduces the fear-provoking thoughts that can incite elevated arousal levels at the mere thought of the performance (Bandura, 1977).

As Rushton et al. (2020) highlight (section 3.3.2), nurses often lack the confidence and self-belief to perform BLS in an emergency. It seems that mental simulation acted as a form of enactive mastery experience (Bandura, 1997) as it promotes behavioural accomplishments and thus reduces fear-arousal. This allowed the participants to overcome their lack of confidence, thus creating self-efficacious students. As further described in section 3.3.2, enactive mastery experiences have been shown to increase efficacy belief levels for a formerly feared and avoided activity (Bandura, 1982), which was undoubtedly the case in this study. They began to believe that they could exercise control over potential psychological threats of a cardiac arrest, ceased engaging in apprehensive thinking and were no longer perturbed by them (Bandura, 1998). This gave them feelings of self-belief in their ability to perform.

As time progressed, the processes and structures of BLS and ALS practice became more evident. The participants began to feel self-efficacious in their technical and non-technical real-world BLS abilities and ALS understanding. Mental simulation gave the participants a "dare to" attitude (Turner, Lukkassen, Bakker, Draaisma, & ten Cate, 2009). They believe they can carry out the required actions when needed. The participants began to believe that they could 'exercise control' (Bandura, 1991) in their ability to function as a valued member of the cardiac arrest team.

The participants reported feeling a greater self-efficacy to life-support skill delivery in a real-world cardiac arrest. The outcome of their engagement in mental simulation was a feeling of readiness for practice. Whilst self-efficacy has been measured in mental simulation, the research to date has tended to focus on the outcome of self-efficacy rather than the process and the journey that leads to the self-efficacy beliefs. Overall, this study has focused on this process. This thesis has explained the journey from motivated but low-efficacious students, through an authentic simulation, to self-efficacious students ready for practice. This journey could only have been explained using qualitative methods. The qualitative methods uncovered the 'how' and 'why', which is unique to mental simulation healthcare education and life-support education research.

14.4.1 Theory to practice

As reflective practice was an essential aspect of learning for the participants, it would seem prudent to include a reflection period in future protocols. Educator designed questions based on knowledge, previous cardiac arrest experiences, or implicit knowledge could be the focus. Encouraging reflective practice in future protocols will be an essential aspect of learning from mental simulation. It appears to help with learning, leading to increased self-efficacy and reduced anxiety about cardiac arrest. Overall, the stress exposure in the mental simulation created a sense of preparedness.

Whilst it is impossible to know whether these fear reduced feelings would transfer to practice, it is exciting to note. It is more likely that mental simulation would help users process the requirements needed to function under such pressure, creating desensitisation (Bandura, 1982). This desensitisation of fear response will likely increase clinical performance (Saunders, Driskell, Johnston, & Salas, 1996). Mental simulation was experienced as robust preparation for clinical practice and created a sense of being ready to tackle a real-world cardiac arrest. There was a feeling of readiness for clinical practice as it gave a sense of self-efficacy not created with mandatory BLS sessions alone. Anxiety reduction is a promising aspect of mental simulation of cardiac arrests. More research primarily examining anxiety reduction would be beneficial for future practice.

There is much more to life-support than just delivering CPR. It consists of the wider life-support skills needed to perform confidently and with self-belief as part of the cardiac arrest team. Educators must acknowledge this and work to remedy it. One way to acknowledge this is by offering students an authentic and immersive experience. The experiences of these participants in this thesis suggest that mental simulation can fill this experience gap, preparing students for practice. After all, preparation for practice is the end goal of professional, pre-registration training.

14.5 Chapter summary

This chapter showed that through self-assessment and reflective practice, the processes of cardiac arrest were illuminated, and real-world BLS and ALS were somewhat demystified. Through further reflection, gaps in knowledge and practice were identified. This illuminated three areas: 1) Scope of autonomous practice- what nurses can do in a cardiac arrest high-stakes setting and where the boundaries of practice lie; 2) roles within the cardiac team became apparent; and 3) the skillset required to undertake life-support measures became evident.

In this instance, the mental simulation acted as a form of enactive mastery experience created feelings of efficacy in their life-support and cardiac arrest self-belief. Through repetition and desensitisation, participants developed an ability to cope with the pressures and high-arousal states evoked in a real-world cardiac arrest emergency. The participants felt confident about performing and felt ready for clinical practice.

The study is drawn together in the final chapter, and conclusions are made. The next chapter will offer an overview of the study, revisit the research questions, draw together the claims to knowledge, and explain each claim. In the final parts of the conclusion chapter, practice recommendations are presented along with a discussion of future research directions.

Chapter 15 - Conclusion

A greater amount of solitary practice accumulated during development is associated with higher levels of attained performance
[K. Anders Ericsson]

15.1 Introduction

The previous chapter is the final findings and discussion chapter. This chapter explores how the participants made sense of their learning. The participants self-assessed against the mental simulation protocol, reflecting on knowledge and performance gaps and creating new knowledge based on these reflections. This new understanding of life-support processes created a feeling of self-efficacy in preparing participants for practice.

This conclusion chapter has been written based on the 'conclusion framework' for thesis writing, set out by Oliver (2014). These elements include: summarising the thesis, overtly acknowledging contributions to knowledge, 'rounding up' the thesis findings, developing practical recommendations, outlining limitations to the study, and possibilities for future research. This chapter begins by revisiting the thesis summary first outlined in chapter 1.

15.2 Thesis summary

This section will revisit the thesis summary first presented in chapter 1 to summarise matters for the reader (Murray, 2002; Oliver, 2014):

Chapter 1

Chapter 1 is the introduction chapter and presents the study's genesis. A synopsis of the study follows this before both phases of the research are described. The theoretical perspective and methodology are discussed in the context of semi-structured interviews and the qualitative reflexive thematic analysis. The findings, implications for practice, and the study's originality are further described.

Chapter 2

This chapter offers a context for the study and gives an overview of pre-registration nursing from the position of graduateness. These graduate attributes include decision making, problem-solving, experimentation, reflective practice and time management. These attributes are identified as being essential for undertaking mental simulation. Chapter 2 further offers the context of a subject-specific attribute of life-support skills that are required for clinical practice.

Chapter 3

This chapter has a focus on skill acquisition. The chapter examines skill retention and skill decay through time without practice. This leads to examining skill retention and decay, specifically in life-support education. As well as skill decay, the authenticity of basic life-support education is explored. This is explored from the perspective of recalling skills and performing under pressure. Mental simulation is introduced as an educational technique that could assist students in learning life-support. In the final part of chapter 3, mental simulation is explored in the context of healthcare simulation and immersive technologies.

Chapter 4

Chapter 4 is a review of the supporting literature. An overview of the literature search technique is presented (linked to appendix 3, section 17.3) along with the guiding review questions. Mental simulation is depicted as a form of deliberate practice with bio-informational theory, dual-code theory and functional equivalence theory offered to explain how people learn using mental simulation. A critical review of mental simulation research in sports (and other domains), nursing and medicine (mainly surgical skills) is presented. The chapter concludes with an overview of the gaps in knowledge and how this thesis aims to address these.

Chapter 5

This chapter offers an overview of the aims, research question and sub-questions that guide the research project.

Chapter 6

This chapter offers an overview of the PETTLEP mental simulation protocol design. This part of the research was phase-1. The chapter offers a pragmatic and evidence-based justification for how the protocol was conceived. The chapter gives an overview of the unique tripartite method used to create the mental simulation script. An overview of the different protocol elements is presented and how each element links to PETTLEP or mental simulation theory (e.g., dual-code theory).

Chapter 7

This chapter presents the philosophy of the research design (phase-2 of the study). The chapter offers an overview of the supporting ontological and epistemological positions that underpin this qualitative interview study. Methodological considerations and theoretical perspectives are reviewed. The chapter concludes with an applied examination of reflexivity and its importance to this study.

Chapter 8

This chapter offers the reader an understanding of the research ethics and ethical principles applied throughout the study.

Chapter 9

This chapter discusses the research study design. The first part of the chapter describes participant recruitment and the purposive sampling technique—an overview of how phase 1 was implemented and how it fitted with phase 2 of the study. The chapter then describes the semi-structured interviews used to collect data and how this was linked to the social constructionist lens from which this research was performed. In the final part of this chapter, there is an overview of the data collection endpoint and how this was applied to the study.

Chapter 10

This chapter presents a step-by-step overview of the data analysis phase. The research design employs a qualitative reflexive thematic analysis as the data analysis method. This chapter offers an overview of the 6-phases and how these were employed within the study (combined with the codebook presented in appendix 9, section 17.9). The chapter concludes with a presentation of the research's rigour, quality, and trustworthiness and further discusses the transparency and audit trail of the research processes.

Chapter 11

Chapter 11 is a short chapter that offers an overview of the three findings and discussion chapters, with a short synopsis of how the findings and discussion sections are described. Braun and Clark's (2006) thematic analysis suggested that the themes and subthemes are defined- this is presented as part of this chapter. A mind map is used to show how the themes link, and a narrative road map diagram is presented to show how the overall themes connect to create the participants' story.

Chapter 12

Chapter 12 is the first findings chapter. In this chapter, the participants articulated what motivated them to undertake mental simulation to the point of enactment. It was not an easy task to complete, as they had to affect their environment, and this was done by experimenting for their own specific needs. Participants employed their graduate attributes, such as problem-solving and decision-making skills, to help create the time and space to undertake mental simulation and give themselves the best opportunity to succeed and evoke high-fidelity images.

Chapter 13

This chapter discusses what they imagined, how they imagined it and how this helped them learn. There is a discussion of the visual, emotional and kinaesthetic images that were generated (or lack thereof in the case of kinaesthetics). The images created an authentic experience with high-psychological fidelity that created 'an individualised experience.'

Chapter 14

This chapter helps explain how the participants made sense of their experiences and created new knowledge. The participants again used their graduate attributes. In this case, they use meta-cognitive skills. The participants used reflective practice to make sense of their learning, and this process is presented. The process of reflection led to a new understanding of the required knowledge and skills for life-support. In turn, this acted as an enactive mastery experience, increased the participants' self-efficacy beliefs, and suggested that they were ready for practice.

15.3 Research questions revisited

It is worth highlighting the research questions again. In this section, I explain how I answered the research questions:

- What are pre-registration nurses' experiences (students) who use mental simulation to gain cardiac arrest and life-support experience?
    - How do students modify their behaviour to incorporate mental simulation into their lives?
    - How does mental simulation create an authentic learning experience that prepares students for real-world delivery of life-support skills?
    - What processes make mental simulation a useful technique as an adjunct to physical simulation of BLS and wider life-support knowledge and skills?

Throughout the thesis, the research questions have been answered. The participants' experiences (Q1) have been articulated (as shown in chapters 11-15). The participants shared their experiences of behaviour modification to enact mental simulation and carry it through for the full 4-weeks. They found both time and space in their busy lives to do so (as shown in chapter 12) (Q2). This fundamental aspect of the process allowed for the necessary concentration and the evocation of high-fidelity images, thus creating an authentic learning experience (as shown in chapter 13) (Q3). After closing knowledge and skills gaps, there was a sense of self-efficacy and readiness for practice, suggesting that mental simulation is a worthwhile learning experience for complementing life-support education (chapters 12-14) (Q4). First highlighted in section 1.6, the claims to knowledge are now discussed in greater depth below in section 15.4. Furthermore, in section 15.4.1, I also signpost the reader to the chapters where this claim is explained and justified. The next section highlights the original contributions to knowledge.

15.4 Originality: claims to knowledge

The claims to knowledge are revisited in this section, but the contributions to knowledge are explained in more detail in the following section. Below are the claims to knowledge that underpin the doctoralness of this thesis:

1. The study uniquely illuminates pre-registration nurses (students) experiences of using mental simulation protocol as a form of solitary, deliberate practice to experience cardiac arrest.
2. The study uniquely examines the mental simulation of a cardiac arrest in the context of healthcare simulation and immersive technologies (SIT)
3. The tripartite PETTLEP mental simulation protocol design assists the learner in creating high-fidelity images.
4. Creating high-fidelity images creates an authentic, immersive experience that increases self-efficacy beliefs in life-support knowledge and skills.
5. The study shows the importance of employing certain graduate traits necessary for successfully completing mental simulation.
6. The self-efficacy gained helps students feel able to cope with the thought of real-world BLS and life-support practice.
7. Mental simulation can be used as an adjunct to physical simulation for learning wider life-support skills- this complements BLS skill acquisition.
8. There may be some elements of mental simulation that match or even outperform the authenticity of physical simulation, for example, in exposing learners to stress.
9. These findings are unique as they are presented in the context of Covid-19 pandemic lockdowns and social distancing measures where distance learning measures are fundamental to future education.

15.4.1 Contributions to knowledge explained

A Doctorate in Education is focused on applied research to solve practical research problems, and these problems are solved using practical solutions, which has been shown throughout this thesis. This research project makes an original contribution to knowledge, and it does this in two ways. Firstly, the study makes an original contribution by taking pre-existing knowledge and shaping it to fit the participants' experiences to create freshly developed ideas. Secondly, this study offers an original contribution to the field of nursing education, life-support and cardiac arrest training and simulation and immersive technologies (SIT). This contribution particularly applies to the 'aftercare' of BLS skill development and maintenance. In other words, what happens after students leave their mandatory training sessions. Using mental simulation in this way is novel, interactive, innovative, unique, and attractive.

This in-depth qualitative study has uniquely shown the learning processes underpinning the participants' application of mental simulation. Most of the previous healthcare mental simulation research has focused solely on the quantitative outcomes of mental simulation, including performance, self-efficacy, and stress. However, up to now, far too little attention has been focused on the processes of how and why the outcomes were reached. Much less is known about the learning journey of the end-users of mental simulation. This qualitative study uniquely addressed these gaps.

More specifically, this section will offer a deeper examination of several original contributions to the field of nurse education and SIT. Therefore, the next section will detail the contribution and map the parts of the thesis linked to each contribution.

15.4.2 Contribution map

In this section, each of the claims is mapped to the thesis for clarity:

(1) *The study uniquely illuminates pre-registration nurses (students) experiences of using mental simulation protocol as a form of solitary, deliberate practice to experience cardiac arrest* (shown in chapters 12-14). This is an original contribution as only two other studies (Bachman, 1990; Fountouki et al., 2021) have researched mental simulation and CPR. Whilst Bachman's study had a qualitative element, the qualitative data was quantified, meaning this study is the only truly qualitative life-support mental simulation study. As described in section 4.7.1, Fountouki et al. (2021) undertook a comparative study.

The outcome showed fewer mistakes were made, and completion of training post-intervention was quicker in the intervention group than in the control group. However, these two CPR studies failed to show that learning can go beyond just learning CPR skills but can contribute to understanding wider life-support skills. What is unclear from the quantitative research is the participants' processes in evoking their mental simulations. The learning developments that occur through mental simulation were not explored in the previous objective research. Nor did they show how participant learning was processed through reflective practice. This current study addresses these gaps in knowledge.

(2) *The study uniquely examines the mental simulation of a cardiac arrest in the context of healthcare simulation and immersive technologies (SIT)* (shown in chapter 13). Using mental simulation as an adjunct to physical simulation has been well documented (for example, Chamanian, Rafei, Nezakat, & Salehi, 2018; Kraeutner, MacKenzie, Westwood, & Boe, 2016; Battaglia et al., 2014), but no other study has examined mental simulation in the context of healthcare SITs or using SIT theory to illuminate mental simulation experiences. Examining it in this context is a fundamental contribution to the already established healthcare SIT discourse. The aim here is for mental simulation to be seen by the simulation-based educator community as a fundamental part of the SIT repertoire and for it to be embraced by the community.

(3) *The tripartite PETTLEP mental simulation protocol design assists the learner in creating high-fidelity images* (shown in chapter 2 [section 2.3.1], chapters 6 and 13). The protocol's design was unique in that it used interviews from potential end-users of mental simulation to help create the script. Life-support guidelines theoretically drove the script (see section 2.3.1), and I used my experience to help construct the mental simulation script and protocol. The personalised images generated from this script created a significantly individualised, unique, and authentic scenario experience that potentially increased functional equivalence (Holmes & Collins, 2001), creating meaningful learning. Again, this is an original contribution as no other study in healthcare education has qualitatively established these links.

(4) Creating high-fidelity images creates an authentic, immersive experience that increases self-efficacy beliefs in life-support knowledge and skills (shown in chapter 13). This original contribution came from the uniqueness of the qualitative design. Only a qualitative design could have uncovered this information. In contrast, quantitative studies have shown that mental simulation often significantly affects outcomes such as performance, stress management, and self-efficacy. However, this study uniquely identifies *why* this may be. No other healthcare mental simulation study has focused on this aspect of learning.

(5) The study shows the importance of employing certain graduate traits necessary for successfully completing mental simulation. As no other study looked at the subject qualitatively, this is, once again, a unique finding. Other studies had failed to address how mental simulation was executed. However, this study showed that graduate traits such as critical thinking, problem-solving, decision-making, time-management, experimentation, and reflective practice were all employed at the start of the participants' mental simulation journey. The participants would have failed to complete the 4-week programme without utilising these graduate traits.

(*6) The self-efficacy gained helps students feel able to cope with the thought of real-world BLS and life-support practice* (shown in chapter 14). Again, the study's qualitative design uncovered this information and contribution. A unique way of looking at mental simulation is preparing students for practice. Self-efficacy originated from the authenticity of the mental simulations and the ensuing new knowledge generated from their reflective practice.

(7) *Mental simulation can be used as an adjunct to physical simulation for learning wider life-support skills- this complements BLS skill acquisition* (shown in chapter 13). As discussed in the final findings chapter, the experience of mental simulation created knowledge of cardiac arrest processes that created new life-support knowledge that goes beyond just learning CPR skills, as first assumed. This is a promising finding from this study and supports the inference that mental simulation can complement mandatory BLS training. I would anticipate making mental simulation resources available to students in their virtual learning environments, and these resources would be available to students for use on their simulated placements.

(8) There may be some elements of mental simulation that match or even outperform the authenticity of physical simulation, for example, in exposing learners to stress (shown in section 3.4 and chapter 12). As described in section 3.4, the fidelity of mandatory BLS sessions is often low using part-task trainers (see picture 1). In chapter 12, the participants describe the authentic experience felt during mental simulation. This included feeling emotions akin to real-world practice, such as stress and anxiety, to the point of creating a somatovisceral response in some. Due to a lack of authenticity, these feelings are unlikely to be evoked during mandatory BLS sessions.

(9) *These findings are unique as they are presented in the context of Covid-19 pandemic lockdowns and social distancing measures where distance learning measures are fundamental to future education* (as seen throughout). The data collection for this study was collected pre-pandemic, but the data analysis was

performed during. Whilst the study did not set out to present the data in light of Covid-19 restrictions, it cannot go unmentioned that mental simulation's mobile nature can assist with a distance or blended learning approach during any future lockdowns. As first described in section 1.17, the mobility and self-directedness of mental simulation could be viewed as advantageous during the lockdown periods of Covid-19, where remote and blended learning have become an essential aspect of education provisions (Carter Jr, Rice, Yang, & Jackson, 2020; Mali & Lim, 2021). This thesis was written during a global pandemic where the United Kingdom has been through several lockdown periods.

These lockdowns have severely affected students' time in the classroom, including the simulation laboratory. It is currently unknown whether more lockdown periods will be required in the future. Whilst this current study suggests that mental simulation creates a sense of self-efficacy and the thesis offers an overview of the learning processes (e.g., reflective practice), it is still unclear whether mental simulation objectively assists the learning of life-support skills. Therefore, the current Covid-19 pandemic has perhaps created an urgency for mental simulation to be objectively measured in terms of efficacy for learning. See section 15.6.1 below for a more detailed overview of how this future research project might be designed.

This section has given some grounding to the study's originality claims and has mapped out the claims to specific thesis chapters. Table 23 below offers an overview of the study's findings to help the reader process the long thesis document.

