# Clinical simulations using virtual patient avatars for pre-registration pharmacist training: a mixed methods evaluation

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# Abstract

Virtual patients (VPs) are routinely used in the training of medicine and nursing professionals but uptake into pharmacy has been slower. The pharmacy pre-registration training year takes place in the workplace and a disparity in the perceptions of support provided and the pre-registration examination pass rates has been established between the training sectors. This programme of work aimed to evaluate the effectiveness of virtual patients (VPs) at supporting pre-registration training when compared to a non-interactive (NI) learning tool.

Following institutional ethical approval, a mixed methods approach was adopted to evaluate the VP technology. A purposive sample of 165 pre-registration trainees (2014-2015) who were completing their training in a UK-based community or hospital pharmacy were recruited. Participants were randomly stratified to receive three VP or NI case studies. Knowledge surrounding the case studies was assessed using a quasi-experimental evaluation and thoughts on the two learning tools were obtained and compared via questionnaires and semi-structured telephone interviews. Quantitative data was analysed using descriptive and inferential statistics and qualitative data was analysed using content analysis (questionnaire) and framework analysis (interviews).

No significant differences in knowledge improvement between pre-registration trainees in the VP and NI groups were obtained. Significant improvements in knowledge were found between the sectors of training for the three case studies. Pre-registration trainees reported that the VP enabled them to apply their learning and engage in experiential learning. The VP case studies were associated with greater satisfaction and were reported to provide a more realistic, interactive and enjoyable learning experience. Pre-registration trainee's perspectives of the VP technology as a learning tool were more favourable regarding the development of real-life complex skills and aspects of learning, which provides a remit for further evaluation of the technology in undergraduate and postgraduate pharmacy training.

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# Abbreviations

3D – Three-Dimensional

AAMC – Association of American Medical Colleges

ACCP- American College of Clinical Pharmacy

ACPE – The Accreditation Council for Pharmacy Education

BNF – British National Formulary

BPSA – British Pharmaceutical Students' Association

CAI – Computer-aided instruction

CMS – Content/Course Managing Systems

CPD – Continuing Professional Development

CPPE - Centre for Pharmacy Postgraduate Education

CPR – Cardiopulmonary resuscitation

CVD – Cardiovascular disease

DOH - Department of Health

EHC – Emergency hormonal contraception

ELT – Experiential Learning Theory

EMR – Electronic medication record

FAQ's – Frequently asked questions

FIP – International Pharmaceutical Federation

GMC – General Medical Council

GPs – General practitioners

GPhC – General Pharmaceutical Council

HPS – Human patient simulation

HPV – Human papilloma virus

ICA – Interactive clinical avatar

IPE – Interprofessional education

IUD – Intrauterine device

IVR – Interactive voice response

IPPE - Introductory Pharmacy Practice Experiences

IT – Information technology

JT – Jessica Thompson

KAVE - Keele Active Virtual Environment

LMS – Learning management system

LMWH – Low molecular weight heparin

LSI – Learning Style Inventory

MCHP – Multimedia case history program

MCQs – Multiple choice questions

MEP – Medicines, Ethics and Practice

MHRA – Medicines and Healthcare Products Regulatory Agency

MPharm – Master of Pharmacy (degree)

MUR – Medicines use review

NASA – The National Aeronautics and Space Administration

NRLS – National Reporting and Learning System

NHS – National Health Service

NI – Non-interactive

NMC – The Nursing and Midwifery Council

NMS – New medicine service

NPA – The National Pharmacy Association

NQP – Newly qualified pharmacist

OSCE – Objective structured clinical examination

OTC – Over-the-counter

P – Pharmacy Only Medicine

PGD – Patient Group Direction

POM – Prescription-only medicine

PRISMA – The Preferred Reporting Items for Systematic Reviews and Meta-Analyses

PSNC – Pharmaceutical Services Negotiating Committee

RAF – Royal Air Force

RCT – Randomised control trial

RPS – Royal Pharmaceutical Society

RR – Response rate

SOAP – Subjective-objective-assessment-plan

SP – Standardised/Simulated patient

TTS – Text-to-speech

UK – United Kingdom

UPSI – Unprotected sexual intercourse

USA – United States of America

VLE - Virtual learning environment

VP – Virtual patient

WHO – World Health Organisation

# 1. Introduction

## 1.1 Foreword

This thesis presents a mixed methods study of pre-registration pharmacist's perspectives on the usefulness and usability of interactive clinical avatars (ICAs) compared with a non-interactive learning tool.

An overview of a pharmacist's role is given in section 1.2 before a discussion of the skills that pharmacists should possess in section 1.3. The education of undergraduate pharmacists and training of postgraduate pharmacists is discussed in section 1.4. Pedagogy and the cycle of learning is considered in section 1.5 before the use of e-learning in education is discussed in section 1.6 and the history of simulation is discussed in section 1.6.1. The study is briefly introduced and the organisation of the thesis outlined in section 1.7.

## 1.2 A Pharmacist's Role

A pharmacist is "a person who is professionally qualified to prepare and dispense medicinal drugs" (Oxford Dictionaries, 2017a). In recent years, the role of a pharmacist has progressed from purely dispensing and compounding medicines to the integration of a more clinical and patient-centered approach to care (DOH, 2003, 2005, 2008; RPS, 2015). Pharmacists primarily worked within community or hospital sectors but new roles are rapidly emerging and becoming established (DOH, 2005, 2008; Smith *et al.*, 2013; RPS, 2015; Barnes *et al.*, 2017).

Integration within the overall healthcare team is now increasingly emphasised within the pharmacy profession (DOH, 2008; NHS England, 2014a). Work sectors are also expanding with pharmacists now

having a greater role in GP practices in primary care; a change supported by government initiatives (RPS, 2014; NHS England, 2016a). This is a welcomed advancement for the pharmacy profession as their knowledge of medicines is essential to ensuring patient safety (Wagner, 2000; Hanlon *et al.*, 2004; DOH, 2008; Brown *et al.*, 2014; NHS England, 2014a; RPS, 2015).

The education and training of undergraduate and post-graduate pharmacists needs to align with the changing profession to ensure students are equipped with the necessary knowledge and skills when entering practice (DOH, 2008; Guile and Ahamed, 2009; Smith and Darracott, 2011).

## 1.3 Skills of Pharmacists

The World Health Organisation (1997) discussed the role of a pharmacist and the specific knowledge, skills, attitudes and behaviours they should possess, and in doing so created 'The Seven-Star Pharmacist'. This concept was taken up by the International Pharmaceutical Federation in 2000 in its policy statement on 'Good Pharmacy Education Practice' (FIP, 2000), insisting that pharmacists should be: care-givers, decision-makers, communicators, leaders, managers, life-long learners and teachers. As a result of the advancing career and requirement for evidence-based practice, a second WHO report added that pharmacists should also possess researching skills (Wiedenmayer *et al.*, 2006).

The American College of Clinical Pharmacy (ACCP) proposed that all pharmacists should become 'clinical pharmacists'. A competent clinical pharmacist is one who holds the knowledge, skills and attitudes to provide safe and effective patient-centered care and can ensure rational medication use (Burke *et al.*, 2008). This may also be considered appropriate for UK-based pharmacists because of the advances in areas such as prescribing, service-based community practice, consultant pharmacists and Multispecialty Community Providers (NHS England, 2014a).

Further competencies which pharmacists should possess have been suggested in the literature, with Jungnickel *et al.* (2009) discussing self-directed learning, interprofessional collaboration and cultural competence. The increasing interdisciplinary roles of pharmacists and the increasingly multicultural nature of the United Kingdom (UK) may indicate these as worthwhile considerations for competencies which pharmacists should possess (Office of National Statistics 2011). Understanding the varying cultures of patients which may affect attitudes towards medicines or the effectiveness of certain medicines themselves are potential areas where further support may benefit pharmacists.

Specific skills will be discussed below in sections 1.3.1 to 1.3.3. Section 1.4 will discuss the potential issues with ensuring pharmacy graduates are able to meet these competencies before qualification. The use of e-learning as a tool to aid competency development will be discussed in section 1.6.

### 1.3.1 Communication Skills

Pharmacists are an underutilised healthcare profession. There has been a push for patients to visit their local community pharmacy to obtain advice and information on a wide range of conditions, minor ailments and medications rather than visiting their general practitioners (GP's) (DOH, 2005; Porteous *et al.*, 2006; Saramunee *et al.*, 2012; NHS England, 2013; Paudyal *et al.*, 2013; Anderson and Thornley, 2014; Brown *et al.*, 2014; Watson *et al.*, 2015). This has been encouraged by NHS campaigns such as 'Stay Well This Winter', 'Choose the Right Service' and the 'Ask your Pharmacist' full NPA Campaign (NHS, 2015, no date; NPA, 2016). Pharmacists may not be using the complete range of skills and knowledge which they develop during their undergraduate and postgraduate education and training; this push is hoping to utilise their expertise more fully.

The number of medicines available to the public without a prescription has increased, and will continue to do so, which pharmacists need to be able to supply safely (Rutter *et al.*, 2004; Watson and Bond, 2004; Hanna and Hughes, 2012; Paudyal *et al.*, 2014; Fingleton *et al.*, 2016; RPS, 2016). The

public need to have confidence in the pharmacy profession and, as stated in the GPhC 'Standards for Pharmacy Professionals', pharmacists must provide patient-centered care and communicate effectively (GPhC, 2017). The internet is a resource that is used by a large majority of patients and has resulted in the creation of 'expert patients' (Hardey, 1999; Diaz *et al.*, 2002; Henwood *et al.*, 2003; Fox *et al.*, 2005; Scottish Health Council, 2011; Rozenblum and Bates, 2013; Ziebland *et al.*, 2015). The increased information available to patients has been identified as a barrier to the patient-centered, collaborative relationships pharmacists wish to build (Hardey, 1999; Henwood *et al.*, 2003; Fox *et al.*, 2005). This, along with a lack of patient understanding of the pharmacy profession, may have led to an increased difficulty for pharmacists to interact with these expert patients as they believe they know what medicine they require and prefer to purchase it without input from a pharmacist (Hardey, 1999; Henwood *et al.*, 2003; Fox *et al.*, 2005). Effective communication skills are key to ensuring safe and effective practice and providing patients with the best care possible (Barber *et al.*, 2003; Leonard *et al.*, 2004; DOH, 2005; Johnson, 2013; Jee, Schafheutle, *et al.*, 2016b; van Eikenhorst *et al.*, 2017). The growing distribution of ethnic minorities entering the pharmacy profession has led to the GPhC producing the document 'Guidance on Evidence of English Language Skills' and creating new resources which could help improve communication skills may be beneficial (Willis *et al.*, 2006; Seston and Hassell, 2009, 2011; Hassell, 2012; GPhC, 2016a).

The literature surrounding pharmacist's communication skills has established that their consultation skils could be improved by becoming more patient-centered and thus potentially increasing adherence to medication regimes and advice given (Hargie *et al.*, 2000; Blom and Krass, 2011; Greenhill *et al.*, 2011; Jee, Grimes, *et al.*, 2016). Pharmacists are confident when using the 'WWHAM' questioning technique but research has found that individuals may be too reliant on the formulaic questions and fail to explore a full symptomatic history to ensure safe and effective treatment (Rutter *et al.*, 2004; Watson and Bond, 2004; Watson, Bond, *et al.*, 2006; Watson *et al.*, 2009; Inch *et al.*, 2017; van Eikenhorst *et al.*, 2017). A 'Which?' report in 2013 established variation in the quality of

advice offered by pharmacies. Unsatisfactory advice was given on 43% of occasions; independent pharmacies provided the worst advice and counter assistants gave significantly poorer advice than pharmacists (Pearl, 2013). These results illustrated only a negligible improvement from the 2008 'Which?' investigation into the quality of community pharmacy advice, so it is implicit that there is still a need for all pharmacies to meet high practice standards (Which?, 2008). Poor advice may be elicited to a number of factors related to inadequate communication skills, for example incorrect or insufficient questioning, lack of empathy or a lack of rapport building to obtain information (Hargie *et al.*, 2000; Maguire, 2002a, 2002b; Greenhill *et al.*, 2011). The poor levels of advice noted in the 'Which?' reports may have led to a loss of confidence in the profession by the general public and contributed to the underutilisation of pharmacies (Hargie *et al.*, 2000).

Pharmacists also need to be competent and confident at interacting with other healthcare professionals, especially with the increasing multi-disciplinary nature of pharmacists' roles. The Joint Commission for Hospital Accreditation revealed that communication failure may be the primary cause of over 70% of patient safety incidents in the United States (Leonard *et al.*, 2004). In the United Kingdom, poor communication at handover has been identified as a particular area of risk and accounted for approximately 33% of the 10,000 incidents reported to the National Reporting and Learning System (NRLS) in 2014 (NHS England, 2014b). Standards have been produced to improve communication between healthcare professionals and ultimately improve patient outcomes, however these are only for patients upon discharge from hospital, and other areas of interdisciplinary working may benefit from such standards (NHS England, 2016b). Research has found that pharmacy students do not feel confident when interacting with professionals from other health disciplines, which highlights this as an area for improvement in their education to ultimately reduce the likelihood of patient harm and ensure effective transfer of patient care when in practice (Smith and Darracott, 2011; Vyas, McCulloh, *et al.*, 2012; Hagemeier *et al.*, 2014; Agomo *et al.*, 2016; Yu *et al.*, 2016).

### 1.3.2 Clinical Reasoning

The 'Seven Star Pharmacist' noted that pharmacists should be decision-makers (Wiedenmayer *et al.*, 2006). Whilst this remains an important competence, as the clinical role evolves, pharmacists need to progress their skill level to clinical reasoning and not just simply 'decision-making' or 'problem-solving'. Clinical reasoning is a learnt skill which all healthcare professionals should possess to deliver the highest standard of patient care (Levett-Jones *et al.*, 2009; Kassirer, 2010). It has been defined as "the process by which nurses (and other clinicians) collect cues, process the information, come to an understanding of a patient, problem or situation, plan and implement interventions, evaluate outcomes, and to reflect on and learn from the process" (Hoffman *et al.*, 2009; Levett-Jones *et al.*, 2009). Clinical reasoning involves higher order thinking skills such as: gathering information, recalling knowledge, reviewing information, interpreting, making inferences, predicting, analysing, synthesising and evaluating; thus, involving both cognitive and reflective thinking (Hoffman *et al.*, 2010; Kassirer, 2010; Lapkin *et al.*, 2010; Simmons, 2010; Vyas *et al.*, 2011).

Critical patient incidents commonly occur as a result of poor clinical reasoning by healthcare graduates (Del Bueno, 2005; New South Wales Department of Health, 2006; Aiken *et al.*, 2011). Those with inadequate clinical reasoning skills are less likely to notice patient deterioration compared to those with effective clinical reasoning skills, which ultimately leads to poorer patient care (Kassirer, 2010; Lapkin *et al.*, 2010; Levett-Jones *et al.*, 2010). Thus, improving students' clinical reasoning skills may have a positive impact on patient care once qualified.

Pharmacy students may have less practical clinical experience compared with those in medicine and nursing, which can lead to reduced clinical reasoning skills once qualified if one accepts the premise that clinical reasoning skills are learnt (DOH, 2008). It has been established that traditional learning techniques do not effectively facilitate the development of clinical reasoning skills, therefore

additional, novel educational tools may provide benefit (Del Bueno, 2005; Lapkin *et al.*, 2010; Forsberg *et al.*, 2011).

### 1.3.3 Continuing Professional Development

WHO (2006) suggest that pharmacists should be 'life-long learners' (Wiedenmayer *et al.*, 2006). Pharmacists are required to undertake continuing professional development (CPD) to demonstrate their commitment to delivering high quality care to patients (DOH, 1998; GPhC, 2011b). This involves the continual reflection and expansion of knowledge, skills and attributes throughout their career (GPhC, 2011b). Pharmacists' engagement with CPD has been found to be limited and the importance of CPD may need to be highlighted to a greater extent at an undergraduate level (Bell *et al.*, 2001; Attewell *et al.*, 2005; Tunney and Bell, 2011).

Healthcare is constantly progressing and pharmacists need to keep up-to-date with changes to medicines, the law and treatment guidelines to ensure patients are provided with the best care. For pharmacists to be able to complete CPD successfully they must have the necessary skills for self-directed learning; which should be taught and implemented during undergraduate education (Jungnickel *et al.*, 2009; Tunney and Bell, 2011). Knowles (1975) defined self-directed learning as "a process in which individuals take the initiative, with or without the help of others, in diagnosing their needs, formulating learning goals, identifying human and material resources for learning, choosing, and implementing appropriate learning strategies and evaluating learning outcomes". Undergraduate and postgraduate pharmacists should be able to identify their learning needs and understand the learning required to meet them (Mills *et al.*, 2005; Tunney and Bell, 2011). Having a range of accessible resources available for individuals to engage with self-directed learning may be beneficial for their learning (McKimm *et al.*, 2003).

## 1.4 Pharmacy Education

A four-year Master of Pharmacy (MPharm) degree at University and a fifth pre-registration training year are required to become a pharmacist in the UK. Some Universities currently offer an integrated five year course. There is a drive to encourage more Universities to offer this, due to the potential benefits that the integration of theory and practice can have on learning (Reeves *et al.*, 2002; Illing *et al.*, 2008; Brazeau *et al.*, 2009; Smith and Darracott, 2011; GPhC, 2015b). A licensing examination must be successfully passed at the end of the five years for an individual to be registered with the General Pharmaceutical Council (GPhC). The GPhC have created standards for the 'Initial Education and Training for Pharmacists' (GPhC, 2011a) which contain educational outcomes that all pharmacy students must be able to demonstrate by graduation. Individuals' competence is primarily measured by Miller's Triangle (Miller, 1990) which will be discussed in greater depth in section 1.4.1.

In April 2008, the Government published a White Paper entitled 'Pharmacy in England: Building on Strengths – Delivering the Future.' The aim of this White Paper was to advance and improve the pharmacy profession (DOH, 2008). One of the recommendations was to increase the amount of real pharmacy experience for undergraduate students due to the substantial difference in the level of clinical experience received by pharmacy students in comparison to other healthcare disciplines. A report was created in response to the White Paper which identified current issues with the education and training of undergraduate pharmacists and discussed improvements which could be made to ensure students enter practice with sufficient knowledge and skills to work safely and effectively (Guile and Ahamed, 2009). Both pharmacy students and pharmacy employers reported a deficit of skills upon entering practice, particularly with the application of knowledge. Implicit in this is the need for students to undertake standardised placements and have enough pharmacy practice experiences to enable them to link learnt material with practice. This, however, may become more difficult due to the increasing numbers of undergraduate pharmacy students and potential pharmacy cuts. Alternative methods of teaching may be beneficial in helping to tackle the 'theory-practice gap'

which has been identified (John *et al.*, 2005; Whelan *et al.*, 2007; Guile and Ahamed, 2009; Willis *et al.*, 2009; Langley and Aheer, 2010; Smith and Darracott, 2011).

### 1.4.1 The Pre-registration Training Year

Pre-registration training can be undertaken in many areas of the pharmacy profession (see Figure 1-1). Variation has been established in the experiences and support individual pre-registration trainees have, and not all will enter practice with the same standard of knowledge and skills (Guile and Ahamed, 2009; Blenkinsopp *et al.*, 2013, 2015). This variation has been reflected in the disparity of pre-registration exam results between community and hospital based trainees (GPhC, 2015a).

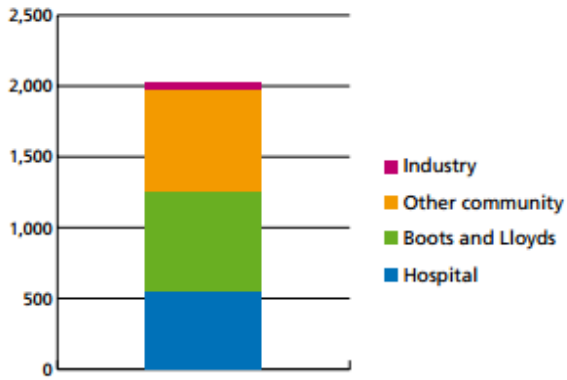



**Figure 1-1 Illustrates the pre-registration trainee distribution in England 2009-2010.The majority of trainees complete their training in the community-based sector, followed by hospital and then industry. Image from Smith and Darracott (2011).**

In addition to the initial standards for education, there are an additional set of outcomes set by the GPhC which must be achieved during the pre-registration training year (GPhC, 2013). The assessment of competence in pharmacist education is based on the theory shown by Miller's Triangle (Figure 1-2). Miller's Triangle differentiates between having underpinning knowledge (knows), the competence to

apply that knowledge (knows how), the ability to demonstrate that knowledge (shows how) and one's performance or action in daily practice (does).

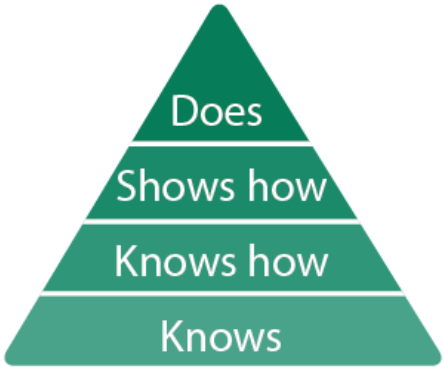



**Figure 1-2 Miller's Triangle taken from the pre-registration manual 2013.**

During undergraduate education and at baseline in pre-registration training, individuals may be at different levels of Miller's Triangle. Many will be at the 'knows how' level for applying knowledge, some may have progressed to the 'shows how' level for certain competencies which may have been developed through simulations or objective structured clinical examinations (OSCEs) and some individuals may even be at the 'does' level if they have sufficient real-world pharmacy experience. Throughout the pre-registration training year, students should progress up Miller's Triangle to the 'does' level for the competencies set out in their training manual (GPhC, 2013).

The variation in pre-registration training can affect individual competence development. There may be differences in exposure to certain situations which can affect the development and application of knowledge and skills. For example, within the GPhC pre-registration training manual, one of the performance standards states trainees should "respond appropriately to requests to dispense prescription-only items without a prescription". Individuals who complete their training in a hospital may find it more difficult to show their competence for this standard at the 'does' level, as emergency supplies are not routinely issued in a hospital setting. Similarly, those students who complete their training in a community pharmacy may find it difficult to develop and reach the 'does' level of

competence at “constructing medication histories using a range of sources”; although with the integration of Summary Care Records into community pharmacy this may become easier in the future (NHS England, 2014a; PSNC, 2017).

The role of simulation in healthcare education and training will be discussed in Chapters 2 and 3 but the range of learning tools encompassed in the term ‘simulation’ have been found to be effective for individual progression to the ‘shows how’ level of competence. Considering the ‘theory-practice’ gap which has been established in the literature, the problems with standardising placements and the increasing numbers of pharmacy students entering University, simulation as a preparatory tool for clinical practice or as a substitute when that experience is not available may provide benefits to the training of pharmacists. The use of learning tools which engage and promote learning are of interest to pedagogical researchers and will be discussed throughout this thesis.

## 1.5 Pedagogy and Learning

The term ‘pedagogy’ has been difficult to define amongst researchers and educators of different disciplines, nations and backgrounds, however Watkins and Mortimore (1999) have broadly defined pedagogy as “any conscious activity by one person designed to enhance learning in another”. It refers to both the understood theory and the application of that theory to the practice of teaching which encompasses all disciplines, forms of understanding and learning activities (Beetham and Sharpe, 2007). Although used interchangeably, the terms ‘learning’ and ‘education’ do differ from one another. Education relates to the perspective of an educator that a specific activity which is intended to produce a change in knowledge, skills or attitudes can actually produce a change. Learning is from the perspective of the learner and implies a process by which knowledge is created or a change in skills or attitudes is acquired (Knowles *et al.,* 1998). Learning may not always take place as an

educator assumes and, when creating or designing learning tools, it must be remembered that learners may develop unexpected knowledge or skills.

There are various theories of learning established in the literature which should be considered in the development of new learning tools. 'Behaviourist theories' relate to learning through reward or punishment and have a more passive process of learning. 'Cognitivist theories' relate to the acquisition, storage and organisation of knowledge and the ability of an individual to apply the same knowledge to different situations, which includes both passive and active processes of learning. 'Constructivist theories' refer to a more learner-centred learning approach in which new learning builds on top of existing knowledge (Knowles *et al.*, 1998; Masters and Ellaway, 2008; Fry *et al.*, 2009; Harasim, 2012; Moseley and Whitton, 2012).

Whilst there is little evidence to show that learning in children and adults differ from one another (Barr and Tagg, 1995; Cook, 2009; Fry *et al.*, 2009), the development of learning theories has expressed a disparity between the two (Knowles *et al.*, 1998). One of the most widely used constructivist theories of learning is Kolb's Experiential Learning Theory (ELT) (Kolb, 1984). ELT is a cyclical model of learning for adults consisting of four stages (Figure 1-3) which abides by the theory that learning is a "process whereby knowledge is created through the transformation of experience" (Kolb, 1984). The ELT is "a holistic integrative perspective on learning that combines experience, perception, cognition and behavior". Learning can be viewed as a continuous process grounded in experience, within which previous learnt knowledge can and should change based on new experiences (Kolb, 2015).

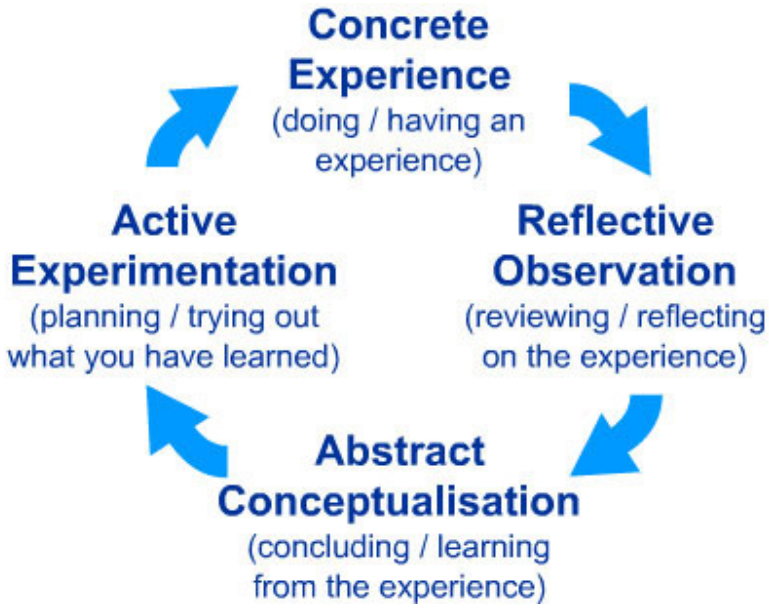



**Figure 1-3 Kolb's Experiential Learning Cycle. Taken from McLeod, S. A. (2013).**

In ELT, an individual is required to progress through the four stages of the cycle to declare that effective learning has taken place; experiencing, reflecting, thinking, and acting. Individuals can begin the cycle at any stage, but must complete the sequence to achieve a full cycle of learning. It is important that users remember that learning outcomes may not match the learning objectives set by educators, reinforcing the more learner-centered approach of the cycle (Kolb and Kolb, 2005). Ideally, the experiential learning cycle should start with concrete experience, such that an individual must actually have an experience to learn from it, to encourage active involvement in the learning process. These experiences are the basis of observations and reflections which lead to the conceptualisation, interpretation and understanding of relationships. The final stage is when the learner considers how they are going to apply their learning and create new experiences (Kolb, 1984). Inherent in the experiential view of learning is that learners are self-directed, able to take responsibility for their own learning and able to reflect on their own practice; all of which are essential for the lifelong learning of

healthcare professionals. The creation of resources which promote experiential learning may be beneficial in the training of undergraduate and postgraduate pharmacists.

In addition to understanding the cycle of learning, it is also important to consider how individuals learn to ascertain the correct instructional tools are created and provided. The notion of learning styles is problematic as there are several categories of 'styles' (Fry *et al.*, 2009). One of the most influential models of learning styles is Kolb's Learning Style Inventory (LSI) which suggests that learners draw on their preferences for the different phases of the ELT (Kolb and Kolb, 2005). However, although learners may have preferences, individuals should be encouraged to use a range of learning styles and tools to enhance their learning to the greatest extent.

The four distinct learning styles Kolb describes are: converger, diverger, assimilator and accommodator. The convergent learning style lies within 'abstract conceptualisation' and 'active experimentation' and is associated with problem-solving, decision-making and application of knowledge. The divergent learning style lies within 'concrete experience' and 'reflective observation' and these individuals tend to be more imaginative and are able to view situations from many perspectives. Assimilators lie within 'abstract conceptualisation' and 'reflective observation' and focus less on individual needs and more on ideas, concepts and logical arguments. Accommodators lie within 'concrete experience' and 'active experimentation' indicating that they learn better from more 'hands on' experience (Kolb and Kolb, 2005). Research has evaluated the learning styles of pharmacists and pharmacy students using the LSI, and has identified a proportion of individuals who fit into each of the LSI categories (Austin, 2004; Williams *et al.*, 2013). This substantiates the requirement for a variety of learning tools and resources to be provided to pharmacy undergraduates and postgraduates to assist with their learning and CPD.

Beetham and Sharpe (2007) explain that "learning is a set of personal and interpersonal activities, deeply rooted in specific social and cultural contexts. When those contexts change, how people learn

also changes". The 'information age' is here and the technological advances have changed the contexts in which people learn, leading to an increase in technology-enhanced learning, or e-learning (Gordon, 2014). Learners are not the same as they were before the digital transformation, therefore a re-evaluation and adaptation of teaching and assessments is required to meet their needs (Bryant, 2012).

## 1.6 Use of e-Learning in Education

The increasing use and availability of computers and technology in everyday life has, not surprisingly, led to their use to support education (Cook, 2006; Masters and Ellaway, 2008). The advances in technology has created a 'digital native' generation in which individuals are 'native speakers' of the digital language of computers, video games and the Internet (Prensky, 2001). This is opposed to the previous 'digital immigrant' era, where technology wasn't as prevalent; individuals who grew up in this time may be more confident using books to learn (Prensky, 2001). Learners are different now; they are used to receiving information extremely quickly, they like to multi-task and seek to find the best way to solve a problem using a multitude of resources (Prensky, 2001; Harasim, 2012). As such, the way 'digital natives' are taught needs to adapt to meet their learning needs.

Technology-enhanced-learning (or e-Learning) has been described as "a web-based system that makes information or knowledge available to users or learners and disregards time restrictions or geographic proximity" (Sun *et al.*, 2008). Another new method of learning is m-learning, which describes mobile learning, and is becoming increasingly popular in medical education due to the portability of mobile devices (Masters and Ellaway, 2008). E-learning encompasses many different tools, including Virtual Learning Environments (VLEs), Learning Management Systems (LMS), Content/Course Managing Systems (CMS), ePortfolios, eAssessments and synchronous or asynchronous communication tools (McKimm *et al.*, 2003; Ellaway and Masters, 2008). E-learning is

primarily concerned with using computer technologies to foster a paradigm shift from teaching to learning and supports specific pedagogic concepts, such as: flexible learning, blended learning, personalised learning, gamification and asynchronous or synchronous learning networks (Barr and Tagg, 1995; Vrasidas, 2004; Dabbagh, 2005; Bliuc *et al.*, 2007; Fry *et al.*, 2009; Gordon, 2014).

There has been an increase in the quality and quantity of distance learning programmes which utilise e-learning because of the flexibility of learning that they provide (Bryant, 2012; Hammersley *et al.*, 2013). As well as students being from a digital native generation, the number of more mature students is also increasing (NUS, 2012; Hammersley *et al.*, 2013). Being able to access course material remotely is of great benefit as it encourages users to take responsibility for their learning and promotes individualised learning; both of which have been identified as features of effective learning (Dabbagh, 2005; Sun *et al.*, 2008; Fry *et al.*, 2009). However, when e-learning is used alone, issues may arise due to differences in individuals' confidence or abilities in using technology. E-learning needs to be accessible to all users and considerations need to be made for those with poor information technology (IT) skills, as they may not engage in the learning process to the same extent. Ensuring effective support and training for e-learning may help to reduce this potential issue. Another potential solution would be for educators to implement a blended learning approach which combines e-learning with other non-technological learning tools (Harasim, 2012). This maintains the flexibility and individualised aspect of e-learning but may promote a greater sense of educator support and has been established as an effective teaching approach for adult learners (Childs *et al.*, 2005; Bliuc *et al.*, 2007; Harasim, 2012).

Blended learning has been used in 'flipped classroom' teaching, in which standard teaching is replaced with e-learning (Hammersley *et al.*, 2013; Gordon, 2014). Users are required to complete this e-learning in their own time before face-to-face seminars, lectures or computer-mediated discussions are held (Hammersley *et al.*, 2013; Gordon, 2014). This allows the tutor-led sessions to be

focused on particular issues, higher order questions and the integration of student-led problem based learning (Hammersley *et al.,* 2013; Gordon 2014). The effectiveness of this flipped classroom technique has been evaluated with favourable effects on student's critical thinking skills, student's knowledge and student satisfaction with learning (McLaughlin *et al.*, 2014; Wong *et al.*, 2014; Moraros *et al.*, 2015).

E-learning can be tailored for different pedagogical goals. For example, as Fowler and Mayes (1999) discuss, primary learning tools may simply present information, secondary learning tools support active learning and feedback, and tertiary learning tools support and promote the application of learning. The current pedagogical design of most curricula applies the traditional model of knowledge transmission of specific subject matter, whereas e-learning can promote the higher levels of learning (Dabbagh, 2005; Bryant, 2012). Encouraging individuals to be at the centre of their learning process may encourage self-reflection which is of upmost importance within pharmacy (Droege, 2003; Black and Plowright, 2010; GPhC, 2011a; Williams *et al.*, 2013).

The advent of the digital native generation of students and the benefits e-learning can offer provides a rationale for the use of these tools in pharmacy education. The range of knowledge and skills which pharmacists should possess have been discussed in detail throughout this chapter; creating resources which provide experiential learning to meet a range of learning outcomes and the demand for innovative learning tools is an area for further exploration.

A type of e-learning is simulation, although there are many different types of clinical simulation tools and not all require a computer or IT (as will be discussed in Chapter 2).

### 1.6.1 History of Simulation

Simulation has been defined as an "imitation of a situation or process" (Oxford Dictionaries, 2017b). Essentially a simulation is something that is created to look, feel or behave like a real-life situation, in which participants take on a specific role and work through a task or scenario which progresses based on their decisions and performance (Ker and Bradley, 2010).

Simulation has primarily been used for skill-enhancement within professional training (Issenberg *et al.*, 1999; Bradley, 2006; Rosen, 2008). A major development in the area of simulation was the production of the 'Link Trainer' in 1929, which was used to train Royal Air Force (RAF) pilots in World War II. It consisted of an imitation cockpit which allowed pilots to practice flying in a safe environment (Taylor and Walford, 1972). Throughout the 1930's, Armed Forces from around the world began purchasing these trainers to improve the training of their pilots and in 1955, civil aviation began using simulation training methods (Page, 2000; Rosen, 2008). The Federal Aviation Administration determined that pilots should use these simulators as a recertification method to maintain their pilot licenses due to their effectiveness at enhancing skills (Page, 2000; Bradley, 2006; Issenberg *et al.,* 1999). Use of simulation in the Armed Forces has continued to develop at a steady pace, with its use becoming increasingly widespread. At present, war simulations are an essential part of the training of soldiers in most armies throughout the world (Tansey and Unwin, 1969).

Another important milestone in simulation occurred in 1960 by The National Aeronautics and Space Administration (NASA). Simulators were created for NASA astronauts to experience different events and incidents which they may be faced with during a flight, to enable them to practice how they would respond (Rosen, 2008; Bradley, 2006).

In addition to the high-risk professions discussed above, simulations are also widely used in the training of business and management personnel and as an educational tool for child and adult learners. In academia, the most common use of simulation (other than healthcare) is in the education

of social sciences and the preparation of trainee teachers (Taylor and Walford, 1972). One of the benefits of simulation is the ability for users to develop knowledge and skills in a safe, controlled environment, which is important for the high-risk professions or where practical, real-world experience may be limited. The uses and benefits of clinical simulation in the training of undergraduate and postgraduate healthcare professionals will be explored throughout this thesis.

## 1.7 Introduction to the Study and Organisation of the Thesis

The premise of this study was to evaluate the usefulness of ICAs at enhancing learning during the pre-registration training year.

The literature surrounding simulation in healthcare education and the various virtual patient tools available are discussed in Chapter 2. A systematic, narrative review of the literature evaluating virtual patients in pharmacy education is presented in Chapter 3. A mixed method study design was used which incorporated both quantitative and qualitative data collection tools; the theoretical reasoning for the chosen methodology and the methods relating to the research are discussed in Chapter 4 and Chapter 5, respectively. Initially, a pilot study was conducted to test and finalise the study design and data collection instruments; the methods and results of this are provided in Chapter 6. The statistical results obtained from the quasi-experiment are displayed and discussed in Chapter 7. Chapter 8 presents and discusses the quantitative and qualitative results from the questionnaire. The qualitative interview results are reported and discussed in Chapter 9, including reflexive issues. All results are triangulated and discussed in relation to the literature in Chapter 10, where the strengths and limitations of the study and the implications of the study including future work are also discussed.

# 2. Literature Review – An Overview of Simulation use in Healthcare

## 2.1 Introduction

This chapter presents a review of the literature surrounding the use of simulation in healthcare education and training. A full narrative synthesis of the literature relating to virtual patient use in pharmacy is provided in Chapter 3.

The chapter begins with a discussion of the literature search in section 2.2, including the aim of the review (section 2.2.1), the search strategy (2.2.2), the eligibility criteria for study inclusion (section 2.2.3) and the appraisal of the literature (section 2.2.4). A classification of the simulation tools used in healthcare education and training is then provided in section 2.3. These tools are then discussed in turn; section 2.4 discusses standardised and simulated patients, section 2.5 discusses human-patient simulation and section 2.6 discusses computer-aided instruction. Virtual patients are introduced in section 2.7; their typology is presented in section 2.7.1 and their design is presented in 2.7.2. The literature surrounding virtual patient use in medicine and nursing is reviewed in section 2.7.3. Considerations of clinical simulation are then discussed in section 2.8, starting with the benefits (section 2.8.1), the limitations (section 2.8.2) and the current integration of simulation in healthcare education and training (section 2.8.3). A Chapter is summarised in section 2.9.

## 2.2 Literature Review: Background

### 2.2.1 Aim

The aim of the literature review was to identify the range of literature and define the different types of clinical simulation and their uses in healthcare education and training.

### 2.2.2 Search Strategy

A literature search was performed in September 2013 and repeated at regular intervals throughout the duration of the PhD (until December 2017) to identify appropriate literature. A number of electronic databases appropriate for locating articles on clinical simulation were searched (see Table 2-1). Both recent, up-to-date literature and historical work was sought and considered for inclusion in the literature review.

| **Electronic Databases Searched in the Literature Review** |
|---|
| Web of Science (1960 – 2017) |
| PubMed (1960 – 2017) |
| MedLine (1960 – 2017) |
| Science Direct (1960 – 2017) |
| BioMed Central (1960 – 2017) |
| Cumulative Index to Nursing and Allied Health (CINAHL) (1960 – 2017) |
| Google Scholar (1960 – 2017) |

**Table 2-1 Electronic databases and their associated dates for literature searching.**

The search strategy involved using keywords in combination with Boolean operators (e.g. AND, OR, NOT) to search the electronic databases. The keywords included: 'simulation', 'simulate', 'education', 'training', 'learning', 'pharmacy', 'medicine', 'nursing', 'healthcare', 'technology', 'computer', 'e-learning'. Thesaurus or MeSH terms were used within databases to help expand the search strategy. Truncation was used to search for all terms which belonged to a particular string of letters (e.g. using the word 'simulat*' to find 'simulation', 'simulate', 'simulators').

In addition to searching the above electronic databases, the archives of particularly relevant journals were accessed and searched directly. These included: Pharmacy Education, American Journal of Pharmaceutical Education and The Pharmaceutical Journal. Literature obtained from these search strategies allowed for 'snowballing' of other, relevant literature from their bibliographies (Greenhalgh and Peacock, 2005). In addition, books which related to simulation or technology and learning were identified via the Keele University library search function and included in the review (Keele University, no date). Grey literature was identified from Government and regulatory bodies (e.g. Department of Health and The General Pharmaceutical Council).

Initially, the literature surrounding the use of virtual patients in pharmacy education and training was searched. There were few recorded uses of virtual patients in pharmacy, thus a systematic approach to the review of this literature was adopted; the results of which are presented in Chapter 3. As a result, the search strategy for this general review was expanded to include the use of virtual patients in the education and training of all healthcare professions. This identified that the term 'virtual patient' was used for a wide variety of tools (see section 2.7.1). Few studies reported generalisable evidence of the pedagogical benefits of virtual patients which led to a more inclusive search of the literature relating to technology-enhanced learning and clinical simulation, as research in these fields had shaped that of virtual patient simulation.

### 2.2.3 Inclusion and Exclusion Criteria

Wide inclusion criteria were employed during the early stages of the literature review due to the variety of keywords, healthcare professions and uses of simulation. This allowed for a wide range of literature to be retrieved and reduced the potential of missing relevant literature. As this produced more 'hits' during the literature search, titles and abstracts of potential literature were briefly appraised to determine those which were relevant; full papers were examined where required.

Papers which related to simulation in areas other than healthcare education and training were excluded because of the differences in uses and outcome measures.

Searches included the keywords presented in section 2.2.2 and were limited to include only articles in the English language. Date limitations were also applied, particularly in the latter stages of the research, to ensure the most recent literature was identified. Short conference abstracts (less than one page), conference proceedings without full-text available online, conference presentations or posters and articles where no full text was available were not included in the review.

### 2.2.4 Literature Appraisal

A great breadth of literature was identified, so in line with the principles laid out by Bryman (2012), relating to the variety of methods used in the literature, an exhaustive coverage of all literature associated with simulation in healthcare education and training was deemed beyond the scope of this research. The literature review revealed more research relating to simulation use in other healthcare professions, particularly medicine and nursing, rather than in pharmacy. As this was relevant and could serve to inform the benefits and disadvantages associated with the implementation of computer-based simulation as a training tool, these papers were included in the review.

A critical approach to appraising the literature was adopted, but a systematic review was not conducted in relation to the use of simulation and technology-enhanced learning in healthcare education and training. An in-depth appraisal of all the literature regarding clinical simulation in healthcare was not the aim of the literature review, instead an overview of the main tools, their uses and outcomes was sought; thus a systematic review was not required.

A literature referencing library was created using Mendeley®. This was updated continuously throughout the duration of the PhD and duplicates were removed periodically. Literature was categorised based on the type of clinical simulation and the professional area.

The findings from the literature review are discussed in the following sections: classification of clinical simulation (section 2.3), standardised and simulated patients (section 2.4), human-patient simulation (section 2.5), computer-aided instruction (section 2.6) and virtual patients (section 2.7).

## 2.3 Classification of Clinical Simulation

Simulation in healthcare has been defined as:

> *"…a technique, not a technology, to replace or amplify real experiences with guided experiences, often immersive in nature, that evoke or replicate substantial aspects of the real world in a fully interactive fashion"* (Gaba, 2004).

The term 'simulation' encompasses a variety of tools which can be classified in a number of ways; the most common is based on the fidelity of the tools. Fidelity refers to "the degree of exactness with which something is copied or reproduced" (Oxford Dictionaries, 2017c) and thus refers to the accurate, real-life portrayal of the simulation. Simulation can be split into three categories on the basis of fidelity:

1. Low fidelity – part-task trainers, non-computerised simulation
2. Medium fidelity - standardised patients, computer programs, video games, human-patient simulation
3. High fidelity – virtual reality, computerised human-patient simulation

(Seropian *et al.*, 2004; Bradley, 2006; AAMC, 2007; Scalese *et al.*, 2007; Harder, 2010; Ker and Bradley, 2010).

Although simulations can be categorised, it is possible for a simulation to span the range of fidelity based on factors including: the creation of the tool, the utility of the tool and expected learning outcomes (Seropian *et al.,* 2004). Within healthcare the optimum simulation attempts to achieve a high enough fidelity to convince users they are, in fact, using something that resembles what they would encounter in real life but should not be too realistic and fall into the 'Uncanny Valley' (Mori, 2012). This hypothesis suggests that objects which portray human characteristics are viewed positively, up to a certain point when the degree of visual similarity to real humans becomes unsettling and triggers negative thoughts (Macdorman *et al.,* 2009; Cheetham *et al.,* 2003; Lay *et al.,* 2016). Thus, clinical simulations should mimic the clinical environment and allow the learner to apply cognitive, affective, and psychomotor skills in a realistic scenario, without inducing negative emotions. All types and fidelities of simulation are effective learning tools; the type of simulation required will ultimately depend on the intended learning outcomes (Seropian *et al.*, 2004). Throughout the literature, there is variability in the depth of descriptions provided regarding simulation tools, thus it can be difficult to determine study quality and understand the predictors of simulation which lead to effective learning.

A systematic review carried out by Issenberg *et al.* (2005) identified ten features of high-fidelity medical simulations that lead to effective learning: feedback, repetitive practice, curriculum integration, range of difficulties, multiple learning strategies, clinical variation, controlled environment, individualised learning, defined outcomes, simulator validity or authenticity. Throughout this thesis, the effectiveness of the various simulation tools will be discussed in relation to these ten features.

The definitions of the different simulation tools vary but those most commonly implemented in healthcare education and training can be classified as: standardised or simulated patients, human-patient simulators, computer-aided instructions and virtual patients (Gaba, 2004; Seropian *et al.*, 2004; Bradley, 2006; AAMC, 2007; Rosen, 2008; Rosen *et al.*, 2009; Chapman, 2012). Each of these will be discussed in turn below.

## 2.4 Standardised and Simulated Patients

Standardised patients can either be actors playing the role of a patient, or they can be real patients who have been trained to present specific emotional, verbal and behavioural responses (Barrows, 1993; Adamo, 2003).

The process of using standardised patients in education began in 1963 (Barrows, 1993), but they were considered expensive and unrealistic due to their inability to portray abnormal physiological signs or symptoms, thus were not utilised as fully as expected (Rosen, 2008). They have since become commonplace, especially in healthcare professions education as the benefits have been found to outweigh the limitations. Standardised patients offer the benefit of 'real-human' interaction which may be essential for the development of affective skills which are integral to all healthcare professions, such as communication or consultation skills (Lust and Moore, 2006). Standardised patients provide a safe environment for students to practice and develop their affective skills and knowledge before transitioning to real patients, which can only be beneficial to improve their confidence and competence (Barrows, 1993; Schultz and Marks, 2007; Ker and Bradley, 2010; Basheti, 2014).

Standardised patients have been found to ensure consistency for specific learning outcomes (Adamo, 2003). They are required to adopt certain behaviours or characteristics to provide standardisation of a learning experience (Barrows, 1993). Standardised patients are different to simulated patients

which refer to individuals involved in a medical simulation that is conducted purely for educational purposes, during which, the 'patients' may act and respond as they would do during any real-life consultation; thus there is less standardisation of the learning experience (Adamo, 2003; Ziv *et al.*, 2005). Simulated patients (SPs) are also a useful training tool as they provide 'real human' benefit, which other types of simulation may not. The terms 'standardised patients' and 'simulated patients' are used interchangeably within the literature, which can make it difficult to ascertain where both tools are best placed to be used in education, but these two types of simulation do differ and should be recognised as such[1] (Wallace *et al.*, 2002; Adamo, 2003; Wind *et al.*, 2004; Ker and Bradley, 2010). Both have been identified as useful educational simulation tools and it may be appropriate to 'mix and match' between the two to allow students to meet different learning or assessment outcomes. They could also be used in different stages of education, for example, standardised patients could be used in lower years to develop students' communication skills and confidence and the integration of simulated patients could come when students are more confident and able to deal with more unpredictable consultations.

Simulated patients may be preferred over standardised patients in healthcare education "due to the authenticity of role play and the quality of feedback [which] take precedence over uniformity and consistency of role play" (Wind *et al.,* 2004). Authenticity has been established as one of the factors of high-fidelity medical simulations that lead to effective learning (Issenberg *et al.,* 2005). SPs are used in the training of medics and nurses all over the world and their reliability, validity and feasibility have been confirmed in several studies, however this may have led to a reduction in more current, up-to-date literature evaluating their usefulness. With the growing pool of more interactive forms of simulation, it may be appropriate for researchers to evaluate current students' perspectives of SPs with or without a comparison to other forms of simulation (Wallace *et al.*, 2002; Adamo, 2003; Wind

[1] For the purpose of this review, the abbreviation 'SP' will be used when referring to either standardised or simulated patients.

*et al.*, 2004; McGaghie *et al.*, 2010). SPs have also been studied in pharmacy education, but to a lesser extent, which may be due to the perceived less clinical nature of pharmacists. However, with the increasing clinical aspect of a pharmacist's role and focus on consultation skills, SPs are a prime tool for training pharmacy students to improve their confidence and competence before qualification. A large proportion of SP literature, like all simulation literature, has focused on their effectiveness and usability with emphasis on student satisfaction (reported by questionnaires or interviews). These are suitable methods of data collection, but are associated with limitations, including bias, misunderstanding of questions or the Hawthorne effect. When assessing an educational intervention which is a core part of a curriculum, there is the risk of students responding in a positive way or how they anticipate they should, which can therefore affect the reliability and validity of results obtained. These methods of data collection also don't allow for the actual effectiveness of SPs in the development of knowledge or skills to be evaluated and, as such, more formal checklists of competence could be used.

SPs are played by human beings, and as such, there is a risk of variation due to fatigue, memorisation and bias (Austin *et al.*, 2006; Lurie *et al.*, 2008; Schwartzman *et al.*, 2011). Wind *et al.* (2004) created an instrument to evaluate the quality of SP performances and provide more rigour when SPs are used (especially in assessments), however there has been little discussion regarding utilisation of this tool in the literature. The authors found that simulation authenticity and SP feedback were the two most important components of a high-quality SP interaction. These findings have also been noted by Issenberg *et al.* (2005) as important factors of high-fidelity medical simulation that lead to effective learning. The literature has specified that the majority of SP consultations end with the provision of individualised feedback to the students, which can therefore aid their learning.

SPs require organisation by faculty members and the cost associated with their use and the time required to train the SPs themselves and the associated assessors have been identified as barriers to

their use (Barrows, 1993; Hubal *et al.*, 2000; Ker and Bradley, 2010). SPs may provide benefits when used in addition to, and not instead of, real-patients as they offer a complementary learning experience for students (Chapman, 2012). There have been few instances where SPs have been evaluated against another learning tool, however those studies which have included this as an outcome have found little difference regarding knowledge or skill development, but have identified that users respond with greater empathy towards the SPs (Cook and Triola, 2009). Thus, there are benefits for different simulation tools to be used in combination depending on the intended learning outcomes. Over the past few decades, the use of standardised and simulated patients in education has become utilised to such an extent that they are now often included in undergraduate exams and licensing examinations of healthcare professionals, as well as postgraduate performance reviews, but complete utilisation may be limited by the factors discussed above (Adamo, 2003; Munoz *et al.*, 2005; Austin *et al.*, 2006; Watson, Norris, *et al.*, 2006; Rosen, 2008; Mesquita *et al.*, 2010).

## 2.5 Human-Patient Simulation

Human-patient simulation (HPS) includes the use of mannequins or part-task trainers to simulate patient care experiences (Gaba, 2004; AAMC, 2007; Rosen, 2008; Ker and Bradley, 2010).

Part-task trainers can be anatomical models of specific human body parts in their normal or diseased states or surgical task trainers which simulate specific surgical procedures (Gaba, 2004; Bradley, 2006; Scalese *et al.*, 2007). They include those technologies that replicate a portion of a complete process or system. They are designed for students to practice and perfect specific technical, procedural or psychomotor skills, so when faced with a real patient they are competent and confident at completing the task (Bradley, 2006; Ker and Bradley, 2010). Part-task trainers are routinely used and are associated with high satisfaction scores for the development of basic skills, such as catheterisation or venepuncture, and more complicated surgical and diagnostic skills which may be difficult to attain

through traditional learning, placements or initial practice (Rosen *et al.*, 2009; Ker and Bradley, 2010). However, their use is limited, as more difficult practical skills or 'affective' skills cannot be developed via the use of part-task trainers, thus educational centres would have to invest in additional simulation tools for individuals' more rounded development.

A second HPS tool is mannequins. These are anatomical models of the human body which can vary in their fidelity based on the model used and the associated technology (Cooper and Taqueti, 2004; Seropian *et al.*, 2004; Bradley, 2006; Lapkin *et al.*, 2010). They can be non-responsive, voiced by an individual or able to portray specific physiological signs and symptoms; all have been successful at developing skills, knowledge and are associated with high user satisfaction (Cooper and Taqueti, 2004; Seropian *et al.*, 2004; Rosen, 2008). The fidelity of mannequins can affect the realism of a simulation and ultimately students' skill development, with those that are higher-fidelity being reported as more realistic and thus more effective at skill development. They are also likely to be more expensive and may require increased staff or student training to use, therefore institutions would have to weigh up the costs:benefits to make an informed decision regarding students' training needs and therefore the most appropriate simulation tool (Seropian *et al.,* 2004; Lapkin e*t al.,* 2010).

The literature search revealed that mannequin simulations were not a new concept in medical education. They were first used in the 1500's when Hieronymus Fabricius described a mannequin used to teach the reduction of joint dislocations (Cooper and Taqueti, 2004). The first latter day mannequin in widespread use was Resuci-Anne, a low-fidelity mannequin developed in 1960 by Asmund Laerdal for medical students to practice cardiopulmonary resuscitation (CPR). Resuci-Anne has been established as a successful teaching tool that it is currently used in the training of a wide range of healthcare professions and general first aid training (Cooper and Taqueti, 2004; Bradley, 2006; Fritz *et al.*, 2008; Rosen, 2008). It has been associated with measurable improvements in

students' performance and high satisfaction of use; both of which are important considerations when evaluating learning tools.

Despite Resuci-Anne's success, developments continued in HPS and the first computer-controlled full-body mannequin (Sim One) was created in 1967 (Cooper and Taqueti, 2004; Bradley, 2006; Fritz *et al.*, 2008). Although research using this mannequin to augment anaesthetic training showed a trend toward faster skill acquisition and subjective performance improvement, the mannequin itself was not widely accepted as the associated costs were too expensive for many educators (Cooper and Taqueti, 2004; Bradley, 2006; Fritz *et al.*, 2008). This started the movement for the development of other higher fidelity mannequins which were able to portray physiological signs and symptoms that may be beneficial for the training of healthcare professions (Cooper and Taqueti, 2004; Bradley, 2006; Fritz *et al.*, 2008; Rosen, 2008).

The first human mannequin simulation course was offered to medical students in 1994 (Seybert *et al.,* 2006). Mannequins in medical education primarily focused on anaesthesiology training but over the last decade they have begun to be introduced into other disciplines including trauma, paediatrics and emergency medicine; as well as nursing and pharmacy to a lesser extent (Schwid, 2000; Gordon *et al.*, 2001; Holcomb *et al.*, 2002; Seybert *et al.*, 2006; Fritz *et al.*, 2008; Hunt *et al.*, 2008; Bray *et al.*, 2011; Crea, 2011; Reape *et al.*, 2011; Branch, 2013). Both students and educators have been positive towards the use of mannequins in healthcare education and believe they should be utilised more thoroughly (Weller, 2004; Seybert *et al.*, 2006; Lapkin *et al.*, 2010; Reape *et al.*, 2011; Branch, 2013; Smithburger *et al.*, 2013). Similarly to SPs, a large majority of the literature has utilised self-reporting techniques which limit the reliability and validity of results, especially due to the limited discussion or use of validated data collection instruments (see Chapter 5 for further discussion). As mannequins primary use is in the development of skills, research should include a statistically significant measurable outcome in addition to user satisfaction scores.