Table 23: Contextualising the study findings (overview)

Motivation and preparation	**Description**	**Buying into the mental simulation**	**Description**	**Reflective practice and self-efficacy**	**Description**
Assessment of current knowledge and skills	• Assessment of current BLS and life-support skills • See the benefits of mental simulation in improving their abilities and confidence	Listening to the script (with sound effects) and watching the film helped create images	• Looking after self-in the forethought stage will assist mental simulation	Images created whilst performing the mental simulation illuminated the CPR, BLS and ALS processes.	• The authentic images create an experience • As with many educational experiences, self-assessing and reflective practice is required • This increases their understanding of life-support
Motivation	• Could be CPR performance anxiety from anticipatory self-arousal or past experience or, • Career aspirations-joining a community of practice • Striving for excellence • Patient safety	Images are evoked between the script and narration	• Fundamentally, the narration must be understood in a "native" language. • Use of glossary of terms could be an adjunct for understating the language and converting language to images (dual-code theory)	Current knowledge and past practice	• Self-assessing [against the protocol] of current knowledge and past practice illuminates gaps: • Autonomous practice • Role as a team player • Skillset • Implicit knowledge
Volition	• Must turn this motivation into action	Visual images (could "see" the scenario)	• Visual images can be evoked from real-world,	This reflection led to a new	• Allows for abstract conceptualisation occurs. Making sense

	• Management of time using experimentation and management of self-		simulation and audio-visual experiences • Will piece this together like a jigsaw	understandin g and new skill level	of what has been reflected. • Internal feedback creates new knowledge and skills
Experimentation, critical thinking, problem-solving and decision-making	• Experimentation with different aspects of time and space (when and where) • Evaluate the experimentation. This evaluation will lead to routine	Emotional images (Higher arousal created)	• Feeling this will help with desensitisation and coping. • Will help with 'dealing' with emotions	Enactive mastery experience	• Mental simulation is a form of enactive mastery experience • Using reflective practice skills to undertake the protocol appears to increase self-efficacy • It appears to reduce anxiety (arousal) around real-world delivery of life-support
Time management	• (Further student experimentation needed) • Positive time attitude required to fit mental simulation into busy life schedules	Kinaesthetic (haptic) images	• This part may not be as high-fidelity as visual and emotional images • Can use a real-world (approximate) experience to increase fidelity	Clinical practice	• Feel ready for real-world practice • Feeling prepared
Study space: quiet time	• (Further student experimentation needed)	Individualised and unique	• The mental simulation is individualised and personal, helping		

	• Will need to create a quiet space with no distractions		to create an authentic experience • Individualisation can increase functional equivalence		
		Pieces together to form a 'real' experience, high in psychological fidelity and authenticity	• The experience is personal, professionally relevant and bound within 'reality.' • The created images will be 'situate the user in the moment.' • It will feel 'real' like the user is 'there.'		

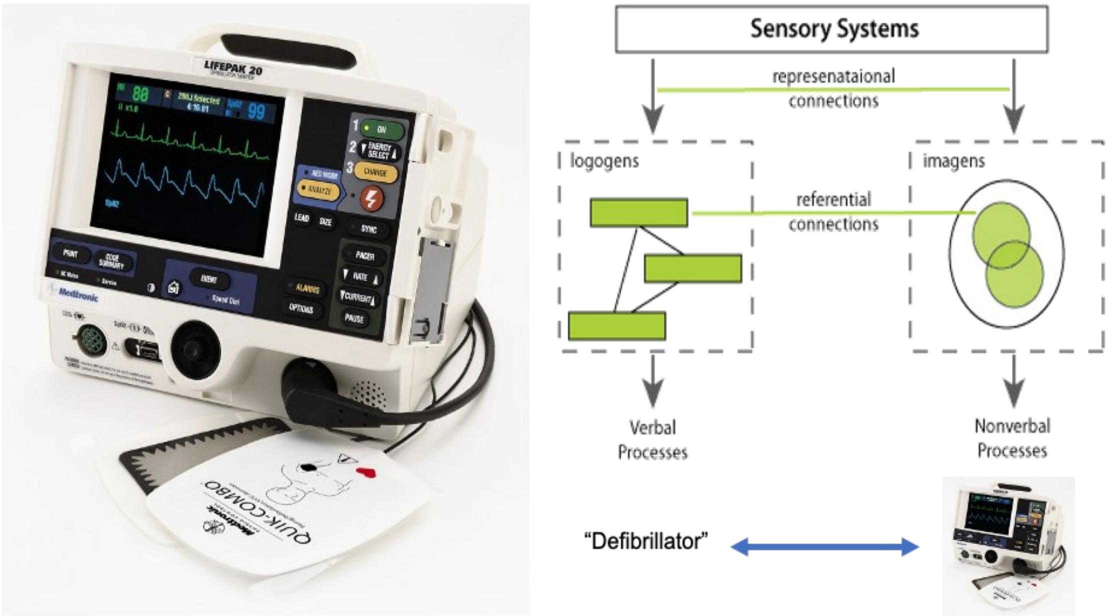
15.5 Understanding key elements of mental simulation: drawn conclusions

Promisingly, the visual imagery aspect of mental simulation appeared to be something that all participants could produce. For this reason, the participants were able to piece together scenarios in their 'mind's eye' from various experiences such as real-world practice, simulated practice and the audio-visual (the first-person protocol film [all participants], TV shows [Wendy], or YouTube [Claire] for example). This element is crucial for educators, especially if mental simulation is introduced to junior pre-registration nurses.

It suggests that educators could manufacture images that can help influence what the student 'sees.' It could be that pictures or more detailed films [perhaps with visual captions] could be produced to help their 'mind's eye.' These pictures, for example, could be produced with the name of the object, linking logogen and imagen together (Clark & Paivio, 1991; Paivio, 1986). See pictures 9 and 10 for an example:

Picture 9: Potential image to be used in future protocols to increase referential connections

These labelled pictures could assist students in making referential connections between verbal and non-verbal systems. It means that verbal and non-verbal systems can be manipulated by educators when creating mental simulation protocols. This element may help students produce higher fidelity images (Holmes & Collins, 2001; Smith, 2010).



Picture 10: Dual-process theory: verbal and non-verbal systems (Clark & Paivio, 1991) adapted to apply to life-support mental simulations

The emotional imagery aspect drew on experiences too. It appeared to draw on real-world cardiac arrest involvement. If the participants had not experienced real-world cardiac arrest, they appeared to draw on their anticipatory self-arousal (Bandura, 1977). As there was a lack of opportunity for participants to practice in real-world environments, there was a lack of haptic memories for evocation, meaning that kineasthetics were weak compared to visual and emotional images. However, drawing on Paula's 'approximation' experience, future protocols could integrate this method by asking students to think about approximate experiences that are 'close' to the real thing.

As described in chapter 13, the lack of kinaesthetic memories evoked did not detract from the overall experience of a cardiac arrest. The mental simulation still created an experience akin to real-world practice. It represented the complexity and the cognitive demands of a cardiac arrest creating an 'authentic approximation' of practice. This authentic approximation created high-psychological fidelity that assisted the participants in feeling as though they were situated in a cardiac arrest scenario. This experience increased their self-efficacy beliefs (Bandura, 1997) and a feeling of 'coping' with real-world high-stakes pressures. Students' feelings of self-efficacy in coping are fundamental for 'free decisions' made by students, such as pulling the bed out and dropping the bed flat using the 'CPR catch.' These are critical and desirable aspects of well-designed healthcare simulations as it prepares students for clinical practice.

Whilst this study used pre-registration (student) nurses as the participants, the findings may also be interesting and useful to other disciplines considering mental simulation in learning life-support skills. Next, I outline practice recommendations based on the findings and conclusions.

15.6 Recommendations for practice

The project's long-term aspirations would see a suite of scenarios that could play randomly for students. The unpredictable and variable nature of cardiac arrest must be considered in future protocols. The scenario in the current protocol did not vary, and this does not necessarily link with real-world practice. In an attempt to overcome the dynamic nature of cardiac arrests and life-support delivery, future protocols will include multiple scenarios. This suite would give students more diversity of experience, further enhancing authenticity.

A further long term goal for practice would be to create a smart-device application that housed the protocol. This protocol would include several PETTLEP based scenarios, cardiac arrests, a glossary, film(s), and labelled photos to assist with verbal and non-verbal referential connections (Paivio, 1986). It would also be essential to influence a time commitment to be designed into the curriculum for mental simulation. This time allocation would show students that mental simulation is valued as an education technique. This show of support may also assist with student engagement.

It is also important to recognise other nursing fields at this time. This research project was aimed at adult [general] pre-registration nurses. However, expanding this to other fields is a requirement moving forward. This expansion will mean developing the suite of scenarios to include mental health [for example, a hanging scenario], midwifery [for example, post-partum haemorrhage], children [for example, asthma] and learning disabilities [for example, choking/ hypoxia (low blood oxygen levels)]. An additional element to be considered is how the protocol can be adapted to be inclusive for students with learning contracts. For example, a hard of hearing student would currently be disadvantaged with the protocol in its current format. This element would need some consideration but could include a written script or a hearing loop device. Inclusivity should form part of future research studies.

Mental simulation appears to increase self-efficacy in the pre-registration. However, it works differently from my pre-study understanding of working only for CPR skills– this can be seen in diagram 3, section 1.8. There is more to performing life-support than just performing CPR, and the data that emerged uncovered this. My initial ideas for mental simulation were that it could potentially assist the students in their technical CPR skills. As seen through the participant experiences, mental simulation goes beyond this and offers learners the chance to learn wider life-support knowledge and skills. Mental simulation does this by creating an experience that exposes participants to what it feels like to be part of a cardiac arrest team. This is invaluable preparation for practice.

Mental simulation works, but it only works in certain conditions. Some of these conditions can be manipulated by educators. These conditions include:

- Students will need past experiences to draw on. These can be manipulated through the use of videos, such as the POV video and pictures (see pictures 9 & 10 above)
- Lack of kinaesthetic memories means that some participants could not imagine this aspect. This did not reduce their overall experience, but educators should still strive to enhance this for a more authentic experience. This can be manipulated by using 'approximations' of the experience. Layered Stimulus Response Training [LSRT] can be further enhanced and is described in chapter 6, table 12.
- One cannot manipulate motivation and volition. However, one can influence it by sharing some of the study findings and selling the concept of mental

simulation in terms of wider life-support knowledge and increase in self-efficacy.

- Just as some will move from motivation to enactment, some will not. While the educator can point out how important mental simulation is, motivation must come from within.

The second to final section will offer a description of future research studies as this thesis has raised some questions that were not answered by this study.

15.7 Further research

This section presents what is known and where further research needs to occur. I describe the questions and knowledge gaps that this thesis has generated, and I suggest the direction of future research.

15.7.1 Quantitative investigation of mental simulation for learning life-support skills

This study is constrained by generalisability. This is not to say that the position and design of this study are incorrect. However, as described during my epistemological grapple, healthcare is heavily influenced by positivistic scientific research. If life-support mental simulation is to gain accepted traction within healthcare education, one must recognise that quantitative generalisable research is perhaps necessary for the future. It is not within the study design to produce generalisable results, nor would it fit with the study's ontology or epistemology.

As described in section 4.7.1, Fountouki et al. (2021) showed that mental simulation positively impacted the number of technical CPR mistakes. As described, however, there were some significant methodological limitations identified. The main issue identified is one of replicability. Therefore, objective, reproducible research building on Fountouki et al.'s research is perhaps necessary. It would be important to design the research into a double-blind, randomised control trial. I would use the mental simulation script designed as part of this study for the intervention group, with a control group with a non-related task. The non-related task control design would be used because, currently, students do not get any other life-support training outside of their mandatory training. Therefore, it is important to test it against what they 'normally would get,' which is no extra training. This could include objective electronic manikin testing of the participants by asking them to perform life-support skills in simulation and digitally measure compression accuracy.

Furthermore, whilst the participants in this study suggested that self-efficacy was an end product of mental simulation, this could also be tested empirically using an experimental pre- and post-intervention design where life-support self-efficacy was tested before and after a 4-week period of mental simulation.

15.7.2 Research into the effects of different aspects of the protocol

Research using external objects to create realistic kinaesthetic (haptic) images would be beneficial (creating 'false memories'). Lack of kinaesthetic images did not affect the participant experience in terms of self-efficacy. However, increasing kinaesthetic imagery could add value to students' experience, increasing the likelihood of measurable, observable changes in behaviour (Zabicki et al., 2019). Furthermore, specific research on sound effects and other protocol elements could be researched. This could be designed as qualitative research where participants are interviewed using semi-structured interviews to gain insight and understand how and why each element helped create an authentic learning opportunity.

Quantitative measures could also be used to assess which aspects of the protocol helped create the greatest changes in high-fidelity images. This would require several arms to the trial that each studied different parts of the protocol, for example, sound effects or first-person film. Pre- and post-test completion of the Movement Imagery Questionnaire-Revised second version [MIQ-RS] (Gregg, Hall, & Butler, 2010), could be used to measure the effects and changes to fidelity in the participants' images. According to Gregg et al. (2010, p. 250):

> *The MIQ is comprised of nine visual imagery and nine kinesthetic imagery items, each of which involves the movement of an arm, leg or the entire body. In order to complete each item, four steps are required. The starting position for each movement is described, and the participant assumes this position. The movement is then described, and the participant physically performs the movement. Next, the participant retakes the starting position and images the movement without physically performing the movement. Finally, the participant rates the ease or difficulty of imaging the movement on a 7-point scale anchored by 1=very easy to picture/feel and 7=very difficult to picture/feel.*

The MIQ was initially developed for and utilised in motor skill mental simulation research and is a valid and reliable method for measuring the fidelity of images in quantitative research.

There were several limitations identified during this study. In the following section, these limitations are discussed.

15.8 Limitations

Several limitations were identified and are now presented in this section. Firstly, I attempted to take field notes during the interviews. Using field notes was an attempt to document my initial reflections of what was being said during the interviews (Bryman, 2004). However, during the interviews, I found two main issues. 1) the notes were not adding anything to the process. They merely described what was already said and recorded; 2) I was often more focused on taking notes than on the conversation, which began to impact on listening and the two-way conversation process required for semi-structured interviews (Brinkman & Kvale, 2015). I attempted to be more analytical in later interviews but found taking field notes distracted the conversation once again. I did not want the interview data quality to be affected, so I continued with descriptive field notes. These notes were considered during the analysis phase. However, they were extremely limited in value due to their descriptive nature.

A second limitation was that whilst the participants claimed they felt more self-efficacious in their skills, there is limited evidence from this study and the thesis that this self-efficacy would transfer to practice. It is crucial to highlight that this is not a flaw of the research design. The research design was correct for this research and the research questions. However, it does limit the scope of claims made within the thesis.

A third limitation of this study was the attrition rate. Five (5) out of sixteen (16) original participants dropped out mid-protocol. It would have been highly insightful to interview these participants about why they had dropped out of the study. I assessed the situation and discussed it with my supervisory team. The consensus was that it would not be ethical to gather this data as all participants cited 'personal reasons', bar one participant who stopped engaging. One can only hypothesise the reasons, partly based on the study's findings. For example, perhaps some participants were not encouraged enough by the life-support subject to turn motivation into volition. Or perhaps they could not find the correct sanctuary and quiet space. Perhaps they were ego depleted due to course, life or family demands. It could be that life situations changed, and life focuses were reprioritised, meaning that mental simulation could no longer fit in with a schedule.

However, the attrition did not overtly affect the findings of this study. Perhaps I would have had more data about the difficulties of undertaking mental simulation if I had interviewed them. However, I still used the methods summaries in section 8.7 on the endpoint of data collection. Therefore, this study adhered to a rigorous data collection process even though attrition was high. It does perhaps give insight into the uptake of mental simulation as an educational technique, but this remains to be seen. The data and experiences from these participants will be used to 'sell' mental simulation to future users, which could help with future participation and volition.

15.9 Chapter summary

This chapter has outlined a broad overview of the thesis. It outlines the study's theoretical links and claims to knowledge in terms of the gaps in the literature and the unique perspective generated by this qualitative design. I have detailed where this study has made an original contribution to nursing education and the simulation community. Practice recommendations have been generated by this research project and articulated above. The short-term goal of mental simulation of life-support training has already been locally adopted, and I will have a significant role in incorporating this into the curriculum. Future research directions and study limitations have also been articulated in this chapter. Further dissemination of the study findings and conclusions are now warranted. The findings and conclusions should now be shared with the broader nursing education and simulation community through peer-review journal articles and conference presentations.

Chapter 16 References

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Chapter 17 Appendix

17.1 Appendix 1: Permissions to reproduce

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This form covers the use of printed and on-line materials.

Name	Nick White
Organisation	Sheffield Hallam University
Address *Please include* **Post code**	25 Brook Road Sheffield S8 9FH. (Home address)
Email	n.white@shu.asc.uk
List of material to be reproduced	BLS algorithm/ advanced life-support algorithm
Purpose of reproduction	I would like to reproduce them in my doctoral thesis only. They will go either in the m body or the appendix. I am writing a thesis that explores student nurse perspectives of using mental simulation for learning CPR in an ALS scenario and it would be good to the algorithms as supporting evidence to help my examiners, who may not have a med background- many thanks for the consideration, Nick

I apply for permission from the Resuscitation Council (UK) to reproduce the material listed above. As the signatory I am authorised to agree on behalf of all parties concerned with the publication to the following conditions:

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6. 6. Some materials, notably resuscitation guidelines, are based on International Liaison Committee on Resuscitation (ILCOR) recommendations and are subject to review every five years. As such, these materials will have a finite life span. The Resuscitation Council (UK) takes no responsibility for any consequences arising from the use of obsolete material contained in any publication for which consent for publication has been granted.
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This form covers the use of printed and on-line materials.

Name	Nick White
Organisation	Sheffield Hallam University
Address *Please include* **Post code**	25 Brook Road Sheffield S8 9FH. (Home address)
Email	n.white@shu.asc.uk
List of material to be reproduced	Chain of survival image
Purpose of reproduction	I would like to reproduce this image in my doctoral thesis only. They will go either in the main body or the appendix. I am writing a thesis that explores student nurse perspectives of using mental simulation for learning CPR in an ALS scenario and it would be good to use the algorithms as supporting evidence to help my examiners, who may not have a medical background- many thanks for the consideration, Nick

I apply for permission from the Resuscitation Council (UK) to reproduce the material listed above. As the signatory I am authorised to agree on behalf of all parties concerned with the publication to the following conditions:

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Nick White

Nov 17, 2016

Dear Professor

I hope this message finds you well. I am currently undertaking a taught doctorate in the U.K., and as part of the doctorate I'm looking at skill acquisition and skill retention. I have thoroughly enjoyed your paper: 'An integrated theory for improved skill acquisition and retention in the three stages of learning'. I'm currently writing my literature review and I wondered if might recieve your permission to include (fully referenced of course) your 'theory of skill retention' model/ figure that is included In the paper. This is towards a taught module, so it's not for my final thesis- just for a pass/ fail module

I do hope this is ok, I look forward to receiving your answer. Thank you in advance

Nick

IMG_1645.PNG

- 

Jong W Kimto you

Nov 21, 2016

Please feel free to include the figure with appropriate citation. The skill retention theory is more fully explained with data in the paper: Kim, J. W., & Ritter, F. E. (2015). Learning, forgetting, and relearning for keystroke- and mouse-driven tasks: Relearning is important. Human-Computer Interaction, 30(1), 1-33.