Mannequins provide safe and controlled simulations to aid in the development of knowledge and skills which may be difficult for students to receive adequate real-life experiences in. They allow users to gain confidence in these areas before interacting with real patients (Gordon *et al.*, 2001; Cooper and Taqueti, 2004; Issenberg *et al.*, 2005; Seybert *et al.*, 2006; Lapkin *et al.*, 2010; Crea, 2011; Branch, 2013). They have also shown benefits in interprofessional education by aiding the development of teamworking and communication skills, however this has been studied less than outcomes for single healthcare professions and due to the increasing multidisciplinary nature of the NHS, should be considered as an outcome in future research (NHS, 2014; Seybert *et al.*, 2008; Vyas, McCulloh, *et al.*, 2012; Smithburger *et al.*, 2013; Nazar *et al.*, 2017). Mannequins are unable to address emotional intelligence, thus their use may be limited to technical or physical technique. It has been noted that HPS may not develop transferable skills due to their limited realism, which therefore may not prepare students to perform in an actual clinical environment (Feingold *et al.*, 2004). There has been limited study of these aspects of student development and may be a useful area for future research, to allow educators to understand the long-term usefulness of HPS. This, however, may not be a problem with higher-fidelity mannequins and the complete integration of HPS into curricula rather than their intermittent usage (Issenberg *et al.,* 2005).

HPS in healthcare education and training appears to be gaining acceptance but it has not yet reached widespread adoption, particularly in the UK and the nursing and pharmacy professions (Lapkin *et al.*, 2010; Kane-Gill and Smithburger, 2011; Reape *et al.*, 2011; Branch, 2013). Additionally, there has been little research into their use in assessments, which may be a role for future research as many education centres are moving away from the primary use of written assessments to include more practical exams and measures of competency rather than recalled knowledge. While HPS are in use, they are still the exception, not the rule, for healthcare education and training. The benefits that HPS can offer may determine them as effective complementary simulator experiences to real-patient exposure. The main concerns associated with HPS, especially those which are higher-fidelity, are the

cost of production, the storage requirements and the technical support required; with staff needing to be sufficiently trained before their inclusion into healthcare curricula (Chapman, 2012; AAMC, 2007; Issenberg *et al.,* 2005; Gaba, 2004). If the future implications of transferable skills are studied, this may make the cost:benefit decision easier for education centres but currently the long-term benefits are unknown. HPS also removes the option of self-directed learning by the student, as the simulation can only take place during scheduled time, which may affect their usefulness (Jungnickel *et al.,* 2009; Tunney and Bell, 2011). As stated previously, HPS cannot address emotional intelligence; other types of simulation may be better suited to this and thus better suited for use in pharmacy education and training. Although, the increasing clinical role of pharmacists may benefit from the use of HPS to develop those more practical skills, such as blood pressure checks or vaccination practice, therefore their role in these areas should be further studied.

## 2.6 Computer-Aided Instruction

Computer-aided instruction (CAI) encompasses a wide variety of technology, all of which use a computer to deliver information and promote active learning (AAMC, 2007). The technologies included in CAI range from lecture capture, computerised medical notes, computerised videos or games (Chapman, 2012; Smith and Benedict, 2015). CAI primarily encompasses low fidelity simulations which have low physical interactivity, which may affect the acceptability and usefulness felt by students and educators (AAMC, 2007; Hussainy *et al.*, 2012; Smith and Benedict, 2015). As discussed in Chapter 1, students are of an increasingly digital native generation so they may enjoy CAI but some tools can allow more 'passive' rather than 'active' learning, which may not encourage experiential learning and therefore may not promote effective knowledge or skill development.

Unlike SPs and HPS, CAI can be accessed anytime which encourages self-directed learning; an important trait for healthcare professionals (see section 1.3.1.iii). Additionally, the costs of production

and use are relatively low, which may make them a more acceptable simulation tool for some institutions (AAMC, 2007). The high costs and storage requirements associated with mannequins has led to the consideration of CAI as a training tool for practical skills, however research is limited in this area (Krummel, 1998; Ramshaw *et al.*, 2001; Nyssen *et al.*, 2002). Research has found no differences in the development of knowledge when using CAI compared with HPS and, as such, it has been determined that CAI can contribute to the training of technical skills, knowledge and individual competence (Fuhrman Jr. *et al.*, 2001; Nyssen *et al.*, 2002; Leong *et al.*, 2003; Smith and Benedict, 2015).

The first use of CAI in medicine was in 1961 and the development of further computer-based simulations occurred slowly due to the limitations in technology and medical knowledge (Piemme, 1988; Rosen, 2008). However, over the past few years, a variety of CAI has been developed which exists in the literature of healthcare education (Duque *et al.*, 2008; Rosen, 2008; Hussainy *et al.*, 2012; Salter *et al.*, 2014; Cain and Piascik, 2015; Smith and Benedict, 2015). This can make it difficult to ascertain the effectiveness of CAI as different programmes have different fidelities, authenticities and interactivities and not all research is specific regarding these aspects of the tool(s) studied. Within the research available, a lack of comparative studies are noted (Cook, 2005), possibly because it is difficult to conduct controlled trials comparing two types of learning tools and be sure the results are down to the interventions alone and no other confounding variables (Cook, 2009, 2010). When the effectiveness of CAI have been evaluated, knowledge and skills across a wide range of clinical topics have improved; illustrating the potential of computer-based simulations in the training of healthcare students (Duque *et al.*, 2008; Cook *et al.*, 2011). The variation in CAI tools can make it difficult to ascertain these attributes to all types and it may be useful for different CAIs to be compared against one another to allow educators to make informed decisions.

Research has established that CAI is easy to use but effects on student learning and satisfaction is varied (Smith and Benedict, 2015; Hussainy *et al*., 2012). This could be due to the diverse technologies included in 'CAI'. Research which has evaluated more interactive CAIs have found more favourable results than those which have evaluated tools which allow for more passive learning (e.g. lecture captures), however it is important to consider the intended learning outcomes and choose the most appropriate simulation tool (Smith and Benedict, 2015; Hussainy *et al.,* 2012). One of the most interactive forms of CAI are immersive environments. One such is the Keele Active Virtual Environment (KAVE); a room in which images are projected onto three walls and the floor to create a computer generated virtual environment (Keele University, 2014). Whilst in the KAVE, users wear 3D glasses and a tracking unit which allows a computer to pick up and respond to movements (Keele University, 2014). The KAVE can be used to simulate different environments to teach students of a single healthcare profession, or to promote interprofessional education. Immersive environments have also been used to enhance the teaching of anatomy, pharmacology and medicinal chemistry, with high user satisfaction (Chapman, 2012; Humphreys *et al.*, 2013; Richardson *et al.*, 2013). Although there are multiple benefits associated with immersive environments, the costs associated with their development and upkeep and the requirement for trained educators to be present during use, may affect full utilisation of the technology. It may be beneficial for these immersive environments to be evaluated against other forms of CAI or less interactive simulation tools, to see where they may fit in healthcare profession education. However, due to the costs and training requirements for creation and use, there are few immersive environments currently being used in healthcare education and therefore a limited scope for research.

'Gamification' is a new term which refers to "the addition of elements commonly associated with games (e.g. game mechanics) to an educational or training program in order to make the learning process more engaging" (Landers and Callan, 2011). Gamification may also be called 'educational games', 'serious games', or 'game-based learning' (Deterding *et al.*, 2011; Sera and Wheeler, 2017).

Games used within healthcare education don't only include CAI, they also include puzzles, strategy games and role-playing (Akl *et al.*, 2010; Cain and Piascik, 2015; Sera and Wheeler, 2017). The value of gamification in healthcare has been recognised, with education as the most popular area for use. Published research in this area is limited, particularly within pharmacy and countries other than the United States, and again the variety of games which could be used can make it difficult to ascertain which elements are required for effective learning to take place (Aburahma and Mohamed, 2015; Cain and Piascik, 2015; Sera and Wheeler, 2017). Research that has been conducted on gamification has described positive impacts on a range of skills and other areas including: critical thinking, communication, knowledge, confidence, enjoyment and engagement with learning, thus may be a potential avenue for further exploration (Duque *et al.*, 2008; Gormley *et al.*, 2009; Aburahma and Mohamed, 2015; Cain and Piascik, 2015; Sera and Wheeler, 2017). The limited research base, the increasing digital native generation of students and the abundance of literature which shows enjoyment as a key part of learning may determine that the benefits of gamification should be evaluated more thoroughly.

With more students entering undergraduate pharmacy curriculums who are familiar with video games and game-based living, it may be beneficial for pharmacy educators to explore how these instructional technologies could benefit a new generation of pharmacy students.

## 2.7 Virtual Patients

No single definition of a virtual patient (VP) exists in the literature; different institutions and authors describe them in different ways, which can make it difficult to appraise the quality of the literature.

The Association of American Medical Colleges (2007) defines VPs as:

*"A specific type of computer based program that simulates real-life clinical scenarios; learners emulate the roles of health care providers to obtain a history, conduct a physical exam, and make diagnostic and therapeutic decisions."*

A second definition is provided by The MedBiquitous Virtual Patient Working Group:

*"An interactive computer simulation of real-life clinical scenarios for the purpose of medical training, education, or assessment. Users may be learners, teachers, or examiners"* (Ellaway *et al.*, 2006).

Although multiple definitions exist, commonalities between them also exist. VPs are a computer-based simulation of real-life clinical scenarios to train healthcare professionals.

### 2.7.1 VP Typology

Unlike other forms of computer assisted learning, the outcomes of VP simulations are directly related to learner input which encourages users to take responsibility for their actions and learn from their mistakes (Cook and Triola, 2009). The term 'virtual patient' encompasses programs of differing interactivities and realisms, including: still photos, video clips, avatars and immersive virtual reality simulations (Chapman, 2012), however all must ensure the outcome is dependent upon user input.

In the context of a healthcare training tool, an avatar is a computer-generated animation which represents a patient or healthcare professional (Park and Summons, 2013a). Avatars can be described as 'asynchronous' or 'synchronous' (Bell, 2008; Petrakou, 2010). Asynchronous avatars (or non-real-time avatars) are those which students are able to access anytime without the requirement for another individual to be available; the simulations are created and stored for students to work

through in their own time. Synchronous avatars are those that are active in real-time and simulations may require input from multiple users or educators, thus they are not as flexible (Bell, 2008; Petrakou, 2010).

VPs are generally web-based which allows for a range of features, such as images or videos, to be easily integrated into their design (Huang *et al.*, 2007; Woodham *et al.*, 2015). It also allows users to access the simulations anytime, promoting self-directed learning (Dewhurst *et al.*, 2009; Poulton and Balasubramaniam, 2011; Benedict *et al.*, 2013; Hege *et al.*, 2016). Ensuring ease of access to resources encourages student involvement with their own learning and the use of VPs has found to improve engagement with distance learning (Zary *et al.*, 2006; Guise, Chambers and Välimäki, 2012; McFalls, 2013; Ghanbarzadeh *et al.*, 2014). Issenberg *et al.* (2005) stated repetetion as an important feature to aid learning in high-fidelity medical simulations. The web-based aspect of VPs enables repetitive practice with increased standardisation over traditional real-person interactions (Johnsen *et al.*, 2005).

A problem when searching the literature and drawing conclusions on the use of VPs in healthcare education and training is the variety of tools which can be classed as 'virtual patients' and the [lack of] descriptions which are provided. The majority of research has been carried out using non-animated VPs or those which utilise video clip responses; asyncronous or synchronous avatars and immersive reality are discussed to a lesser extent (Cook and Triola, 2009; Cook *et al.*, 2010; Jabbur-lopes *et al.*, 2012; Ghanbarzadeh *et al.*, 2014; Hege *et al.*, 2016). The different types of VP used can ultimately affect the usefulness of the tool for the proposed learning outcomes and student satisfaction with the learning experience (Bergin and Fors, 2003; Huwendiek *et al.*, 2009; Hege *et al.*, 2016).

To overcome the range of tools which are described as VPs in the literature, VP 'typologies' have been proposed to help with the categorisation and classification of VP simulations (Huwendiek *et al.*, 2009; Kononowicz *et al.*, 2015). Researchers need to be more explicit when explaining the VP used in

their research to ensure more thorough comparisons can be made between different VP types and outcome measures (Kononowicz *et al.,* 2015; Huwendiek *et al.,* 2009; Cook *et al.,* 2010).

### 2.7.2 VP Design

VPs may be costlier to produce than other CAIs due to the technological requirements of the software and the abilities of staff required to develop simulations. However, once established, the cost and time to create new simulations may be less than with other types of simulation tools. Once an underlying avatar model has been created, it can be reused and a new 'skin' or appearance can be created for it, therefore making new cases or updates quick and easy to do. Additionally, avatar algorithms (or scripts) are relatively quick and easy to update if required in comparison video-based VPs which would require re-filming and editing of whole simulations. VPs are easily customisable allowing for many simulations to be created; thus institutions may find the benefits of the technology outweigh the costs (AAMC, 2007). Ellaway *et al.* (2008) describes 'virtual patient commons' which allow the sharing of VP cases:

> *"A virtual patient commons is one where a particular community creates, adapts, shares, reuses and otherwise makes use of a bank of virtual patient cases held by and on behalf of that community."*

These VP commons encourage the sharing of VP cases across a range of disciplines and locations to overcome some of the issues associated with the creation of the cases which, again, may allow the benefits to outweigh the costs but other problems may arise, such as intellectual property (Huang *et al.*, 2007; Ellaway *et al.*, 2008; Poulton and Balasubramaniam, 2011). As the use and development of

technology increases, the initial outlay costs of avatars are likely to decrease, and therefore they may become an affordable option for most educational centres.

VPs can be created and customised in many ways depending on the learning outcomes, design knowledge of the individual creating the cases and the time available (Ellaway *et al.,* 2008; Huwendiek *et al.,* 2009; Poulton and Balasubramaniam, 2011). The two main VP designs are branching or linear (Ellaway *et al.*, 2008; Huwendiek *et al.*, 2009; Bateman *et al.*, 2013; Woodham *et al.*, 2015). Linear VPs have a single core pathway, which users are redirected back to irrespective of the decision made (Bateman *et al.*, 2012). Branching VPs are based on a decision tree or a 'Markov Model' (Sonnenberg and Beck, 1993) which allows users to make decisions at selected points throughout a simulation, which have the potential to change the pathway through a case and the overall outcome (Ellaway *et al.,* 2008; Woodham *et al.,* 2015; Benedict, 2010). Branching VP designs have been found to encourage user engagement and promote self-directed and reflective practice to a greater extent than linear cases, thus they may be better placed for the training of healthcare professionals, as there is rarely a definitive correct and incorrect answer in real-life consultations (Poulton *et al.*, 2009; Poulton and Balasubramaniam, 2011). Cook and Triola (2009) discovered that the branching VP model is particularly useful for learning critical decision-making skills, due to the dependency of the case outcome on user inputs (Cook & Triola, 2009). In fact, a large proportion of research into VP use has focused on their development of clinical reasoning skills, with encouraging results (Cook and Triola, 2009; Cook *et al.*, 2010; Forsberg *et al.*, 2011; Poulton and Balasubramaniam, 2011; Bateman *et al.*, 2012, 2013; Berman *et al.*, 2016).

VPs in healthcare education and training is an under-researched area, which may be because of the trained technical staff required to create and maintain VP simulations. It also may be due to the limited research which documents how VPs should be used, their precise design information and study outcomes, thus researchers interested in evaluating VPs in education may not understand how

to do so. The findings of the literature search are discussed below in section 2.7.3. The systematic review of VP use in pharmacy is presented in Chapter 3.

### 2.7.3 Virtual Patients in Medicine and Nursing

The first mention of VPs in medical education literature is by Harless *et al.* (1971) who described a computer-aided simulation, in which medical students interacted with a text-based VP via free-typing questions, ordering laboratory tests and making diagnoses, which culminated with input-specific feedback. Despite the technology being around for the past 40 years, it has been established that few medical schools incorporate VP simulations into their curricula; with only 24% of medical schools in the United States and Canada using VPs as an educational tool in 2007 (Huang *et al.*, 2007). Since this time, their use may have expanded to more than 130 medical schools in the United States, Canada and many European countries, however exact figures are unknown as it has not been the focus of a research paper in recent literature (Berman *et al.*, 2016). This may be an area for future research, especially in relation to Pharmacy Schools as this has not been investigated.

Two important literature reviews have been conducted into the use of VP simulation in healthcare education and training (Cook and Triola, 2009; Cook *et al.*, 2010). Research has established VPs as an effective learning tool, but there has been significant difficulty when trying to determine whether VPs are more effective in comparison with established learning tools due to few papers investigating this (Cook and Triola, 2009; Cook *et al.*, 2010). This may be unsurprising as it is difficult to assess the effectiveness of any type of learning tool; to claim a difference is due to the intervention itself and no other influential factors. Those studies which have compared VPs with other interventions have generally found small and non-significant differences in learning outcomes surrounding skill development, clinical reasoning and knowledge improvement (Cook *et al.,* 2010). This is not to say they are not useful learning tools, as significant differences between different learning tools may be

unlikely, especially those which encourage active learning. It is therefore beneficial to establish that VPs show similar efficacy to more established learning tools. Research comparing VPs with SPs have found little differences in clinical outcomes, but did find that users may show less empathy and warmth to a VP, signifying the importance of 'real patient' experiences to develop these affective skills (Deladisma *et al.*, 2007). Cook and Triola (2009) also noted that repetitive use of VP simulations is required for an effect on learning, which is a benefit of VP tools that promote independent self-directed learning.

Although real or simulated patients have been shown to help with the development of affective skills, VPs have been found to aid the development of communciation skills (Sijstermans *et al.*, 2007; Botezatu, Hult, Tessma, *et al.*, 2010a; Foronda, Gattamorta, *et al.*, 2013; Kleinsmith *et al.*, 2015). Research has described the development of emotional intelligence from completing VP simulations, which was something initially thought to be outside the realm of VP capabilities due to their technological nature but may be possible dependent on the fidelity of the VP tool; higher-fidelity tools aid the development of these skills more than the lower-fidelity VPs due to their increased realism and promotion of emotional intelligence in the users (Bearman *et al.*, 2001; Bearman, 2003; Stevens *et al.*, 2006; Deladisma *et al.*, 2007; Kleinsmith *et al.*, 2015). With regards to communciaiton skills, the more interactive the VP tool, the greater the impact on communication skills; with immersive reality simulations enhancing this skill the most but all VP tools improving these skills to some extent (Stevens *et al.,* 2006; Deladisma *et al.,* 2007). The majority of research has assessed communication skills as an outcome using self-reporting techniques and there is a lack of more robust assessment methods. The importance of effective communication skills has been discussed in Chapter 1, and the creation of a resource which can promote the development of these skills in a safe environment and be used in an individuals' own time may show benefit over other simulation tools which are currently utilised more thoroughly in undergraduate curricula. Little research has evaluated VPs effects on the communication skills of qualified healthcare professionals, therefore it is unknown

whether these benefits are limited to undergraduate students and may be elicited to their limited real-world exposure, or whether similar results would be found in a post-graduate sample. This therefore currently limits the scope of use of VPs as training tools, until these areas are evaluated.

The virtual reality, immersive environment that has been predominantly studied in medicine is 'DIANA' the Digital Animated Avatar created by The University of Florida (Johnsen *et al.*, 2005; Stevens *et al.*, 2006). The system incorporated additional components which help to increase the realism of a simulation, such as the tracking of a user's head and hand movements and the use of a microphone to allow verbalisation of questions (Johnsen *et al.*, 2005; Stevens *et al.*, 2006). The interactivity of DIANA resulted in positive comments from medical students regarding the realism of clinical scenarios, the development of clinical skills and overall satisfacton with the learning tool, however results are limited to one sample of students at one University, but the few immersive environments which exist prevent more widespread analyses (Johnsen *et al.*, 2005; Stevens *et al.*, 2006). In addition to these comments, problems were noted with the speech recognition software, with individuals reporting a negative effect on their overall immersion but no negative impact on their learning experience as a whole, which questions the need for greater immersivity (Johnsen *et al.*, 2005; Stevens *et al.*, 2006; Deladisma *et al.,* 2007). The additional hardware components of the system to track gestures and eye contact were reported as unecessary as students "did not think gestures were important to the experience". This may indicate that students do not expect to develop the more affective skills, such as body language, from using VPs, indicating different utilites of different learning tools.

The postive comments associated with the realism of DIANA, such as the ability of the tool to develop clinical skills, communciation skills and high levels of enjoyment have also been identified with less immersive VP tools (Triola *et al.*, 2006; Gesundheit *et al.*, 2009; Cook *et al.*, 2010; Hoffman *et al.*, 2010; Gormley *et al.*, 2011; Consorti *et al.*, 2012). Immersive virtual reality tools have an associated

extra cost, do not allow students to engage in distance learning and may elicit problems with speech recognition software, which has led to researchers understanding that although higher-fidelity simulations provide the most realistic simualtion, the intended learning outcomes need to be considered and the correct VP tool should be used to achieve these (Dieckmann *et al.*, 2012). Additionally, not all institutions will have the capacity for these immersive environments, and due to the limited number which have been created and studied, it may impact the number of future reseachers or educators who will invest in these simulations; until more thorough evaluations which establish their benefits as learning tools are conducted.

The use of synchronous and asynchronous avatars have been investigated as potential training tools for medics and nurses. They both offer greater interactivity and realism than is found with non-animated or video based VP tools and they have the abitility to offer additional learning exercises and opportunities outside of scheduled learning time; promoting and helping develop the integral skills of self-directed and reflective learning, however they are lower-fidelity than immersive environments. A smaller proportion of research has focused on asynchronous avatars, but that which has, has demonstrated significant outcomes in the development of knowledge, skills and confidence to interact with real patients (Kenny *et al.*, 2008, 2009; Kleinsmith *et al.*, 2015; Moule *et al.*, 2015). The primary evaluation methods used have been via self-reporting techniques, which are not without their limitations. The individuals carrying out the study and data collection are normally known to the students, and therefore they may feel pressured to respond positively. Results have been comparable with other forms of VP simulation, but greater reinforcement of the benefits of asynchronous avatars would be useful to cement them as established learning tools.

A number of virtual worlds have been created which can be defined as “a syncronous, persistent network of people, represented as avatars, facilitated by networked computers” (Bell, 2008). They are easily accessible, high-fidelity, immersive environments (Boulos *et al.*, 2007; Foronda and

Bauman, 2014). The virtual world most utilised in education is Second Life, which allows users to create an avatar and interact with each other via text and voice recognition software (Tilley and Kaihoi, 2011; Ghanbarzadeh *et al.*, 2014). When first created, these worlds were primarily used as a social interaction interface, but have since found use as a training tool for many institutions, businesses and government agencies (Tilley and Kaihoi, 2011; Ghanbarzadeh *et al.*, 2014). Synchronous avatars, if not properly controlled, may lead to distraction from the intended learning outcomes but they have found use in a range of areas including laboratory techniques, critical appraisal skills and interprofessional working (Boulos *et al.*, 2007; Beard *et al.*, 2009; Seefeldt *et al.*, 2012; Caylor *et al.*, 2015). They allow individuals to learn from one another in a simulated environment. A majority of virtual worlds require staff or research personnel to be present online to oversee the simulation. Having the pressure of staff and other students being present in the simulation may affect users' experiences, however allowing users to be directly observed for the associated learning outcomes, to see how they behave or how their knowledge or skills develop, is useful in measuring their usefulness as learning tools. The majority of research has also used self-reporting techniques, which are useful to establish users' enjoyment of the simulation tool, and results in more than one type of data being collected and a more thorough evaluation.

Most errors in clinical reasoning are as a result of pressure, uncertainty and low self-confidence. These errors have shown to cause suboptimal treatment of patients and represent a significant cause of patient morbidity (Barber *et al.*, 2003; Ziv *et al.*, 2005; Heaton *et al.*, 2008; Levett-Jones *et al.*, 2010). The integration of VP simulations into the training of medicine and nursing students has improved clinical reasoning skills, which may therefore reduce errors and lead to better patient outcomes (Cook and Triola, 2009; Botezatu, Hult, Tessma, *et al.*, 2010a; Cook *et al.*, 2010; Forsberg *et al.*, 2011; Berman *et al.*, 2016). There has been little research into their use in qualified individuals, which may be an avenue for future research; to see the effectiveness of these tools once healthcare professional are in the workplace. VPs have been found to promote knowledge development and aid

understanding of a wide range of topics, including: core medical topics (e.g. cardiology, haematology), emergency care and emergency situations, paediatrics, mental health, medical history taking, procedural skills and prescribing (Kenny *et al.*, 2008; Botezatu, Hult, Tessma, *et al.*, 2010a; Hurst and Marks-Maran, 2011; Guise, Chambers and Välimäki, 2012; Ekblad *et al.*, 2013; Farra *et al.*, 2015; Sansom, 2015). A large proportion of research has utilised self-reporting techniques to establish whether VPs are useful learning tools. These studies have found positive results but a lack of significance regarding knowledge improvement or probing on users' thoughts, which affects the generalisability and understanding of the results in a wider context (Gormley *et al.*, 2011; Consorti *et al.*, 2012). Research has shown that VPs can improve student's confidence in their own abilities regardless of whether their performance improves, as this is rarely studied, therefore it is difficult to understand their actual impact on learning or development (Bearman, 2003; Huang *et al.*, 2007; Peck and Miller, 2010; Hurst and Marks-Maran, 2011; Guise, Chambers, Conradi, *et al.*, 2012; Yang *et al.*, 2013). There is a lack of both longitudinal research evaluating the use of VPs over time and research evaluating the sustainability of learnt knowledge from the tools (Botezatu, Hult, Tessma, *et al.*, 2010a). Knowledge declines at the rate of one-fourth to one-third after 12 months and after 4 years knowledge retention does not exceed 30% (Custers, 2010). However, knowledge loss does not become a problem if repetitive practice occurs, which is a benefit of VP simulation, especially those tools which allow for independent distance learning (Issenberg *et al.*, 2005; Karpicke and Roediger, 2008; Cook and Triola, 2009; Botezatu, Hult, Tessma, *et al.*, 2010a). Research establishing the long-term effects of knowledge or skills learnt from VP use may be of benefit to pedagogical researchers.

Cendan and Lok (2012) noted that as VP technology is underutilised, the literature surrounding the best practices of VP use is in its infancy. There are few longitudinal studies of VPs, little work into optimal forms for integrating VPs into a course or curriculum, and few explorations into knowledge retention or behavior changes. Additionally, the majority of research has incorporated self-reporting scales to determine skill or knowledge development which do not statistically measure

improvements. Additionally, there is limited research into how VPs can be used as an assessment tool. Further research needs to evaluate when and how to integrate VPs into both undergraduate curricula and postgraduate training.

## 2.8 Considerations of Simulation in Healthcare Education

### 2.8.1 Benefits of Simulation

The benefits of the different types of simulation tools have been discussed in respect to the literature in sections 2.4 to 2.7 above. The overall benefits of simulation in healthcare professions education will be discussed below.

It has been established that there are increasing numbers of undergraduate healthcare professionals entering university and this, along with shorter inpatient stays and student placements in the clinical environment, has led to questions regarding the use of simulation as a training tool (Badcock *et al.*, 2006; Ellaway *et al.*, 2008; Arthur *et al.*, 2010). Experience alone is not enough for individuals to obtain mastery of clinical skills (Jeffries *et al.*, 2011) and simulation-based learning can be instrumental in promoting experiential situated learning and bridging the gap between theory and practice without differences in educational outcomes (Weller, 2004; Hicks *et al.*, 2009; McGaghie *et al.*, 2010; Barnett *et al.*, 2016).