Thank you.
Jong Kim

- 

Nick White

Nov 29, 2016

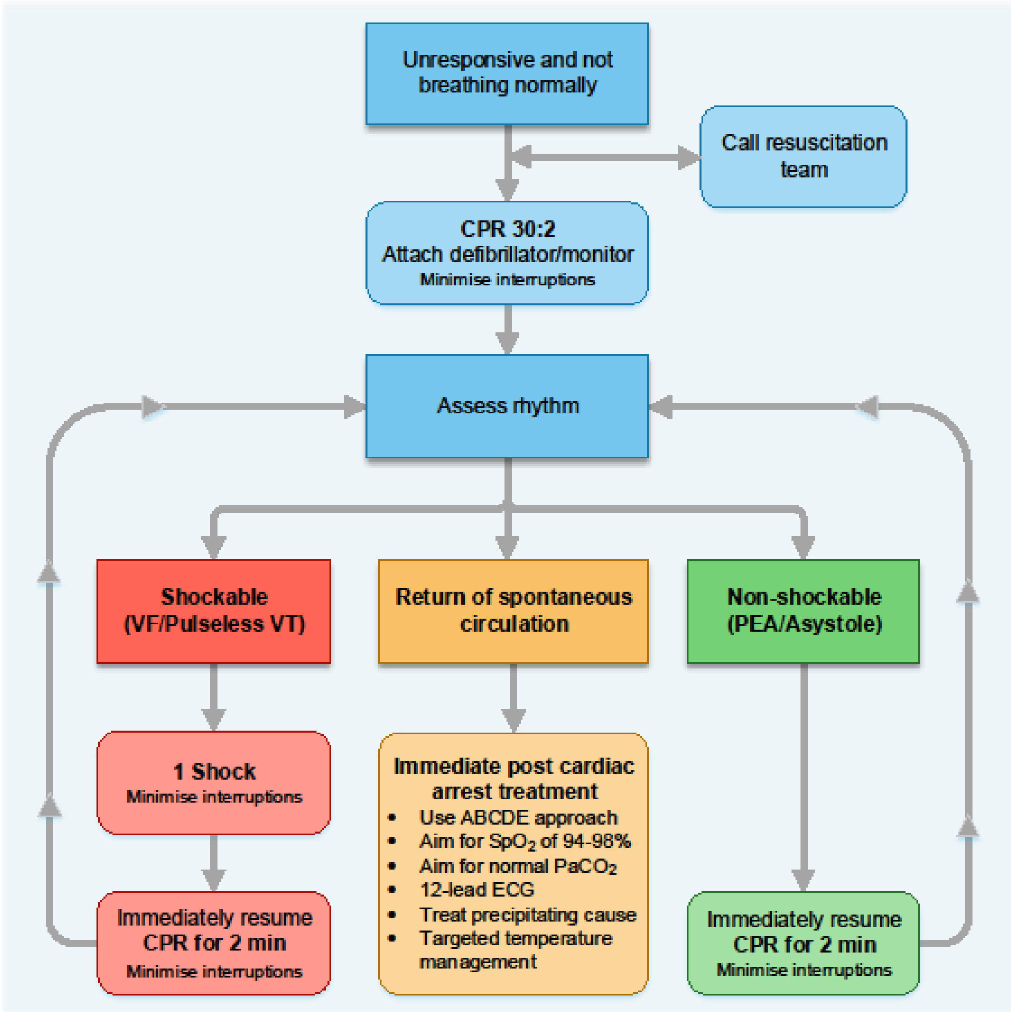
Many thanks, i will be sure to cite it correctly and take a look at the above paper. Many thanks for getting back to me, its much appreciated

Nick White

17.2 Appendix 2: Advanced and Basic Life-Support Algorithms

Resuscitation Council (UK) GUIDELINES 2015

Adult Advanced Life Support



During CPR
- Ensure high quality chest compressions
- Minimise interruptions to compressions
- Give oxygen
- Use waveform capnography
- Continuous compressions when advanced airway in place
- Vascular access (intravenous or intraosseous)
- Give adrenaline every 3-5 min
- Give amiodarone after 3 shocks

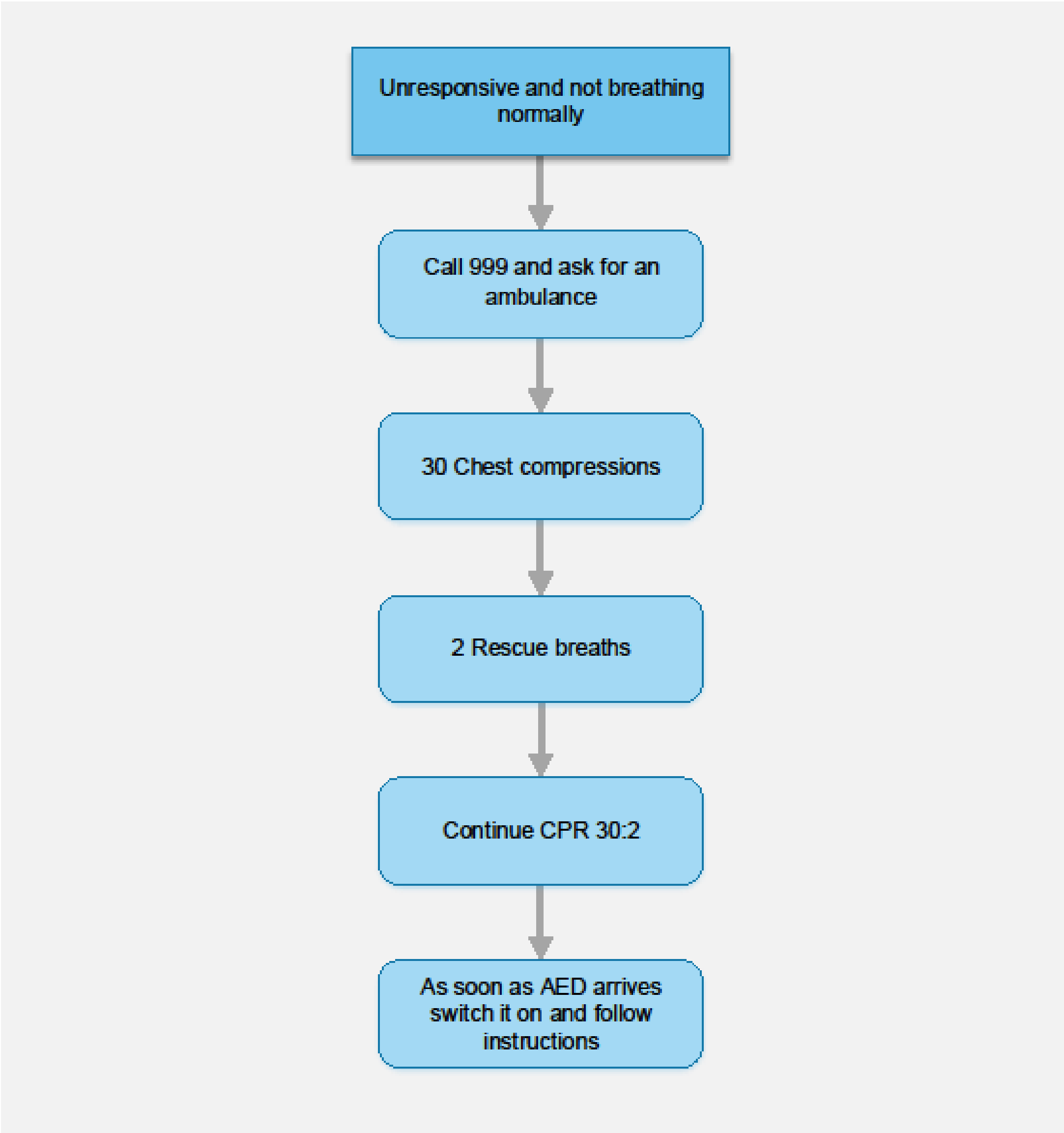
Treat Reversible Causes
- Hypoxia
- Hypovolaemia
- Hypo-/hyperkalaemia/metabolic
- Hypothermia

- Thrombosis - coronary or pulmonary
- Tension pneumothorax
- Tamponade – cardiac
- Toxins

Consider
- Ultrasound imaging
- Mechanical chest compressions to facilitate transfer/treatment
- Coronary angiography and percutaneous coronary intervention
- Extracorporeal CPR

Resuscitation Council (UK) GUIDELINES 2015

Adult Basic Life Support



17.3 Appendix 3: Databases and search information

There six databases identified:

1) *CINAHL* (Cumulative Index to Nursing and Allied Health Literature): The CINAHL Database provides indexing of nursing and allied health peer-reviewed literature, including nursing journals and publications. This database was chosen so that nursing literature could be identified
2) *PubMed*: PubMed is a database that principally accesses the Medline databases on life sciences and biomedical topics. This database was chosen so that both nursing and medical literature could be identified
3) *PsycINFO*: PsycINFO is a database for literature in the field of psychology. This database was chosen as mental simulation has been highly researched in the field of psychology and sports psychology.
4) *SPORTDiscus:* SPORTDiscus is a leading database for sports research. Therefore, this database was chosen so the author could examine mental simulation in the field of sport and sports psychology, which could be applicable to CPR mental simulation.
5) *Google Scholar*: Google Scholar is a web-based search engine. Scholar indexes the full-text scholarly literature across an assortment of publishing formats. It is easy to use. This database was used to search for papers from sport, nursing and medical disciplines and showed up some papers that the above databases did not yield. This database was also used for the basic searches as when one is signed into GoogleScholar through one's institution, as it allows access to papers directly.

Search terms

PICO healthcare and Mental Simulation Search Terms

Patient/Population and/or Problem	**Intervention**	**Comparison/Control** ***(if applicable)***	**Outcomes (or effects)**
1	**2**	**3**	**4**
nurs*	"Mental simulation*"		"skills acquisition"
Alternative Words			
"Student nurs*"	Visualisation		Expertise
Doctor*	"Mental rehearsal"		"Skill decay"
Healthcare	"Mental simulation*"		"Mastery learning"
Medic*	"Mental practice"		"Procedural knowledge"
Physician*	Imagery		"Skill retention"
Surge*	Imagination		Learning
Practitioner	"cognitive simulation"		skill
Anaesthe*	"guided imagery"		"Skill development"
			"Skill training"

Limits - peer-reviewed, full text, English texts

PICO Sports and Mental Simulation Search Terms (systematic review and meta-analysis only)

Population and/or Problem	**Intervention**	**Comparison/Control** ***(if applicable)***	**Outcomes (or effects)**
1	**2**	**3**	**4**
Sport*	"Mental simulation*"		"skills acquisition"
Alternative Words			
Music*	Visualisation		Expertise
Athletic*	"Mental rehearsal"		"Skill decay"
"Sports performance"	"Mental simulation*"		"Mastery learning"
Football/ soccer	"Mental practice"		"Procedural knowledge"
"Athletic performance"	Imagery		"Skill retention"
	Imagination		Learning
	"cognitive simulation"		"Skill development"
	"guided imagery"		"Skill training"
			Skill*

Limits – peer review, full texts, English,

Inclusion and exclusion criteria

Inclusion and Exclusion Criteria for Search

Inclusion	**Exclusion**
Full text	Non-peer review
International papers (in English)	Papers other than performance and skill learning
Peer reviewed	Non-English text
Limit dates to 5-years to keep up to date research in sport [I did include older seminal papers that appeared in reference lists and	Mental simulation (non-skill learning, e.g., neurorehabilitation)

papers captured during the literature review module of the EdD. These were not used cited in the numbers below but were used to build a discussion, for example, Driskell et al., 1994]	
Papers up to 30-years old in nursing and healthcare due to a lack of research in this specific field	Papers older than 30-years old in nursing and healthcare due to a lack of research in this specific field
Papers up to 10-years old in medicine (mainly) surgery	Papers older than 10-years old in medicine (mainly) surgery
Systematic reviews up to 5-years old in nursing, medicine and sports	Systematic reviews older 5-years in old in nursing, medicine and sports
English text only	Non-English texts
Qualitative/ qualitative and mixed methods studies	
Mental simulation for skill learning	
PETTLEP studies	
Studies that examined mental simulation performance indirectly, such as increasing self-efficacy and decreasing stress, for example	

Database log

✓ = search term entered into the databases

- Nursing studies have been searched over the last 30 years due to the sparsity of publications
- Medical studies were narrowed to the last 10-years to access the most up to date publications
- Sports reviews and meta-analysis were narrowed to the last 5-years to access the most up to date publications- Five years was chosen as it is a well-researched area, and the evidence is updated quickly.
- Medical reviews were narrowed to the last 5-years to access the most up to date publications. Five years was chosen as there have several high-profile reviews untaken in this time

*Titles were first looked at, and then abstracts and a judgement was made based on inc. and exc. criteria

#	**Keyword/s or Search Term/s**	**PubMed**	**CINAHL**
1	nurs*	✓	✓
2	"Student nurs*"	✓	✓
3	Doctor*	✓	✓
4	Healthcare	✓	✓
5	Medic*	✓	✓

6	Physician*	✓	✓	
7	Surge*	✓	✓	
8	Practitioner*	✓	✓	
9	Anaesthe*	✓	✓	
10	#1 or #2 or #3 or #4 or #5 or #6 or #7 or #8 or #9 or #10	903,660	541,526	
11	"Mental simulation*"	✓	✓	
12	Visuali*ation	✓	✓	
13	"Mental rehearsal"	✓	✓	
15	"Mental practice"	✓	✓	
16	Imagery	✓	✓	
17	Imagination	✓	✓	
18	"cognitive simulation"	✓	✓	
19	"guided imagery"	✓	✓	
20	#11 or #12 or #13 or #14 or #15 or #16 or #17 or #18 or #19	695,006	7,700	
21	Expertise	✓	✓	
22	"Skill decay"	✓	✓	
23	"Mastery learning"	✓	✓	
24	"Procedural knowledge"	✓	✓	
25	"Skill retention"	✓	✓	
26	"skill learning"	✓	✓	
27	"Skill development"	✓	✓	
28	"Skill training"	✓	✓	
29	Knowledge	✓	✓	
30	Training	✓	✓	
31	#21 or #22 or #23 or #24 or #25 or #26 or #27 or #28 or #29 or #30	2,315,892	115,416	
		PubMed	**CINAHL**	
		Total	**Total**	**Total**
	#10 and #20 and #31	435	43	478
	After applying inc. and exc. criteria	24	27	51
	After duplicates removed	11	21	32 (10 nursing + 17 medical + 3 medical systematic reviews)
Sports, music and other **(systematic reviews/ meta-analysis only)**				
		SPORT-Discus	**Psych-INFO**	
1	Music*	✓	✓	
2	Athletic*	✓	✓	
3	"Sports performance"	✓	✓	
4	Football/ soccer	✓	✓	
5	"Athletic performance"	✓	✓	

6	#1 or #2 or #3 or #4 or #5	✓	✓	
7	“Mental simulation*”	62,572	15,476	
8	Visuali*ation	✓	✓	
9	“Mental rehearsal”	✓	✓	
11	“Mental practice”	✓	✓	
12	Imagery	✓	✓	
13	Imagination	✓	✓	
14	“cognitive simulation”	✓	✓	
15	“guided imagery”	✓	✓	
16	#7 or #8 or #8 or #9 or #10 or #11 or #12 or #13 or #14 or #15	✓	✓	
17	Expertise	2,421	11,524	
18	“Skill decay”	✓	✓	
19	“Mastery learning”	✓	✓	
20	“Procedural knowledge”	✓	✓	
21	“Skill retention”	✓	✓	
22	Learning	✓	✓	
23	skill	✓	✓	
24	“Skill development”	✓	✓	
25	“Skill training”	✓	✓	
26	knowledge	✓	✓	
27	training	✓	✓	
28	#17 or #18 or #19 or #20 or #21 or #22 or #23 or #24 or #25 or #26	✓	✓	
		SPORT-Discus	**Psych-INFO**	
29	#6 and #16 and #28	**Total**	**Total**	**Total**
		14	19	33
	After applying inc. and exc. criteria	1	2	3
	After duplicates removed	1	2	3

The final number of papers after inc. and exc. criteria applied:

Nursing	11
Medicine	17
Sports, music and others (SR and meta-analysis)	3
Medical/ surgery systematic reviews	3

17.4 Appendix 4: Study overview and consent form

Study overview

Visualisation of CPR Skills Research

Project Title***: Developing and evaluating a visualisation script to aid the learning of cardio-pulmonary resuscitation skills***

Legal basis for research for studies. The University undertakes research as part of its function for the community under its legal status. Data protection allows us to use personal data for research with appropriate safeguards in place under the legal basis of public tasks that are in the public interest. A full statement of your rights can be found at https://tinyurl.com/ycz9pdtp. However, all University research is reviewed to ensure that participants are treated appropriately, and their rights respected. This study was approved by UREC with Converis number (ER6761857). Further information can be accessed at https://www.shu.ac.uk/research/ethics-integrity-and-practice

Please will you take part in my doctoral research project. This project is researching the use of visualisation techniques to aid in the learning of Cardio-pulmonary Resuscitation (CPR) skills. The use of visualisation is a technique to supplement physical practice could potentially assist learning, both in the initial attainment and the continued long-term retaining of (CPR) skills. Visualisation is the rehearsal of a task in the mind's eye but using no physical movement.

Before you decide whether you wish to take part as a participant, please take time to read this sheet carefully, so that you understand what the project is about and please ask for clarification if necessary. Please take time to decide whether you are willing to be involved.

Research Project
I have asked you to take part in this research project because you fit my demographics. I am looking for 2nd or 3rd year student nurses who have been carried out hands on CPR in one or more cardiac arrest.

What will I be required to do and why?
This research project is split into two parts. You will only be involved in one part of the study

**The first part is a semi-structed interview where I will ask you questions about your involvement in undertaking CPR in practice. I want to develop an understanding of your experiences of the internal and external factors that might have affected your performance. The data from the interviews in this part of study will be used in two ways. The first is that the data will help to construct a visualisation script that can be used by others to learn CPR skills and will form part of my doctoral thesis. The second use for the data is to explore ways in which performance in CPR skills might be affected by certain internal and external factors. Your data may help me to find out what these certain factors are. This will be published in peer reviewed journals at a later date. You will only be interviewed once, and the interview will last about 1 hour. No deception is required to undertake this part of the study. You will be debriefed at the end of the interview

The interviews will take place on campus and will be audio-recorded

**The second part of the study is an evaluation of the visualisation script. Participants will be asked to use the newly constructed student visualisation script for 10 minutes, 3 times per week, for 4 weeks. You will then be invited to physically practice CPR in simulation. Soon after I will conduct a semi-structed interview examining your experiences of using the said script. You may be asked some questions on your opinion about the feasibility of using visualisation for learning CPR skills-. You will only be interviewed once, and the interview will last about 1- 1.30 hours. No deception is required to undertake this part of the study. You will be debriefed at the end of the interview

**delete as appropriate

Do I have to participate?

No. All participation in this study is voluntary. If you decide to participate you will be given this information sheet and asked to sign a consent form. If you choose not to participate or later decide to withdraw, you can do so without prejudice. However, the data collected from your participation, will be analysed soon after the end of your research input as it will feed into the next research session. Therefore, you have 72-hours to withdraw your data, before it is used and can longer be reasonably withdrawn from the study. Any decision about not to participate will not be recorded in any way that may affect your relationship with myself or the university.

Are there any potential risks and disadvantages involved in participation?

There is the potential for a negative emotional risk that might be linked to thinking about and discussion about CPR situations, especially if you have been involved in a particularly traumatic cardiac arrest or the patient died. You can request a stop to the participation of the research at any point and if you so wish, we will have a chance to debrief if you feel that you require it. If you have been involved in a traumatic cardiac arrest and you feel emotional about the subject, it is worth considering whether you are happy to be involved in the research project.

What will the potential benefits

The potential benefits to this research are not fully known. The results of this study could potentially that student nurses are better equipped with the skills to deliver high-quality CPR when called upon to do so. This in turn could save the lives of the patients that student nurses look after in the clinical environment

Will my participation be kept confidential?

All data will be stored and secured on an encrypted data drive that the university provides. This is a secure data drive. You will be given a number that links you to the research, but there are no identifying features on the material- it will be carried out in confidence. Your voice-recording will be transcribed, so that there is no identification with it. I am fully responsible for the data that is produced from this study and only I will have to access to the data that can identify it as coming from you. Your anonymised data may be used in the following ways:

- TEDEd online
- Conference(s)
- Potential peer review publication(s)
- Book chapter(s)
- Doctoral thesis

The study will last up to approximately two years. This includes, data collection through interviews, transcribing, data analysis and writing up my EdD thesis. You can read about this study by contacting me for your transcript or for a copy of the final thesis in electronic format.

This pilot study complies with the Freedom of Information Act (2000) and the Data Protection Act (1998).

Thank you for taking the time to read this information sheet. If you would like to take part or discuss this research in more detail, then please get in touch with Nick White at the following contacts

If you have any concerns about this study or your participation, please contact

either myself or my director of supervision

Contact details

Researcher: Nick White
Tel: 0114 2252346
Email: n.white@shu.ac.uk

Director of Supervision:
James Rumbold PhD
(hwbjr1@exchange.shu.ac.uk)

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

17.5 Appendix 5: Consent form

Agreement to participate

Project Title***: Developing and evaluating a visualisation script to aid the learning of cardio-pulmonary resuscitation skills***

I volunteer to participate in a research project conducted by Nick White. I understand that this research project is designed to gather data for the doctoral work of a faculty member on campus.

1. My participation in this project is completely voluntary. I understand that I will not be paid for my participation. I may withdraw and discontinue my participation. Once data has been collected it will be immediately analysed as it will inform further research sessions. This means that after 72-hours after the research session, I will not have the right to withdraw my data from the study and the data will be used as part of the research. If I decline to participate or withdraw from the study, no one will be told, nor information held.

2. Some participants *may* find the research interesting and thought-provoking. If, however, I feel uncomfortable in any way during the research session, I have the right to decline to answer any question or to end the session at any time I deem necessary.

3. Participation involves undertaking and being interviewed by a researcher from SHU. The interview will last approximately 60 minutes. Notes will be written during the interview. An audio-recording of the interview of the dialogue will be made. If I do not want to be audio-recorded, I will not be able to participate in the study and I need to withdraw.

4. I understand that the researcher will not identify me by name in any reports using information obtained from this interview, and that my confidentiality as a participant in this study will remain secure. Subsequent uses of records and data will be subject to standard data use policies which protect the anonymity of individuals and institutions.
   Chapter 1:

5. In interview set 1, the data from this interview will be used to create a visualisation script and will as well as helping to create a visualisation script, the data from interview set 1 will also be used to examine student nurse self-perceived performance of undertaking CPR. Examination of the data from this perspective might go some way to helping to explain some of the reasons why performance of CPR skills vary. This will not be written up in this format as part of my doctoral studies but will be written up as part of post-doctoral studies and will be submitted for publication. As this is not part of my main doctoral study, nor is the data

being used for its original purpose, i must declare this now and seek full and informed consent before the study begins, so that i can use the data for both purposes. *

Chapter 2:

In interview set 2, the data from this study will be used as part of the evaluation of the use of the new designed visualisation script and will be written up as part of my thesis (as well as other publications) *

*delete as necessary

6. Faculty and administrators from my campus will neither be present at the interview nor have access to raw notes or transcripts. This precaution will prevent my individual comments from having any negative repercussions.

7. I understand that this research study has been reviewed and approved by the SHU ethics committee. For research problems or questions regarding anything about the study, the Institutional Review Board may be contacted independently.

8. I have read and understood the explanation provided to me. I have had all my questions answered to my satisfaction, and I voluntarily agree to participate in this study.

9. I have been given a copy of this consent form.

I agree to take part in this this pilot study:

Participant Signature (below):

Print Name: **Date:**

Researcher Signature (below):

Print Name: N A White **Date:**

17.6 Appendix 6: Interview questions iterations

Iteration 1

Participant name:

Date of interview:

Location:

Questions	Notes
Experiences of using the imagery audio-script (some of the discussion will need to be around the script, but some will need to be around imagery in general) Discuss language that you will use to distinguish between imagery and kinaesthetic (define these terms from the participants) Imagery/ imagine/ visualise= what you could see Kinaesthetic= what you could feel Vividness= how well you see/ feel the scenario Imagery ability/ imagery vividness **<u>Visualisation/ Imagery</u>** 1. Can you tell me about your previous experiences of undertaking CPR previous to starting this study?	