Clinical knowledge is expanding rapidly, which demands not only more efficient teaching methods but also the teaching of 'knowledge management', yet lectures remain the primary teaching method in many Universities (Berman *et al.*, 2016). Lalley and Miller (2007) have described a 'Learning Pyramid' which illustrates the average learning retention rates of different instructional tools (Figure 2-1). The 'Learning Pyramid' illustrates that the retention of information after a lecture with audiovisual enhancement is predicted to be only 20% whilst interactivity or 'practice by doing' methods, such as

simulations, increases the retention to 75%. In addition to this, Lalley and Miller (2007) conducted a literature review and found that no learning tool was superior at producing knowledge retention, and all methods were effective in certain contexts. This identifies the need for different educational tools to be used in combination, as per recommendations in the simulation literature (Hicks *et al.*, 2009; Jeffries *et al.*, 2011; Lin *et al.*, 2011; Kononowicz *et al.*, 2012).

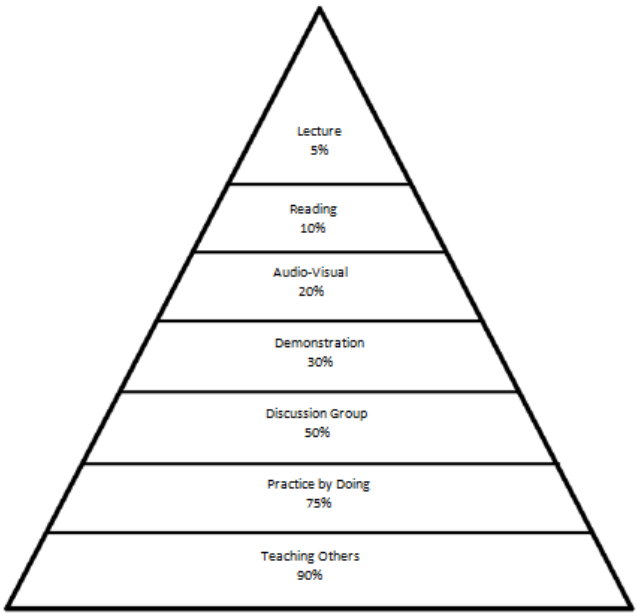



**Figure 2-1 The learning pyramid created by Lalley and Miller (2007).**

Simulation offers many advantages over traditional learning techniques, and should be used in combination with these to allow students with different learning styles to find a resource most appropriate for them and to allow students to apply their learnt knowledge to practice (Hicks *et al.*, 2009; Ker and Bradley, 2010; Kononowicz *et al.*, 2012; Foronda, Godsall, *et al.*, 2013; Barnett *et al.*, 2016). Kolb's learning cycle has been described in section 1.5 and simulation has been established as a technique to encourage experiential learning which may help overcome some of the problems with standardised placements (Fritz *et al.*, 2008; Jarmon *et al.*, 2009; Jungnickel *et al.*, 2009; Harder, 2010;

Ker and Bradley, 2010; Hussainy *et al.*, 2012; Foronda, Godsall, *et al.*, 2013; Illing *et al.*, 2013). Traditional learning tools allow students to learn in a linear fashion whereas VPs provide the opportunity for users to practice real-world scenarios and make mistakes, promoting a more dynamic learning approach which may result in better retention of knowledge and skills (Aldrich, 2005). Allowing students to practice, make mistakes and visualise the consequences from these mistakes can help prevent them happening in the future and encourage reflective learning on how to overcome these problems in practice (Triola *et al.*, 2006; Scalese *et al.*, 2007; Murray *et al.*, 2008; Lewis, 2009; Poulton *et al.*, 2009). Simulations provide a safe environment for students to practice and develop specific skills and knowledge without the risk of harming real patients. Although exposure to real patients is important, certain skills and knowledge have been found to be successfully developed via simulation (Weller, 2004; Stevens *et al.*, 2006; Murray *et al.*, 2008; Seybert *et al.*, 2008; Hicks *et al.*, 2009; Ker and Bradley, 2010; Gormley *et al.*, 2011; Jabbur-lopes *et al.*, 2012). Research has found that simulation reduces the pressure and anxiety felt by individuals when completing new tasks to a greater extent than other learning tools, which ultimately may increase users' confidence for completing the same tasks in practice with real patients, and can therefore only be beneficial (Deladisma *et al.*, 2007; Hoffman *et al.*, 2010; Ker and Bradley, 2010).

Research into the effective use of simulation for learning has identified the benefits of feedback and repetitive practice (Issenberg *et al.,* 2005; Ker and Bradley, 2010). Simulation repetition may improve students' confidence in their own abilities, resulting in better patient care in practice. It is difficult to standardise placements for healthcare profession students and simulations offer a controlled environment for specific learning objectives to be met (Ker and Bradley, 2010). Simulations allow for the provision of immediate feedback, which may be individualised, to allow students to instantaneously understand their strengths and weaknesses, integrate new skills and recognise the consequences of decision making (Nestel *et al.*, 2007; Orr, 2007; Scalese *et al.*, 2007; Courteille *et al.*, 2008; Lin *et al.*, 2011).

Simulations provide many benefits to help both the more logistical issues of education (increasing numbers of students, standardisation of placements) and the learning experience by developing a wide range of skills and knowledge. There are many simulation tools available, all with their own strengths and weaknesses and individual institutions need to ascertain those which benefit their curricula most effectively. However, in addition to simulation providing many benefits, there are also limitations associated with their use.

### 2.8.2 Limitations of Simulation

There are also a number of limitations of simulations which may explain why they are not fully utilised in healthcare education and training. Firstly, simulations are not real. As already discussed, simulations offer a controlled environment for students to learn and develop specific knowledge or skills, but they can never truly represent real-life situations as humanistic factors cannot be portrayed the same (Hicks *et al.*, 2009; Ker and Bradley, 2010; Guise, Chambers, Conradi, *et al.*, 2012). The use of simulation in combination with real-patient experiences may overcome this limitation (Hicks *et al.*, 2009; Ker and Bradley, 2010; Lin *et al.*, 2011; Kononowicz *et al.*, 2012). Concerns relating to the transferability of knowledge and skills from the simulated to the clinical environment have been expressed (Feingold *et al.*, 2004; Lambton *et al.*, 2008; Hicks *et al.*, 2009; Ker and Bradley, 2010). The majority of research has evaluated short-term outcomes, and these longer-term outcomes need to be investigated to understand the full potential that simulation can offer (Feingold *et al.*, 2004; Abdo and Ravert, 2006; Rosen, 2008; Cook, 2010; Ker and Bradley, 2010; Consorti *et al.*, 2012).

Another limitation to the utilisation of simulation is the cost and time associated with the development and training of staff or other personnel (AAMC, 2007; Rosen, 2008; Cendan and Lok, 2012; Chapman, 2012; Guise, Chambers, Conradi, *et al.*, 2012). Few studies have investigated the cost:benefits associated with the different types of simulation and a lack of established, significant

improvements in knowledge or skills may lead to a reduced uptake (Lok *et al.*, 2006; Fernandez *et al.*, 2007; Lin *et al.*, 2011; Hussainy *et al.*, 2012). Incorporating a 'Virtual Patient Commons' as suggested by EllaWay *et al*. (2008) allows for the initial development cost to be offloaded but without the increased integration of universities or simulation centres to create these tools, it is difficult to establish simulation as a prime instructional tool in all healthcare professions curricula and there may be intellectual property considerations with this.

Technological-barriers are also present with computer-based simulation. These barriers are not specific to simulation and have been raised in various areas when looking to incorporate technological tools into healthcare (Ertmer, 1999; Short *et al.*, 2004; Dieckmann *et al.*, 2012). Although technology is enhancing in everyday life and current students represent the digital-native generation, not all individuals will have the same skills and confidence for using technology which needs to be considered upon development of new learning tools (Short *et al.,* 2004). Simulations should promote individualised, self-directed learning but if students are not engaged or motivated to learn, they may not participate fully and fail to meet the intended learning outcomes (Jungnickel *et al.*, 2009; Cendan and Lok, 2012; Benedict *et al.*, 2013). This may show the applicability of simulation as an additional educational tool, in combination with more established tools, to ensure all individuals are exposed to a learning technique most appropriate for them (Taylor and Walford, 1972; Dutile *et al.*, 2011; Lin *et al.*, 2011).

### 2.8.3 Current Integration of Simulation into Healthcare Education

Simulations have been found to support the development of diagnostic skills, anatomical and physiological knowledge and skills, clinical reasoning skills and communication skills of healthcare professionals (sections 2.5 to 2.7). Research has also found that graduate healthcare professionals are not ready for practice and their lack of clinical reasoning skills contribute to errors and result in

negative effects on patient care (Heaton *et al.*, 2008; Likic and Maxwell, 2009; Levett-Jones *et al.*, 2010; Morrow *et al.*, 2012; Illing *et al.*, 2013).

Resulting from the body of research, a significant change has occurred within the individual professional bodies and Government to promote the inclusion of simulations as a resource into the undergraduate curriculum of healthcare professions. In 2011, The Department of Health advocated using simulation as a route to improve patient care, recommending that healthcare professionals learn skills in a simulated environment before undertaking them in practice (DOH, 2011). The Nursing and Midwifery Council (NMC) also advocated simulation as a safe and effective means of learning clinical skills and recommended its use as an adjunct to practice-based learning. In addition, the NMC allowed simulation to replace up to 300 hours of the required practice-based learning within qualifying programmes (NMC, 2011).

Simulation has also been accepted as an appropriate educational tool in pharmacy curricula. The Accreditation Council for Pharmacy Education (ACPE) have decided that simulation can make up 20% of introductory pharmacy practice experiences in Schools of Pharmacy in the USA (ACPE, 2015). The 2008 White Paper 'Pharmacy in England: Building on Strengths – Delivering the Future' recommended increased pharmacy practice experiences and recognised the difficulty in providing enough 'real-world' experiences to students (DOH, 2008). As a result, Guile and Ahamed (2009) and Smith and Darracott (2011) recommended an increased implementation of simulation teaching methods into UK-based undergraduate pharmacy curriclum, however no specific guidelines have currently been produced relating to this.

## 2.9 Chapter Summary

The review presented above has identified the main themes running through clinical simulation literature. A range of simulation tools which are used in the training and education of healthcare

professionals were discussed. Literature relating to these simulation tools in pharmacy education is less than for medicine and nursing. There was also more literature originating from the USA compared to the UK or Europe. All simulation tools have identified positive effects on the development of knowledge and skills as well as a high-level of user satisfaction, however there are a lack of statistically significant findings relating to knowledge or skill improvement, and most relate to self-reporting scales. The different simulation tools are not always explicitly described in the literature which makes it difficult to ascertain the features or components of simulations which are the most effective. The positive findings have led to professional bodies and the UK Government promoting the use of simulations as a resource in the undergraduate curriculum of healthcare professions.

VPs are a relatively new simulation tool and the initial costs and technical skills required for creation and upkeep are associated barriers which may explain their limited development. Research has determined that creating online communities may be a way to overcome these problems and may promote greater utilisation of VP technology.

A systematic review of the literature surrounding VPs in pharmacy education will be presented in the next chapter.

# 3. Narrative Synthesis of VP use in Pharmacy

## 3.1 Introduction

This chapter presents the systematic search and narrative synthesis of the literature surrounding VP use in pharmacy education and training. The chapter begins by discussing the general principles of systematic reviews (section 3.2) and the aims of this systematic search (section 3.3). The methods of the systematic search are presented in section 3.4, including the eligibility criteria of studies (section 3.4.1), the search strategy (section 3.4.2), the study selection (section 3.4.3), extraction of data from the studies (section 3.4.4) and quality assessment of the studies (section 3.4.5). The findings of the systematic search are then presented as a narrative synthesis in section 3.5. An overview of the findings is presented in section 3.5.1 before the themes running through the literature are reported in sections 3.5.2 to 3.5.5. The limitations of the studies included in the review are discussed in section 3.6 and the rationale for the use of VPs in pre-registration training (i.e. rationale for this thesis) are presented in section 3.7. A summary of the chapter is presented in section 3.8.

## 3.2 Systematic Literature Review

From the literature review preceding the systematic search (Chapter 2), it was noted that the research base investigating the use of VPs in pharmacy was smaller than that surrounding their use in other healthcare professions. As a result, a systematic search was conducted as this “attempts to collate all empirical evidence that fits pre-specified eligibility criteria in order to answer a specific research question” (Higgins and Green, 2011). Thus a systematic review would produce a more organised collation of the literature regarding VP use in pharmacy education which could be used to inform methodological decisions in this thesis.

Most systematic reviews utilise meta-analyses to summarise the findings from the search, however a narrative synthesis approach was adopted in this research (Popay *et al.*, 2006). Meta-analyses use statistical methods to summarise the results of research studies to, primarily, provide more precise estimates of the effects of healthcare (Higgins and Green, 2011). Whereas a narrative synthesis "refers to an approach to the systematic review and synthesis of findings from multiple studies that relies primarily on the use of words and text to summarise and explain the findings of the synthesis" (Popay *et al.*, 2006). A meta-analysis was not appropriate because there were no randomised controlled trials conducted into VP use in pharmacy. A narrative synthesis is useful for systematic reviews which focus on a wide range of questions, not only those which relate to the effectiveness of a particular intervention; which was suitable for this review, as presented below in the aim of the review (Popay *et al.*, 2006).

## 3.3 Aim of Systemic Review

The aim of the systematic review was to identify and examine the effectiveness of VPs in the education and training of pharmacists.

The primary outcome measure was to identify the learning outcomes which VPs had been evaluated against in pharmacy education. Secondary outcomes included the type of VP used in the research, the education level of research participants (undergraduate/postgraduate) and the types of data collection tools used.

## 3.4 Methods of Review

A literature review is considered systematic if it is guided by a research question and if the processes of identification, selection, appraisal, and synthesis of the literature are explicitly described (Popay *et*

*al.*, 2006; Higgins and Green, 2011; Uman, 2011). The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist as reported by Liberati *et al.* (2009) was adapted for the inclusion of studies with various methodologies and used as a guide for reporting this literature review.

The steps described by Popay *et al.* (2006) in relation to the narrative synthesis of the literature were also followed and included: the creation of a preliminary synthesis of the findings, an exploration of the relationships between studies and an assessment of the robustness of the synthesis.

### 3.4.1 Eligibility Criteria

The inclusion and exclusion criteria used to screen the studies retrieved in the systematic search were based on the PICOS approach (participants, interventions, comparators, outcomes, and study design) (Liberati *et al.* 2009). These criteria are included in Table 3-1 with further exclusions including: papers not in the English language, short conference abstracts, conference proceedings without a full-text online, conference presentations or posters and studies where no full text was available.

| PICOS | Inclusion Criteria | Exclusion Criteria |
|---|---|---|
| **Participants** | Pharmacy undergraduate students<br>Pharmacy postgraduate students<br>Qualified pharmacists | Participants in other healthcare areas (not pharmacy) |
| **Intervention** | Virtual patients which relate to the definitions set out in Chapter 2 (section 2.8) | Papers not describing the type of VP used<br>VPs not consistent with the definitions set out in Chapter 2 (section 2.8) |
| **Comparison** | Studies with or without comparison of VPs with another learning tool | Studies were not excluded based on the absence of a control |
| **Outcomes** | Learning tool<br>Assessment tool<br>Self-reporting tool | No outcomes reported |
| **Study design** | Evaluative studies – quantitative, qualitative and mixed-method studies<br>Literature reviews | Studies describing creation of VPs with no evaluation |

**Table 3-1 Describes the inclusion and exclusion criteria used to screen studies based on the PICOS approach (Liberati et al. 2009).**

### 3.4.2 Search Strategy and Data Sources

The search strategy employed in the systematic review was similar to the one described previously (Chapter 2, section 2.2.2). An initial scoping of the literature was conducted in 2013 to determine the level of research available and help inform the methodology of the research. The systematic search was conducted in June 2017. The databases included in the search are listed in Table 3-2.

| **Electronic Databases Used in the Literature Review** |
|---|
| Web of Science (1970 – 2017) |
| PubMed (1970 – 2017) |
| Science Direct (1970 – 2017) |
| BioMed Central (1970 – 2017) |
| MEDLINE (1970-2017) |

**Table 3-2 Presents the databases that were searched in the systematic review process. All databases were searched from 1970 as the first mention of VPs in healthcare education was 1971.**

The search strategy involved using keywords in combination with Boolean operators to search the title and/or abstract of papers. The primary keywords used were:

1. 'virtual patient'
2. 'virtual patients'
3. 'virtual patient*' (to find virtual patient, virtual patients and virtual patient's)
4. 'pharmacy'
5. 'pharmac*' (to find pharmacy, pharmacist, pharmacies, pharmacology, pharmaceutics)
6. 1 OR 2 OR 3 AND 4 OR 5

Other, related search terms such as case-based learning or e-learning were not included in the systematic search because it was considered essential for this review to focus specifically on the concept of virtual patients; thus, research had to relate to computer-based simulations of real-life clinical scenarios to train healthcare professionals, in which simulation outcome was dependent on user input (section 2.7). Additionally, as the systematic review was focused on research that had been conducted in pharmacy, other healthcare professions were excluded.

In addition, the archives of particularly relevant journals were searched, such as Pharmacy Education, American Journal or Pharmaceutical Education and The Pharmaceutical Journal. The search also extended to the professional and regulatory bodies' websites to uncover any other useful resources.

### 3.4.3 Study Selection

References were imported into and managed using Mendeley®. Screening of the identified studies was initially based on the title, then the abstract and finally the full-text. If studies seemed to meet the inclusion criteria or a decision could not be made based solely on review of the title or abstract, full-text copies were obtained. The process to determine the papers for review is shown in Figure 3-1. The literature search and initial appraisal of the articles was conducted by the lead researcher (JT). Studies were then appraised by the supervisory team and discussions led to the inclusion of 37 articles in the narrative synthesis.

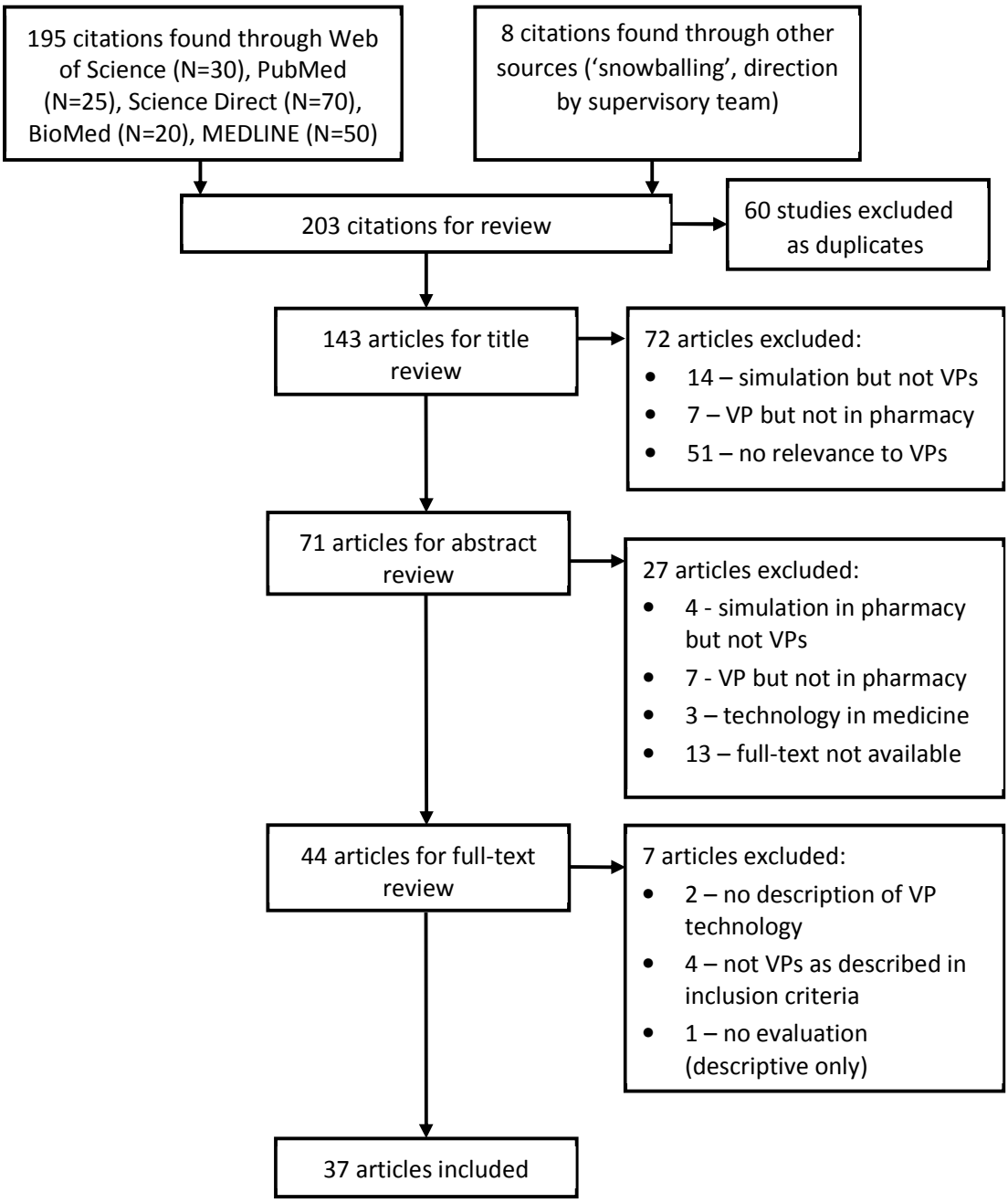



**Figure 3-1 A flow diagram illustrating the screening process, as recommended by Liberati *et al.* (2009). In total, 37 articles were included in the narrative synthesis: two conference papers, three review articles and 32 evaluative studies.**

### 3.4.4 Data Extraction

Preliminary synthesis of the 37 review studies occurred. The following information was extracted and is presented in Table 3-3: authors, year of publication, country of study, participant characteristics (number, year of study or age, University or area of residence), type of VP tool (video clips, asynchronous avatar, synchronous avatar), data collection tools used and outcome measures.

A full review of the studies was completed by the lead researcher (JT) and thematic analysis was carried out to extract the main themes relating to VP use in pharmacy education (Braun and Clarke, 2006). The themes were categorised and are discussed in the narrative synthesis of the literature (sections 3.5.2 to 3.5.5).

### 3.4.5 Quality Assessment

Due to the variability of methodologies and reported outcomes, the quality of the articles could not be assessed using the methods set out by Liberati *et al.* (2009). Instead, a nine-point checklist created by Morrison *et al.* (1999) to critically appraise reports of educational interventions was used. The studies were critiqued based on the following factors: clear research question, clear learning need (aims and objectives), clear description of the educational context (participants, setting, integration into curriculum), clear description of the intervention, appropriate study design, appropriate methods, appropriate outcomes (reliable, valid), any other explanations of results and explanations of unanticipated outcomes. A presentation of these findings can be found in section 3.6 with a discussion of the main points throughout section 3.5. The full quality assessment can be seen Appendix 1.

| Author (year) | Country | Types of VP | Participants | Data Collection | Outcomes |
|---|---|---|---|---|---|
| Al-Dahir *et al.* (2014) | USA | DecisionSim<br><br>No further description on how users interact with VP or how VP responds | 119 fourth year pharmacy students<br>1 University | Knowledge based pre-post-MCQs<br><br>Evaluative survey - Likert scale | VP vs PBL<br><br>Significant improvement in knowledge in both groups (PBL>VP)<br>VP increased comfort with e-learning<br>PBL>VP users recommend learning tool |
| Barnett *et al.* (2016) | USA | Text based<br>Students select questions, VP responds via text | 134 third year pharmacy students<br>1 University | Pre-post evaluative survey –<br>Likert scale<br><br>Subjective-objective-assessment-plan (SOAP) | VP vs paper-based<br><br>Significant increase in confidence items for both groups (VP>paper)<br>N.S. difference found between groups for rest of items<br>VP increased interest, enjoyment, relevance, realism, learning new content<br>SOAP - Little difference between groups |
| Battaglia *et al.* (2012) | USA | Text based<br>Students select questions, VP responds via text | 80 third year pharmacy students<br>1 University<br>42 Pharmacists | Pre-post assessment –<br>Likert scale, MCQs and short answer Q's | Significant improvement – pharmacists more than students<br>VP helped develop knowledge, develop skills, understand MTM better |
| Benedict (2010) | USA | vpSim<br><br>No further description on how users interact with VP or how VP responds | 107 third year pharmacy students<br>1 University | Knowledge based questions<br><br>SOAP<br><br>Evaluative survey | VP use in PBL<br><br>Average score on VP learnt content - 87%<br>SOAP average – 90%<br>VP and PBL - intellectually challenging, covered learning objectives (PBL>VP), contributed to learning (PBL>VP), enjoyed (PBL>VP) |

| Author (year) | Country | Types of VP | Participants | Data Collection | Outcomes |
|---|---|---|---|---|---|
| Benedict and Schonder (2011) | USA | PharmaCAL<br><br>Input by pre-select options<br><br>No description on how VP responds | 190 third year pharmacy students<br>1 University | Pre-post knowledge quiz<br><br>Final exam scores – knowledge retention<br><br>Evaluative survey – Likert scale | Significant improvement on pre-post-knowledge quiz<br>Significant improvement on final exam<br><br>VP – easy to use, enjoyed using, stimulated interest in learning, allowed application of learning, acceptable teaching tool, further incorporated into the course, immediate feedback useful |
| Benedict *et al.* (2013) | USA | vpSim/ DecisionSim<br><br>No further description on how users interact with VP or how VP responds | 106 third year pharmacy students<br>1 University | Pre-post knowledge quiz<br><br>Final exam scores – knowledge retention<br><br>Evaluative survey – Likert scale | VP vs lectures<br><br>Significant improvement on post-knowledge quiz for both groups (N.S. difference between groups)<br>Retention of knowledge similar in both groups (N.S)<br>VP – organised, appropriate content, enjoyable, challenging, aids understanding and self-directed learning |
| Bindoff *et al.* (2014) | Australia | Asynchronous avatars<br><br>User selects pre-populated questions VP responds via text and animations | 33 third and fourth year pharmacy students<br>1 University | Pre-post knowledge quiz<br><br>Pre-post self-assessment of competencies<br><br>Evaluative survey – Likert scale and open-ended Q's | VP vs paper-based<br><br>N.S. difference in knowledge, competencies or satisfaction for both groups (VP>paper)<br>Third year students had greater improvement in both groups (N.S)<br>Third year - VP more accepted, VP more fun, better to learn<br>Fourth year – preferred paper-based |

| Author (year) | Country | Types of VP | Participants | Data Collection | Outcomes |
|---|---|---|---|---|---|
| | | | | | Both years – VP more engaging, easy to use, simulate whole dispensing process, difficulty using the system, overly simplistic dialog |
| Bracegirdle and Chapman (2010) | UK | Asynchronous avatars<br><br>MCQ and free-text input<br>Avatar responds via text and speech | 90 stage 1 pharmacy students<br>1 University | WWHAM questioning<br><br>Anecdotal feedback | Emotional engagement from students<br>Natural language used in questions<br>Students used 'text-speak' |
| Cavaco and Madeira (2012) | Europe | Review Article | 194 students at European Pharmacy Students' Association Annual Congress – 23 countries and 46 Universities | Evaluative survey regarding use of VPs, perceptions of VPs in education –<br>Likert scale | 12 (6.2%) previous VP experience -<br>3 used simulation which used 3-D images and sound, 9 used other forms of VP simulation<br>8 used VP with MCQs, text-boxes or audible responses<br>6 used VPs in pharmacy course, independent study, group work, case studies, practical teaching, supplementary resource<br>83.5% felt VPs should be used in curricula<br>73% thought VPs useful as individual learning tool<br>Agreement for use in blended learning |
| Caylor *et al.* (2015) | USA | Synchronous Avatars<br><br>Second Life (SL) and audio over Skype | 21 students from nursing, medicine, and pharmacy<br>1 University | Pre-post IPE Perception Scale – Likert scale<br><br>Pre-post teamwork Questionnaire – | Perception scale - increase in all areas except medicine lower perceived need for cooperating<br>Attitudes - increase in all except medicine reduced for leadership |