<table>
<tr>
<td>
a. How did listening to the script and emotions/ images conjured up compare to your real-life experience

2. Which was more ‘naturally’ vivid for you? Imagery or kinaesthetics or both equally
a. Why do you think this is?
b. Is this due to past experiences do you think?

3. To what extent have you used mental imagery previously to this study?
a. What was your understanding of imagery?
b. Did you use a script?
c. Informally?
d. Do feel that you use imagery in your day-to-day learning

4. To what extent could you imagine from a first-person perspective?
a. Why?

5. To what extent were you able to vividly feel (kinesthesis) from a first-person perspective?
a. Why?

6. Can you tell me about your body position did take when you did your imagery learning?
a. Sitting/ standing
b. Which was your better position?
</td>
<td></td>
</tr>
</table>

c. Why do you think was? 7. Was easier to use the script when you closed your eyes or keep the open? a. Why was this? Why did this make it better? 8. Did practice/ repetition affect the vividness of you experiences as you went through the 4-weeks? (use the MIQ-RS to generate discussion here) a. Visualisation? b. Kinaesthetics? c. Why do you think this was so? 9. To what extent do you feel that using a visualisation script package like this is something you could use in future? a. Were there any factors prevented you from practicing imagery? b. Why was this? 10. Do you feel like 10-15 minutes 3x per week was enough for you to learn the skill? a. Why is this? b. Do you think this level of use is sustainable? c. Would using it for even more time be possible in your busy university schedule? d. How often would you be able to use the imagery package? e. Were you able to fit into to your work/ life balance?	

11. Based on your personal experience if you could adapt how you used imagery in future, how might you adapt it? 12. What time of day best suited you for using imagery? a. Why is this? 13. To what extent do you think that imagery is a valid way of learning skills in nursing? **<u>The POV film</u>** I set this part of the study up so you could watch the POV film multiple times: Tell me about your experiences of using the POV film in this study? 14. How many times did you need to watch the POV film? a. Why this much? 15. How did the POV film to affect your ability to visualise in the first-person? 16. Is there anything in particular about the POV film in particular that influenced your: a. Imagery vividness? b. Kinaesthetic vividness? i. Why is this?	

17. To what extent did the POV film evoke other thoughts and feelings and what might these have been?
 	
<u>Instructions</u>
 	
18. To what extent did the instructions affect your ability to understand the task of undertaking imagery?
    a. Why was this?
 	
19. To what extent did the screencast affect your ability to understand the task of imagery?
    a. Was it easy or hard to follow?
    b. Why was this?
 	
20. Is there anything that could have been added or removed from the instructions that may have affected your ability to understanding the task of imagery?
    a. Why is this?
 	
<u>The basic script</u>
 	
In this section, I'm wanting to know about your experience of using the basic script. I want to know both how the script affected your ability to feel what was happening in the scenario and your ability to see what was happening in the scenario	

21. Overall, how was using the basic script for you?
  a. Was it easy to follow and understand?
 	
22. How did having a basic level script affect your learning of the basics of undertaking CPR?
  a. Why is this do you think?
  b. Can you give me an example of where using the script was helpful for learning the basics of CPR?
  c. Did affect your ability to visualise in the advanced script, having done the basic script before?
 	
23. How was the pace and tempo of basic audio scripts?
  a. Was it too fast or too slow?
    i. Why is this do you think?
  b. As you listened to the script did it feel as though portray a sense of urgency (did it feel like a cardiac arrest)?
    i. Why? Was this important do you think? Did it need to be a fast tempo?
 	
24. To what extent did the tempo of the script affect your ability to follow and therefore visualise/ feel the scenario in the basic script?
  a. Why was this?
  b. To what extent did it get easier when you used the script numerous times?
 	
25. To what extent do you feel that it got easier to visualise from the basic script, the more you used it?
  a. Why is this do you think?	

26. To what extent did the script assist you in 'feeling' what it might be like to undertake CPR? a. How did it help? b. Why do you think it didn't help? **Advanced Script** Again, in this section, I'm wanting to know your experience of using the basic script. I want to know both how the script affected your ability to feel what was happening in the scenario and your ability to see what was happening in the scenario 27. How was using the advanced-script overall? a. Was it easy to follow and understand? 28. To what extent do you feel that using the advanced script affected your ability to learning the use of CPR in cardiac arrest setting? a. In what way did it help/ hinder? 29. To what extent did it get easier to visualise from the advanced script, the more you used it? a. Why is this do you think? 30. How was the pace and tempo of the advanced audio scripts?	

a. Was it too fast or too slow? i. Why is this do you think? b. As you listened to the script did it feel as though portray a sense of urgency (did it feel like a cardiac arrest)? i. Why? Was this important do you think? Did it need to be a fast tempo? 31. To what extent did the 'human emotion' parts help you to feel the scenario? a. E.g. your body feels with adrenaline/ your blood pressure goes up b. How did it affect your imagery vividness? 32. In what ways did the scripts affect: a. The way 'feel' in your mind's eye? i. E.g. the patient's chests feel cool to touch 33. To what extent does the advanced script prepare you for clinical practice when compared to simulation? a. Why is this do you think? 34. To what extent did the sound effects assist your imagery ability in the advanced scenario? a. Why is this? 35. Was there any part of script that affected imagery vividness more than the other? a. Ask about kinaesthetics and imagery	

b. Was there any part of the script where you vividly see/ feel? c. Was there any part of the script where you could not vividly see/ feel? i. Why is this do you think? 36. How did the sound effects embedded into **<u>both of the audio scripts</u>** affect the vividness of your imagery? a. Did they help or hinder? b. Why? 37. Overall, do you think there is a place for the advanced script in your learning or would the basic script have been adequate? a. Why is this? 38. If you were to adapt the audio script based on your personal experience, how would you adapt it? **<u>Confidence and learning</u>** **Consider how you felt when you just did CPR on the manikin:** 39. To what extent do you feel that using the imagery package has affected your confidence in doing CPR in practice? a. What was it about the package that made you feel more/ less confident?	

40. How much more imagery do you feel that you would need to undertake for your skills to become more automated? a. Why is that? 41. To what extent do you feel that the process of imagery might have produced a stronger learning opportunity if there was occasion for physical practice combined intermittently? a. Why is this? **<u>Glossary/ algorithms</u>** 42. To what extent did you use the glossary of terms at all? a. Did help? Why was this? 43. Was the language used in the audio script affect the vividness of your experiences 44. To what extent did you use resuscitation algorithms? a. How many times? b. How did it affect your thinking/ understanding/ learning? 45. Is there anything else that could have been added to the scripts (package) that would have affected your learning experience overall?	

46. What recommendations would you give to future users of both the basic and advanced scripts, to help the confidently learning the key principles of CPR? a. Is there anything you would tell them to avoid or to spend more time on? b. Or recommendations for when they should use them and for how long?	

Iteration 7 (highlighted segments denote changes/ iterations from version 1)

Participant name:

Date of interview:

Location:

Questions	Notes
Experiences of using the imagery audio-script (some of the discussion will need to be around the script, but some will need to be around imagery in general) Discuss language that you will use to distinguish between imagery and kinaesthetic (define these terms from the participants) Imagery/ imagine/ visualise= what you could see Kinaesthetic= what you could feel Vividness= how well you see/ feel the scenario Imagery ability/ imagery vividness **<u>Visualisation/ Imagery</u>** 1. Can you tell me about your previous experiences of undertaking CPR previous to starting this study? a. How did listening to the script and emotions/ images conjured up compare to your real-life experience	

2. Now that you've used imagery for 4 weeks, what does imagery mean to you? 3. Which was more 'naturally' vivid for you? Imagery or kinaesthetics or both equally a. Why do you think this is? b. Is this due to past experiences do you think? 4. To what extent have you used mental imagery previously to this study? a. What was your understanding of imagery? b. Did you use a script? c. Informally? d. Do feel that you use imagery in your day to day learning 5. To what extent could you vividly imagine from a first-person perspective? a. Why? 6. To what extent were you able to vividly <u>feel</u> (kinesthesis) from a first-person perspective? a. Why? 7. Can you tell me about your body position did take when you did your imagery learning? a. Sitting/ standing b. Which was your better position? c. Why do you think was?	

8. Was easier to use the script when you closed your eyes or keep the open? a. Why was this? Why did this make it better? b. Blackened room/ lights off c. Headphones/ without headphones d. How did this help your imagery overall? 9. Did practice/ repetition affect the vividness of you experiences as you went through the 4-weeks? (use the MIQ-RS to generate discussion here) a. Visualisation? b. Kinaesthetics? c. Why do you think this was so? 10. To what extent do you feel that using a visualisation script package like this is something you could use in future? a. Were there any factors prevented you from practicing imagery? b. Why was this? 11. Do you feel like 10-15 minutes 3x per week was enough for you to learn the skill? a. Why is this? b. Do you think this level of use is sustainable? c. Would using it for even more time be possible in your busy university schedule? d. How often would you be able to use the imagery package?	

e. Were you able to fit into to your work/ life balance? 12. To what extent did you manage to get in all of the sessions over the 4 weeks? 13. How did you spread the days out across the week? a. Did it make a difference to how you focused? 14. Based on your personal experience if you could adapt how you used imagery in future, how might you adapt it? 15. What time of day best suited you for using imagery? a. Why is this? 16. To what extent do you think that imagery is a valid way of learning skills in nursing? 17. Simulated practice: how do you feel about simulation sessions at university a. Clinical skills (catheterisation) b. Full environment like SMART/ CALS/ role play **The POV film** I set this part of the study up so you could watch the POV film multiple times: Tell me about your experiences of using the POV film in this study?	

18. How many times did you need to watch the POV film?
    a. Why this much?
 	
19. How did the POV film to affect your ability to visualise in the first-person?
 	
20. Is there anything in particular about the POV film in particular that influenced your:
    a. Imagery vividness?
    b. Kinaesthetic vividness?
        i. Why is this?
 	
21. To what extent did the POV film evoke other thoughts and feelings and what might these have been?
 	
22. Even when you didn't 'use the video', did you visualise the POV video at all, to help you further down the line?
 	
<u>The basic script</u>
 	
In this section, I'm wanting to know about your experience of using the basic script. I want to know both how the script affected your ability to feel what was happening in the scenario and your ability to see what was happening in the scenario
 	
23. Overall, how was using the basic script for you?
    a. Was it easy to follow and understand?	

24. To what extent did you add in your memories to the imagery to 'fill in the blanks'?
    a. Where did you visualise you were undertaking this part of the scenario?
 	
25. How did having a basic level script affect your learning of the basics of undertaking CPR?
    a. Why is this do you think?
    b. Can you give me an example of where using the script was helpful for learning the basics of CPR?
    c. Did affect your ability to visualise in the advanced script, having done the basic script before?
 	
26. How was the pace and tempo of basic audio scripts?
    a. Was it too fast or too slow?
        i. Why is this do you think?
    b. As you listened to the script did it feel as though portray a sense of urgency (did it feel like a cardiac arrest)?
        i. Why? Was this important do you think? Did it need to be a fast tempo?
 	
27. To what extent did the tempo of the script affect your ability to follow and therefore visualise/ feel the scenario in the basic script?
    a. Why was this?
    b. To what extent did it get easier when you used the script numerous times?	

28. To what extent do you feel that it got easier to visualise from the basic script, the more you used it? a. Why is this do you think? 29. To what extent did the script assist you in 'feeling' what it might be like to undertake CPR? a. How did it help? b. Why do you think it didn't help? 30. Did the basic script evoke any emotions in you as you were listening to it? a. If yes, what sort of emotions- why? b. If no, why do you think this is? 31. To what extent was the basic script required for your learning in this situation? 32. Could you have gone straight to the advanced script? a. What was it about the basic script that helped (if they answer to needing the basic script)? 33. Overall, tell me what you got out of using the basic script **<u>Advanced Script</u>** Again, in this section, I'm wanting to know your experience of using the basic script. I want to know both how the script affected your ability to feel what was happening in the scenario and your ability to see what was happening in the scenario	

34. How was using the advanced-script overall? a. Was it easy to follow and understand? 35. Describe the detail for you to be able to imagine and feel the scenario as it unfolded a. Too much? b. Just enough? c. Too little? 36. What was it about the detail of the script that helped you to visualise/ put you off visualising? 37. To what extent do you feel that using the advanced script affected your ability to learn the use of CPR in cardiac arrest setting? a. In what way did it help/ hinder? 38. To what extent did it get easier to visualise from the advanced script, the more you used it? a. Why is this do you think? 39. How was the pace and tempo of the advanced audio scripts? a. Was it too fast or too slow? i. Why is this do you think? b. As you listened to the script did it feel as though portray a sense of urgency (did it feel like a cardiac arrest)?	

i. Why? Was this important do you think? Did it need to be a fast tempo? 40. To what extent did the 'human emotion' parts help you to feel the scenario? a. E.g. your body feels with adrenaline/ your blood pressure goes up b. How did it affect your imagery vividness? 41. In what ways did the scripts affect: a. The way 'feel' in your mind's eye? i. E.g. the patient's chests feel cool to touch 42. To what extent does the advanced script prepare you for clinical practice when compared to simulation? a. Why is this do you think? 43. To what extent did the sound effects assist your imagery ability in the advanced scenario? a. Why is this? 44. Was there any part of script that affected imagery vividness more than the other? a. Ask about kinaesthetics and imagery b. Was there any part of the script where you vividly see/ feel? c. Was there any part of the script where you could not vividly see/ feel? i. Why is this do you think?	

45. Overall, do you think there is a place for the advanced script in your learning or would the basic script have been adequate? a. Why is this? 46. To what extent did the (basic and then advanced) script feel like it was authentic? a. Did it 'feel' real to you? 47. Did the advanced script evoke any emotions in you as you were listening to it? a. If yes, what sort of emotions- why? b. How was this connected to the patient (if at all)? c. If no, why do you think this is? 48. To what extent did you think about the script when you weren't doing it (ie on your 'days off')? What did you think about? a. Why is that? 49. Overall, tell me what you got out of using the advanced script **<u>Adding the detail/ filling in the blanks</u>** 50. To what extent did you add in your memories to the advanced imagery script to 'fill in the blanks'? a. Where did you visualise, you were undertaking this part of the scenario?	

51. Can you tell me where you feel that created detail from your own imagination, where there wasn't the detail in the script?
    a. Can you tell why you imagined this? Where these images had come from?
 	
<u>Sound effects</u>
 	
52. How did the sound effects embedded into **<u>both of the audio scripts</u>** affect the vividness of your imagery?
    a. Did they help or hinder?
    b. Why?
 	
53. Describe to me the effect that the background sounds of the cardiac arrest had on your visualisation?
 	
54. If you were to adapt the audio script based on your personal experience, how would you adapt ii
 	
<u>Confidence and learning</u>
 	
Consider how you felt when you just did CPR on the manikin:
 	
55. To what extent do you feel that using the imagery package has affected your confidence in doing CPR in practice?
    a. What was it about the package that made you feel more/ less confident?	

56. How much more imagery do you feel that you would need to undertake for your skills to become more automated? a. Why is that? 57. To what extent do you feel that the process of imagery might have produced a stronger learning opportunity if there was occasion for physical practice combined intermittently? a. Why is this? 58. What knowledge and skills as it given you? [added in for last interview] **Glossary/ algorithms** 59. To what extent did you use the glossary of terms at all? a. Did help? Why was this? 60. Was the language used in the audio script affect the vividness of your experiences 61. To what extent did you use resuscitation algorithms? a. How many times? b. How did it affect your thinking/ understanding/ learning? 62. Is there anything else that could have been added to the scripts (package) that would have affected your learning experience overall?	

63. Overall, did you find it interesting to do or did find it tedious? a. Why is this- tell me more about this? 64. What recommendations would you give to future users of both the basic and advanced scripts, to help the confidently learning the key principles of CPR? a. Is there anything you would tell them to avoid or to spend more time on? b. Or recommendations for when they should use them and for how long?	
Changes from topic guide 1, based on initial analysis of previous interviews	

17.7 Appendix 7: Debrief checklist

Pilot Study Participant Debrief Checklist

Project Title*: **Developing and evaluating a visualisation script to aid the learning of cardio-pulmonary resuscitation skills***

Thank you for your participation in this study! Your participation is greatly appreciated.

Purpose of the Study:

I have previously informed you that the purpose of the study is to develop an understanding of your experiences of undertaking CPR in practice and this data will feed into the creation of visualisation script for learning CPR skills* / evaluating the use of using a visualisation script*.

The goal of the overall research is to understand whether the use of visualisation, can enhance learning of cardio-pulmonary resuscitation (CPR) skills. For this a visualisation script must be developed. The pilot study research that you undertook today, will help to create a visualisation script*/ evaluate the use of a visualisation*.

I realise that discussing CPR can evoke an emotional response. Some of the questions asked may have provoked strong reactions. As a researcher, I do not provide mental health services and we will not be following up with you after the study. However, I can refer to you to the university's counselling team, if this is something you require. Please let me know if this is this case.

Student Wellbeing Service
Good psychological wellbeing is fundamental to being comfortable, healthy and happy which in turn is the bedrock of being a successful student. Student Wellbeing Service can help to support your psychological wellbeing in order for you to manage your studies and make the most of university life

In a Student Wellbeing Service appointment, we will discuss your concerns and help you find ways of coping with the immediate situation. Student Wellbeing Service can help you make positive changes with targeted, proactive support to overcome any difficulties you are facing. The emphasis is on being well and staying well, managing emotions, building resilience, and exploring and strengthening your personal resources. You will need to register before booking an appointment.

https://students.shu.ac.uk/shuspacecontent/wellbeing/student-wellbeing-service

You would need to go onto SHUSpace and register with UNIHUB to sign up for counselling

If I can answer any questions directly, I will do so. Please don't hesitate to ask

*delete as appropriate

Confidentiality:

You may decide that you do not want your data used in this research. If you would like your data removed from the study and permanently deleted please contact myself directly, via email (n.white@shu.ac.uk). As the data from your part of the research will inform the next part of the study the data will be analysed almost immediately. Therefore, if you do not want your data to be used in the study, you have 72-hours to inform me. After this period the data will not be removed, due to logistical reasons.

Final Report:

If you would like to read the completed electronic copy of my completed thesis, once finished, please contact me

Useful Contact Information:

If you have any questions or concerns regarding this study, its purpose or procedures, or if you have a research-related problem, please feel free to contact me, ***Nick White,*** *n.white@shu.ac.uk*

If you have other concerns about this study or would like to speak with someone not directly involved in the research study, you may contact my Director of Supervision, James Rumbold PhD (hwbjr1@exchange.shu.ac.uk)

***** Please keep a copy of this form for your future reference. Once again, thank you for your participation in this study! *****

17.8 Appendix 8: Mental simulation scripts

Mental simulation scripts (co-constructed written script)

<u>Basic</u> mental simulation script

You are washing your patient in bed when you notice they look unwell. The patient then rolls their eyes back and slumps forward. You intuitively know this is an emergency straight away. You take the patients shoulders and you shake and shout: "are you OK?!" There is no response from your patient…

You pull the CPR handle on the bed *Insert bed fall noise* and it instant falls flat. You shout, "can I have some help please?!" and you pull the emergency buzzer *insert emergency buzzer* and you open your patient's airway by tilting their head and lifting their chin (head tilt chin lift) into a sniffing a morning air position to check their airway.

Whilst keeping the airway open, you bring your ear down towards the patient's nose and mouth, feeling and listening for air on your cheek whether there are any movements, whilst doing this, you feel for a carotid pulse you very gently grip the patient's trachea with your fingers on one side and thumb on the other, immediately releasing your thumb once in position- this puts your fingers in a perfect place to feel the carotid pulse. You can't feel or hear breathing, nor can you feel a carotid pulse. You immediately realise that your patient is in cardiac arrest and you call out "can you call the cardiac arrest team please!!!"

You get yourself into position right above the patient and you get your knees on the bed to help this. For a fleeting moment, your mind goes blank, and you think, 'what do I do with my hands'. But this doesn't last, and you recall your training, and you start CPR by placing the heel of your hand in the middle of the lower half of the sternum and pushing down 5-6cm at a rate of 120 bpm or 2 compressions per second *insert metronome*. You are going to do 30 compressions to 2 breaths. You allow the chest to recoil fully after each compression and there is an even amount of time, 50/50, on compression and relaxation. A healthcare assistant colleague joins you, and she places a face-mask on and bags the patient's airway with 15 litres of oxygen straight away but awaits your compressions getting to a count of 30.

In your head you are counting to 30 and with each count pushing down 5-6cm or a third of the depth of the chest *insert metronome* as you get to 25 compressions you count out loud… "25, 26, 27, 28, 30", allowing the person doing the airway to know to give breaths. You keep your hands in position on the patient's chest as the support worker gives two breaths and once again you start to count as you recommence chest compressions… 1, 2, 3, 4… pushing down 5-6cm, at a rate of

100-120bpm *metronome* and allowing the chest to fully recoil after each compression. In your head you are counting to 30 and with each count pushing down 5-6cm or a third of the depth of the chest as you get to 25 compressions you count out loud… “25, 26, 27, 28, 29, 30”, allowing the person doing the airway that breaths are required

Once again, you keep your hands in position on the patient’s chest as the support worker gives two breaths and once again you start to count as you recommence chest compressions… 1, 2, 3, 4… pushing down 5-6cm, at a rate of 100-120bpm *metronome* and allowing the chest to fully recoil after each compression. In your head you are counting to 30 and with each count pushing down 5-6cm or a third of the depth of the chest as you get to 25 compressions you count out loud… “25, 26, 27, 28, 29, 30”, allowing the person doing the airway to know to give breaths. As you your arms start to tired, you call a nursing colleague to take over at the end of this set of compressions and they agree.