| Author (year) | Country | Types of VP | Participants | Data Collection | Outcomes |
|---|---|---|---|---|---|
| | | | | Likert scale<br><br>Team Performance Observation Tool – Faculty members<br><br>Evaluative survey – Likert scale and open-ended Q's | Observation - all teams worked well, pharmacy students actively participated however more teamworkers than leaders<br>SL improved learning, convenient, realistic, reduced stress related to simulation and IPE<br>Technical issues – awkward navigation, crashing PC, lack of body language |
| Chaikoolvatana and Goodyer (2003) | UK | Multimedia case history program (MCHP)<br><br>Text and video clips | 79 final year pharmacy students<br>1 University | Care plan<br><br>Face-to-face consultation<br><br>Evaluative survey – Likert scale | VP vs SP<br><br>VP group performed significantly better on care plans<br>VP positive – easy to use, useful, enjoyed using, learnt how to take a patient history, design of VP good<br>VP negative – program took too long to complete, keyword system difficult |
| Claudio *et al.* (2015) | Portugal | Asynchronous avatars<br><br>Users choose pre-set options<br>Avatar responds via speech and animations | 7 qualified pharmacists | Evaluative survey – Likert scale and open-ended Q's | VP positive - layout, easy to use, realistic appearance and animations, useful learning tool, immediate feedback and monitoring of progression, developing accurate and consistent professional skills<br>VP negative - body motion, listening comprehension, synchronisation of lips and speech<br>Improvements - more facial expressions, more variety of patients<br>Not replace real-human interactions |

| Author (year) | Country | Types of VP | Participants | Data Collection | Outcomes |
|---|---|---|---|---|---|
| Douglass *et al.* (2013) | USA | TheraSim<br><br>Select pre-inputted options<br>Text, pictures, video clips, electronic medication record (EMR) | 135 final year pharmacy students<br>1 University | Pre-post-test of clinical competence<br><br>Evaluative survey - Likert scale | Significant improvement on skills based competencies<br>88% of students achieved 73% of competencies from VP<br>VP improved chronic disease and medicine management skills, understanding EMR, ability to identify patient-specific information and provided good summary of course |
| Ferrone *et al.* (2017) | USA | MyDispense – Asynchronous avatars<br><br>Pre-selected options or free-text input<br>Avatar responds via text | 241 pharmacy students from 3 Universities | Evaluative survey – Likert scale and open-ended Q's | VP easy to use, more realistic than paper-based, provides safe learning opportunity, helpful, enjoyable, challenging, provides practice at collecting patient info, reinforced patient counselling, simulate whole dispensing process, useful introduction to community pharmacy<br>Need training before use |
| Fleming *et al.* (2009) | USA | SIMmersion<br><br>Spoken questions through microphone or pre-inputted text-based<br>Video clip response | 102 healthcare professionals (10 physicians, 30 physician assistants or nurse practitioners, 36 medical students, 26 pharmacy students) | Pre-post SP consultations to measure clinical skills | VP vs control (paper-based)<br><br>Significant improvements in each group – screening skills, brief intervention skills<br>Significant difference between groups for alcohol screening and brief intervention skills (VP>control) |

| Author (year) | Country | Types of VP | Participants | Data Collection | Outcomes |
|---|---|---|---|---|---|
| Fuhrman Jr. *et al.* (2001) | USA | Virtual Family<br><br>Text based – students enter answers in text-boxes, marked by faculty | 58 first year pharmacy students<br>1 University | Students graded on their responses<br><br>Knowledge exam<br><br>Evaluative survey – Likert scale | VP vs control<br><br>Student responses accurate and timely<br>N.S. difference in mean number of questions answered correctly semester 1, significant difference in mean number of answers correct (VP>control) semester 2<br>N.S. difference in mean time to complete the exam in either semester<br>VP helped understand disease states, develop knowledge beneficial for future<br>66% rated VP experience excellent, 32% good, 2% average |
| Hussein and Kawahara (2006) | USA | Computer telephony interactive voice response system (IVR) and a text-to-speech (TTS) system | 34 third year pharmacy students<br><br>6 faculty members | Assessed on care plan and messages left on telephone<br><br>Final knowledge exam<br><br>Faculty evaluative survey – Likert scale<br><br>Students evaluative survey –Likert scale and open-ended Q's | Progress through course - communication better and more confident, able to utilise different resources to create care plans<br>Faculty – VP innovative, further understanding of topics, challenging, encourage communication between students<br>Students – VP innovative, interactive and dynamic, patients not textbook, apply therapeutic learning, enhanced learning, concentrated more because of user-patient effect<br>Data collection too long, difficult to connect with, unreliable |

| Author (year) | Country | Types of VP | Participants | Data Collection | Outcomes |
|---|---|---|---|---|---|
| Jabbur-lopes *et al.* (2012) | World | Review Article | Literature search – 1960 – 2009 VPs in pharmacy | | 7 articles met inclusion criteria – 4 North America, 2 Australia, 1 Europe<br>Sample sizes ranged from 34-202, most common third year pharmacy students<br>Evaluation mostly by satisfaction survey<br>All studies found increased satisfaction with VPs, stimulating, innovative and highly applicable to real practice |
| Lambertsen *et al.* (2017) | UK | PharmaComm Asynchronous avatars<br><br>Users pick questions and textual response | 6 third year pharmacy students<br>1 University | Observation on use of VP<br><br>Focus group | Observation – students engaged, used reference sources<br>Focus group – VPs vital sign changes good, instant feedback, realistic animations, communication and medication chart useful, safe learning environment, improve confidence, positive impact on motivation to learn, enjoyed using and likely to engage in SDL, useful in IPE |
| Lichvar *et al.* (2016) | USA | vpSIM<br><br>Text-based input<br>No description of VP response | 109 second year pharmacy students<br>1 University | Pre-post knowledge quiz<br><br>End of year exam – knowledge retention<br><br>Evaluative survey – Likert scale and open-ended Q's | VPs in flipped classroom vs paper-based<br><br>Significant increase in knowledge for both groups (VP>paper)<br>VP group significantly better on Q's assessing higher level learning<br>27 students used VP for independent learning after study<br>VP helped understand and apply learning, interactive nature, preferred over paper |

| Author (year) | Country | Types of VP | Participants | Data Collection | Outcomes |
|---|---|---|---|---|---|
| Loke *et al.* (2011) | New Zealand | SimPharm<br><br>Text based, users select pre-populated options | 20 fourth year pharmacy students<br>1 University | Audio recordings and observations in class<br><br>Focus groups | VP vs paper-based<br><br>VP requires gathering of more clues, more independent learning, not linear completion, more responsibility, saw as real patient and had to make decisions<br>More reference sources used for paper |
| Marriott (2007) | Australia | Text-based VP | 360 third and fourth year pharmacy students | Oral presentation<br><br>Evaluative survey – Likert scale | VP easy to access and use, self-selection of patients was innovative but faculty assignment may have been better<br>VP realistic and engaging, having same VP for two years improved learning |
| McDowell *et al.* (2016) | Australia | MyDispense Asynchronous avatars<br><br>Pre-select options, free-text, make notes but don't interact with avatar | 199 first year pharmacy students<br>1 University | Performance on MyDispense exam<br><br>Evaluative survey - Likert scale and open-ended Q's | Median score of 98% on exam<br>VP helped understand dispensing procedure, medications, professional enculturation, record keeping, improved confidence, stimulating learning environment, learn from mistakes, feedback useful, realistic and helped prepare for real-world<br>Negative – 'bugs' in software<br>Improvements – reliability of software, learning support, avatar design |
| McFalls (2013) | USA | Animated VPs<br><br>Students asked questions (no info as to how)<br>VP responds via speech | 127 second year pharmacy students<br>1 University | Pre-post knowledge quizzes<br><br>Case for submission<br><br>Evaluative survey – Likert scale | VP in PBL<br><br>Post-quiz scores significantly higher than pre-quiz<br>Students liked PBL and liked using VP |

| Author (year) | Country | Types of VP | Participants | Data Collection | Outcomes |
|---|---|---|---|---|---|
| Menendez *et al.* (2015) | Brazil | PharmaVP system,<br><br>Pictures and text<br>Tutor gives feedback | 31 pharmacy students<br>1 University | Evaluative survey - Likert scale | VP novel, understand not textbook patients, improve confidence, more realistic than written cases, patient outcomes affected by input enhanced learning process, challenging, enhanced understanding, engaging, realistic, instructive, fun |
| Olin and Cole (2015) | USA | DecisionSim<br><br>Free text and MCQ input<br>Textual output | 93 third year pharmacy students<br>2 campuses | Evaluative survey – Likert scale | VP promoted understanding of key concepts, should be continued in course, helped identify learning needs, immediate feedback enhanced learning<br>Improvement – use as individual learning tool (group use in study) |
| Orr (2007) | USA | Emails with pharmacists<br><br>Feedback provided 1-2 weeks after submitted | 132 third year pharmacy students<br>1 University | Email interactions graded by tutor<br><br>Pre-post skills based survey – Likert scale<br><br>Evaluative survey – Likert scale | Improved responses as the semester progressed<br>Average grade 88%<br>Written communication skills improved<br>Significantly more confident in self-care competencies, knowledge, problem-solving, communication and professional skills<br>VP valuable learning tool, realistic innovative, interesting |
| Park and Summons (2013a) | Australia | The Virtual Pharmacy Patient<br><br>3D talking head – expressions and speech<br>Textual input | 30 pharmacy students<br>2 Universities | Evaluative survey – Likert scale | VP useful for those that have little experience in pharmacy, helped identify areas of weakness, improved confidence with real patients<br>Negative – appearance of VP wasn't authentic, didn't act like a real patient, didn't answer questions in a natural manner, voice pitch was poor |

| Author (year) | Country | Types of VP | Participants | Data Collection | Outcomes |
|---|---|---|---|---|---|
| Pereira and Cavaco (2014) | Portugal | Asynchronous avatars<br><br>Users pre-select questions<br>Response via text | 717 pharmacy undergraduates and internship students in Portugal | WWHAM and communication skills – VP transcripts<br><br>Evaluative survey-Likert scale | Mean patient counselling scores – 8/10<br><br>Students with previous work experience scored statistically better<br>Significantly lower mean score in the early years of study<br>Mean agreement of use of VP to assess counselling skills |
| Seefeldt *et al.* (2012) | USA | Synchronous avatars<br>Second life (SL) | 47 in total - 7 first year pharmacy students, 8 third year pharmacy students, 10 nursing students, 8 physician assistant students, 7 physical therapy students, 7 occupational therapy students | Facilitator observation<br><br>Pre-post survey of perceptions and knowledge of IPE – Likert scale and open-ended Q's | Post-survey - larger percentage of students recognised characteristics of effective IPE<br>VP allowed students to see perspectives of other health professions, convenient and flexible tool, interactive nature was realistic<br>Issues – technical, missing information or health profession (i.e. medics), differences in levels of education, audio capabilities, lack of non-verbal communication<br>94% not used SL before<br>60% agreed SL was useful for IPE<br>Third year pharmacy students contributed most |
| Smith and Benedict (2015) | World | Review article | Literature review on effectiveness of educational technologies | | 104 articles found – 19 articles met inclusion criteria<br>7 studies – CAI, 5 studies – HPS,<br>7 studies – VPs |

| Author (year) | Country | Types of VP | Participants | Data Collection | Outcomes |
|---|---|---|---|---|---|
| | | | | | Assessment of VP by SOAP, exam scores, pre-post-tests, presentations, self-evaluation, peer assessment<br>VPs improved scores on examinations/post-tests in all 7 studies (3 significant improvements)<br>VP significantly improved knowledge and problem-solving, communication and professional skills |
| Smith *et al.* (2014) | USA | vpSIM<br><br>No further description on how users interact with VP or how VP responds | 105 third year pharmacy students<br>1 University | Pre-post-knowledge quiz<br><br>Evaluative survey – Likert scale and open-ended Q's<br><br>Final exam – knowledge retention | VP improved learning of higher and lower-level (higher-level>lower-level)<br>Median final exam score 84.6%<br>VPs effective at practicing clinical applications of asthma, should be incorporated into curricula, users accessed the case to prepare for the exam, enjoyed use, appropriate content |
| Smith *et al.* (2016) | USA | vpSIM<br><br>No further description on how users interact with VP or how VP responds | 131 third year pharmacy students<br><br>3 faculty members | Pre-post -knowledge quiz<br><br>Faculty evaluative survey<br><br>Student evaluative survey –<br>Likert scale | Post-quiz knowledge improved (N.S)<br>Faculty – case sharing allowed use of more VP cases and better return on investment, minimal time and effort to create, easy customisation, peer review helpful in improving cases<br>Students – VP allowed clinical application of knowledge, should use in all clinical components of course, enjoyed using, appropriate content, enhanced learning |

| Author (year) | Country | Types of VP | Participants | Data Collection | Outcomes |
|---|---|---|---|---|---|
| Taglieri *et al.* (2017) | USA | Shadow Health Digital Clinical Experience<br>Asynchronous avatars<br><br>Free-text input<br>Avatar responds via text and speech | 335 third year pharmacy students<br>1 University | Pre-survey, interim survey, post-survey – Likert scale and open-ended Q's<br><br>Performance in mock clinic | VP vs control<br><br>Significant improvement pre-post for both groups (VP>control)<br>Little change in confidence in either group<br>VPs easy to use, realistic, ability to practice in own time<br>Negative – learn to obtain a history, practice synthesising data and reflect on performance, patients and scenarios pre-set and not realistic, technical issues, time consuming |
| Villaume *et al.* (2006) | USA | Auburn University Virtual Patient (AUVP)<br><br>Video responses<br>Speech recognition – users ask Q's – responses shown on screen and user must pick one to say | 125 first year pharmacy students<br>1 University | Students script for VP - graded<br><br>Final exam – Knowledge retention | Motivational interviewing<br><br>Students – use of closed-questions, problems with empathetic responses, too many problems with the technology and project took too much time<br>Technological issues - audio recordings of VP, debugging the script files, formatting script<br>VP improved understanding of motivational interviewing – scores on these questions significantly better than scores on the other questions |

| Author (year) | Country | Types of VP | Participants | Data Collection | Outcomes |
|---|---|---|---|---|---|
| Zary *et al.* (2006) | Sweden | WebSP<br><br>Picture, Text, video output<br>MCQs and free-text input, select tests or exams | 283 in total - 70 medical students<br>123 dentistry students<br>90 pharmacy students | Evaluative survey – Likert scale and free-text comments | Easy to create and edit VP cases without need for computer specialists<br>VP has significant educational value, easy to use, engaging, realistic, instructive, fun to use<br>Technology issues – case notes differing from VP disease state |
| Zlotos *et al.* (2016) | UK (Scotland) | Asynchronous avatars<br><br>MCQ input<br>Speech output and animations | 106 pre-registration pharmacist trainees | Pre-post-test and 6 months later – Likert scale | Confidence increased significantly regarding respecting patient, describing barriers to accessing care, recognising drug misuse symptoms, developing empathy, understanding 'harm reduction'<br>Significant increase in test scores post-test<br>Significant decrease in scores between post-test and 6-month (still significant improvement from baseline) |

**Table 3-3: Presents the studies which were identified from the literature search as meeting the eligibility criteria and being included in the review.**

## 3.5 Literature Review Findings

### 3.5.1 Overview of Findings

In total, 37 studies met the pre-defined literature review inclusion criteria (section 3.4.1). Of these studies, three were review articles (one literature review specific to VP use in pharmacy, one literature review regarding e-learning in pharmacy and one review of the use of VP technology in pharmacy education by questioning pharmacy students), two were conference papers and the remaining 32 were full evaluative studies, with or without a control measure.

There were eight different types of VP tools described in the literature (see Table 3-4). From the descriptions provided in the studies, it was difficult to establish some of the VP tools used but, where necessary, further investigation was carried out, such as going to the software developers' websites. For example, VPsim and DecisionSIM were used interchangeably in the literature with little explanation as to the type of VP tool (i.e. how users input and how VP responds), but further exploration found they utilise the same multimedia based output software (Kynectiv Inc., 2017; MedBiquitous Consortium, 2017). One study provided the name of the VP programme used but no information could be found regarding how the VP interacted with users (PharmaCAL). The most common types of VP used in the evaluative studies were asynchronous avatars and those which utilised various multi-media outputs. Although asynchronous avatars were commonly used, there was a noted lack of standardisation with this type of tool; with variations in user interactions being reported in the literature. Of the nine studies which reported their use, one reported using only free-text inputs, five reported utilising MCQs or pre-populated options and three reported incorporating both types of input. Five of the studies used text-only outputs from the VP and four integrated speech with or without text.

Differences in the utilisation of the VPs to provide feedback to users was also discovered in the literature review. Feedback was provided by the VP itself in 16 studies, by faculty members in 11 studies and there was a lack of detail as to the provision of feedback in seven studies.

| Type of VP tool | Number of studies | Specific Tools (No. of studies) |
|---|---|---|
| Text-based output | 6 | SIMPharm (1) |
| Video-based output (+/- text) | 3 | SIMmersion (1) |
| Image-based output (+/- text) | 1 | PharmaVP (1) |
| Multimedia output (video + images + text) | 9 | VPSim (5)<br>DecisionSIM (2)<br>TheraSim (1)<br>WebSP (1) |
| Animated output | 2 | |
| Telephone based | 1 | |
| Asynchronous avatars | 9 | MyDispense (2)<br>PharmaComm (1)<br>Shadow Health Digital Clinical Experience (1) |
| Synchronous avatars | 2 | Second Life (2) |
| No Info. | 1 | PharmaCAL |

**Table 3-4 displays the number of different VP tools described in the literature.**

The use of comparative studies was also of interest to the researchers. Review of the literature identified that, of the 34 evaluative studies (32 evaluative studies and 2 conference papers), 24 of them had no comparator to the VP, three had a control group, four compared VPs against paper-based case studies, one compared VPs with standardised patients (SPs), one compared VPs with lectures and one compared VPs with problem-based learning (PBL).

This literature review also identified that the majority of studies investigating VP use in pharmacy education were undertaken in America, which correlates with the findings by Jabbur-lopes *et al.* (2012). The split of the studies are as follows: 21 from the USA, four from the UK, four from Europe, four from Australia, one from New Zealand, one from Brazil and two worldwide.

In addition to location of the studies, the subset of the participants was also of interest to determine where the utility of VPs had primarily focused. The literature review found the majority of studies (33)

evaluated VP use in pharmacy undergraduate education, however the quality assessment did establish studies where the participants could have been explained in greater depth (see table 3.5 and Appendix 1). Two studies evaluated VPs in interprofessional education, one included undergraduate pharmacists and pre-registration trainees, one included undergraduate pharmacists and teaching staff and one included undergraduate pharmacists and qualified pharmacists. One study evaluated VP use in pre-registration trainees and one evaluated their use in qualified pharmacists.

The literature was also reviewed for the types of data collection tools used. The most common methods of data collection were exams to assess knowledge retention (11 studies) pre-post questions to assess a range of knowledge or skills (14 studies) and evaluative surveys to obtain user satisfaction with the VP tools (27 studies). Other methods of data collection included focus groups, subjective-objective-assessment-plans (SOAPs), observations, care plans, SP consultations and presentations. Results from this review are reinforced by those found by Smith *et al.* (2015) who also reported that the most common data collection tools were pre-post quizzes, exams and satisfaction surveys.

All 37 included review studies were screened for their evaluations on VP use in pharmacy education or training. Thematic analysis was conducted in accordance with Braun and Clarke (2006) which led to the identification of the following themes, which will each be discussed in turn in sections 3.5.2 to 3.5.5.

- Use of VPs to improve knowledge
- Use of VPs to develop skills
- User satisfaction with VPs
- Technological issues associated with VPs

### 3.5.2 Use of VPs to Improve Knowledge

Overall, the literature review indicated that VPs were useful tools to improve knowledge of both undergraduate pharmacy students and postgraduate pharmacists in a wide range of areas. The significance of results varied, with research finding significant improvements in knowledge on pre- to post-quizzes (Chaikoolvatana and Goodyer, 2003; Battaglia *et al.*, 2012; Benedict *et al.*, 2013; McFalls, 2013; Al-Dahir *et al.*, 2014; Smith *et al.*, 2014, 2016; Lichvar *et al.*, 2016; Zlotos *et al.*, 2016; Taglieri *et al.*, 2017) but little significant difference when VPs were compared with other learning tools (Benedict *et al.*, 2013; Bindoff *et al.*, 2014). One research study even found problem-based learning improved student's knowledge more significantly than VPs (Al-Dahir *et al.*, 2014).

The literature also evaluated VP effects on knowledge retention. All research which included this as an outcome found knowledge improvement from baseline but with varying significance. (Villaume *et al.*, 2006; Benedict and Schonder, 2011; Benedict *et al.*, 2013; Smith *et al.*, 2014; Lichvar *et al.*, 2016; Zlotos *et al.*, 2016). When VPs were compared with lectures, although knowledge improved significantly from baseline, there was no significant difference in the level of knowledge retention between the two groups (Benedict *et al.*, 2013). Research has also found a significant decrease in knowledge 6-months after post-testing (Zlotos *et al.*, 2016). These results indicate that VPs are effective at improving knowledge (shown by users' increase in knowledge from baseline) but knowledge retention may not be superior to what is achieved by other learning tools and the evidence for long-term knowledge gain is limited.

As well as investigating the effects on knowledge from the use of VPs, research has evaluated user's perceptions regarding the ability of VPs to improve their knowledge base. This is most commonly conducted via Likert scales, with favourable results being reported. A large proportion of studies reported that VPs were effective tools at developing new knowledge and reinforcing previously learnt knowledge (Fuhrman Jr. *et al.*, 2001; Zary *et al.*, 2006; Orr, 2007; Benedict, 2010; Battaglia *et al.*,

2012; Al-Dahir *et al.*, 2014; Menendez *et al.*, 2015; Olin and Cole, 2015; McDowell *et al.*, 2016; Smith *et al.*, 2016). Lichvar *et al.* (2016) and Smith *et al.* (2014) reported that students used the VP for independent learning after completion of the study due to the benefits they felt it provided to their learning. Contrasting results have also been found, with students reporting VPs as ineffective tools to acquire new knowledge (Douglass *et al.*, 2013) with more direct learning tools (i.e. lectures) being superior at this (Benedict *et al.,* 2013). VPs have also been effective at identifying gaps in users' knowledge and promoting self-directed learning; an essential skill for pharmacists to possess in practice (Benedict *et al.*, 2013; Olin and Cole, 2015; Lambertsen *et al.*, 2017).

### 3.5.3 Use of VPs to Develop Skills

In addition to knowledge development, VPs have been reported as useful tools to aid the development of a range of skills in undergraduate pharmacy students and postgraduate pharmacists. When VPs have been compared with other learning tools, it has been found that the different tools complement each other and are needed to develop different skills (Benedict, 2010; Loke *et al.*, 2011; Bindoff *et al.*, 2014; Taglieri *et al.*, 2017).

Most commonly reported in the literature is the development of communication skills by VPs (Chaikoolvatana and Goodyer, 2003; Hussein and Kawahara, 2006; Orr, 2007; Fleming *et al.*, 2009; Bracegirdle and Chapman, 2010; Park and Summons, 2013a; Bindoff *et al.*, 2014; Pereira and Cavaco, 2014; Ferrone *et al.*, 2017; Taglieri *et al.*, 2017). Those studies which utilised asynchronous avatars most frequently discussed the development of communication skills with users reporting the development of emotional intelligence and counselling skills after completing a simulation (Bracegirdle and Chapman, 2010; Bindoff *et al.*, 2014; Pereira and Cavaco, 2014; Ferrone *et al.*, 2017; Taglieri *et al.*, 2017). The more interactive nature of asynchronous avatars may promote the development of communication skills, thus, account for the increased reporting. When other types of

VPs implement a more realistic user input (i.e. free-textual input, spoken input) communication skills were also reported as being developed (Chaikoolvatana and Goodyer, 2003; Hussein and Kawahara, 2006; Orr, 2007; Fleming *et al.*, 2009). Non-verbal communication skills were reported as difficult to develop using VP technology and some users indicated this as a barrier to the simulation; particularly in Second Life when users from different healthcare disciplines were interacting with each other in avatar form (Seefeldt *et al.*, 2012; Caylor *et al.*, 2015).

The studies included in the review evaluated the development of communication skills in various ways, including phone messages, presentations and by consultations with SPs, which have found users are more thorough and confident with their questioning after using VPs (Chaikoolvatana and Goodyer, 2003; Fleming *et al.*, 2009; Taglieri *et al.*, 2017). Written communication skills have also been assessed via free-text input into the VP systems and have found to improve as the simulation progresses or after multiple attempts (Orr, 2007; Bracegirdle and Chapman, 2010). When compared with more traditional teaching methods, VPs have been found to be superior at aiding the development of communication skills, specifically those related to brief interventions (Fleming *et al.,* 2009) and patient counselling (Bindoff *et al.*, 2014; Ferrone *et al.*, 2017). User's perceptions of their communication skills have also been reported via the use of Likert scales with reported improvement after using a VP (Orr, 2007; Park and Summons, 2013a; Pereira and Cavaco, 2014).

A second area of improvement which has been reported after using VPs is user's self-confidence (Park and Summons, 2013a; Menendez *et al.*, 2015; Olin and Cole, 2015; Barnett *et al.*, 2016; McDowell *et al.*, 2016; Zlotos *et al.*, 2016; Lambertsen *et al.*, 2017; Taglieri *et al.*, 2017). This includes confidence in their own abilities, confidence to undertake tasks, confidence to interact with real patients and confidence to pass their exams. Only one study which evaluated the development of user's self-confidence reported no improvement after using the VP, but individuals' competence in completing certain tasks was found to significantly improve, which may indicate difficulty in assessing self-

confidence (Taglieri *et al.*, 2017). Self-confidence has primarily been measured by Likert scales, with one study reporting the use of focus groups instead. Both of these data collection methods are associated with subjectivity of responses, which also illustrates the difficulty in assessing this area of development.

Teamworking skills were also found to improve after the use of VPs. The literature included in this review reported the use of synchronous avatars as a tool for interprofessional education (IPE) with favourable results (Seefeldt *et al.*, 2012; Caylor *et al.*, 2015). This type of VP technology was found to encourage users to work as a team and improve knowledge of IPE, as reported by findings from faculty observations and user's self-reporting. Studies have also evaluated the use of VPs as teamworking tools in groups of pharmacy students, which found that VPs were able to improve this and allowed students to learn from others in the group (Hussein and Kawahara, 2006; Orr, 2007). One study reported contrasting results with students believing that VPs were not suitable as group working tools and should have instead been used as independent learning tools to allow for better assessment of individual learning needs (Olin and Cole, 2015).

Other skills have been described less commonly in the literature. VPs have been reported on self-rating Likert scales to improve students problem-solving skills when used alone and have been reported as superior to standard paper-based cases in doing this (Orr, 2007; Loke *et al.*, 2011). VPs have also been found to promote self-directed learning, with observations and assessments illustrating that students utilised more resources when completing VP simulations than other learning tools (Hussein and Kawahara, 2006; Lambertsen *et al.*, 2017). Task-based skills, such as dispensing, have also been reported to be enhanced by the use of VPs (Bindoff *et al.*, 2014; McDowell *et al.*, 2016; Ferrone *et al.*, 2017), indicating that VPs could be used to promote skill development in practical aspects of a pharmacist's role. Finally, VPs have been reported to aid in the development of

'accurate and consistent professional skills'; but no further explanation of what these skills were was provided in the literature (Claudio *et al.*, 2015).

### 3.5.4 User Satisfaction with VPs

As reported in the previous sections 3.5.2 and 3.5.3, many of the findings reported in the literature have come from self-rating Likert scales (or other evaluative surveys). These surveys cover many aspects related to the design of a VP, usefulness of a VP and enjoyment of using a VP.