Again, you keep your hands in position on the patient’s chest as the support worker gives two breaths and once again you start to count as you recommence chest compressions… 1, 2, 3, 4… pushing down 5-6cm, at a rate of 100-120bpm *metronome* and allowing the chest to fully recoil after each compression. In your head you are counting to 30 and with each count pushing down 5-6cm or a third of the depth of the chest as you get to 25 compressions you count out loud… “25, 26, 27, 28, 29, 30”, allowing the person doing the airway to know to give breaths

You step back as your nursing colleague takes over chest compressions, just as the cardiac arrest team turns up and the crash trolley and defibrillator arrive at the scene

<u>Advanced</u> mental simulation script

Key:
This = section added by the researcher from his own knowledge and experience
This = section added from the phase 1 student interviews
This = section added from the official Resuscitation Council [RCUK] Guidelines for BLS / ALS (theory)

Advanced Script (construction)

You are helping to wash a patient in a bay close to the nurses' station. You hear the emergency 'buzzer' go off… your body floods with adrenaline and you feel your blood pressure go up making you feel slightly dizzy, but you feel in control of your emotions and you control your stress levels and think clearly. You feel like your pupils are dilated and your senses are heightened as you hear a commotion and realise that this isn't a false alarm. You want to freeze in the moment, but you pull focus and you move towards assessing the patient. You see a healthcare support worker next to the patient and she says he just drained of colour and she didn't know what it was… she knew something wasn't right. You instantly feel afraid as you know this is an emergency situation

You quickly rush over to the patient, pulling the 'CPR release catch' behind the head of the bed and this quickly flattens the bed and the patient. The patient has the look of someone who might be dead… your adrenaline is flowing… you focus your thinking and remember that you had excellent training[9]. You *shake the patient's shoulders and ask loudly*, "are you OK?!" … the patient *does not* respond to this. You are now very concerned this patient is in cardiac arrest- time to check. You open your patient's airway by tilting their head and lifting their chin (head tilt chin lift) into a *sniffing a morning air* position to open their airway.

Whilst keeping the airway open, you bring your ear down towards the patient's nose and mouth, feeling and listening for air on your cheek and looking across the chest to see whether there are any breathing movements… whilst doing this, you feel for a carotid pulse under your fingers. You very gently grip the patient's trachea with your fingers on one side and thumb on the other, immediately releasing your thumb once in position- this puts your fingers in a perfect place to feel the carotid pulse. You can't feel or hear breathing, nor can you feel a carotid pulse. You immediately realise that your patient is in cardiac arrest and you call out "can you call the cardiac arrest team please!!!" A colleague rushes off to ring for the cardiac arrest team

You get yourself into position right above the patient and you get your knees on the bed to help this. For a fleeting moment, your mind goes blank, as you think, 'what do I do with my hands'. But this doesn't last, and you recall your training and you start CPR by placing the heel of your hands in the middle of the lower half of the sternum and pushing down 5-6cm at a rate of 120 bpm or 2 compressions per second. You allow the chest to recoil fully after each compression and there is an even amount of time on compression and relaxation. A healthcare assistant colleague joins you, and she places a face-mask on and bags the patient's airway with 15 litres of oxygen straight away but awaits your compressions getting to a count of 30. As you are undertaking CPR the bed is pulled out away from the wall and someone took the bedhead off to make it easier to get to the patient's airway.

One of the other support workers draws the curtains around the other patients' beds in the bay, so they do not have to watch what is going on

In your head you are counting to 30 and with each count pushing down 5-6cm or a third of the depth of the chest *insert metronome*. As you do compressions your patient's chest feels cool and clammy under your hands and the chest feels spongier and bouncier than you'd imagined, but you are focused on undertaking chest compressions and getting this right, although you are aware of other activities going on around. As you get to 25 compressions you count out loud… "25, 26, 27, 28, 30", allowing the person doing the airway to know to give breaths. You keep your hands in position on the patient's chest as the HCA gives two breaths and once again you start to count as you recommence chest compressions… You recommence compressions… 1, 2, 3, 4… You are feeling very warm and sweaty due to the situation and you feel hyped up with adrenaline. As you look down the patient appears fragile and it feels as if the patient you have been looking after for days, has somehow shrunk. You re-focus your attention back to undertaking high-quality chest compressions.

As you are undertaking the chest compressions, you notice that the cardiac arrest team arrive and who appears to be a senior doctor take charge, asking the ward doctors if it's Ok for her to lead the cardiac arrest. It is… the cardiac arrest team introduces themselves as they arrive. You go back to focusing on your chest compressions, so that you are delivering high quality CPR. As the crash trolley arrives *insert trolley noises* one of your colleagues takes the pads from defibrillator and starts to plug them in. You do not interrupt chest compressions whilst the pads are being placed- they work around you. The defibrillator starts to 'beep' and 'alarm' as it is switched on, but compared to this noise of the whole cardiac arrest situation the defibrillator alarms are quiet. As you are undertaking your chest compressions you can hear the suction and oxygen flow that is giving the life-saving breaths to the patient *insert suction and oxygen flow noises*

Once again, in your head you are counting to 30 and with each count pushing down 5-6cm or a third of the depth of the chest *insert metronome* as you get to 25 compressions you count out loud… “25, 26, 27, 28, 30”, allowing the person doing the airway to know give breaths. You keep your hands in position on the patient’s chest as the HCA gives two breaths and once again you start to count as you recommence chest compressions… You recommence compressions… 1, 2, 3, 4… As you are undertaking the chest compressions, you can hear the bed creaking and moving*insert chest compression noises*. Once again, you are focused on undertaking chest compressions and getting this right, other activities continue to go on around you. You signal to the staff nurse that after the defibrillator checks are complete, you need someone to take over chest compressions.

At the start of the compressions you felt good, but now after the fourth set of compressions you can feel your arms becoming tired and your body starts to feel drained and you don’t want your chest compressions to drop in standard.

The doctor in charge of the defibrillator asks you to “pause for a rhythm check”. The doctor then calls out, “the patient is in a shockable rhythm everybody, please restart chest compressions and everyone else stand clear, I’m charging the defibrillator”. All other team members move back from the patient as the defibrillator is charging. The doctor calls, “everybody stand clear” and you stop chest compressions and move away from the patient. The doctor instantly delivers the shock and your colleague immediately restarts chest compression in your place

As you stand back ready to start compressions when your colleague gets tired. You see that the team functioning and notice how noisy the cardiac arrest situation is. As you continue to watch the cardiac arrest, you notice that teamwork is well coordinated by the leader and that the team responds well to direction and coordination. Numerous tasks were being done simultaneously in attempt reverse the causes of the cardiac arrest. The anaesthetist, who has taken over the airway and breathing is giving oxygen, the junior doctor is taking an arterial blood gas sample from the femoral artery, the sister is checking results such as blood results and old ECGs, the healthcare assistant is checking a blood glucose, whilst the staff nurse puts up an IV fluid infusion into the IV cannula. The nurse on the chest looks over to you and asks for you take over chest compressions after the rhythm check

At this point, the doctor in charge of the defibrillator, calls to the team: “that is 2 minutes, please stop for a rhythm check and they check the monitor…… that is a rhythm compatible with life, please check a pulse… “There’s no pulse” says the , this is PEA… Continue chest compressions”

Once again you get yourself into position right above the patient and you get your knees on the bed to help this. You once again place your hands in the middle of the lower half of the sternum and pushing down 5-6cm at a rate of 120 bpm or 2 compressions per second. You allow the chest to recoil fully after each compression and there is an even amount of time on compression and relaxation. You continue to do a ratio of 30 compressions to two breaths.

This time you notice the nurse inject adrenaline into the patients cannula as you are doing the compressions. You refocus your attention to chest compressions… In your head you are counting to 30 and with each count pushing down 5-6cm or a third of the depth of the chest *insert metronome* once again as you get to 25 compressions you count out loud… "25, 26, 27, 28, 30", allowing the person doing the airway to know to give breaths. As you do compressions your patient's chest still feels cool under your hands but you are still focused on undertaking chest compressions and getting them right, other activities continue going on around you, but you remain focused on high-quality chest compressions. You are still feeling very warm and sweaty and you can still your adrenaline flowing. You re-focus your attention back to undertaking high-quality chest compressions.

Two more minutes pass. The leader says, "pause for a rhythm check please" and you stop. You see the sister reach forward and she feels the carotid pulse… "there is a pulse she claims"

The cardiac arrest leader now instructs the junior doctor to assess to the patient, by undertaking an A to E assessment, they ask the nurse to do an ECG, they look for the precipitating causes of the cardiac. The leader doctor asks you about the family and asks if you can call them to come into to hospital and you go off to the nurses' station feeling relieved and happy about the outcome of the situation

17.9 Appendix 9: Code Books (NVivo)

Main Study Data Analysis – thematic analysis phases 2-5

Phase 2- Generating initial codes (after checking the transcriptions and initial phase 1, familiarisation)

1. *Files= no of participants that the code relates to/ **References= the number of data extracts relating to said code

Name	Code description	*Files	**References
Ad hoc visualisation	This code represents discussions where the participants discuss thinking about the script away from the audio and then 'playing it' and visualising it ad hoc	1	2
Advanced script (importance)	Participants felt that the advanced script was an important step to get to in their learning	2	2
A question of ethics	This code represents discussions that question the ethics of creating the emotions that go with experiencing a CA	1	1
Advanced script is advanced	This code relates to discussions about the advanced script being advanced. Perhaps it is OK to start with for staff who are further down the ALS line- A&E or resus staff<	5	8
Advanced script has more detail	This code relates to discussions around the detail of the advanced script and 'the extras' such as sounds etc	3	3
Detail is important	The AS script offered more detail to help create images	4	6
Mental simulation is portable	This code represents discussions where the participant discusses mental simulation as being portable and able to use often- whereas simulation is not- simulation is 'static' this is dynamic	1	1
Need to build up to advanced	One needs to build up to the advanced, both from a mental simulation perspective and technical perspective (mainly technical)	2	4
The advanced script could be	The basic script was helpful. The advanced script alone would have been	1	1

Name	Code description	*Files	**References
overwhelming	overwhelming		
Started off basic	The AS started off as being very basic- until the CA team arrived	1	2
Anxiety reduction through mental simulation	This code is about perceived reductions in anxiety post- mental simulation	2	5
Audio mental simulation reduced the thinking load	The sounds seemed to reduce the thinking load for some participants	2	2
Audio might help in real life	This code represents discussions around the sound effects potentially making real-life Was feel familiar	1	1
Automated practice	At the bottom here, the participant is surprised to realise that 'it just came to her' in the simulation. She seemed to be surprised that mental simulation appeared to help her 'just jump into action' in simulated practice	3	6
Basic script is basic	This is around discussions that are looking why the basic script is required for learning- it offers the basics first before advanced script	9	31
Basic script felt easier	This code relates to the basic script feeling easier once they had engaged with the advanced script	1	2
Basic script is good for rhythm	This code represents data that alludes to the basic script being good for seeing and good rhythm and pace of the CPR	1	1
Basic script is like simulation (mandatory)	This code relates to the basic script being more like a classroom session (especially when compared to the advanced script)	5	9
Basic script lacked urgency	This code represents discussions around the basic script lacking a sense of urgency	1	2
Basic script slows me down	This is a discussion around the basic script slowing the participant down in their preserved development	2	3
No frills- Less detail	This is code for discussions around the detail in the basic script	4	8
Basic is too basic to feel	This code represents discussions where the participants allude to the basic script being too basic to 'feel.'	4	5

Name	Code description	*Files	**References
Blend into one script	Because the participants had used both scripts, the two details tended to blend into one memory of 'the script.'	4	4
Calming influence	This code is around discussions of a calming influence in the mental simulation practice	1	2
Casual mental simulation	The informal mental simulation used for everyday life and professional life	1	2
Comfortable position	Despite this not being a relaxing topic or 'meditation', participants often felt like they got themselves into a comfortable position	5	7
Position is distracting	This code looks at discussions around the position the participants take, actually being distracting	2	2
Suitable position	This code relates to participants getting into a suitable position rather than a comfortable position per se	1	2
Comfortable with the script	This code relates to when the participant discusses being comfortable with the script and implying that it is 'working for them.'	4	11
Concerns about technical ability	This code relates to the participants alluding to being concerned about their technical abilities in CPR	1	1
Confidence in own performance and feeling prepared	Some of the participants overtly suggest that this experience has given them (perceived) confidence- this could be compared to Jack, who has experienced a CA	9	47
Feeling of under-confidence	This is a code-based around discussions of underconfidence in the participants, either before or after mental simulation	3	8
Confusing	This code relates to areas of confusion that were identified whilst using the script	1	2
Continuous audio help to keep focus	Here the participant alluded to the fact that their mind could wander, and background noises may help with focus	1	2
Coping with stress	This code refers to discussions about their ability to cope with stress (in sim or real life)	2	2
CPR is sexy- offers motivation to learn	This code relates to discussions around the driver for CPR mental simulation is the	5	9

Name	Code description	*Files	**References
	topic itself- its 'sexy' nature and the scary as hell nature		
Did basic script longer than I needed to	This code represents discussions where the participants alluded to doing the script longer than they needed to because they were asked to or felt they 'should.'	1	1
Different frame of mind	This code relates to the participants discussing that being in university and being in placement gives them a different frame of mind. Being at university and thinking about clinical practice and being in practice and thinking about practice is different	1	1
Distracting cast (video and setting)	Some of the participants actually felt that 'knowing the cast' was off-putting	5	9
Distraction (video)	This code relates to the discussions around the video being a distraction	2	7
Reliance on the video	This code relates to discussions of over-reliance on the 1st person-video	1	14
Video authenticity	The video has issues with authenticity due to myriad factors	1	1
Distraction-less time needed to perform	Participants suggest that they need to be in a distraction-less environment	8	39
Comfortable frame of mind	This alludes to comfort as being in their suitable space, frame of mind and readiness	3	12
Concentration span required for mental simulation	This code relates to participants who discuss their concentration span	5	19
Easy to use	Suggests that, as a whole, the package was easy to use	1	1
Emotionless reaction	Here the code is looking at how the participants struggled to conjure up emotions (either through the video or the scripts)- this did vary between participants, so there will be a counter code to this	5	15
It doesn't fully help with emotions	This discussion is around mental simulation not fully helping with the emotions of CPR	3	4
Emotions got less with practice	This code relates to discussions about practice helping to reduce the emotions involved	2	2

Name	Code description	*Files	**References
Emotions come at the end	This node relates to the feeling that emotions come at the end of a CA, not during it	1	3
Emotions fade	This code represents discussions around the participants feeling like the emotions they feel in and around CA fade with time	1	1
Fear of the unknown	When people hadn't heard the script, they listened and focused on 'what was coming' instead of visualising. I could have asked the participants to 'warm up' by listening to the script on several occasions without 'visualising' per se. Then it wouldn't be any 'redundant' visualisation session	1	2
Feeling prepared	This code relates to the feeling of being prepared for practice and preparation for doing CPR	4	4
This is happening	This relates to the fear of the CA event… oh my goodness, this is happening….	1	1
Fidelity aids authenticity	This code relates to discussions around how the images created offered a sense of authenticity and fidelity	8	43
Audio didn't increase the vividness	Some of the participants didn't find that the sound created a more vivid mental simulation environment, whereas, for some of the participants, the sounds became a thing that lit the script up	2	6
Audio fidelity	This code is related to sounds increasing the authenticity of the mental simulation script and mental simulation practice	6	30
Audio situates me in the moment	Hearing the sound effects placed the participants there at the scene	1	1
Authenticity of PP	This describes discussions around the importance of authenticity of PP (high fidelity simulation)	4	4
Body position direction	There could have more detail around body position in the advanced script (like you have your knees on the bed)	1	2
Continuous audio would increase authenticity	The noise in the background would be better for realism	1	2
Emotional fidelity increases	This code is for discussions around the stress and emotions that come from CPR	8	21

Name	Code description	*Files	**References
authenticity	and visualisation (or lack thereof)		
Fear of panic and stress	This code is related to the emotions that are linked to undertaking CPR in practice and how this links into discussions of the script	3	9
A physical reaction to the emotions	This code is created to discuss when participants talk about physical reactions that they had to the script	5	26
Fidelity levels bring back memories	This code considers discussion around how clear the images were and that they evoked past memories	1	1
Help with real-life stress of CA	This code relates to discussions around parts of the script helping with practice	1	2
Kinaesthetic fidelity	This code relates to discussions around kinaesthetics requiring more detail in the script	4	8
Lack of fidelity affected the authenticity	There are areas where the script might lack authenticity	9	29
Leading	This code refers to the discussions around the mental simulation script perhaps being a little leading. For example, the script alludes to the patient being unwell. The participant didn't have to think this through- this is very interesting	1	1
Metronome beats help to learn	This code relates to discussions about the metronome beats and them being helpful to the scenario and to learning	4	8
Missing sounds and noises	This code relates to the participants feeling like certain sounds were missing from the script	3	9
Patient may die		1	1
POV authenticity	This code relates to the POV video being authentic	3	4
Real-time	This is a discussion about the issues thrown up when the script isn't in real-time	5	10
Stress directions	This code relates to discussions about the stress of the mental simulation script- the added text within the mental simulation script that was supposed to add a 'feeling of stress.'	1	2

Name	Code description	*Files	**References
True to life	This code represents discussions where the participant alludes to the script being true to life	1	1
Filling in the blanks	This is starting to refer to what I might call authenticity- the participants here create their own authenticity- add their own 'stamp' to the scenario they have been given.	5	16
False memory	This discussion is around the participants creating a 'false memory' around the CPR skills to fill in the blanks	1	3
Filling in the blanks (peripheral)	Filling in the blanks about the environment is interesting, but the participants also discuss 'filling in the blanks' of the equipment and the staff- I've tried to uncover where these memories have come from, but they do seem to be subconscious and not in the participants' control	5	13
Peripheral items discussion	This is not really a code per se, but somewhere to keep my discussions about the peripheral items of the package- I'm not sure how useful this is to the study overall, but it is good to keep them together for ease	2	2
Moving around	This code relates to discussions around participants moving around a lot and having experienced many wards etc. Therefore they imagine generic settings	1	2
Random ward (subconscious)	This code represents discussions around the participant alluding to their 'filling in of the blanks' being random	1	1
Reasons for filling in the blanks	This code is a justification for filling in the blanks the way that they did, or the fact that they couldn't fill in the blanks very well and a discussion of why	2	5
Self-adaptation of script	This is where the participants discuss how they consciously adapted the images and scenario to help their development	4	4
Subconscious images	This code relates to the unconscious images that people create in their minds, with seemingly no control	8	29
Unsure where images are pulled from	The codes represent discussions around the participants being unsure where there their images were 'pulled from.'	2	3

Name	Code description	*Files	**References
Vividness through experience	This code relates to the discussions of experience increasing vividness	8	41
Easier to adapt memories than to create own	This code talks about creating memories from nothing is more complex than 'having real memories' and adapting them	2	2
Superimposed real-life CA	This code is for specifically discussing personal CA experiences and how they subconsciously fitted 'over' the script	3	4
First-person is important	This code relates to discussions of the importance of first-person (how and why)	2	2
Focused (tunnel vision with the mental simulation)	Participants report that they are focused on the mental simulation, meaning they often don't see detail outside of their task- this code is related to this. Could this be mental simulation situation awareness?	1	5
Found it useful	This code relates to the participants finding the mental simulation scripts useful to their learning	1	1
Frontloading	This code is for when participants discuss or allude to 3x week being front-loaded but not sustainable	2	2
Frustrations	This is a discussion around the frustrations of doing mental simulation- either from a kinaesthetic or from a visualisation perspective	1	3
Halted progress	This code discusses issues that participants discuss around their progress being halted in some way along the way	1	1
Home is relaxing	This is around discussions that being at home is relaxing, and there are the distractions (other students/ lecturers etc.) that there are in university	1	2
I want the practice	Students often want the practice of doing CPR, and this came in this part of the conversation 'unfortunate not see a CA.'	1	1
Mental simulation and PP practice combined	This code relates to discussions about the combination of PP and mental simulation and how they can create images for use in mental simulation practice and/or how mental simulation helped in PP	4	7
Mental simulation benefited me	The code relates to discussions around the participants perceiving that mental	2	2

Name	Code description	*Files	**References
	simulation benefited them for learning skills		
Mental simulation helped with muscle memory	The participant overtly said that the mental simulation helped with muscle memory in simulation	1	1
Mental simulation is hard at first	The node discusses the issues around mental simulation is challenging to start with	2	2
Mental simulation is sometimes more of a focus than the skill	This code represents discussions around mental simulation is sometimes more of a focus than the skill	1	1
Mental simulation of self is difficult	This code relates to the participants' discussions around kinaesthetic ability and easy it was (often when compared to visualising)	1	1
Mental simulation outside of CPR	This code is around discussions of using mental simulation outside of CPR	1	1
Mental simulation unlocked	This code is a discussion about how mental simulation has been ‘unlocked’ within the participants	1	1
Mental simulation used in a previous life	This code relates to participants discussing previous experiences of mental simulation (this code is related to a question, so might need to analyse further and coded better)	6	11
Mental simulation in other technical tasks	This code represents discussions about other technical tasks that mental simulation may have been used for in the past	3	3
Lost mental simulation as I got older	This code relates to codes where mental simulation got lost as a practice as the participant got older	1	1
Mental simulation vividness	This is a general, probably comprehensive code about vividness. I’m not if it will be too broad, but it might be worth having	4	5
Imagining demonstrations for use in practice	This relates to how participants discuss imaging their tutors demonstrating the skill during PP time	1	1
Breaking images into chunks	Breaking images into chucks of information, especially when doing it informally	1	1
Improvised PP	This code represents discussions around improvised PP during the mental	1	1

Name	Code description	*Files	**References
	simulation process		
Incorrect practice	This code relates to practice that has shown to be incorrect	1	6
Individual life circumstances	Individual life circumstances often seem to affect how mental simulation is seen and experienced- this code relates to this	1	2
Individualising the process- what works for me	It appears that some participants changed the rules of the 'game' to suit their own needs/ learning	2	12
Inspiring	This code relates to feeling inspired by using doing CPR. by using mental simulation to do this	1	1
Instruction confusion	This code relates to the confusion of the instructions and how they sent participants off at a tangent	1	3
Is it mental simulation at all	Are they actually visualising the task per se, or are they working through mental checklists? I would argue that this isn't the same	1	1
It brought back memories	This code is a discussion about the basic script bringing back past memories (alluding to memories of BLS)	1	1
Kinaesthetic successes	Was able to feel in their mental scenario	1	1
Kinaesthetic struggles- challenging to feel	Was not able to feel in their mental scenario	8	44
Kineasthetics and experience	This code relates to participants discussing difficulties with kinaesthetics of they hadn't done CPR previously	3	8
Kinaesthetics from experience	This is a code that looks at the discussion around kinaesthetics and real-world experiences	3	7
Kinaesthetics from mental simulation experience	This is a code that examines how the kinesthetics got easier as the participants went along	4	7
Knowing what's coming	It wasn't easy to visualise when we couldn't feel what was coming in the script	1	2

Name	Code description	*Files	**References
Leading is stressful	This code relates to the stress of leading a cardiac arrest before the team arrives (even during mental simulation)	4	5
Learn to visualise	One can learn to visualise the more you practice- this will increase, likely due to commitment and repetition	1	4
Learning	This code is around discussions of learning from using the script	4	20
Battle scars	This code is used to discuss how reflecting on practice has left participants with 'scars' that have affected them. Mental simulation has made them realise it didn't go to plan the first time	1	7
It becomes easier (like riding a bike)	This code is based on the participants having time away from visualising and finding it easy when they come back to it	2	7
Go at your own pace	This code relates to the discussion around the participants 'going at their own pace' whilst undertaking the script	1	1
Intrinsic feedback	This code relates to discussions around how participants know they are 'doing it right'- this could be through PP, for example	1	2
Lack of ALS knowledge	This code relates to a lack of knowledge around ALS (this isn't surprising!). However, this is then illuminated through using mental simulation	1	2
Learning different things	This code relates to the participant discussions around learning different things as the task went on	1	1
Learning in practice	This code relates to discussions around how hard it is to learn in real cardiac arrests	1	1
Learning styles	Some participants discuss learning styles. This is important as there is little evidence for learning styles, and yet it pervades the education system- this will be worth looking at perhaps in light of other aspects	3	5
New insights	This code refers to participants having new insights into practice - based on their mental simulation experience	2	2

Name	Code description	*Files	**References
Prepared for the move from basic to advanced	This code relates to the participant being ready to move from one script to the other (either ready or not, as the case may be)	1	1
Rate and rhythm	This is coded because rate and rhythm are both very important aspects of undertaking CPR	2	2
Reflective tool	This code relates to mental simulation as a reflective learning tool	7	43
Correcting mistakes	This node relates to mental simulation helping students to correct mistakes from clinics practice	1	5
MDT roles in a CA	This code relates to discussions around the roles and skills of other members of the MDT	2	3
Scope of practice	This is where participants consider their scope of practice based on their reflection through mental simulation	3	12
Repetition is the key to the vividness	Participants talk about the vividness of the scenario coming about through repetition- the more they engaged with the script, the clearer it got	8	28
Repetition is off-putting	This code relates to the repetition of the script- some participants didn't find it off-putting or boring, but some seemed to find it off-putting in the end. Whilst I asked this question outright in Amy's interview, this question had been created from the previous interviews	5	10
Vividness increases with experience	The code relates to discussions around vividness of images getting strong through doing the script(s) more times	3	6
Repetition keeps it at the forefront of your mind	This code represents participants discussions around the repetition of the script, keeping things at the forefront of their mind	1	1
Revision	Learning through revision	2	3
Rote learning	This code represents discussions around the participants alluding to them rote learning- almost using the emery as a checklist	4	8
Seeing the bigger picture	This code relates to seeing the bigger picture of the cardiac, through using the	2	13

Name	Code description	*Files	**References
	mental simulation script		
Skill decay recognition	This code relates to the participant recognition of skill deterioration/ decay	5	7
Stage of learning	This code relates to the learning stage of the students and how this could be affected by using mental simulation	1	2
Technical discussions	This code is around the technical knowledge that is discussed around the students learning	7	32
CPR is busy	This code relates to discussions around the hustle and bustle and busyness of a CA	1	1
Knowledge linked to mental simulation vividness	This code is used around discussions of an increase in vividness linked to an increase in knowledge of CPR technical understanding	2	8
Lack of opportunity to hone skills	This code relates to there being a lack of opportunity to hone skills in clinical practice	1	1
Unsure of own learning	This code relates to participant discussion around them being unsure about how often they would need to use it to maintain ‘skill/ confidence.’	1	1
Video as a standalone learning experience	She of the participants feel like the video was a learning experience in its own right- this could have been due to the ‘first-person’ aspect of the video	4	6
Repetition (video)	This code is around discussions of coming back to the video as it helped their learning to watch it numerous times	1	1
Video as process	The video offered a view of the process of CPR and ALS	2	3
Video as context	In this code, the participant needed context for the script- perhaps this suggested the video was more than just ‘being able to see from the first person.’	3	4
Video gave me time	This code related to discussions around the video being able to contextualise the participant previous experience of a CA (if they had one).	1	1
Vividness through PP	Did doing PP increase the vividness of the using mental simulation- this code discusses	5	12

Name	Code description	*Files	**References
Learning the script	This is discussion around being to anticipate was going in the script, either through personal experience or through visualisation	2	5
Focused on the mental simulation	This discussion is about focusing on mental simulation once the script was 'learnt.'	1	1
Life's busy conflict	This code looks at how participants have to fit their mental simulation around their busy lives	9	25
Listening to the voice, not visualising	This code represents discussions where the participant alludes to not being able to tell whether they are visualising or just listening	1	3
Memorised the script	Some participants feel like they have built up memory and allude to being able to visualise without the script, almost becoming self-sufficient	1	3
Mental simulation is mobile	Visualisation stays with me wherever I go- its mobile	1	2
Metronome keeps you focused	This code refers to discussions around the metronome helping one to stay focused, even though a lot is going on around the bed in the form of CPR	1	1
Mix and match (Script)	This code represents discussions around participants going 'backwards and forwards' between basic and advanced scripts	1	2
More than learning a skill	This code refers to discussions around the participants feeling like doing CPR is more than just delivering a skill- it is life or death	1	2
Motivation comes from a lack of experience	This code describes discussions around the motivating factor being that the participants don't get to practice the skill of CPR very often	1	1
Narrator is authoritative	This code represents discussions around the participants alluding to the narrator being an authoritative voice	1	2
Natural progression in the scripts	This code is for when two scripts were used to together one after each other- again, at the moment, not a particularly analytical script	2	5
Need real-life practice	This represents discussions around needing real-life practice	1	2
Needing to be that person	This code relates to discussions about being the 'person delivering the CPR.'	2	2

Name	Code description	*Files	**References
Nervous around PP	This node relates to being nervous around PP - often due to being watched by both the tutor and classmates	1	1
No experience needed	This code relates to discussions around not needing to have seen something first hand to be able to visualise this	1	1
No need for a script	This code represents discussions around the participants, alluding to perhaps being able to run the script/ scenario in their head without listening to the audio	1	1
No need to practice	This is a code that describes discussions around the assumption that if one experiences something in clinical practice, they no longer need to practice it (in sim/ using mental simulation)	1	1
No noise was distracting	As above	1	1
No peer pressure	There is no one watching you when you are using mental simulation… unlike in simulation when your peers are watching and judging you	1	2
No time to think	Things happen so fast when one experiences being involved in a cardiac arrest- this node relates to this	1	1
Not enough chances to practice	This code relates to participants alluding to them not having enough time for PP in the form of simulation in university	1	1
I only listened to the basic once	This code represents discussion where the participants only use the basic script once (5 mins)	1	1
I needed to be relaxed	This code relates to students saying that they need to relax when doing mental simulation- they almost see it as meditation	3	12
Outside influences	This code relates to influences outside of 'real life' experiences and the mental simulation package	2	7
Patient in CA	Discussions around vividness and patient relationships	3	7
Patient vividness	This code refers to discussions around the visualisation of patients for whom CPR is taking place- how easy was it to visualise them, was the face blank?	2	2

Name	Code description	*Files	**References
Patients create emotion	This is code about the emotions that come with getting to know patients (either experiences or hypothetically)	3	4
Personal interest in the subject	The code refers to do discussions around the topic of CPR being interesting to the participant and this acting as a driver for using it	1	1
Perspective	Thinking about the perspective of the mental simulation that is taking place	3	5
Basic and first-person	This is discussions around it being easier to see in the first person during the basic script	1	1
First-person perspective	The code relates to the first-person perspective discussions	5	10
1st person, practice makes perfect	This node discusses the first-person perspective getting easier with practice	1	2
First-person was straightforward	This code relates to participants discussing that they are first it was straightforward for them to see from the first person	2	3
First-person difficulties	This code relates to discussions of the difficulties in visualising from the 1st person	4	10
Fourth person perspective	This code relates to not being able to visualise themselves at all	2	8
Perspective based on experience	This represents discussions around the participants alluding to their experience of the skill affecting perspective. if they had only observed- 3rd person, if they had done it themselves, 1st person	1	1
Perspective changes with experience	This code relates to discussions of participants discussing changes in perspective as they gain more experience with PP	1	1
Perspective flips	This code relates to participants discussions around their perspectives flipping at times, despite being asked to image in the 1st person	1	2
Perspective-thinking	This code refers to discussions around changing perspectives, altering how the participants thought about this role within the cardiac arrest	1	1
POV helped with perspective	This is what it says on the name	1	1
Third-person perspective	This code looks at discussions around the third-person perspective	5	17

Name	Code description	*Files	**References
3rd person = situation awareness	This code relates to being able to see the bigger picture/ have great SA in the 3rd person	1	1
3rd person easier	The 3rd person is easier to image	4	7
Look at	This code suggests that, to the participant, visualise means to look at, not look from	1	1
Not good for emotions	This code represents discussions around the third perspective not being good for emotions	1	1
Not ideal for kinaesthetics	Third-person perspectives are not ideal for kinaesthetics	1	3
Third-person drift	This code represents where participants discuss automatically going into third-person perspective without effort	1	1
Visualising self is harder	This relates to the participants finding it difficult to visualise themselves doing the CPR / tasks when compared to seeing other people doing tasks	1	1
Visualising yourself on TV	People often resorted to seeing themselves in the 3rd person or at least did at the start	1	2
Physical practice	Here we talk about the influence of physical practice and training in the rest of the course	3	8
Playing the scenario back	This represents the participants suggesting that they played the scenario back in their minds whilst using the resus manikin	1	1
Post-research mental simulation usage	Some of the participants discuss how they would use the script post-research intervention	4	11
Use for rarer skills	This code represents discussions around using mental simulation for events that don’t require a high frequency of skills deployment	1	3
POV and advanced script are more related	This code represents discussion where the participants allude to the advanced script being more akin to the POV video than the basic	1	2
POV film empathy	This is empathy with the person in the video	1	1

Name	Code description	*Files	**References
POV helps with the basics	This code represents discussions where the participants feel like the POV film actually did part of the job of the basic script	1	1
POV stopped my visualising my own images	This is straightforward - as the title suggests	1	1
PP and mental simulation go hand in hand	As above - this code relates to PP and mental simulation complimenting each other	4	7
PP engagement	Discussions around it being difficult to engage with PP for various reasons	1	1
Practical position	Whilst most participants take a comfortable position, there was discussion of taking a CPR type body position	1	2
Practice is more than just 'having a go.'	This represents discussions about practising past just 'having a go'	1	1
Practice makes perfect	This code relates to participants discussing how they got better and mental simulation with practice	3	4
Practicing under physical stress and fatigue	This code represents discussions from the participant, discussing performance under stress and fatigue and how this might affect the quality of performance	1	1
Prepare ones-self	This code looks how it is more than just 10-minutes in a day, and there is an element of preparing yourself, mentally and logistically	1	1
Principles of physical practice	This code represents discussions around physical practice and the principles as they understand it	1	1
Process and structure driven	This is looking at how the participants felt that either video or the script helped them to understand the BLS and ALS process and gave them structure	8	44
Checklist	Think as a checklist as opposed to mental simulation	1	2
CPR process becomes clear	This code refers to images becoming so clear in the students' mind	1	1
Mental simulation as reference or guide	This code relates to mental simulation as a reference for doing things properly	2	4

Name	Code description	*Files	**References
Routine	I used the NVivo code for this- it felt like it was routine	4	9
Understanding the algorithm	This code is around discussions of CPR mental simulation and the algorithm	1	2
Professionalism	Discussions around the mental simulation help to give the students a professional identity through skill acquisition	1	2
A sense of responsibility	This code relates to the participants discussing feeling a sense of responsibility for the patient (often until the CA arrest team arrived) - this then links with a sense of relief when the CA arrest team arrives	2	3
Project oneself	This code refers to discussions around the script allowing participants to project themselves to a cardiac arrest from their home/ bedroom etc	1	1
Reality of CPR	This code represents discussions around the participants feeling like CPR is messy and feel chaotic	1	1
Refresher	In-vivo code. Using the script is like having a refresher on BLS (PP)	1	1
Refresher of skills	This code refers to discussions around the basic script being a refresher of BLS skills before they move on to the advanced skills	1	2
Relief of the team arriving	This code relates to discussions around the participants discussing a sense of relief when the CA team arrived in their mental simulation scenario	4	5
Repetitive nature	This code relates to the repetitive nature of the audio script in so much as it repeats, almost like it's on a loop	1	3
Repetition increases learning	This code represents discussions around the participants feeling like they have learned 'something' due to the repetitive nature of the task	3	4
Drilled into you	This code represents discussions around repetition in learning being positive for learning different things	1	1
Repetition is distracting	This code relates to discussions are the repetition of the script actually being distracting	3	5
Visualising is strongly linked to	This code represents discussions around the participants alluding to being able to	1	2

Name	Code description	*Files	**References
kinaesthetics	feel more once their visual image of the situation was stronger (through repetition/ practice)		
Righthand side	Visualisation position of the participant concerning the patient- could this affect the student's learning? Could it be detrimental?	1	3
Script limitations	There are clearly going to be limitations with the script, and the participants highlighted this	2	2
Length of script	This code is related to participants talking about the length of time that the script runs for and is closely linked to the 'repetition is off-putting' code	2	5
Seeing the whole scene	The code relates to discussions around seeing the whole of the mental simulation scenario	3	5
Self-directed PP	This is discussions around the participants doing self-directed PP with their beds and pillows etc. at home	1	1
Sense of urgency	I wanted the script to create a sense of urgency, yet this aspect was met with mixed 'reviews.' This code relates to these discussions	4	16
Rhythm and flow	The pace of the script is discussed as being too fast, too slow, or just right - there are also discussions of the sense of urgency that this creates (or not)	6	12
Simulation (PP) is stressful	Simulation is stressful as there are the stressors of other people watching/ lecturers watching - this is considered pressurised by students	1	1
Simulation vs reality vs mental simulation	Throughout the study, this has been a theme, including the pilot study- simulation cannot capture the reality of the real-life situation- use data from the pilot study. However, can mental simulation capture this?	3	13
Skill acquisition	This code relates to participants discussing skill acquisition through mental simulation	1	1
Some things are still not clear	The mental simulation script left some things a little unclear, and this code is around this	1	1

Name	Code description	*Files	**References
Sound effects are neither here nor there	This code relates to participants not really feeling like the sound effects made a difference to their mental simulation vividness	1	3
Sound effects broke up the narration	This code represents discussions around the sound effects breaking up the narrator's voice and alluding to it as a 'relief.'	1	1
Sound effects situate	This code relates to discussions around the sound effects helping to situate the participants	4	6
Stick with it	This code relates to the participants suggesting that you have to stick with it to see the benefits	1	1
Stickability	This relates to discussions about how participants get certain things to 'stay or stick in their minds'	4	5
Stress of a CA	This code discusses participants feelings of the effects of stress in real-life CA situations	4	12
Student 'mentality'	This code relates to the students being in student mode. Students often feel they will be corrected if they do things wrong, despite being taught to do it correctly and an expectation that they are 'competent/ proficient.'	5	17
Superpower	This relates to participants feeling that the adrenaline and stress of the CPR situation keeps them going even when they are physically tired	2	3
Sustainability	The intervention frequency is n sustainable for most of the participants	2	3
Taken away	This code relates to discussions around the participants felt they were 'away from the room' whilst they were visualising	1	1
Technical confusion	There is often confusion about A to E assessment in cardiac arrests. A to E assessments are done for patients who breathe and have a pulse. When they don't (i.e., in CA), we do an A to C quick assessment and then CPR/ BLS and ALS when possible	2	3
Tenacity	Tenacity is required- you need to stick with it	1	1

Name	Code description	*Files	**References
The detail is there	This code relates to discussions around the detail of the advanced script, working for the participant	2	3
The script has a structure	The scripts add structure and clarity to the scenario	1	1
The voice is distracting	This code relates to discussions around the voice of the narrator actually being distracting	1	1
Think in pictures	This node refers to people alluding to thinking in pictures	1	2
Third-person take over	This code is around taking over from the third-person perspective	1	2
This is normal	The script might help one to be able to cope with emotions, even if you didn't feel the emotions during the mental simulation. However, the 'words' may resonate and be called on during the cardiac arrest proper	1	1
Time	Here the length of the script was discussed- some people felt as though the script was too long, and some felt like it was just right	5	6
10-minutes can be longer than you think	10-minutes to some of the participants can be 'longer' than it appears temporally. Some participants feel that they are focused on it, even when they are not doing it- it weighs on their minds. It's another thing they have to do in their busy life. Some have to mentally prep for it	4	14
The forefront of my mind	Mental simulation is always on the mind of the participant	1	1
Short bursts only	This code represents discussions around 10 minutes being long enough and alluding to doing mental simulation in 'short bursts'	1	1
Time management	Discussions around the scripts/ mental simulation have been doable, but one needs time management to get it done	2	4
Time of day does not make a difference	Some of the participants feel that the time of day does make a difference from a focus/ engagement perspective, but others feel that it does not make a difference to their focus	2	6
The spread of days made a	This code relates to the spread of days, making a difference	1	1

Name	Code description	*Files	**References
difference			
Time of day does make a difference	Whilst this code is related to the question, everyone had a certain time of day that seemed to suit them, despite the time of day suiting them for varying reasons	7	17
Time to dedicate to the task	This code relates to discussions around the length of time given to the task was either enough or not enough	4	10
Time to refresh	This code relates to participants discussions around most skills not being required as urgently as CPR skills. Therefore, one can take their time to 'get it right', whereas CPR skills need to be performed correctly, immediately	1	1
Timing	This code relates to the speed of CPR	1	1
Tiredness interferes	This code represents discussions around tiredness interfering with their ability to visualise/ image	1	1
Video as instructional	This code relates to discussions about the video where participants discuss it offer them some form of structure and 'instruction', and this is helping them (or not)	2	3
Video helped with compressions	This code represents discussions where the participant alludes to the POV helping with compressions	1	1
Video helps to visualise	This code looks at how and why the video helped the participants	7	26
Create a strong memory	This code represents discussions around the POV, creating strong and vivid memories	1	1
POV film creates no emotions	This code represents discussions around the POV, creating no emotions that could be related to cardiac arrests	2	3
POV was not high end	This code relates to discussions around the POV film not being a high-end production and, therefore, could not be bought into	1	1
Video as warm-up	This is around discussion of the video being a warm-up - something to help get the imaginary juices flowing	3	6
Video helps with clarity	This code relates to discussions around the video, helping the participants to see	2	3