The literature review shows users favourability towards the use of VPs, with reports of high levels of enjoyment and interest by both undergraduate students and postgraduate pharmacists (Chaikoolvatana and Goodyer, 2003; Zary *et al.*, 2006; Benedict and Schonder, 2011; Benedict *et al.*, 2013; Smith *et al.*, 2014, 2016; Menendez *et al.*, 2015; Barnett *et al.*, 2016; Ferrone *et al.*, 2017; Lambertsen *et al.*, 2017). When VPs have been compared with other learning tools, studies have reported various differences in enjoyment. Benedict (2010) evaluated the use of VPs in problem-based learning (PBL) and found that students reported enjoying PBL more than using the VP. Barnett *et al.* (2016) compared VPs and paper-based case studies and found students reported greater enjoyment at completing the VP case. This has also been reported by students in lower levels of education in a study by Bindoff *et al.* (2014), who found that third year students enjoyed completing the VP case more than the paper-based case, but fourth year students enjoyed the paper-based case more. This was attributed to the difficulty level of the cases created (at a third year level) thus, fourth year students may have found them too easy. However, both sets of students reported greater engagement with the VP.

Students may have reported engaging with the VP more because of the sense of 'emotional engagement' it encourages, as reported by Bracegirdle and Chapman (2010). A number of studies reported that user's felt the VP created a sense of responsibility, due to their individual actions and

decisions affecting the outcomes of the VP, which was not reported from completing the paper-based case studies (Hussein and Kawahara, 2006; Benedict and Schonder, 2011; Loke *et al.*, 2011; Smith *et al.*, 2014; Menendez *et al.*, 2015). For example, in the study by Lambertson *et al.* (2017) the VP's vital signs changed based on user's decisions, which allowed them to see how their actions may affect a real-life patient.

Users also reported that the VP created a safe learning environment, where they could apply their knowledge and were not afraid to make and learn from their mistakes (Hussein and Kawahara, 2006; Benedict and Schonder, 2011; Smith *et al.*, 2014; Smith and Benedict, 2015; Lichvar *et al.*, 2016; McDowell *et al.*, 2016; Ferrone *et al.*, 2017; Lambertsen *et al.*, 2017). One of the design aspects of the VP which was reported to aid learning was the provision of immediate, individualised feedback based on a user's actions (Benedict and Schonder, 2011; Claudio *et al.*, 2015; Olin and Cole, 2015; McDowell *et al.*, 2016; Lambertsen *et al.*, 2017). Some studies reported providing incremental feedback as a case progressed (Fleming *et al.*, 2009; Battaglia *et al.*, 2012; Al-Dahir *et al.*, 2014; Pereira and Cavaco, 2014; Olin and Cole, 2015; Barnett *et al.*, 2016; Lichvar *et al.*, 2016; Ferrone *et al.*, 2017; Lambertsen *et al.*, 2017) whereas others reported the provision of feedback at the end of a VP simulation (Zary *et al.*, 2006; Bracegirdle and Chapman, 2010; Douglass *et al.*, 2013; Bindoff *et al.*, 2014; Claudio *et al.*, 2015). Those studies which utilised computer telephony (Hussein and Kawahara, 2006) and email-based VPs (Orr, 2007) described taking longer to provide their students with feedback, but all provisions of feedback were received well and reported as a useful aspect of the VP design.

Another element commonly included in the evaluative surveys was the ease of use of the VP. Users generally perceived the VP as easy to use; specific technological issues impacting their ease of use are described in the next section (Chaikoolvatana and Goodyer, 2003; Zary *et al.*, 2006; Marriott, 2007b; Benedict and Schonder, 2011; Bindoff *et al.*, 2014; Claudio *et al.*, 2015; Ferrone *et al.*, 2017; Taglieri *et al.*, 2017). In addition to being easy to use, VPs were reported as innovative learning tools by both

undergraduate students and postgraduate pharmacists (Hussein and Kawahara, 2006; Orr, 2007; Menendez *et al.*, 2015). This may be because of their limited use in pharmacy education. The literature reviews which have been undertaken (including this one) report few studies which have evaluated VP use in pharmacy (Cavaco and Madeira, 2012; Jabbur-lopes *et al.*, 2012; Smith and Benedict, 2015). Since these reviews, research evaluating VP use in pharmacy has increased and the literature pool is becoming more inclusive (as evidenced by this current literature review); however, it still lags behind that of medicine and nursing, as noted from the literature review in Chapter 2.

Another aspect of VPs which is commonly evaluated by self-reporting surveys is their realism. The majority of studies in this review reported that user's felt the VPs were realistic and, when compared with paper-based methods, were reported as being more realistic (Zary *et al.*, 2006; Hussein and Kawahara, 2006; Marriott, 2007b; Orr, 2007; Loke *et al.*, 2011; Claudio *et al.*, 2015; Menendez *et al.*, 2015; Barnett *et al.*, 2016; McDowell *et al.*, 2016; Taglieri *et al.*, 2017; Ferrone *et al.*, 2017; Lambertsen *et al.*, 2017). The most common aspects associated to realism which are evaluated relate to the design of the VP (i.e. interactivity, authenticity, scope, clinical environment) and the case study topics (similar to real-world patients or issues). The different types of VPs have been reported as realistic, but no studies have directly compared the different VP tools, which may be useful to determine the aspects of VPs which are particularly important at increasing their realism.

Undergraduate students, postgraduate pharmacists and faculty members who participated in the studies included in this review, believed that VPs were useful learning tools and felt they should be utilised more in all areas of pharmacy education and CPD (Benedict and Schonder, 2011; Cavaco and Madeira, 2012; Park and Summons, 2013a; Smith *et al.*, 2014, 2016; Claudio *et al.*, 2015; Olin and Cole, 2015; Ferrone *et al.*, 2017; Lambertsen *et al.*, 2017).

### 3.5.5 Technological Issues Associated with VPs

In addition to the positive findings on the evaluative surveys, negative comments relating to issues with VP technology were also reported in the literature. One of the most common problems with using the VPs was the lack of training and thus difficulty in using the tools, although upon further review of the literature, specific explanations relating to areas of difficulty were limited (Bindoff *et al.*, 2014; McDowell *et al.*, 2016; Ferrone *et al.*, 2017). Where further explanations were provided, the main problems seemed to be regarding navigation around the VP programmes and issues with the keyword recognition software not understanding users' inputs (Chaikoolvatana and Goodyer, 2003; Caylor *et al.*, 2015). These problems seemed to cause user frustration but did not detract from the learning experience. Other issues included glitches in the software which led to the VP crashing or taking too long to connect (Hussein and Kawahara, 2006; McDowell *et al.*, 2016; Taglieri *et al.*, 2017). Users also reported the VP cases taking too long to complete, yet these studies also reported improvements in knowledge, skills and enjoyment in completing the case studies, so again, the time-consuming nature didn't appear to detract from the learning experience (Chaikoolvatana and Goodyer, 2003; Hussein and Kawahara, 2006; Taglieri *et al.*, 2017).

The most prominent issue with the more animated VPs related to the design of the VP. Some studies found that, although the VP cases were more realistic than other learning tools, the appearance of the avatar or interactions between the user and the avatar were unrealistic (Park and Summons, 2013a; Bindoff *et al.*, 2014; Claudio *et al.*, 2015; McDowell *et al.*, 2016; Taglieri *et al.*, 2017). Where simple dialogue was used (i.e. selecting pre-defined options), this was reported to affect immersion in the simulation and their realistic nature (Bindoff *et al.*, 2014). Other users reported, particularly with asynchronous avatars, issues with synchronisation of the VPs speech, expressions, animations and textual components (Claudio *et al.*, 2015).

## 3.6 Limitations of Studies in this Review

Upon review of the studies, there were many limitations which ultimately led to difficulty in assessing study quality. The checklist created by Morrison *et al.* (1999) was used to critically appraise the studies in this review. Table 3.5 presents the main quality assessment criteria, and a further, elaborative table of the quality assessment of the 37 included review studies is provided in Appendix 1. The most notable limitations were with VP descriptions, participant descriptions, reliability or validity of the data collection tools and an explanation of other or unexpected findings.

| Paper | Learning need | Educational context | Intervention | Methods/ Study Design | Outcomes | Secondary explanation | Un-anticipated outcomes |
|---|---|---|---|---|---|---|---|
| Al-Dahir *et al.* (2014) | Yes | Yes | Partly | Yes | Yes | Yes | Yes |
| Barnett *et al.* (2016) | Yes | Yes | Yes | Yes | No | Yes | Yes |
| Battaglia *et al.* (2012) | Yes | Yes | Yes | Yes | No | Yes | Yes |
| Benedict (2010) | Yes | Yes | Partly | Yes | No | Yes | Yes |
| Benedict and Schonder (2011) | Yes | Yes | Partly | Yes | No | Yes | Yes |
| Benedict *et al.* (2013) | Yes | Yes | Partly | Yes | Yes | Yes | Yes |
| Bindoff *et al.* (2014) | Yes | Yes | Yes | Yes | No | Yes | Yes |
| Bracegirdle and Chapman (2010) | Yes | Yes | Yes | Yes | No | Yes | No |
| Cavaco and Madeira (2012) | Yes | Yes | N/A | Yes | No | Yes | No |
| Caylor *et al.* (2015) | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Chaikoolvatana and Goodyer (2003) | Yes | Yes | Yes | Yes | No | Yes | Yes |
| Claudio *et al.* (2015) | Yes | Yes | Yes | Yes | No | No | No |
| Douglass *et al.* (2013) | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

| Paper | Learning need | Educational context | Intervention | Methods/ Study Design | Outcomes | Secondary explanation | Un-anticipated outcomes |
|---|---|---|---|---|---|---|---|
| Ferrone *et al.* (2017) | Yes | Yes | Yes | Yes | No | Yes | Yes |
| Fleming *et al.* (2009) | Yes | Yes | Yes | Yes | Yes | Yes | No |
| Fuhrman Jr. *et al.* (2001) | Yes | Yes | Yes | Yes | No | No | No |
| Hussein and Kawahara (2006) | Yes | Yes | Yes | Yes | No | Yes | Yes |
| Jabbur-lopes *et al.* (2012) | Yes | N/A | Yes | Yes | No | Yes | No |
| Lambertsen *et al.* (2017) | Yes | Yes | Yes | Yes | No | Yes | Yes |
| Lichvar *et al.* (2016) | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Loke *et al.* (2011) | Yes | Yes | Yes | Yes | Yes | No | No |
| Marriott (2007) | Yes | Yes | Yes | Yes | No | Yes | No |
| McDowell *et al.* (2016) | Yes | Yes | Yes | Yes | No | No | No |
| McFalls (2013) | Yes | Yes | Partly | Yes | No | No | No |
| Menendez *et al.* (2015) | Yes | Partly | Yes | Yes | Partly | No | No |
| Olin and Cole (2015) | Yes | Yes | Partly | Yes | No | Yes | Yes |
| Orr (2007) | Yes | Partly | Yes | Yes | No | Yes | Yes |
| Park and Summons (2013a) | No | Partly | Yes | Yes | No | No | No |
| Pereira and Cavaco (2014) | Yes | Yes | Yes | Yes | No | Yes | Yes |
| Seefeldt *et al.* (2012) | Yes | Yes | Yes | Yes | No | Yes | No |
| Smith and Benedict (2015) | Yes | N/A | Yes | Yes | No | No | No |
| Smith *et al.* (2014) | Yes | Yes | Partly | Yes | Partly | Yes | Yes |
| Smith *et al.* (2016) | Yes | Yes | Partly | Yes | Partly | Yes | No |
| Taglieri *et al.* (2017) | Yes | Yes | Yes | Yes | No | Yes | Yes |
| Villaume *et al.* (2006) | Yes | Partly | Yes | Yes | No | No | Yes |
| Zary *et al.* (2006) | Yes | Yes | Yes | Yes | No | No | No |

| Paper | Learning need | Educational context | Intervention | Methods/ Study Design | Outcomes | Secondary explanation | Un-anticipated outcomes |
|---|---|---|---|---|---|---|---|
| Zlotos *et al.* (2016) | Yes | Yes | Yes | Yes | No | Yes | No |

**Table 3-5 displays a summary of the quality assurance criteria for each of the 37 studies in the literature review based on the checklist by Morrison *et al.* (1999). Further explanation is provided in Appendix 1; particularly where studies have only 'partly' met a criteria.**

The first limitation to be noted was the lack of variation in participants recruited across the studies. The majority of studies evaluated the use of VPs with undergraduate pharmacy students but only five studies recruited from two or more schools of pharmacy or different year groups. This reduces the generalisability of the results to students different to those studied. Four studies were associated with poor explanations of participants, such as not describing what year of study the participants were in, which affected their quality assessment (Menendez *et al.,* 2015; Orr, 2007; Park and Summons, 2013a; Villaume *et al.,* 2006). A second problem related to the participants was the lack of power calculations to select a sample size which would obtain statistically significant results. A power calculation is required when trying to determine superiority of learning tools and it was found to be missing or not sufficiently reported in the literature; with four studies making reference to their lack of calculating one but no others mentioning it in any context (Al-Dahir *et al.*, 2014; Bindoff *et al.*, 2014; Pereira and Cavaco, 2014; Barnett *et al.*, 2016).

All studies were associated with appropriate methods and study design. A large proportion of the data collection tools used in the literature were self-reporting evaluative surveys, which are associated with limitations. They are useful to obtain participants thoughts, feelings and attitudes but it can be difficult to ensure data obtained is valid and reliable (see discussion below). It is also difficult to ascertain that all participants read and interpret questions the same and completing a questionnaire does not allow for clarification on questions. When Likert statements are used, there is also the worry that participants may not be able to put themselves into an absolute category or may

answer in a way which they think they should; which can lead to untrustworthy data (see Chapter 4 for greater discussion of these points).

To assess the methodological design of a study, the detailed content of the self-reporting data collection tool is required. Of the 27 studies which included a self-reporting evaluative survey, 23 of these reported one or more of the questions which were asked (Fuhrman Jr. *et al.*, 2001; Chaikoolvatana and Goodyer, 2003; Hussein and Kawahara, 2006; Zary *et al.*, 2006; Marriott, 2007b; Orr, 2007; Benedict and Schonder, 2011; Seefeldt *et al.*, 2012; Battaglia *et al.*, 2012; Cavaco and Madeira, 2012; McFalls, 2013; Park and Summons, 2013a; Benedict *et al.*, 2013; Douglass *et al.*, 2013; Al-Dahir *et al.*, 2014; Smith *et al.*, 2014, 2016; Bindoff *et al.*, 2014; Menendez *et al.*, 2015; Olin and Cole, 2015; Barnett *et al.*, 2016; McDowell *et al.*, 2016; Taglieri *et al.*, 2017; Ferrone *et al.*, 2017). The remaining four studies made no reference to the questions that were asked (Benedict, 2010; Pereira and Cavaco, 2014; Caylor *et al.*, 2015; Claudio *et al.*, 2015). Throughout the literature there was limited information regarding the validity of the survey-based data collection tools used. Few papers discussed the use of pre-validated tools or the creation of new tools, with only three studies reporting the Cronbach alpha (score of reliability) of their questionnaire (Al-Dahir *et al.*, 2014; Caylor *et al.*, 2015; Barnett *et al.*, 2016). Two of the studies reported using focus groups, in which one included the general themes which were explored (Lambertsen *et al.*, 2017) and one did not (Loke *et al.*, 2011), which again makes it difficult to assess the quality of methods used and determine whether appropriate conclusions have been drawn from the data.

A second problem related to the data collection is a lack of information regarding the personnel conducting the focus groups, observations or assessments. Interviewer bias can arise in interviews or when facilitating questionnaires and including information of the individual(s) collecting the data can help to assess the bias present. Out of the 30 studies which utilised surveys, focus groups or observations, 15 did not provide any information regarding the personnel collecting the data, six

studies reported faculty members (Douglass *et al.*, 2013; McFalls, 2013; Smith *et al.*, 2014; Caylor *et al.*, 2015; Olin and Cole, 2015; Lichvar *et al.*, 2016), six studies reported the researchers (Chaikoolvatana and Goodyer, 2003; Hussein and Kawahara, 2006; Loke *et al.*, 2011; Claudio *et al.*, 2015; Ferrone *et al.*, 2017; Lambertsen *et al.*, 2017), two studies reported that the surveys were integrated into the VP system (Seefeldt *et al.*, 2012; Pereira and Cavaco, 2014) and one study reported an external company providing the survey (Taglieri *et al.*, 2017). The majority of these studies investigated the use of the VP in undergraduate students, which may have led to a power imbalance if those who carried out the data collection were known to the students.

Another limitation of the studies was the lack of information regarding the types of VP tools which were used. Having little explanation regarding this made it difficult for accurate representations of the types of VP tools used in pharmacy education or to make comparisons between the studies to determine differences in effectiveness of the tools. As already reported in section 3.5.1, one study provided little information on the VP tool used and seven provided the name of the tool but no further explanation regarding the interactions between the users and the VP. This is reflected in table 3.5 which indicates that eight of the studies were only assessed as having partly described the intervention (Al-Dahir *et al.,* 2014; Benedict, 2010; Benedict and Schonder, 2011; Benedict *et al.,* 2013; McFalls, 2013; Olin and Cole, 2015; Smith *et al.,* 2014; Smith et al., 2016).

A final limitation of the studies as determined by the quality assessment was the lack of 'other explanations of outcomes' or discussion of unanticipated outcomes. Ten of the studies did not provide any other explanation of their results, e.g. if students were not positive regarding their experience or an aspect of the VP then this was reported but no further explanations were discussed. In addition, there was no discussion on aspects of bias or maturation (Claudio *et al.,* 2015; Fuhrman Jr. *et al.,* 2001; Loke *et al.,* 2011; McDowell *et al.,* 2016; McFalls, 2013; Menendez *et al.,* 2015; Park and Summons, 2013a; Smith and Benedict, 2015; Villaume *et al.,* 2006; Zary *et al.,* 2006). Similarly,

seven of the studies did not discuss any unanticipated findings; they may have reported them but did not explore them further (Bracegirdle and Chapman, 2010; Cavaco and Madeira, 2012; Claudio *et al.,* 2015; Fleming *et al.,* 2009; Fuhrman Jr. *et al.,* 2001; Jabbur-Lopes *et al.,* 2012; Loke *et al.,* 2011; Marriott, 2007; McDowell *et al.,* 2016; McFalls 2013; Menendez *et al.,* 2015; Park and Summons, 2013a; Seefeldt *et al.,* 2012; Smith and Benedict 2015, Smith *et al.,* 2016; Zary *et al.,* 2006; Zlotos *et al.,* 2016). These limitations affected the quality of the studies as there was a lack of assurance that the findings have been explored thoroughly.

## 3.7 The Virtual Patient and Pre-registration Training

During the pre-registration year, pharmacy graduates are required to demonstrate their competence relating to a defined set of standards, without which they are unable to sit the registration examination (see Chapter 1, section 1.4.1). As pre-registration trainees complete all, or the majority, of their training in a single sector it can be difficult for them to have sufficient experiences to progress to the top level of Millers Triangle for all competencies, as discussed in section 1.4 (Miller, 1990). The level of support which pre-registration trainees receive throughout the training year has also been found to vary (Blenkinsopp *et al.*, 2013, 2015; Mills *et al.*, 2013; Jee, Schafheutle, *et al.*, 2016a). A noticeable difference between pre-registration sector training and examination results has been acknowledged which may be attributed to the variable experiences and levels of support identified (GPhC, 2015a). Previous research that has evaluated VPs in education has established them as realistic and engaging learning tools which are able to improve the knowledge and skills of healthcare professionals and have been met with high levels of user satisfaction (Chaikoolvatana and Goodyer, 2003; Orr, 2007; Burke *et al.*, 2008; Cook and Triola, 2009; Bracegirdle and Chapman, 2010; Battaglia *et al.*, 2012). VPs may therefore be beneficial learning tools to bridge the variation gap found within and between sectors of pre-registration training.

Advances in technology and its increasing use in healthcare has led to greater interest in how technology can be used in the education and training of healthcare professionals (Aldrich, 2005; Duque *et al.*, 2008). When considering how VPs may support the pre-registration training year, the features described by Issenberg *et al.* (2005) regarding high-fidelity simulations and effective learning need to be reviewed. VP simulations can be designed for clinical and non-clinical topics, varying levels of difficulties and to meet a range of learning objectives (Chapman, 2012). Previous research has found VP technology can successfully simulate situations which may rarely occur in practice or those which may be associated with ethical issues, such as consultations with mental health patients, children or substance misuse patients (Kenny *et al.*, 2008; Fleming *et al.*, 2009; Zlotos *et al.*, 2016). It may not always be appropriate for pre-registration trainees to observe certain consultations or activities which occur, and the ability to simulate these kinds of experiences offers a huge benefit and illustrates the ability of VPs to meet the 'effective learning tool criteria' related to creating simulations which have a range of difficulties, clinical variation and defined outcomes.

A sense of authenticity has also been identified as a feature of effective learning. Various types of VP tools have been described in the literature but all have been associated with a greater interactivity and sense of realism than standard paper-based cases (or other more traditional learning tools). VPs have also been identified as tools which allow users to apply their learning, which may help pre-registration trainees 'show' their competencies within the experiences they haven't had.

Another aspect of VP simulations which meets the effective learning tool criteria is the promotion of individualised learning. VPs have been created as flexible, independent learning tools which users can choose to engage with. Pre-registration trainees may enjoy the flexible aspect of VPs as they can complete the simulations in a short period of time and as such can fit them in with their other training requirements. Additionally, the use of VPs in combination with other learning tools allows for a more blended teaching approach, which may result in more competent, well-rounded pharmacists, as it has

been established that different learning tools are useful for different kinds and levels of skill or knowledge development (Hicks *et al.*, 2009; Ker and Bradley, 2010; Jeffries *et al.*, 2011; Lin *et al.*, 2011; Kononowicz *et al.*, 2012).

Repetitive practice and a controlled environment have also been identified as aspects of effective learning. VPs can be used repetitively by pre-registration trainees to improve their competence of new skills and knowledge before qualifying. In VP simulations, users assume the role of a healthcare professional in a safe and controlled environment, without compromising patient safety. The outcome of a VP simulation is directly related to user input which may encourage repetitive practice and allow individuals to learn from their mistakes. This may encourage a sense of clinical responsibility within pre-registration trainees which can be difficult to emulate with other learning tools. The provision of immediate, individualised feedback, which is also an aspect of VPs, has been established as a feature of effective learning. For pre-registration trainees, this may be beneficial for them to understand how well they performed and how to improve before completing the simulation again. This may also invoke the practice of self-directed and reflective learning which are essential skills for pre-registration trainees to develop and may help with the commitment to CPD throughout their career (Zary *et al.*, 2006; Huwendiek *et al.*, 2009; Benedict *et al.*, 2013).

## 3.8 Chapter Summary

The systematic review undertaken has established the reduced amount of research regarding VP use in pharmacy education compared to other health professions. This review has identified that the literature contains numerous examples of different types of VPs in pharmacy education. Many of the studies contained little information regarding the type of VP used which made it difficult to compare studies and understand which aspects of VPs are most beneficial to the learning process. In addition, most research has been conducted in the USA with few studies looking at their use in UK-based

pharmacy curricula. The majority of the research has investigated their use in undergraduate education, with one study solely evaluating their use in pre-registration training in the UK, however this was related to a specific area of substance misuse, thus there is scope for further research in this level of training to be conducted.

Most studies utilised qualitative methods of data collection which found high proportions of satisfaction with VPs as a learning tool, but little statistical significance has been obtained regarding their effectiveness as learning tools. There were few studies which reported the validity or reliability of their data collection tools, which called into question study quality. Additionally, there has been a noted lack of comparative studies which has made it difficult to determine the usefulness of VPs compared with more traditional learning techniques.

Overall, the literature largely supports VP use as learning tools. VPs have been reported to be useful learning tools, have aided the development of knowledge and skills and have been associated with high user satisfaction. The results from the narrative review indicate that users were able to engage with the VPs at increasingly meaningful levels, reaching Bloom's taxonomy (Bloom, 1984) levels of analysis and synthesis. Due to the technological nature of the VPs, software limitations were noted, but these did not prevent users from meeting the intended learning outcomes. VP technology has the potential to be an innovative and effective educational tool in pharmacy education, particularly for optimising the teaching of pharmaceutical care. Future research needs to focus on the validation of VP tools and how and when these should be integrated into both undergraduate curricula and postgraduate training.

The methodological considerations and approaches to the programme of work are discussed in the next chapter.

# 4. Methodology

## 4.1 Introduction

This chapter discuss the methodology of the research study. Section 4.2 begins with discussing the choice of the methodology, identifying the differences between qualitative, quantitative and mixed methods research. Philosophical perspectives underlying the methodology choice are discussed in section 4.3. The study design is discussed in section 4.4 and the reasoning for the adoption of a mixed method design in this research is explained in section 4.5. The issues of quality in research are discussed in section 4.6. A chapter summary is provided in section 4.7.

## 4.2 Philosophical Perspectives

Philosophical perspectives can be considered as:

> *"… a set of basic beliefs (or metaphysics) that deals with ultimates or first principles. It represents a worldview that defines, for its holder, the nature of the 'world', the individual's place in it, and the range of possible relationships to that world and its parts…"* (Guba and Lincoln, 1994).

Creswell (2014) uses the term 'worldview' to define what others may have named 'paradigms' or 'epistemologies and ontologies' and defines a worldview as:

> *"… a general philosophical orientation about the world and the nature of research that a researcher brings to a study. Worldviews arise based on discipline orientations, students' advisors/mentors inclinations, and past research experiences."*

This implies a researcher's worldview influences the decisions they make in adopting a research methodology. The worldview from which this research was created was shaped by the background of the lead researcher (JT), the research supervisors and the literature review which uncovered the use of both qualitative and quantitative methods as a means for exploring simulation and VP technology in education (Chapter 2 and Chapter 3).

When discussing worldviews, two associated theoretical considerations are ontology and epistemology. Broadly speaking ontology is the nature of reality and has been defined as "…the ideas about the existence of and relationship between the people, society and world in general" (Eriksson and Kovalainen, 2008). In contrast, epistemology is the theory of knowledge. It is "…the branch of philosophy that deals with questions concerning the nature, scope, and sources of knowledge" (Derose, 2005). A significant concern of epistemology is what counts as 'legitimate knowledge'(Braun and Clarke, 2013). This is particularly related to how different disciplines determine and accept knowledge, and whether the natural sciences and social sciences can and should be studied using the same "'principles, procedures and ethos" (Bryman, 2012). Therefore, a single definition of the term 'knowledge' is difficult to attain. Moser *et al.* (1998) note that "…a theory of knowledge may have to explain a variety of specific concepts of knowledge as well as a common general concept of knowledge underlying the various specific components". In other words, a general meaning of 'knowledge' can be given to all disciplines but consideration also needs to be given to how knowledge may be perceived by different people, different countries, different levels or courses of education.

To a greater or lesser extent, research and researchers themselves may be classified depending on their ontological and epistemological views of knowledge and reality and their existence in relation to human practices and understandings (Bryman, 2012). According to Rolfe (2013) "all researchers work within frameworks or paradigms of underpinning philosophical assumptions about the nature of

knowledge (epistemology), the nature of reality (ontology) and philosophy of science". Qualitative and quantitative research are associated with different ontological and epistemological positions but the theories behind research methods are essentially just viewpoints and not specific guidelines to abide by. Researchers do not necessarily hold fixed epistemological views, they may change depending on the chosen research design.

Quantitative methods tend to be linked to a positivist paradigm (Tashakkori and Teddlie, 1998; Onwuegbuzie, 2000; Creswell and Plano Clark, 2011; Creswell, 2014). Positivists may portray more deterministic and reductionist characteristics which lead them to apply cause-and-effect logic to problems (Creswell, 2014). They may associate themselves with falsifiability, a principle made famous by Popper (1965), which requires the testing of hypotheses against a specific set of variables for something to be considered scientific research. This type of research primarily generates 'objective' data, such that psychological and social phenomena may be viewed as having an objective reality that is independent of the subjects being studied to allow for theory verification (Onwuegbuzie and Leech, 2007b; Creswell and Plano Clark, 2011; Yilmaz, 2013). With respect to ontological differences, theoretically, positivists may believe in a single reality which can be deduced from a standardised test or intervention (Tashakkori and Teddlie, 1998; Johnson and Onwuegbuzie, 2004; Yilmaz, 2013). Positivists also seemingly contend that reality should be studied objectively, as a researcher and the subjects are viewed as separate and independent from one another (Tashakkori and Teddlie, 1998; Yilmaz, 2013).

In contrast, qualitative methods are usually considered to be more interpretavist, or constructivist, and go against the assumptions of positivists (Johnson and Onwuegbuzie, 2004). Instead, constructivists predominantly seek understandings of phenomena and may explore multiple participant meanings to generate a theory or pattern of views (Creswell, 2014). Constructivist researchers recognise that findings are subjective and reality or knowledge is socially and

psychologically constructed; there is no objective reality in social research to discover (Onwuegbuzie and Leech, 2003; Creswell and Plano Clark, 2011; Yilmaz, 2013; Creswell, 2014). They tend to believe that there are multiple, socially constructed realities which are open to interpretation from different researchers that are all equally valid (Onwuegbuzie and Leech, 2003; Yilmaz, 2013). Constructivists also tend to believe that a researcher and object of study are dependent on each other, which results in the researcher positioning themselves as close as possible to the concepts being studied (Onwuegbuzie and Leech, 2003; Yilmaz, 2013).

A mixed methods approach, utilises both quantitative and qualitative methodologies and as such takes an almost dual philosophical stance known as pragmatism (Tashakkori and Teddlie, 1998; Onwuegbuzie, 2000; Maxcy, 2003; Creswell and Plano Clark, 2011). Pragmatists may consider the research question to be more important than the method or the worldview held by the researcher (Howe, 1988; Tashakkori and Teddlie, 1998; Johnson and Onwuegbuzie, 2004; Feilzer, 2010). Indeed, the connection between research methodology and philosophical views has been described as being a 'mere association' and not the deterministic factor in deciding how a research question should be approached (Bryman, 2012). Researchers should make the most efficient use of the different methodologies to better understand social phenomena rather than focusing on which worldview is held up by the methodological choice (Tashakkori and Teddlie, 1998; Greene and Caracelli, 2003).

Pragmatists seemingly understand that research is influenced by theory, hypotheses, observations, facts, and evidence and individuals should use both inductive and deductive logic to obtain results. The use of dual methodologies leads to the generation of different types of data (quantitative and qualitative) which can be triangulated to give a deeper insight to answer the research questions. Pragmatists may entertain the existence of causal relationships, but also agree that they may not be able to pin down many of these relationships due to the many variables and potentially socially contingent nature of data obtained (Tashakkori and Teddlie, 1998; Creswell, 2014). They tend to

accept external reality and believe that values play a role in the interpretation of results, utilising both subjective and objective data depending on the research question and choose the explanations that best produce desired outcomes.

In the case of this research, the use of mixed methods acknowledges the constructivist nature of individuals' experiences (relating to VP technology and pre-registration training) whilst also attempting to obtain a more objective, standardised view on a social construct (effectiveness of VP technology as a training tool).

## 4.3 Choice of Research Methodology

Methodology refers to a specific framework within which research is conducted. Braun and Clarke (2013) describe methodology as:

> *"… a theory of how research needs to proceed, to produce valid knowledge about the psychological and social world. It is what makes our research make sense, both in terms of design, and in terms of process."*

This is different to research 'methods' which refers to a tool or technique for collecting or analysing data and are discussed in relation to this research in Chapter 5.

### 4.3.1 Qualitative Research

Over the past decade, qualitative methods have become utilised to a greater extent in areas such as health services research and health technology assessments (Mays and Pope, 2000).

The goal of qualitative research has been described as:

> *"…the development of concepts which help us to understand social phenomena in natural (rather than experimental) settings, giving due emphasis to the meanings, experiences, and views of all the participants"* (Pope and Mays, 1995).

In the broadest sense of the term, qualitative research uses words as data and is more specifically concerned with explanations and descriptions of events or phenomena. It tends to rely on an inductive view of the relationship between theory and research and aims to generate theories from the data obtained rather than testing specific pre-created hypotheses or principles (Pope and Mays, 1995; Bryman, 2012). Qualitative researchers usually seek to provide meaning to research questions and the interpretation of social phenomena whilst understanding that data is produced in a socially contingent context and is subjective, thus they don't seek to make generalisable conclusions (Basit, 2010; Bryman, 2012; Braun and Clarke, 2013). Data is therefore created in the context of a particular set of participants at a specific time.

The data obtained tends to be richer and more descriptive than from quantitative methods, which may provide a more detailed understanding of social phenomena. This may be useful depending on the research aim but prevents statistically significant conclusions to be drawn (Johnson and Onwuegbuzie, 2004). Researchers work to uncover patterns within the data, although differences can also be explored and comparisons made, which establishes qualitative research as a more preferable approach to address research areas that are poorly understood.

Johnson and Onwuegbuzie (2004) discuss the importance of considering the strengths and weaknesses of methodological approaches when deciding upon a research design. The use of qualitative methods was considered appropriate for this research because the evaluation of VPs in pre-registration pharmacist training was found to be an under-researched area (as determined by the

systematic review in Chapter 3), therefore a deeper understanding relating to their effectiveness as learning tools was sought by the research team.

### 4.3.2 Quantitative Research

In contrast to qualitative research, quantitative research is associated with measurements and statistical significance to illustrate the effectiveness of an intervention. It has been broadly defined as:

> *"… a type of empirical research into a social phenomenon or human problem, testing a theory consisting of variables which are measured with numbers and analysed with statistics in order to determine if the theory explains or predicts phenomena of interest"* (Yilmaz, 2013).

In contrast to qualitative research, quantitative methods usually seek to identify relationships between variables, test hypotheses and generalise findings to a wider population (Basit, 2010; Bryman, 2012). It tends to be more deductive in its nature and often tests theories which have been previously created rather than generating new theories specific to that dataset (Pope and Mays, 1995; Pierce, 2013). Quantitative research seemingly views the social world as objective and assumes clear cause-and-effect relationships which can be statistically analysed (Basit, 2010; Bryman, 2012). Quantitative data may be considered as 'shallow' in the sense that there may be little exploratory detail obtained from participants; an intervention is statistically tested but perceptions or reasons are not sought which may prevent understanding of a phenomena (Braun and Clarke, 2013).

The use of quantitative methods was considered appropriate for this research because the evaluation of VPs in pre-registration training is an under-researched area. The effectiveness of VPs as a learning tool in pre-registration training was considered an essential outcome of the study and the use of

statistics was the most appropriate method at investigating this, by determining the significance of knowledge improvement.

### 4.3.3 Mixed Methods Research

Mixed methods research was first used by Campbell and Fiske in 1959 but remained an unpopular methodology until the 1980's (Teddlie and Tashakkori, 2003; Bryman, 2006; Johnson *et al.*, 2007; Creswell and Plano Clark, 2011). Mixed methods research, as a methodology, has been applied widely in many fields of social science, including sociology, education and health science (Sale *et al.*, 2002; Bryman, 2006). There is still no precise definition of mixed methods research but has been loosely defined by Tashakkori & Teddlie (1998) as:

> *"…the combination of qualitative and quantitative approaches in the methodology of a study."*

The definition has since progressed to focus primarily on the viewpoints and theoretical perspectives underpinning the methodological choice:

> *"… an approach to knowledge (theory and practice) that attempts to consider multiple viewpoints, perspectives, positions, and standpoints (always including the standpoints of qualitative and quantitative research)"* (Johnson *et al.*, 2007).

Further advances in mixed methods research has now established the research question as the determining factor of a methodology choice:

> *"… an approach to inquiry involving collecting both quantitative and qualitative data, integrating the two forms of data, and using distinct designs that may involve philosophical assumptions and theoretical frameworks. The core assumption of this form of inquiry is that the combination of qualitative and quantitative approaches provides a more complete understanding of a research problem than either approach alone"* (Creswell, 2014).

The overall aim of a research study can have multiple objectives which may be difficult to answer using a single methodological approach (as each is associated with certain general principles and characteristics) (Johnson and Onwuegbuzie, 2004). No single research approach can discover absolute truths as all approaches provide partial depictions of reality and as such, many research questions are best and most fully answered through mixed methods (Greene and Caracelli, 2003; Onwuegbuzie and Leech, 2003; Johnson and Onwuegbuzie, 2004; Creswell and Plano Clark, 2011).

The combination of both qualitative and quantitative methodologies in a piece of research has the potential to complement the strengths and minimise the weaknesses associated with each individual approach (Creswell *et al.*, 2003; Morse, 2003; McLaren, 2013). For example, quantitative research may be weaker at understanding the context in which people talk and voices of participants may not be directly heard, which can instead be achieved in qualitative research. In contrast, interpretations of qualitative data are subjective to the individual researcher, whereas quantitative researchers tend to place themselves in the background of a research study to try and prevent their personal views affecting data collection or analysis (Creswell, 2014). Mixed methods enables research findings to be generalised to a population (as in quantitative research) and allows for a detailed exploration of a concept to be created (as in qualitative research) (Creswell and Plano Clark, 2011; Creswell, 2014). Data obtained in mixed methods research can also be triangulated to provide a more comprehensive

picture than single studies can do alone. As a result, mixed method approaches have been found to provide stronger inferences between datasets and a greater opportunity to present divergent views (Greene *et al.*, 1989; Creswell *et al.*, 2003; Onwuegbuzie and Leech, 2003).

One of the main barriers to the utilisation of mixed methods research is the lack of understood philosophical foundation (as presented in section 4.2). Previous theories contend that researchers should always work within a qualitative or quantitative framework (Howe, 1988; Guba and Lincoln, 1994; Onwuegbuzie and Leech, 2003). However, over the past few years, this has changed such that philosophical perspectives can be mixed in conjunction with the methods required to achieve the most appropriate outcome for the research question (Greene *et al.*, 1989; Bryman, 2012). Nowadays, mixed methods has become a third paradigm in social science (pragmatism) and "has evolved to the point where it is a separate methodological orientation with its own worldview, vocabulary, and techniques" (Teddlie and Tashakkori, 2003; Johnson and Onwuegbuzie, 2004).

Another barrier to the full utilisation of mixed methods, is the realisation that it is more difficult to carry out than single research design approaches (Bryman, 2012). Researchers need to have the skills to understand the theoretical perspectives, data collection and data analysis methods associated with both quantitative and qualitative methodologies (Creswell and Plano Clark, 2011). A mixed methods programme of research is likely to take more time than if a single approach was chosen, due to the collection and analysis of both qualitative and quantitative data (Creswell and Plano Clark, 2011). Despite these barriers, should the research question be more fully answered using mixed methods, this approach should be considered.

## 4.4 Mixed Methods in this Research

This thesis adopted a mixed methods approach to explore a central research question: how do different learning tools affect the knowledge and experiences of pharmacy pre-registration trainees?

As stated in section 4.3.3, a mixed methods approach incorporates both quantitative and qualitative aspects of data collection and analysis. During the literature review, it was identified that a variety of quantitative and qualitative methodologies have been adopted to explore the effectiveness of VPs or simulation in education. Currently there has been little research into the use of VP technology in the training of pre-registration trainees, thus, a mixed methods approach was adopted to strengthen the overall findings and allow the weaknesses associated with each individual methodology to be offset. Both the statistical effectiveness of VPs as a learning tool and trainee's perspectives on the tool could be obtained which would pave the way for future research to advance on these findings.

Statistical results of the effectiveness of the learning tools at improving knowledge were sought by the research team, thus a quasi-experiment was decided upon (see section 4.5.1). Trainee's thoughts and opinions on the learning tools were obtained quantitatively via a questionnaire and qualitatively via open-ended questions on the questionnaire and the telephone interviews (see sections 4.5.2 and 4.5.3). These multiple datasets allowed comparisons between the effectiveness of the learning tools (via the quasi-experimental evaluation) and individual participant thoughts to be made. Trainee's expressions from the survey could also be reinforced by the telephone interviews and themes explored in more depth, before triangulation of all three datasets to meet the aim and objectives of the research (Mays and Pope, 2000) (Chapter 5, section 5.2). The socially contingent nature of the qualitative results were triangulated with the quantitative results to determine if the actual (statistical) effectiveness of the VP technology as a learning tool matched what participants reported. Additionally, any significant findings (or lack of) from the quantitative results were triangulated and explained by pre-registration trainee's perspectives. This resulted in an increased quality of the thesis,

as research claims have been established as stronger when based on a variety of methods (Gorard and Taylor, 2004).

A sequential explanatory mixed methods design was implemented in this study. Quantitative data collection and analysis from the quasi-experiment occurred first, followed by quantitative and qualitative data collection and analysis from the questionnaire, which was used to inform the final questions for the qualitative telephone interviews. An equivalent status design was used which placed equal weighting of importance on the qualitative and quantitative strands - the actual impact on knowledge and perceived impact on training were considered equally important to investigate and understand (Teddlie and Tashakkori, 2003; Gorard and Taylor, 2004; Creswell and Plano Clark, 2011).

## 4.5 Study Design

A mixed methods design integrating a quasi-experimental evaluation, a questionnaire and qualitative telephone interviews was chosen because of the pragmatic approach to knowledge evaluation. The quasi-experimental evaluation allowed statistical improvements in trainee's knowledge to be assessed and significance to be calculated. The questionnaire collected quantitative data which could be statistically analysed to determine significance in thoughts on the learning tools. The questionnaire also collected qualitative data via open-ended questions to allow for trainee's to express their thoughts on the learning tools in their own words and were able to reach a large sample. Telephone interviews were used to further explore trainee's thoughts on the learning tools to a greater depth than the questionnaire allowed.

### 4.5.1 Quasi-Experimental Evaluation

A quasi-experiment compares the impact of one intervention with either no intervention or a different intervention. This design was considered appropriate as one of the primary objectives of the research was to compare knowledge improvement of trainees who used the different learning tools (Chapter 5, section 5.2). In a quasi-experiment, the effect of independent variable manipulation on the dependent variable is measured but randomisation or matching of participants is not required. This can affect the internal validity of a study but differences in the study groups can be accounted for during data analysis (Basit, 2010; Drennan, 2013). In social research, it has been noted that independent variables are difficult to manipulate (Bryman, 2012) and a quasi-experiment recognises this limitation. The nature of this research had a variety of individual factors which could affect trainee's knowledge improvement scores, such as: sector of work, place of work, tutor support and individual initiative, which could not be accounted for at baseline. Although trainees were randomly stratified to the two intervention groups, they were not matched exactly for age, gender or ethnic origin; which is accepted in a quasi-experiment and was accounted for during analysis.

A randomised control trial (RCT) has been defined as the 'gold standard' experimental research design in health-related fields and was considered in this thesis (Bryman, 2012). Similarly to a quasi-experiment, in an RCT, one intervention is compared with no intervention or a different intervention. However, an important component of an RCT is the ability to manipulate the independent variable to determine any influence on the dependent variable (Basit, 2010; Bryman, 2012). A true experiment also incorporates a control group and random assignment of subjects to allow elimination of rival expectations, thus an RCT was not considered appropriate for this research. True randomisation of participants was not suitable since both groups were required to have similar numbers of pre-registration trainees who were male and female and who were completing their training in the hospital and community sectors. This was to allow for a more direct comparison of views between the two groups and determine any effects these factors may have on knowledge

improvement, whilst ensuring sample sizes remained large enough for significance to be calculated. Additionally, it would have been difficult to control the variety of confounding variables which may have affected individuals' knowledge improvement; thus also making a RCT prohibitively challenging for this research.

A quasi-experiment was considered the most pragmatic approach to effectively measure knowledge improvement of pre-registration trainees. Quasi-experiments are increasingly being used in the healthcare field where RCTs are not appropriate (Drennan, 2013). Quasi-experimental evaluations have been successfully carried out to investigate the effects of educational interventions using pre- and post-tests (Issenberg *et al.*, 2005; Brannan *et al.*, 2008; Bryman, 2012; Drennan, 2013; Barnett *et al.*, 2016). Shadish *et al.* (2008) explained that in a 'non-equivalent control group design' of a quasi-experiment, participants are non-randomly assigned to either an intervention group or a control group. Data is collected from both groups at pre-test, followed by an intervention and a second data collection at post-test, which measures the same dependent variable as during the pre-test phase. The pre-test ensures that, as participants are not randomised, differences which may have impacted on the outcome measures are identified and accounted for during statistical analysis; improving the internal validity of the study (Drennan, 2013).

This 'non-equivalent control group design' quasi-experiment was adopted for this thesis. Participants were randomly stratified to either the intervention or control group, asked to complete a pre-test, receive a learning tool intervention and then complete a post-test to determine any knowledge improvement within and between the groups.

### 4.5.2 Questionnaire

Questionnaires have been established as the most widely used data collection tool in educational research, possibly because they can gather many types of data and are a particularly useful approach

for gathering data pertaining to attitudes and behaviours; a commonly used evaluative method in VP literature as discussed in Chapter 3 (Basit, 2010). Questionnaires can consist of different question types to gather purely quantitative data, purely qualitative data or a mixture of the two. They allow the collection of data from large groups of participants at a specific point in time to explain or provide descriptions of current phenomena and to make comparisons or contrasts between different groups (Calnan, 2013; McLaren, 2013). Although the aim of a questionnaire is not to generalise results to a wider population, this can be done if a large enough sample is utilised (Bryman, 2012; Braun and Clarke, 2013).

Use of a questionnaire in this thesis was appropriate because the reported thoughts and opinions of pre-registration trainees could be quantified via the use of a Likert scale and more in-depth thoughts could be obtained through the use of open-ended questions (see Chapter 5, section 5.10.2 for further explanations on questionnaire design). The findings from the questionnaire could also help to contextualise the statistical findings from the quasi-experiment and could be reinforced and further explored through the telephone interviews, to ground trainee's thoughts in a deeper understanding of the themes surrounding the use of VPs. However, questionnaires are not without their limitations. Even with the addition of open-ended questions, questionnaires tend to be more structured than interviews and place less importance on capturing meanings and perceptions (Fontana and Frey, 2005; Calnan, 2013). Thus reducing the amount of in-depth, exploratory data obtained as it can be difficult to convey feelings or emotions via text. Additionally, questions are open to misinterpretation, which may affect the usefulness of data obtained; the questionnaire was piloted in this research (see Chapter 6) to increase the validity but it is still a potential concern. Despite these potential limitations, questionnaires were considered as an effective method of data collection in this research and allowed for the triangulation of different datasets to obtain a deeper understanding of the themes relating to VP use in pre-registration training.

Electronic questionnaires were developed for this research because of the advantages they offer over other questionnaire delivery methods. Electronic questionnaires cost less than postal questionnaires and are associated with a greater response rate (Basit, 2010; McLaren, 2013). They can be distributed and administered easily to a large sample, and as long as participants have sufficient IT skills, they are uncomplicated to complete and return. They also enable the rapid follow up of non-respondents via email, which can be difficult with postal questionnaires (Braun and Clarke, 2013; McLaren, 2013). Telephone questionnaires were also an option and could have been conducted during the telephone interviews. This was not considered appropriate as the findings from the questionnaires were intended to be confirmed through the use of the interviews and the themes explored to a greater extent, thus questionnaire data collection and analysis was required to occur beforehand (Basit, 2010; Bryman, 2012; Calnan, 2013). The study components and quasi-experimental evaluation were completed online, which further reinforced the appropriateness of an electronic questionnaire.

### 4.5.3 Telephone Interviews

Different qualitative methods were considered, such as telephone interviews, face-to-face interviews and focus groups. Telephone interviews were considered the most appropriate method because they offered more flexibility than face-to-face interviews and the varying locations of pre-registration trainees across the UK was perceived as a logistical issue in organising focus groups. Research has also established that telephone interviews are as effective as face-to-face interviews in obtaining deep and meaningful data (Sweet, 2002; Sturges and Hanrahan, 2004; Irvine *et al.*, 2013).

Interviews are the most commonly used method in qualitative health research (Britten, 2000). Qualitative interviews are a 'professional conversation' and are useful for complex issues which may be difficult to investigate through quantitative means (Braun and Clarke, 2013). The interviewing method of choice depends on a study's overall research aims, the specific questions to be addressed,

the nature of participants involved and the analytic approach to be taken (Sweet, 2002; Novick, 2008; Holt, 2010). Interviews can be classed as being structured, semi-structured or unstructured (Britten, 2000). However, all interviews tend to have some kind of structure, thus classifying them in such a way can be misleading; all interviews involve a conversation with a purpose. To distinguish between the different 'types' of interview, those conducted in this research were described as 'semi-structured' and 'in-depth'. An interview guide was created which included the main themes intended to be covered during each interview (hence being described as semi-structured). However, the actual interviews were guided by the individual interviewee's responses and an effort was made to not use any leading questions. The interviews were 'in-depth' in the sense that they allowed participants to explain their thoughts and feelings in their own words, with further probing or clarification built into the interview guide (Britten, 2000).

Telephone interviews were chosen over face-to-face interviews principally because of the perceived logistical issues with organising times and places for face-to-face interviews or focus groups with geographically dispersed participants. The programme of work was designed so the interviews were conducted after the pre-registration examination but before registration as a qualified pharmacist on the register, thus only a small timeframe was available. Telephone interviews were considered to be the most flexible method as they can be conducted at a time most convenient for the individual participants (Carr and Worth, 2001; Sturges and Hanrahan, 2004; Bryman, 2012).

Focus groups are "a form of group interview that capitalises on communication between research participants in order to generate data" (Kitzinger, 2000). They can be useful and cost-effective as they allow similar or contradictory views of a group of individuals to be captured in a single interview (Fontana and Frey, 2005; Basit, 2010; Braun and Clarke, 2013). A considerable problem with focus groups is the danger of more dominant personalities leading the conversation and their perspectives coming across more forcefully which may reduce the depth of data that is obtained, as shy

individuals or those with differing views may not feel confident expressing themselves (Fontana and Frey, 2005; Bryman, 2012). Focus groups were ruled out as a data collection method for this research, again because of the perceived logistical issues in organising times and places for the interviews due to the location spread of pre-registration trainees.

Face-to-face interviews are still held as the 'gold standard' method for qualitative interviews, despite telephone or other virtual interview (e.g. email, Skype) techniques becoming established (Sweet, 2002; Opdenakker, 2006; Novick, 2008). Telephone interviews are more commonly used in quantitative research (Fontana and Frey, 2005; Calnan, 2013) and there is little methodological discussion of telephone interviews in qualitative research literature, as noted by Irvine (2011):

> *"Despite recognition of a range of practical and ethical advantages, there remains nonetheless a sense throughout the instructional literature that qualitative interviewing by telephone is something of a methodological compromise, with concerns about the quality of the interaction and of the data that can be generated via this mode."*

As with any method of data collection, drawbacks associated with telephone interviews have been noted. These mainly relate to difficulties in building rapport due to a lack of social cues; elements which are considered essential for generating rich qualitative data (Irvine *et al.*, 2013). However, telephone interviews have been found to produce equally as rich data as face-to-face interviews, providing the interview is conducted well. Being able to see an interviewee may enable the visualisation of confusion but research has found clarification requests are prominent in telephone interviews, suggesting that interviewees feel able to request further explanations (Irvine *et al.*, 2013). Telephone interviews have also been found to, more commonly, be shorter in duration than face-to-face interviews (Sturges and Hanrahan, 2004; Irvine, 2011; Irvine *et al.*, 2013). Many reasons

have been expressed to explain this, including participants being more 'spontaneously' forthcoming and researchers providing more frequent 'acknowledgement tokens' in face-to-face interviews which, along with visual cues, may encourage participants to express themselves more freely (Irvine, 2011). It is therefore important that these audible 'acknowledgement tokens' are expressed during telephone interviews to encourage interviewees to open-up and potentially increase the depth of data obtained.

## 4.6 Quality of Mixed Methods Research

Specific methodological considerations regarding sampling, case study design, data collection and data analysis are discussed in Chapter 5. This section of the thesis will consider the specific quality issues of reliability and validity in mixed methods research. Both reliability and validity are important considerations in research and may be seen as going hand-in-hand with one another (Basit, 2010).

### 4.6.1 Reliability

Reliability can be defined as:

> *"The extent to which the results generated could be generated again (e.g. by another researcher, in another context, at another time)"* (Braun and Clarke, 2013).

Reliability in quantitative and qualitative research is measured differently (Basit, 2010). In quantitative research, three main types of reliability should be considered: stability, inter-rater reliability and internal consistency (Tashakkori and Teddlie, 1998; Basit, 2010; Lewith and Little, 2013; McLaren, 2013). The most common method of assessing stability is by using the test-retest method

which determines whether a measure is stable over time (Bryman, 2012; Lewith and Little, 2013). Problems associated with this method relate to individuals' experiences between the two test points which may affect the re-test, resulting in low correlation and poor reliability. Inter-rater reliability is an important consideration when there are multiple researchers and it ensures data is assessed or coded in the same way (Basit, 2010; Bryman, 2012). Internal consistency refers to the degree of rigour or consistency of a data collection tool (Bryman, 2012; Lewith and Little, 2013). Most researchers use Cronbach's alpha (α) as a measure of internal consistency; the application of this measure to the questionnaire used in this thesis is explained in Chapter 5 (section 5.10.2) (Cronbach, 1951; Frey and Edwards, 2001; DeVellis, 2003; Bryman, 2012).

Reliability in qualitative research tends to be a contentious issue since, in qualitative research, human beings are central to the research question and human behaviour is never static; therefore results can be difficult to replicate (Low, 2013). The concept of reliability differs from the traditional quantitative understanding, as the focus is on achieving consistent similarity in the quality of the results rather than achieving the same results (Collingridge and Gantt, 2008). Reliability in qualitative data has thus become more a measure of the trustworthiness or dependability of the data rather than the reliability of the tools or instruments used (Denzin and Lincoln, 2005). Many ways of measuring reliability in qualitative data have been discussed in the literature and it can be difficult for researchers to understand the most effective approach to take (Denzin and Lincoln, 2005; Bryman, 2012; Braun and Clarke, 2013). A recent review by Morse (2015) critiqued the use of recommended strategies for measuring reliability and validity in qualitative research, the findings of which will be discussed throughout the rest of this chapter (sections 4.6.1 and 4.6.2).

It has been stated that a study has dependability if "the process of selecting, justifying and applying research strategies, procedures and methods is clearly explained and its effectiveness evaluated by the researcher and confirmed by an auditor" (Yilmaz, 2013). Morse (2015) reported that the major

strategies for determining reliability occur during the coding process. The most common processes to ensure reliability are the development of a coding system, inter-rater agreement (assessment of transcripts by more than one researcher) or respondent validation (assessment of transcripts by the interviewees themselves) (Pope et al. 2000; Braun & Clarke 2013; Morse, 2015). However, the strategies that have been proposed are not an absolute requirement and researchers will choose those most appropriate based on their requirements and data collection tools.

The appropriateness of inter-rater reliability in qualitative research is contested because of the assumption that coding should be subjective and the socially contingent nature of the data obtained (Armstrong *et al.*, 1997; Mays and Pope, 2000). The themes generated from the analysis of the questionnaire and interview data were discussed in depth with the supervisory team which promoted a review of the analysis and was used as a method to improve reliability. Respondent validation was not considered appropriate for this research because there were a number of different study components and it would have been difficult to obtain accurate validation.