Name	Code description	*Files	**References
	what is going on and offering clarity		
Video is a manikin	The participants refer to the video doing CPR on a manikin- this affected the fidelity of the video for some of the participants	1	1
Video is off-putting	This code relates to discussions around the period when the film (POV) was off-putting	1	3
Video stops creativity	This code relates to the POV video stopping the effective creation of the participants won memories	1	1
Video is visual, not kinaesthetic	The code refers to the video being a visual and auditory tool, but there is not a kinaesthetic element to it	1	1
Visual images vs mental images	This code relates to discussions around visual images (on TV/ video) being more powerful than mental images	1	1
Visual thinking	This code describes discussions around the participants disclosing that they often think things through visually	1	1
Visualisation is new and exciting	Learning something new is often described or alluded to as exciting	1	1
Vividness through comfort	This is where participants become comfortable with the script after multiple usages. Vividness appears to increase as the participants 'know what is coming' in the script	2	7
Warm-up routines	This node describes routines that helped participants to warm-up	2	6
Ways in which mental simulation helped me to learn	Discussions around how mental simulation had helped the participant to learn	1	1
Work hard to get the patient back	This node is about working hard in CA and the emotions that go with this	1	1

Nodes\\Phase 3- Searching for themes (creation of candidate themes)

Name (candidate theme with codes beneath)	Description	*Files	**References
Concerns over CPR performance is a strong motivational driver		0	0
Anxiety around CPR performance (performance anxiety)		8	20
Interest in the CPR and cardiac arrest due to job aspirations		5	8
Intrinsic motivation		1	3
Motivation is a lack of real-world experience		3	3
This is research		4	6
Different life experiences affect mental simulation vividness		0	0
Emotional baggage increases vividness		4	8
Emotional connections increase the vividness		4	11
Emotional fidelity comes from real-world experience		6	12
Patient rapport creates mental simulation emotion		6	16
Experience of script increases vividness		2	5
Kinaesthetics come from real-world experience		3	6
Point of view film creates vividness		3	3
Technical knowledge assists with mental simulation vividness		4	8
Vividness comes from the layering of images (repeated exposure)		2	3
Vividness is created through real-world experience		11	50

Name (candidate theme with codes beneath)	Description	*Files	**References
Vividness is created through simulated-world experience		4	6
Everyday mental simulation is used more than the participants realise		0	0
Education setting		4	7
Everyday life		8	23
In meditation		2	4
Sports mental simulation		2	2
Thinking about technical skills		5	7
Work-based scenarios		2	5
Fidelity of the script imitates and amplifies the imagined scenario		0	0
Audio fidelity amplifies scenario		11	69
Audio distraction		1	3
Audio passed me by		4	5
Audio helps to keep focused		3	6
Basic script replicates mandatory CPR training		5	12
First-person offers authenticity		1	1
Kinaesthetics require more script detail		4	7
Kinaesthetics worked for me		3	5
Lack of authenticity at times		2	3
Basic script had less action		5	5
Less is more in the fidelity of the script		3	11

Name (candidate theme with codes beneath)	Description	*Files	**References
Metronome beats and timing		4	8
Point of view film helps with the vividness of the script		5	12
The real-time pace of the script is important to the vividness		10	34
The script creates a sense of urgency		8	21
Description affects flow		1	3
Script description leads to higher fidelity		11	102
The script captures the real-world		2	2
Script detail adds direction		4	6
Script detail situates me- 'I'm there.'		8	21
Script induces kinaesthetic fidelity		3	4
The script amplifies emotional fidelity and authenticity		11	59
The script does not help to create emotions		2	6
The ethics of inducing emotional fidelity		1	4
Vividness varies throughout		1	3
Mental simulation highlights issues around autonomy and student scope of practice		0	0
Highlights a transition from student to staff nurse		2	3
Leadership		4	8
Leading the situation is stressful		4	7
Relief when the cardiac arrest team turned up		4	9

Name (candidate theme with codes beneath)	Description	*Files	**References
Student mentality		9	31
Understanding student scope of practice		5	19
Autonomy of practice		4	8
Mental simulation offers coping strategies for dealing with the stress of CPR		0	0
Confidence (comfortable) in own performance		10	53
Still have some doubts about the performance		3	6
Feeling prepared for cardiac arrest		3	7
Feeling under-confident- unsure of themselves		2	3
Mental simulation helps to cope with stress		4	4
Mental simulation reduces anxiety		6	16
Thoughts of CPR cause anxiety (performance anxiety)		7	23
Mental simulation vividness develops with repetition and experience		0	0
Mental simulation is tiring		1	2
Mental simulation struggles		2	4
Mental simulation vividness helps with kinaesthetic vividness		1	1
Like riding a bike		1	1
Point of view film creates first-person vividness		4	6
Point of view film creates vividness		4	8
Point of view film adds clarity		6	9

Name (candidate theme with codes beneath)	Description	*Files	**References
Point of view film creates strong memories		4	5
Point of view film is distracting		5	16
Repetition is the key to vividness		10	36
Script repetition is distracting		4	13
The power of imagination		1	2
Kinaesthetic mental simulation- some participants are born more equal than others		0	0
Kinaesthetic struggles (imagining touch is not easy)		10	29
More to kinaesthetics than visualisation		1	1
Kinaesthetics and the unknown		3	3
Kinaesthetics is based on experience		7	12
Visualising is stronger than kinaesthetics		3	3
Mental simulation aids the development of nursing graduate attributes		0	0
Mental simulation aids metacognition		1	1
Mental simulation is a reflective tool (intrinsic feedback)		9	33
Recognition of own learning needs		1	7
Unsure of own learning needs		3	3
Reflect on real-world performance gaps		6	27
Mental simulation package helps to see the bigger picture of practice		7	30
Learning styles (I'm a visual learner)		6	17

Name (candidate theme with codes beneath)	Description	*Files	**References
Rote learning		5	13
Skill learning		11	53
Automated skill		4	4
Learning skills from the point of view video		3	5
Recognition of skill decay through lack of practice		5	7
Miscellaneous theme (redundant codes)		0	0
Audio reduces thinking load		2	3
The authenticity of physical practice		5	7
Authoritative voice helps vividness		1	1
The basic script is basic		9	32
CA is stressful		1	1
Comfortable with the script		6	9
Anticipation		2	3
Confidence in mental simulation performance		2	5
Could run the script in my head		3	4
CPR ~battle scars~		3	15
Creative mind		1	1
Detached from practice		1	1
Emotions got less with practice		3	7
Extrinsic feedback		1	1

Name (candidate theme with codes beneath)	Description	*Files	**References
Felt like practice		1	1
Mental simulation as part of a larger learning exercise		1	1
Mental simulation cannot capture the reality of a cardiac arrest		1	1
Kinaesthetics get easier with time		1	1
Learning mental simulation skills is a driver		1	1
Listening to the voice, not visualising		1	4
No motivation		1	1
No need to practice after real-world experience		1	1
Not too time consuming		1	3
Perspective influenced by observation of the instructor		1	1
Placement Prep		1	1
POV assisted perspective		1	1
POV offers insight into cardiac arrest		2	2
The reality of CPR is messy		2	2
Simulation is stressful		2	4
Third-person comes first		1	1
Third-person not easy for kinaesthetics		1	1
The tone of voice (stress)		1	2
Tunnel vision reduced situation awareness		2	4
Works 'better' than simulation		1	1

Name (candidate theme with codes beneath)	Description	*Files	**References
Participants had subconscious control of their mental scenarios		0	0
Filling in the blanks; creating own little world (subconscious)		11	63
Conscious control of images		2	3
False memories planted		3	6
Students move around a lot		1	2
Subconscious control of environment images		2	3
Subconscious control of equipment and peripheral images		3	4
Subconscious control of team member images		8	14
Subconscious creation of own fidelity and authenticity		3	5
Mental simulation in my dreams		1	2
Perspective flips without conscious control		5	17
Random images created		1	1
Participants have to individualise the mental simulation process to meet their needs		0	0
10-minutes is longer than you think		6	15
The forefront of my mind		1	1
Time is given to the task		4	6
Too long, not long enough		1	2
Time investment		2	2
Adaptation/ personalisation of the of the script		4	9

Name (candidate theme with codes beneath)	Description	*Files	**References
Became reliant on the point of view film		2	8
Being on placement		1	2
Body position is important to how I engage with mental simulation		7	12
Body position is distracting		1	2
Need to be in a practical position		2	5
Need to be in a relaxed position		4	11
Dark room - eyes closed or open		8	10
Distraction-less time required to image		11	48
Get in the zone. Warm-up (preparation)		6	10
Go at your own pace		2	4
The advanced script can be overwhelming		2	3
Time spent on basic script		3	4
Mental simulation and physical practice (simulation) combined		7	37
Individualising the process		4	13
Life's busy conflicts		9	26
Prioritisation of script		2	2
Sustainability		7	11
Mental simulation is mobile~ visualisation stays with me		2	4
A natural progression from basic to advanced		10	38
Moved on early		1	1

Name (candidate theme with codes beneath)	Description	*Files	**References
Over-reliance on the basic script		1	2
Repetition (practice makes perfect)		6	20
Time management		3	6
Time of day		9	17
Time of day does not make a difference		1	1
Tiredness interferes with mental simulation		2	3
Perspective has a bearing on mental simulation and learning		0	0
First-person is like you are doing the skill yourself		1	1
First-person struggles, it's not straightforward		9	20
First-person was natural and easy to me		2	2
First-person works better for learning CPR		2	2
First-person- practice makes perfect		4	5
The mental simulation package helps me to understand the processes of a cardiac arrest		0	0
Helps to understand the CPR~ ALS process		2	4
Process and structure driven		10	42
The process becomes clearer from using the package		7	16
The script is like a checklist		1	2

Phase 4- Reviewing the themes (the themes were refined at this stage)

(sub)Theme with codes beneath	Theme Description	Files	References
(Authentic) Sub-theme- "Hang on to Your Emotions"	Personal experience(s) and connections affect mental simulation vividness: Hang on to your Emotions- Lou Reed		
Emotional connections increase the vividness		4	10
Emotional fidelity comes from real-world experience		6	12
Patient rapport evokes mental simulation emotion		6	17
Emotions are evoked from experience		5	10
Emotions got less with MS practice		3	7
Kinaesthetics come from real-world experience		3	6
MS detail can be created through simulated-world experience		4	6
Technical knowledge assists with mental simulation vividness		4	8
The script evokes visceral emotion		11	57
The script does not help to create emotions		2	6
The ethics of inducing emotional fidelity		1	4
Vividness comes from the layering of images (repeated exposure)		2	3
Vividness is created through real-world experience		11	51
(Authentic) Sub-theme- "Imagination"	Participants had subconscious control of their mental scenarios. Belouis Some - Imagination		
Filling in the blanks; creating own little world (subconscious)		11	65

(sub)Theme with codes beneath	Theme Description	Files	References
Conscious control of images		3	4
False memories planted		3	7
Students move around a lot		2	3
Subconscious control of environment images		3	4
Subconscious control of equipment and peripheral images		4	5
Subconscious control of team member images		9	15
Subconscious creation of own fidelity and authenticity (realism)		4	6
Personalisation of the MS protocol		4	10
Physical practice assisted with mental simulation vividness		7	38
Random images created		2	2
(Get ready) Sub-theme- "Coping"	Mental simulation offers coping strategies for dealing with the stress of CPR in cardiac arrest Coping- Edmund Velasco		
Confidence (comfortable) in own performance		10	53
Still have some doubts about their performance		3	6
Feeling under-confident- unsure of themselves		2	3
Mental simulation helps to cope with stress		4	4
Mental simulation reduces anxiety		6	16
Preparing you for real-world cardiac arrest		3	7
Self-efficacy		3	4

(sub)Theme with codes beneath	**Theme Description**	**Files**	**References**
Skill learning- I'm ready		11	53
Thoughts of CPR cause anxiety (performance anxiety)		7	23
Theme- "Authentic"	Script authenticity can affect the mental simulation experience The Kids From Fame – Hi Fidelity		
Audio fidelity amplifies scenario		11	70
Audio distraction		1	3
Audio passed me by		4	5
Audio helps to keep focused		3	6
Audio reduces thinking load		2	3
The authenticity of the script affects the vividness of images		6	14
Comfortable with the GIS		6	9
Anticipation		2	3
Experience of script increases vividness		2	5
Lack of authenticity at times		4	7
Basic script had less action		5	5
Real-time issues highlight the importance of authenticity		10	34
Less is more in the fidelity of the GIS		3	11
Metronome beats and timing		4	8
POV offers insight into cardiac arrest		2	2
Repetition (practice makes perfect)		6	20

(sub)Theme with codes beneath	Theme Description	Files	References
The script creates a sense of urgency		8	21
Description affects flow		1	3
The tone of voice (stress)		1	2
Script description leads to higher fidelity		11	102
The script captures the real-world		2	2
Script detail adds direction		4	6
Script detail situates me- 'I'm there.'		8	22
The script amplifies emotional fidelity and authenticity		11	59
The script does not help to create emotions		2	6
The ethics of inducing emotional fidelity		1	4
Vividness varies throughout		1	3
Theme- "Get Ready"	The challenges of graduateness and preparedness for nursing Get Ready-Temptations		
Closing skill gaps increases automated skill		4	4
Closing skill gaps increases automated skill		4	4
CPR ~battle scars~		3	15
Learning skills from the point of view film		3	5
Learning styles (I'm a visual learner)		5	16
Mental simulation is a reflective tool (intrinsic feedback)		9	35
Mental simulation protocol helps to reflect on the bigger picture of		7	30

(sub)Theme with codes beneath	Theme Description	Files	References
practice			
Reflect on real-world performance gaps		6	27
Recognition of skill decay through lack of practice		5	7
Rote learning		7	15
(Get ready) Sub-theme- "Harmony"	Understanding the processes and sequence of life-support Harmony-Ikson	0	0
It helps to understand the ALS process		2	4
Structure driven		10	42
The process becomes clearer from using the protocol		7	16
The script is like a checklist		1	2
The script and film assist in demystifying the complexity of ALS		0	0
Process and structure driven		11	46
The process becomes clearer from using the package		7	16
The script is like a checklist		1	2
Theme- "I can't imagine"	Kinaesthetic mental simulation- some participants are born more equal than others Born to be different- Colotron		
Kinaesthetic struggles (imagining touch is not easy)		11	30
More to kinaesthetics than visualisation		1	1
Kinaesthetics and the unknown		3	3
Kinaesthetics is based on experience		7	12

(sub)Theme with codes beneath	Theme Description	Files	References
Kinaesthetics require more script detail		4	8
Kinaesthetics worked for me		4	10
Script induces kinaesthetic fidelity		3	4
Visualising is stronger than kinaesthetics		3	3
Subtheme- "Picture Perfect"	Participants identify the personal side to undertaking MS Chris Brown Ft Will.i.am - Picture Perfect		
10-minutes is longer than you think		7	22
Basic GIS is basic		9	33
Being on placement		1	2
Body position is distracting		1	2
Dark room - eyes closed		8	10
Distraction-free time required to image		11	48
Get in the zone- warm-up		6	10
Go at your own pace		2	4
Mental simulation in my dreams		1	2
Mental simulation is tiring		1	2
Individualising the process		4	13
Life's busy conflicts		9	27
Need head space to undertake the task		9	17
Need to be in a practical position		2	4

(sub)Theme with codes beneath	Theme Description	Files	References
Need to be in a relaxed position		7	19
Prioritisation of protocol		2	2
Sustainability		7	11
Time management is essential		3	6
Tiredness interferes with mental simulation		2	3
Where and how I do MS is essential to how I engage with mental simulation		7	12
Theme- "Motivation"	CPR performance is a strong motivational driver for using mental simulation Kelly Rowland ft. Lil Wayne - Motivation This now has ‘feeling prepared’ in this sub-theme. Feeling prepared for practice was a clear motivation for the participants - this needs to be added to the theme definitions		
Feeling prepared for cardiac arrest		4	8
Feeling under-confident- unsure of themselves		3	4
Mental simulation reduces anxiety		8	21
Interest in the CPR due to career aspirations		5	9
Intrinsic motivation		2	4
Motivation is a lack of real-world experience		3	4
Thoughts of CPR cause anxiety (performance anxiety)		7	24

During phase 6 of thematic analysis, writing the report, analysis proper began. The analysis meant that things evolved during the writing

phase

Phase 5- Naming and defining and codes

Theme/ subthemes	Definition
"Motivation"	CPR performance is a strong motivational driver for using mental simulation
"Picture perfect." (subtheme)	The participants had fit mental simulation into their busy life schedules, creating the time and space necessary to undertake it.
"Hi-fidelity" (theme)	The script narration and cues of the audio-guided mental simulation script (script) created the basis for creating a high-fidelity, authentic, mentally simulated scenario
"Imagination" (subtheme)	The participants tended to produce images evoked by the language within a script, but they significantly individualised the images. The participant created these images from past and memories unique to them.
"Hang on to your emotions" (subtheme)	The narration and the sound effects within the script evoked high-arousal states that are akin to those felt in a real-world cardiac arrest
"I can't imagine." (subtheme)	The majority of participants found the kinaesthetic (haptic) mental simulation challenging. The script did not tend to evoke high-fidelity kinaesthetic images
"Harmony" (theme)	Mental simulation created periods of reflective practice, which illuminated gaps in skill and knowledge and demystified CPR's structure and processes
"Coping" (sub-theme)	The participants were often underconfident and found the thought of doing CPR in practice to be stressful. Still, mental simulation was often discussed as giving them greater self-efficacy towards their ability to perform clinically, meaning they felt ready to cope with real-world CPR practice

Themes, codes and examples of data extracts

Chapter 1

Theme ''Motivation''

Code	Dataset extract example	Participant
Feeling prepared for cardiac arrest	I feel like I know more I've learned more. I'd like to think I'd be less panicked whether, like I said, I think there will always be that panic there. But I think it has helped me. I think I know more what I'm doing now. It's been good.	John
Feeling under-confident- unsure of themselves	Because then obviously, when more people come, those people will check your actions and then they will confirm whether what you're doing is good or not, which is obviously as I always have the problem with myself. If I'm doing the right thing, but when more people come, it gives me…a bit more reassurance that what I'm doing is actually right.	Jack
Mental simulation reduces anxiety	Yeah, definitely-- definitely, I think so. I think now, for me, if I can see things, it will make me less anxious about doing things. So, for example, you spoke about catheters; another anxiety of mine is I have never had to put in male catheters, so, now I am always worried I am going to do it the wrong way. So, I think if I see somebody do it and then I can think about doing it in my head while doing it that would help me.	Emerald
Interest in the CPR due to career aspirations	I am quite interested in this because I want to work in A&E, I am probably going to do CPR at some point.	Wendy
Intrinsic motivation	I mean, certainly, I know one of my friends here is also doing this, and she is like me, she's very much like, "Oh, let's go there, we go to all like… if there's any sessions on for like – extra sessions on our skill sessions—	Paula
Motivation is lack of real-world experience	Possibly yes, because I have not done it, it was harder. But as I said earlier, I think if you had done lots of CPRs I don't think you would-- maybe I'm wrong but I don't know if you would bother with doing this because you've done it and you've got that skill down, I suppose. Whereas, I hadn't done it that is what made this appealing to listen to.	John
Thoughts of CPR cause anxiety (performance anxiety)	Yeah, probably, yeah, I think if I had done it in real life, I probably would know what it felt like. Because yeah, it does scare me thinking of doing it on a real person because it's so different from a spongy mannequin, isn't it.	Mandy
Recognition of skill decay through lack of practice	I think these skills do disappear quite quickly, don't they? I'm sure there's been some research done to show how many weeks and days it takes for those skills to disappear.	Lucy

Sub-theme- ''Picture perfect"

Code	Dataset extract example	Participant
10-minutes is longer than you think	But I must admit it was something that was always in my forefront as in I was always conscious of the fact, "Oh, I haven't done it. I didn't do it yesterday, so I must do it today." Because I felt as if I needed to do it at least three times a week to be able to give the research project its best opportunity.	Amy
Dark room - eyes closed	I think the darkness helps because you have nothing to visually distract you	Emerald
Distraction-free time required to image	Not that it helped me relax but I visualise when I am relaxed, because if there is any interference, I will not be able to visualise. But when it's doing the actual [CPR], I think I will be in it whatever, even if it's busy I will do it. But when I am visualising, I need to be a quiet place in a relaxed position.	Claire
Get in the zone- warm up	I had been thinking about maybe I'd gone off listening from the script. So maybe in the start I was more listening to each and every word. Actually, what I did at the start was I watched the video beforehand and the first couple of times I watched it I thought, "Oh that is so good" it set the mood and I felt panicked and then when I listened to the script, I felt this is probably how it would be feeling going into it.	John
Life's busy conflicts	Yes, when I am busy and I have got assignments at night and sleeping late and children coming in between, I just cannot do it when I am with other things, you know? When my head is telling me it's time to iron or time to do this, I have to do it when I am relaxed.	Claire
Need head space to undertake the task	Yeah, I tried it at around 1(pm) o'clock after my dinner once because I was in the house by myself, my parents were out, and I had got a day off university and I tried it then and I found it quite hard. I think it's maybe because it was bright, and I could hear my dogs walking around in front of me. I think I really need nothing around me to distract me to listen.	Emerald
Need to be in a practical position	I think it did help. Even if they are in a hospital bed you do kneel on it, I think it does help you imagine it because you are already in that position where you can imagine yourself doing it and looking around.	Sarah
Need to be in a relaxed position	It's difficult to visualise something if you are not relaxed because then you are all tense, then you are actually feeling it in your body, and you are feeling other things apart from the things. You are feeling those things instead of what you are trying to feel through the video or through the audio, so, there could be a clash there between	Ralph

	what is real and what isn't real.	
Prioritisation of protocol	But I feel like that is because I am a third year. I think if I was in first year because of who I am, if that had been put on BlackBoard, "Oh, I'm gonna do that," because it's all shiny and new and I have not got job deadlines	Wendy
Time management is essential	No. I am a believer in if you want to do something you will do it. I do not like thinking that you are too busy to do anything, realistically. I did fit it in, and I think doing nursing with the course time management is key with everything.	Ralph
Tiredness interferes with mental simulation	It was dark when you have your eyes shut anyway and so, there wasn't a distraction, so, it was like I was more open to feeling something. But there was one time when I did it when I got up for placement at five [5am], which I really regretted, and it was just that early and I just thought, "I cannot focus on this."	Wendy
Where and how i do MS is important to how I engage with mental simulation	So, I was at home for the most time, apart from one time. I was at home in my bedroom. And I was stood up, with my eyes closed. Didn't have any distractions or anything. Been stood up, even though I wasn't actually in the same position as you would perform. It helped me to kind of visualise being there, kind of with the team and with the patient.	Paula

Chapter 2

Theme- "Authentic"

Code	Dataset extract example	Participant
Authenticity of the script affects vividness images	Yes. When you go to the patient. When you hear the…when you go to the patient and you are just about to assess; the adrenaline rush because I also have very sweaty hands. So, my biggest problem is putting the gloves on in emergency. That's not going to happen. Cause my hands go straight into sweating and there is no way I can do like, simple tasks, to put the gloves on. So, when I watched it for the first time, I felt my hand become straight away sweaty and yes.	Jack
Comfortable with the GIS (script)	No, I think it did because I think you are almost expecting-- you know what is coming at you expecting the healthcare assistants you are waiting for them to say, "Right for two breaths and then--" so yes, the knowledge, as they say that 'knowledge is power' don't, they? Once I knew what was happening and understood it, I could visualise it more because I knew it and it made sense.	John
Anticipation	Yes, I was feeling-- you know, I knew the next… the next [thing] that is coming, with	Claire

	[started to say knowledge] visualisation you have, you know what is coming next.	
POV (Film) offers insight into cardiac arrest	As in 'it wasn't like when you watch some CPR videos you have got one person they are talking to the camera and it is all very vague'. Whereas this I think how this is filmed, it is filmed from someone's point-of-view and it made you feel like you were that person, almost... that was doing the filming and you had people coming in and it didn't feel perfectly filmed or scripted, so it felt like it was kind of happening rather than being a fake, "Now I'm going to do this" kind of.	John
Script creates a sense of urgency	Talking a bit faster but only at specific points. Because obviously, when…so, for example following the advanced script, there is…you were washing the patient and the health care assistant says, come have a look at this patient. At that time everything is calm but then always, as soon as you start to diagnose and do the CPR, things were starting to speed up. So, I think temporary increase of tempo or speediness of the talker, would have helped to make a better visualisation of the scenario.	Jack
Script description leads to higher fidelity	I really liked it overall. I definitely found it easier using that. I found it was more detailed on the whole and I really liked the sound of it, it made it more realistic, and it did help me to feel a bit more in the moment. The first time I used the advanced I did put, "It is still a bit difficult to feel the chest". Sometimes I found it easier than other times to feel the feeling of pumping on an actual human chest. I did enjoy the advanced script. I put, "I could feel the adrenaline/stress of the situation more"	Lucy
Script captures the real-world	Even watching that point-of-view and you have got this other patient that they have made up and whatever's wrong with him, it makes you think of the patient that you have looked after that day. I think especially because a lot of the patients I have been looking after, have been one on one or two on one care kind of thing.	Wendy
Script detail adds direction	I think towards the end when they are talking about where they are in a shockable rhythm or if you have to give adrenaline, I think I could imagine that more. A) because it was a bit different from the advanced script, but I felt then like I was stood listening to a conversation between different people. Whereas the first bit when you are just doing the CPR, I felt like I was there less. I think I imagine the end more and then I think at the end they say about 'you go off to phone the family' or something and I could imagine myself walking to the desk and picking up the-- and I-	John
Script detail situates me- 'I'm there'	No. Hard to describe really. Because it's like you're almost in that person's body, you were actually the person, obviously with the camera on. But it's like you were actually that person, and you were in that scenario. And like even when the other student	Paula

	nurses saying like, oh, we need to take care of chest compressions and stuff in the minute, it’s like you could feel like you were – that person saying to you, you need to jump. You actually could feel yourself almost start to move.	
The script amplifies emotional fidelity and authenticity	The bed. The way the bed was creaking, that was definitely. Because every time it said, I could feel as the time, I am pushing the patient into the bed obviously. Also, one was when I kind of felt that CPR was actually real is when the bed slapped down. When people put CPR button, that’s a sound effect and that was a part where I kind of knew that OK, this is the situation right now	Jack
The ethics of inducing emotional fidelity	I do not know if I have a response to that one. How do you evoke emotions in someone? Everyone is different, everyone has got different triggers. You cannot go, "Here's the answer. let's do this," and if you did, you would be very insensitive to some people. Would you really want to bring some people back to a scenario in their life or a past, you know? You know, if they already been in one arrest then would you actually want to bring them back to bring all those things, would that be ethical? For other people it might be insightful. They might want to know what it might feel like if they have not been in an arrest scenario and they might be intrigued into that. I think, OK, give them a little of taste, but I think it would be very difficult to actually give them a snippet of those emotions.	Ralph
Vividness varies throughout	I think it was a lot easier. I did this thing in my diary, all my lines on how much I could visualise, so, I found this really easy. So, some of them like this was really good and then it went down at the end, that was a really crap day because it was like, "No, don’t know what I'm doing, feel like I'm not involved." That was a really good day, that was a really crap day in the middle, that is because I was bored	Wendy

(Authentic) Sub-theme- ''Imagination''

Code	Dataset extract example	Participant
Filling in the blanks; creating own little world (subconscious)	Mandy: No, I cannot pinpoint where I was. I guess I do a lot of bank shifts and stuff. Interviewer: Was that the same for the advanced script, did you picture yourself anywhere particular for the advanced script? Mandy: Yes, but I do not know where I was.	Mandy
False memories planted	I was on the basic, because I really wanted to imagine, to understanding it more and the speed of it, so, I watched this video and it was just, I don’t it was just two weeks	Claire

	ago… and now every time, I always see them doing it. I do not see myself doing it.	
Students move around a lot	Right, yes. I guess it's probably because I do quite a lot of bank work and lots of different wards and stuff.	Mandy
Subconscious control of environment images	Most probably because it was an environment, I felt comfortable with. You don't make the connection as well on your spokes as you do on your hub. So, my hub was where I felt comfortable.	Amy
Subconscious control of equipment and peripheral images	Yeah, they were the same on the ward I worked on, the red trolley. Probably with the defibrillator a little bit because the defibrillator was different in the two things I was thinking of. It just kind of arrived, I did not think about it getting there. So, maybe I thought about colours and stuff like that and what they actually look like because I never mess around with airways a little bit, we do not really do a lot with them, so, I was thinking about airways and that kind of thing.	Emerald
Subconscious control of team member images	I always bring that doctor in the scenario. It's because I also like to bring him. Why the doctor did not know that, he is looking after this patient, why he did not know that he had a DNR or whatever? At first, I went to the chest, why he did not do the procedures properly? As a doctor, knowing that I am a student, he would have told me check in the mouth, open the airway or something, he could have given me instructions.	Claire
Subconscious creation of own fidelity and authenticity (realism)	It was definitely a ward environment. Although, second year was all in community. For some reason this was always on a ward.	Amy
Personalisation of the of the MS protocol	So, it's like when you are reading a book you have got your own visualisation of what is happening but then somebody else might have a totally different visualisation, so, if you put that into a video, like your point-of-view video that you have made would be different to one that I would make.	Wendy
Physical Practice assisted with mental simulation vividness	I think you'd have a better… I think you would be able to link the two quicker having a pathway between your mental simulation and the real-life thing. So, you would recognise it in real-life and then you would remember what the mental simulation does and then you would be able to apply it. But I think the stages you have to go through in real-life so the actual emotion, the recognising it, the actual assessing it in real life, going through those thought processes because although you know what you are looking for, actually seeing it is different.	John

(Authentic) Sub-theme- “Hang on to your emotions”

Code	Dataset extract example	Participant
Emotional connections increase vividness	Yes, it was a real person but not someone who I knew, particularly. Maybe that would have helped to picture someone maybe how I'd formed a good connection with at some placement or work.	Lucy
Emotional fidelity comes from real-world experience	Not really, I have not really written emotion. I guess it would have been different if I had just written like a cardiac arrest recently and it was someone that I was looking after, yes, I am sure it would probably evoke a lot more stuff, I felt quite detached from it, really.	Mandy
Audio fidelity amplifies scenario	Would I change anything in it? No, I think it was good as it is, yes. It gives me the urgency, the buzzer, everything that is there is what a real scene would be. So, it gives me the image of the real thing, that is what we should do in our practical, they should put everything in because when you hear that buzzer, I think you even first panic before you act but the advanced is giving us the real scene how it should look like, so, I think it’s good.	Claire
Audio helps to keep focused	But that’s the thing. In terms of like learning, the sounds are amazing, because it’s really helped you to be – it makes you – you can imagine yourself be in the situation, especially if you have heard that sound before, and you have	Paula
Patient rapport evokes mental simulation emotion	I suppose it would be different in practice if you actually knew the patient and you'd been looking after them for a while. I imagine it would be more emotional maybe, that would be in the back of your mind. I don't think I pictured anyone body in particular.	Lucy
Emotions are evoked from experience	Yeah. This one patient, she kind of died from a cardiac arrest, so like that even without that scenario, I’d still make that link, I can still see her face, and all this, so I could. Yeah, definitely, I don’t forget her, so yeah.	Paula
Technical knowledge assists with mental simulation vividness	Read the glossary. If you feel unsure with the terminology definitely. I would say watching the video helps, well helped me, provoke the emotion that I needed. I think just the more knowledge you have, anything you don't understand learn about it because that helps you imagine it.	John
Emotions got less with MS practice	you actually start to – you manage your emotion better and things. And you’re actually a bit calmer in the situation. It didn’t feel like really, really urgent or anything, but it didn’t need to be, because I got – whatever was being described to me, I was able to kind of imagine the seriousness of it	Paula
The script evokes visceral	Emerald: Panic.	Emerald

emotion	Interviewer: Did it actually make you feel a little bit panicky? Emerald: I could feel like thinking my hands are getting a bit clammy. Then obviously because you are doing it, I did try and do it myself while I was-- This sounds stupid, but do you know when I was doing it and it said the bones break but my spring went a little bit, so, I it was the springs in the bed I could feel. So, now I always thinking about the noise my bed made when I did it.	
Script does not help to create emotions	I think generally I didn't really feel any strong emotions throughout, really. I think that was true throughout, really. I don't think I felt the same stress I would feel if I was actually there.	Lucy
The ethics of inducing emotional fidelity	You know, if they already been in one arrest then would you actually want to bring them back to bring all those things, would that be ethical? For other people it might be insightful.	Ralph
Vividness comes from layering of images (repeated exposure)	I think if you keep doing it, you are thinking more about it, so, every time you are doing it you keep thinking of more things without even knowing you are doing it, so, it gradually builds up a bigger picture… I think it's just like I was same, the more I used it the more I kind of built the picture up and knew what was coming next	Sarah
Vividness is created through real-world experience	Yes, but even when I start visualising, I have not been visualising my practicals, I visualise the episode that I had. So, I think they should go hand in hand, you do the practical and then you are told to think about this or choking features, so that you can imagine yourself in that position. But the practical just by itself I do not think is helpful.	Claire
MS detail can be created through simulated-world experience	Yes, so I was imagining the advanced script before I'd even listen to it because we'd done it a bit at uni[versity] in quite a bit of detail, what everyone's doing, so I think I was imagining that	Lucy

(Authentic) Sub-theme- "I can't imagine"

Code	Dataset extract example	Participant
Kinaesthetic struggles (imagining touch is not easy)	I think the instructions were quite simple to follow, really. The only thing I had to think about was kinesthetics because I had never really heard of doing that, I had never heard of it before you mentioned it. I had heard of mental simulation because I had done it myself but kinesthetics I did not really know. Nobody mentioned it, first time hearing it.	Emerald
Kinaesthetics worked for me	Yeah, I mean it wasn't like absolutely everything, but it was just like that. Like I said, I could	Paula

	feel my fingers on each side of that. And I could feel the skin and stuff.	
More to kinaesthetics than visualisation	Because I think imagining things is easier than feeling because feeling…I think there is too much going on with the feeling because you feel for the material. You feel for the temperature. You feel for the wind in the environment. Cause obviously, for example, in CPR situation there are people rushing about, bringing stuff, knocking into you or like touching you, obviously while you're doing CPR, people working around you. So, feeling is…in a CPR situation, I think it's harder than imagining you being there because as I said, because of all these. Because seeing is one sense but imagining or like…like feeling for the things, 'cause I think a bit more that's actually happening rather touching because you can feel the material. You can feel the temperature	Jack
Kinaesthetics and the unknown	It could be the fact that it's an unknown. As in I think if you had been in that situation and -- because they all say doing CPR on a dummy to real life is completely different. You know, you've got the clammy skin, everything else. So, whether because I don't have that memory to be able to connect with it, I don't know.	Amy
Kinaesthetics are based on experience	I think the description helped. But maybe without, it's hard to – because I'm not have the experience of actually doing it. Maybe without that description, without that being in the script, I might then not actually be able to feel that myself, because I haven't had that actual experience of doing it. But the descriptions were – it might have been a memory that's retrieved, some things I'm feeling.	Paula
Kinaesthetics require more script detail	Again, it is similar. I think less detail means it's vaguer. I would say feeling it was less. I think it was easier to see with the basic script than feel because it was less detailed, I felt like I was there less. I could feel less because I didn't feel like I was really there may be as much as I did with the advanced script.	John
Script induces kinaesthetic fidelity	That was a lot better, and [I] certainly like using the advanced script, I noticed…. Well, actually, the skill developed a lot quicker with that. And it's because of the detail, a lot more sort of. And so, with the more detail, I was able to be kind of more creative with it. But I was able to feel the scenario, so feel things, that were coming in a lot easier. But again, like I said, the descriptions were – there was more to the descriptions. There was more sort of like you can feel this, or you'll be seeing this and that.	Paula
Visualising is stronger than kinaesthetics	I guess doing the exercise and the questionnaire, feeling is obviously feeling yourself doing it physically because we were not doing it physically. So, I was trying to imagine myself lifting my leg up but then I think that was just me seeing it rather than me feeling it. But yes, I think I am quite good at visualising.	Mandy

Chapter 3

Theme- ''Harmony''

Code	Dataset extract example	Participant
It helps to understand the ALS process	I think because the script was so different to the video, at least it came across that way to me, that I felt like I could put my own spin on it, kind of thing. There were still things like, you know, things were done in a very similar order, so, you were kind of doing the same thing as what had been done in the video but because it was different you could-- So, it's like when you are reading a book you have got your own visualisation of what is happening but then somebody else might have a totally different visualisation, so, if you put that into a video, like your point-of-view video that you have made would be different to one that I would make.	Wendy
Structure driven	Because it gave us structure. It was…because as I said, from my experience the POV video was quite realistic. There was always somebody who went straight into the chest. There was somebody who was at the same time getting oxygen and then they called the crash team. And then what I'd seen in my practice is actually how it happened and then came the anaesthetic or somebody who can take over the…who is a bit more qualified to take over the airway. So, yes.	Jack
Process (CPR) becomes clearer from using the package	It's like something that is giving me the fact(s) or the way to do it. It's something like a guide, something that is guiding me to do the CPR properly. It's difficult to express, but what I want to say is that it's like something that you can remember that image from there, you take back and it guides you on what to do, it helps you on how to do it. Without it, you do it wrong, you start form the wrong place and you will not know how to do it properly.	Claire
Mental simulation is a reflective tool (reflection)	Yeah, I got anxiety I would say, I'd say quite a bit of anxiety, thinking, "where is everything? What can I do? What can I do this?" But like I said, I did replay it last night just to think now I have done this practical will this change my feelings about, feeling things, like, now I can feel it and watch the video and then watch the advanced script.	Emerald
The script and film assist in demystifying the complexity and chaos of advanced life	Because in a way you have to…I know this might be a bit morbid, but you have to take away that that's a person sometimes and make sure that you just say…you do whatever you have to do because obviously, you can't…what I feel like this…as I said,	jack

support	it might be a bit morbid. You can't…I can't view the person who's in a CPR situation as a person, I have to think about it as a task, because obviously, when I break a rib, then I will be just going to total chaos that I could have literally killed my patient	
The process becomes clearer from using the protocol	Yes, and you are just at home a lot more relaxed. I think simulation is a bit more stressful, I guess. Also, I knew I was listening to like, "There's a right way of doing things," so, I guess in simulation you might be watching other people, or you are doing it yourself, not actually the right way and the tutor might just be like, "Yeah, OK. That's fine. Sit down," type of thing. But yes, so, knowing the right way, I think and just the repetition, basically.	Mandy
The script is like a checklist	As I said probably not as well as other people did. I think when I was listening, I thought more along the lines of maybe like a checklist again. I'd be thinking I'd need to check if they are breathing, I'd need to feel for a pulse, I'd need to do all of this.	John
CPR ~battle scars~	Yes, that is what I was seeing [their cardiac arrest experience] and I could see myself saving that patient. I also see that one also I found in the street. So, that is what I used to visualise, but that one, the visualising has given me the-- you know, the depth of it. Because I do remember when we resuscitated this patient in the stroke unit, we just put the bed in the CPR position, I do not remember checking her mouth, I cannot even remember tilting her head, I just went to her chest.	Claire
Reflect on real-world performance gaps	No, it's like a refresher, you have to know the basic before you go to the-- It's refreshing what I knew, you know? It makes me do it properly, have that knowledge. You visualise the right thing. So, before I could have just visualised myself just wait for compression, but not before anything I will first talk to the patient and open his airway. So, that is the basic, starting from the basic that is how we are going to save the patient's life. So, it refreshes my mind of what I had. It added… It polished what I had.	Claire
Mental simulation protocol helps to reflect on the bigger picture of practice	It was, but do you know what I mean? You can only do it to a certain extent, I understand that. But then I found it beneficial because I could see what they were looking for, I could see them doing chest compressions, I could see when it was appropriate to swap chest compressions and when it was not appropriate too, they physically say, "Sorry, can somebody swap with me, I'm getting tired." I could see people delegating, I liked seeing it, I needed to see it.	Emerald
Closing skill gaps increases automated skill	That was just because I'd forgot to write down what I did on my last session I'd done. I'm just scribbling it down to remind me. I felt alright actually, with the manikin	Lucy

	there. I felt like it was sort of was almost automatic because I was having a listen to the script quite a lot of times over the last few weeks. It felt like it was there in my brain, although I did realise I think in my head I've been doing them too fast. They were 60-100 a minute, compressions	

(Get ready) Sub-theme- ''Coping''

Code	Dataset extract example	Participant
Confidence (comfortable) in own performance	I definitely think now, because I used to have quite a bit of anxiety regarding this, I definitely feel more confident now, particularly with the quality of my chest compressions and imagining unresponsive patient, I do feel very confident going through A to E and doing everything in between there.	Emerald
Still have some doubts about performance	I'm hoping that it will work, in the fact that I am hopeful that I will feel more comfortable in a situation and I won't panic, but I don't know.	Amy
Preparing you for real-world cardiac arrest	I think it would mean that when that did happen to you, you would think it's OK that this is happening, it will go in a second. I think it was good rather than-- if you had never heard that I don't know what to do thing and then you were in a situation and you didn't know what to do you would panic and think, "Oh god I'm the only one that doesn't know what I'm doing" or "Why don't I know what I'm doing?". But hearing someone say actually that happens to all of us is useful.	John
Mental simulation helps to cope with stress and anxiety	I think it would help because if you were in practice and you did start feeling that there is a chance it could just snap back, it actually said that in the script, "That is normal. That is fine. Now, just carry on with what you are doing."	Sarah
Mental simulation reduces anxiety	…yesterday and I think I would panic less if it was really happening to me. Not that I would not be panicked because everybody is, obviously, it's an arrest, it's an emergency, we need to do something quick. But I think I could think about what needed to be done, for example, if someone forgot something, I could think about it a little bit more, feel a little bit more confident doing that and I think I would be more confident doing compressions	Emerald

Performance anxiety	I feel like I would know what everybody else was doing. I would know to do chest compressions and stuff but it's quite nice to prepare me as a student for, "That's what that person's doing, that's what that person's doing," because I think that is the stuff that is quite anxiety inducing for students is, "I kinda know what I'm doing but I've got to fit in with in with what everybody else is doing." So, it's like knowing that prepares you a bit better.	Wendy
Skill learning- I'm ready	It improved it because it sticks in my mind and I cannot do a mistake. I know what to do now.	Claire

Nick White (2022)