Another method to increase the reliability, or trustworthiness, of qualitative data is for researchers to explicitly document and keep records of all phases of the research programme (Bryman, 2012). Recording interviews can also enhance the trustworthiness of data as it allows an accurate record of conversation (Tobin and Begley, 2004). During data collection, efforts can be made to increase the depth of information obtained by asking interviewees different types of questions with attempts to avoid leading questions (McKinnon, 1988). Additionally, consistent coding should be applied to improve the trustworthiness of the data (Braun and Clarke, 2013). The interview schedule design and analysis procedures are discussed in Chapter 5 (sections 5.10.3 and 5.11.3, respectively).

### 4.6.2 Validity

Validity can be defined as:

> *"A concern with the integrity of the conclusions that are generated from a piece of research"* (Bryman, 2012).

In the most basic sense, validity refers to whether a piece of research actually shows what it claims to (Bryman, 2012; Braun and Clarke, 2013). As stated by Kaplan *et al.* (1976) "validity is not absolute; it is relative to the domain about which statements are made", thus although validity can be measured, researchers need to remember that it is only valid in a certain context.

In quantitative research, the most common measures are of internal and external validity (Basit, 2010). Internal validity refers to the accuracy of the findings and determines whether a piece of research has achieved what it sets out to measure (McLaren, 2013). Internal validity can be measured via content validity, criterion validity and construct validity (Creswell and Plano Clark, 2011; Bryman, 2012; Lewith and Little, 2013).

Content validity refers to whether items or questions on a data collection tool are representative of what is known about a specific topic (Creswell and Plano Clark, 2011; Bryman, 2012; McLaren, 2013). Efforts can be made to assure content validity by the use of pilot studies or expert panels to review the methodological tools (McLaren, 2013). The components used in this thesis were piloted (see Chapter 6) and reviewed by an expert panel (see Chapter 5, section 5.10.2) to reduce potential threats to the content validity of the study.

Criterion-related validity refers to the correlation between scores on an instrument created for a particular study and a well-established instrument which has been found to successfully measure the phenomenon of interest (Kaplan *et al.*, 1976; Lewith and Little, 2013). Criterion validity is

demonstrated when there is a strong relationship between the scores from the two instruments (McLaren, 2013). This thesis did not measure criterion validity because the instruments used in this thesis were created by the research team specifically for this study, and findings could not be correlated with those from another instrument due to a lack of validated instruments which have measured the effectiveness of VPs.

Construct validity requires researchers to demonstrate that instruments measure what they intend to measure. This can be accomplished through multiple studies which focus on the same constructs and their consistency with the theories they are hypothesised to represent (Dellinger and Leech, 2007; Yilmaz, 2013). As the data collection tools were created for this research, construct validity was not investigated as it develops over time, and cannot be demonstrated in a single study (Kaplan *et al.*, 1976).

External validity refers to the generalisability of results. Rigour in external validity considers the sampling framework adopted, sample size of the study and the inferential statistics used. See Chapter 5 (sections 5.5 and 5.11.1) for discussion of these components relative to the research methods.

Validity in qualitative research is an unclear and ambiguous concept due to the socially contingent nature of data and the capturing of multiple realities (Mays and Pope, 2000; Onwuegbuzie and Leech, 2003; Mason, 2006). However, validity in qualitative research should "centre on the richness of the data that are generated" (Low, 2013). Internal validity, or the credibility of data, refers to the extent to which observations and measurements represent social reality (Bryman, 2012). Ensuring a thick, rich data set can improve the credibility of data as providing a detailed description of the participants, the settings and the interactions allows understanding of the qualitative research process, as described by Geertz (1973) (Yilmaz, 2013; Creswell, 2014; Morse, 2015). The credibility of data can also be enhanced by negative case analysis, in which researchers include all interviewee's perspectives; this again attributes to the obtaining of a rich data set (Morse, 2015). Another

recommended technique for improving credibility is triangulation by using more than one method or source of data in the study (Creswell, 2014; Bryman, 2012). This study used a mixed-methods design which incorporated triangulation of the different data sets to improve the validity (see section 4.4). A final method to improve internal validity is the use of member checking or respondent validation, in which participants check and evaluate research findings to ensure they are a true representation of their interview (Bryman, 2012; Yilmaz, 2013; Creswell, 2014; Morse, 2015). Member checking was not applied in this thesis based on the advice by Morse (2015) who explains the difficulties which can arise if a participant does not agree with an analysis. Additionally, as explained in section 4.6.1, a number of different study components were utilised in this research, which would have made it difficult to obtain accurate validation. Although not respondent validation, the telephone interviews did employ the confirmation of findings from the questionnaire with individuals to enhance the validity.

As previously discussed in section 4.3.1, results from qualitative studies are not intended to be generalisable to a wider population but, instead, to generalise to theory (Bryman, 2012). In addition to enhancing internal validity, obtaining a 'thick description' of data can also help to enhance external validity (or transferability) of results. A thick and rich data set refers to the quality of data obtained from each participant and the level of data obtained across the dataset, as described by Geertz (1973). This can be determined by appropriate sampling procedures, sample size and an exploratory interview guide (see Chapter 5, section 5.5 for discussion of sampling procedures).

In qualitative research, the researcher strives to provide an accurate picture of the social world as it exists to those being interviewed, rather than from their [the researcher's] perspective. The validity of socially constructed data can be improved with appropriate reflexivity, which encourages a researcher to take a systematic, reflective and transparent approach to the research design, methods

of data collection, analysis and interpretation and is discussed below in section 4.6.3 (Pope & Mays 1995).

As already discussed, mixed methods research has the advantage of overcoming weaknesses associated with each method, thus threats to internal and external validity can be reduced by utilising this methodological approach.

Hunter & Brewer (2003) wrote that mixed methods *"… have built into them almost by definition the very essence of what is needed to assess the validity of research. The more diverse the methods, the more likely one is to sense that similar results increase the validity of the research finding. If very similar methods are used and the results are similar, then validity is increased somewhat. If the same method is used and results are similar, then one has an assessment of reliability."*

The use of mixed methods and the triangulation of results can increase the content, criterion and construct validity, as well as the external validity of research and enhance the trustworthiness of an analysis by providing a fuller, more rounded account which compensates for the weakness of one method through the strengths in another (Gorard and Taylor, 2004).

### 4.6.3 Reflexivity

Reflexivity is described by Hall and Callery (2001) as "critically examining one's effect as a researcher on the research process".

Sultana (2007) goes into greater detail and explains that:

> *"…reflexivity in research involves reflection on self, process, and representation, and critically examining power relations and politics in the research process, and researcher accountability in data collection and interpretation."*

It is not enough to only be reflexive during data analysis; the process of reflexivity should arise at the beginning of a piece of research, when the research topic has been decided upon and the aims, objectives and methods are discussed (Finlay, 2002). This encourages the researcher to examine their motivations, assumptions and interests in the research and help to prevent these aspects affecting the research process or data collection (Sultana, 2007). Researchers should view themselves, their methods and their data as being interdependent and interconnected and be aware of their theoretical considerations, interpersonal relationships and any institutional effects which may arise (Mauthner and Doucet, 2003). Reflexivity is a dynamic process and continued reflection is required throughout the research design, data collection, data analysis and write-up stages of a research project to increase the strength and validity of results (Finlay, 2002; Gilbert and Sliep, 2009).

Although the importance of reflexivity has been explained in the literature, there is a significant problem which relates to the ability of the researcher to actually perform it (Mauthner and Doucet, 2003). Sultana (2007) notes that undertaking reflexivity requires a "critically self-conscious researcher" and it has been identified that there may be a limit as to how reflexive researchers can be, especially at the time of carrying out a research project (Mauthner and Doucet, 2003). There is a strong possibility that some influencing factors may only become apparent after completion of a research study (Finlay, 2002; Mauthner and Doucet, 2003). Resulting from this difficulty, Mauthner and Doucet (2003) express that "it may be more useful to think in terms of 'degrees of reflexivity', with some influences being easier to identify and articulate at the time of our work while others may take time, distance and detachment from the research." This will hopefully allow for inexperienced researchers to be reflective during the research process but understand it may not be easy and may continue after the research is over.

The qualitative data obtained from the questionnaires and interviews in this thesis were of a socially contingent nature, thus reflexivity became an important aspect of the research process (Mays and Pope, 2000; Onwuegbuzie and Leech, 2003; Mason, 2006). It cannot be assumed that the questionnaires and interviews provided factually accurate information because of the socially contingent nature of the data. Qualitative data is subjective and was dependent on the lead researchers (JT) beliefs as well as other factors, such as the sampling and recruitment methods, individual participant's beliefs at the time the data collection took place and the particular questions asked, as expressed by Braun and Clarke (2013):

> *"Research is understood as a subjective process; we, as researchers bring our own histories, values, assumptions, perspectives, politics and mannerisms into the research…the topics we find interesting to research, and ways we ask questions about them, the aspects of our data that excite us – these (and many other factors) reflect who we are; our subjectivity. Therefore, any knowledge produced is going to reflect that, even if only in some very minor way. The same has to be said for participants in our research; they bring their own experiences, perspectives and values to the research".*

The quantitative data that was obtained from the questionnaires was also socially contingent, as Likert ranking scales are a method of putting numbers on qualitative data. Comparatively, the statistical data from the quasi-experiment was more objective. The mix of data allowed for the triangulation of findings to ensure comprehensiveness and encouraged a more reflexive analysis of the data (Mays and Pope, 2000).

Understanding and having the ability to be reflexive allows a researcher to be more open during the research process and may lead to the uncovering of alternative or unexpected results or research

questions (Adkins, 2003; Bryman, 2006; Mason, 2006). Reflexivity is essential for the integrity and trustworthiness of data (as discussed in sections 4.6.1 and 4.6.2). As the lead researcher, reflexivity was understood and a reflexive approach was taken from the beginning of the research until completion of thesis write up by the keeping of field notes.

## 4.7 Chapter Summary

This chapter discussed the methodological considerations associated with the study design and presented the reasoning for deciding upon a mixed-methods approach which integrated a quasi-experimental evaluation, questionnaire and qualitative interview design.

The use of mixed methods allows a more detailed description of the research question to be obtained than either a qualitative or quantitative approach would provide if used alone. There has been little research into the use of VPs in pharmacy education and only one study into their use in UK pre-registration training which aligns itself well to a mixed methods design and the substantial quantity of data obtained.

The use of mixed methods was considered as the most pragmatic approach, benefitting from the depth of detail and exploration of new concepts and phenomena with qualitative methods, combined with a more standardised, quantitative component. Findings from the quasi-experimental evaluation which determined the effectiveness of VPs as a training tool can be generalised to a population-level, whereas pre-registration trainee's thoughts and perspectives on the use of VPs as a training tool were gathered from the questionnaire and telephone interviews. All findings were then triangulated and used to reinforce each other; to increase the rigour of the research study. The concept of reflexivity has been discussed in relation to the socially contingent nature of the data obtained and a detailed discussion of the aims of the research, the sampling and recruitment methods, the data collection and data analysis is provided in Chapter 5.

# 5. Methods

## 5.1 Introduction

This chapter discusses the methods used in this research. The chapter begins by setting out the aims and objectives of the research in section 5.2, including the experimental hypotheses for the quasi-experimental evaluation. The study design is described in section 5.3 and ethical approval is discussed in section 5.4. The sampling and recruitment methods are discussed in sections 5.5 and 5.6, respectively. The use of Google Drive in the study is discussed in section 5.7 before a description of the VP case studies (section 5.8) and the NI case studies (section 5.9) are presented. The data collection tools used in the study are discussed in section 5.10 and their associated analysis techniques in section 5.11. The issues of confidentiality and data protection are discussed in section 5.12. A summary of the chapter is provided in section 5.13.

## 5.2 Study Aims and Objectives

The overall aim of the research was to evaluate the effectiveness of interactive clinical avatars (ICAs) at supporting pre-registration training when compared to a non-interactive (NI) learning tool.

To meet the aim, the study had the following objectives:

1. To determine topics or areas of pre-registration training where extra support or learning may be useful
2. To develop ICAs and NI case studies to meet specific learning objectives relevant to these topics or areas

3. To quantitatively assess the ability of ICAs to enhance the knowledge base of pre-registration pharmacists compared to the NI case studies
4. To identify reported differences in the usefulness or enjoyment of the two learning tool or any differences in the inclination of trainees to use either the ICAs or NI case studies as part of pre-registration study
5. To triangulate all the results and compare pre-registration trainee's perspectives on the ICAs and NI case studies with the statistical results obtained

As this research incorporated quantitative and qualitative methods of data collection and data analysis, experimental hypotheses were also proposed:

1. ICA case studies will be superior at improving knowledge compared to NI case studies
2. Pre-registration trainee's knowledge will improve after completion of either type of case study
3. ICAs will be superior at increasing reported enjoyment compared with NI case studies
4. ICAs will be superior at increasing engagement with learning in pre-registration training compared with NI case studies

## 5.3 Study Design

This thesis adopted a mixed methods approach, utilising a quasi-experimental evaluation (pre- and post-test), a questionnaire and qualitative telephone interviews (as previously outlined in Chapter 4).

Figure 5-1 illustrates the programme of work (page 126).

Pre-registration trainees were randomly stratified based on their gender and sector of training into two cohorts (or groups). This allowed a direct comparison of knowledge improvement and perceptions of the learning tools between the groups based on the case studies they used, their

sector of training and their gender. Group 1, the intervention group, received three interactive VP cases to complete (see section 5.8). Group 2, the control group, received three NI cases to complete (see section 5.9). Both groups received case studies on the same topics but via different delivery methods to allow for a direct comparison of the tools (VP vs NI). Participants had access to each case study for a one-month period, during which they were able to complete it as many times as they required. The intervention period lasted for three months and was followed by the questionnaires and telephone interviews.

Each case study had pre- and post-multiple-choice questions (MCQs) to complete which were based on the case study topics. The same questions were used for the intervention and control groups to allow for knowledge improvement to be measured and compared between the groups, sectors of training and genders. For each case study, participants were required to complete the pre-MCQs before they could access the case. Participants were unable to access the next case study without completing the post-MCQs within a one-month period.

Upon completion of the three case studies, participants were provided with an evaluative questionnaire to complete. This was designed to capture trainee's thoughts and perceptions on the learning tools and cases themselves. Participants were then provided with access to the other type of case study; completing the pre-and post-MCQs was not compulsory at this stage. After one month of access to the second type of case studies, a second evaluative questionnaire was sent to participants which consisted of the same questions as on the first questionnaire. It was not essential for participants to complete this questionnaire but they were invited to provide their thoughts to allow for a direct comparison of individual thoughts on the different learning tools.

Pre-registration trainees who completed both questionnaires were provided with access to all study components, plus extra NI case studies in preparation for the pre-registration exam. These extra NI case studies covered other topics: anticoagulants, drug interactions and cardiovascular disease (CVD)

(see section 5.9). These extra cases were created to incentivise participants to complete the full study and reduce the number of drop-outs, thus potentially providing maximum data for analysis.

After the pre-registration examination, a purposive sample of individuals were invited for a semi-structured telephone interview to confirm the findings from the questionnaire and further expand on individual thoughts towards the learning tools and use of case studies as a resource for pre-registration training (see section 5.10).

## 5.4 Ethical Approval

The lead researcher worked with the Research Governance Officer at Keele University regarding the level of ethical approval that was required to undertake this research. After consideration, NHS approval was determined to be unrequired due to the recruitment of participants in their capacity as preregistration students. Therefore, only University ethics was obtained.

An application to conduct this research was submitted to Keele Ethical Review Panel in August 2014 and subsequently approved in September 2014 (Ref: ERP2221) (Appendix 2)

The application was accompanied by the relevant letter of invitation (Appendix 3), patient information sheet (Appendix 4), consent form (Appendix 5), questionnaire (Appendix 6), interview guide (Appendix 7) and other supporting documentation: MCQs for case study one (Appendix 8), link to VP case study one (Appendix 9), NI case study one (Appendix 10).

Written informed consent was obtained from each participant prior to starting the study and, again, before the telephone interviews (Appendix 11) (see section 5.10.3). A second participation information sheet was created and provided for ethical review for the telephone interviews (Appendix 12).

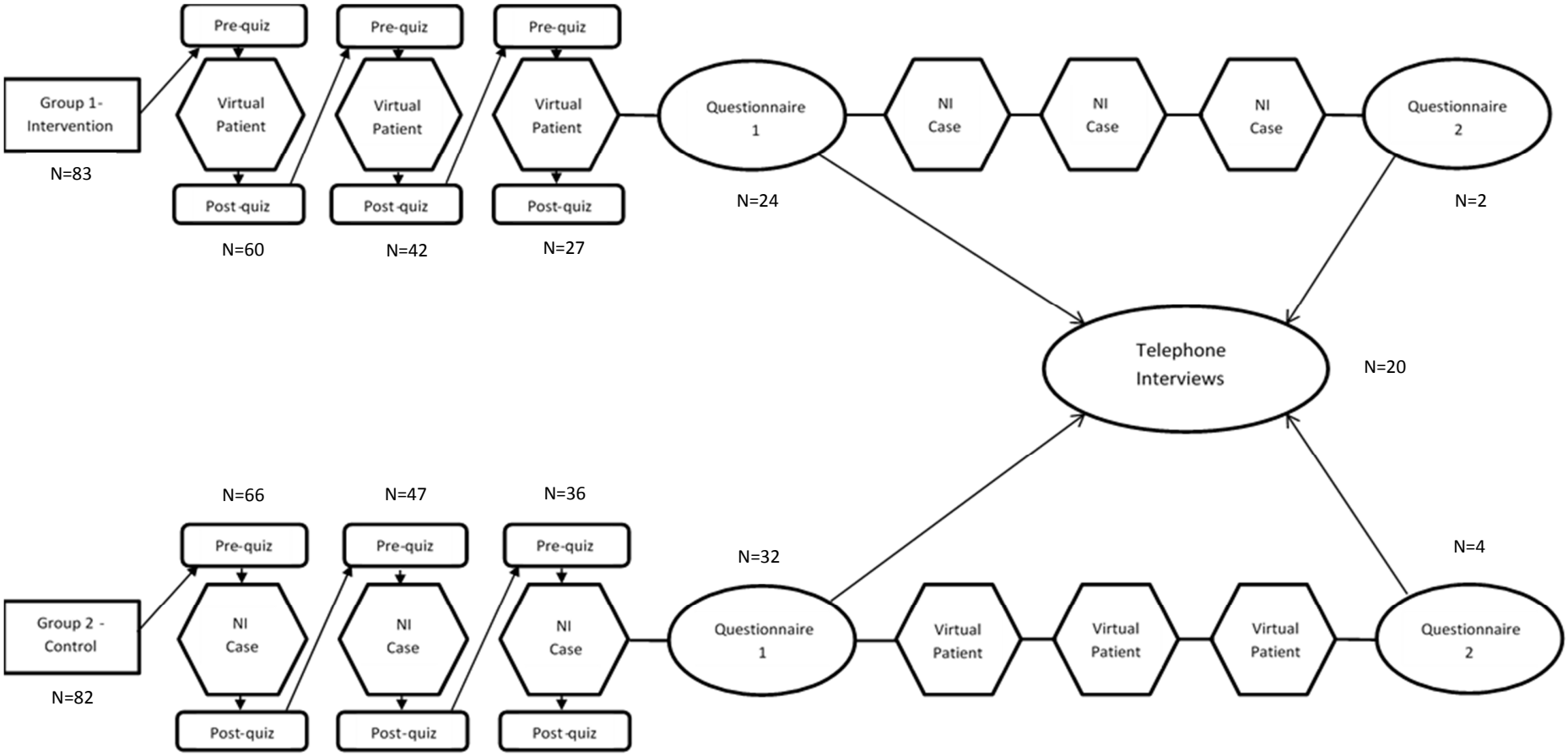



**Figure 5-1 Illustrates the programme of work for the study. It illustrates the two cohorts of pre-registration trainees, the different data collection methods and the number of trainees in the different stages of the study. A sequential mixed methods design was used and the data collected from the MCQs, questionnaires and telephone interviews were triangulated.**

## 5.5 Sampling

Pre-registration pharmacists completing their training in a UK-based hospital or community pharmacy were recruited to participate in the research (training year 2014-2015). Those who responded to the invitation to participate were included in the study upon consent.

### 5.5.1 Sampling for Quantitative Data Collection

Purposive sampling is a technique where units of a sample are chosen because they possess characteristics which the researcher is interested in studying (Henry, 1990; Cohen *et al.*, 2007; Bryman, 2012). The sampling frame from which the non-random, purposive sample was drawn included pre-registration trainees from throughout the UK. The aim of the sampling procedure was to acquire a sample of trainees from hospital or community pharmacy to evaluate the usefulness of VPs and NI case studies, thus purposive sampling was considered appropriate. Due to trainees' different work environments and experiences during pre-registration training, which may affect their knowledge development, seeking trainees from the different sectors was considered appropriate. Attempts were also made to obtain a heterogeneous sample which included men and women and trainees of different ethnicities to obtain a richer data set.

After trainees had consented to participate, random stratified assignment was used to split the participants into two groups based on sector of training, gender, age and ethnicity to achieve a near-equal distribution. This was considered an alternative to true randomisation and was appropriate for the quasi-experimental design (see Chapter 4, section 4.5.1). Random stratified assignment allowed for a direct comparison of views between the two groups and significance calculations of the effects these factors may have had on knowledge improvement scores (Henry, 1990; Cohen *et al.,* 2007).

The sample size for this research was calculated using GPower 3.1 (2014), a computer program designed to calculate sample size based on probability (p-value), power and effect size. A sample size of 52 was calculated to obtain statistically significant results from an independent t-test and a sample size of 23 was calculated to obtain statistical significance from a dependent t-test. A-p value of 0.05 was used in this research as it is the minimum level for rejection of the null hypothesis and provided the best opportunity to identify a statistical difference (if one was present). A power level of 0.8 was used as this is the minimum power for detecting a difference at the effect size specified. An effect size of 0.8 was used and, although this is classed as a high effect size (small 0-0.2, medium 0.2-0.5, large >0.5), previous research into the use of VPs has reported statistical significance using effect sizes from 0.1 to 0.9 (Cunningham and McCrum-Gardner, 2007; Botezatu, Hult, Tessma, *et al.*, 2010a; Salkind, 2011; Consorti *et al.*, 2012).

Within statistical analysis, there are two types of error that can occur depending on the appropriateness of the sample size calculation. A Type 1 error (α) occurs if the null hypothesis is rejected when it is true. A p-value of 0.05 is the probability that 5% of the differences between two groups occurred by chance rather than the study intervention and expresses that a Type 1 errors will occur one in 20 times (Devane *et al.*, 2004; Cunningham and McCrum-Gardner, 2007; McCrum-Gardner, 2010). This has been established in the literature as the minimum level of rejection, hence was used in the sample size calculation in this research (Cunningham and McCrum-Gardner, 2007; McCrum-Gardner, 2008, 2010). A Type 2 error (β) occurs if the null hypothesis is accepted when it is false (Devane *et al.*, 2004; Cunningham and McCrum-Gardner, 2007; McCrum-Gardner, 2010). The statistical power of a test is the probability of not making a Type 2 error and thus identifying a statistical effect when it occurs (Cunningham and McCrum-Gardner, 2007; McCrum-Gardner, 2010) . The minimum probability acceptable for a Type 2 error is usually given as 0.20 (Cunningham and McCrum-Gardner, 2007). Power is calculated as 1-β such that 1-0.20 = 0.80 or 80%, which has been

identified as the minimum power used in clinical trials and was the power chosen for the sample size calculation in this research (Campbell *et al.*, 2007; Cohen *et al.*, 2007).

According to Creswell and Plano Clark (2011), "the effect size is a means for identifying the practical strength of the conclusions about group differences or relationships among variables in a quantitative study". The effect size can be adjusted by the researcher in terms of whether a small, medium or large effect size is expected (Cunningham and McCrum-Gardner, 2007). It has been recommended that the effect size must not be set too high, as this reduces the sample size estimate and so increases the probability of a Type 2 error, thus an effect size on 0.8 was chosen (Cunningham and McCrum-Gardner, 2007).

### 5.5.2 Sampling for Telephone Interviews

Only those pre-registration trainees who completed the questionnaire were invited for a telephone interview. This allowed for participant validation and triangulation of the quantitative and qualitative results. Upon analysis of the questionnaire data, it was identified that response rates were low (see Chapter 7, section 7.2), therefore all pre-registration trainees who completed the questionnaire were invited for a telephone interview.

Initially, a purposive sampling frame was intended to be adopted for the telephone interviews. A smaller purposive sample of participants who expressed different views were going to be invited for a telephone interview to obtain a more complete picture on thoughts of the technology and help explain any variability which may have arisen (Patton, 1990). The purposive sample was also going to consider specific characteristics, such as sector of training, gender, age, ethnicity, previous use of VPs and degree classification to determine any differences these variables may have had. However, due to the low response rates associated with questionnaire completion, all trainees were invited for a telephone interview to ensure a large enough sample to reach data saturation of the main themes.

The sample of trainees who consented for an interview was checked against the original purposive sampling characteristics to determine how broad the range was of views represented.

In general, sample sizes in qualitative research have no fixed criteria, the main aspect relates to data saturation whereby no new themes emerge from the data (Guest *et al.*, 2006). This is problematic because at any point, one more interview could lead to new information emerging. Thus the concept of saturation is based on the absence of something, which is harder to prove than determining the presence of something. Small sample sizes may not allow data saturation to be achieved but large sample sizes may make it difficult to undertake a deep, case-oriented analysis (Onwuegbuzie and Leech, 2007a). Morse (1995) identified that "saturation is the key to excellent qualitative work," but at the same time noted that "there are no published guidelines or tests of adequacy for estimating the sample size required to reach saturation", because of the problematic nature of the concept. Previous researchers have identified that data saturation depends on the type of research, the length of the interview, the number of times each participant is interviewed, sample homogeneity and the research questions (Braun and Clarke, 2013).

The significance of sample sizes and saturation in other studies is not clear. Previous studies that have investigated VPs have not routinely reported data saturation from interviews and a range of sample sizes have been used, from as few as nine participants to over 300 (Chaikoolvatana and Goodyer, 2003; Austin *et al.*, 2006; Pantziaras *et al.*, 2012; Ekblad *et al.*, 2013). In this research, interviews were aimed to be conducted until saturation of the broad themes occurred, which were already decided from the construction of the semi-structured interview guide. However, as there were a fixed number of people to interview (i.e. only those trainees who completed the questionnaire), a pragmatic approach was taken to assess when these broad themes were saturated.

## 5.6 Recruitment

Pre-registration trainees were recruited by a range of methods, which will be discussed below.

Fourth year pharmacy students from Keele University were recruited towards the end of their academic year (May 2014, before they entered pre-registration training in summer 2014). A presentation was done at a 'Transition to Pre-registration Training' study day organised by Keele University School of Pharmacy. This provided an opportunity to introduce the research and demonstrate the VP technology. This training day was not compulsory, so subsequent emails were sent out to all Stage 4 students explaining the research and providing the lead researcher's (JT) contact details for those interested in taking part or with questions (Appendix 13). The letter of invitation and participant information sheet were attached to the email.

Pre-registration trainees completing their training with Boots pharmacy were recruited for the study via emails. Boots is a large, UK wide pharmacy multiple with a large number of pre-registration trainees and thus was a strong avenue for recruitment. Meetings were held with the national pre-registration training lead for Boots who promoted the research to all Boots pre-registration trainees throughout the UK. Emails were distributed to the pre-registration tutors and pre-registration trainees which explained the research and had the participant information sheet and letter of invitation attached. Pre-registration trainees were encouraged to email the lead researcher (JT) with any questions or their interest in participating. All pre-registration trainees were encouraged to participate in the research by their pre-registration tutors but it was voluntary and did not impact on their progression through the year.

Those completing their pre-registration training in a UK-based hospital were recruited via emails and face-to-face presentations. Regional hospital pre-registration training programme organisers were contacted prior to summer 2014 to obtain consent for presentations and email distribution. Presentations were given at the North West, West Midlands, East Midlands and South East regional

study days to explain the research and introduce the VP tool. Trainees who were interested in participating were asked to provide the lead researcher (JT) with their contact details. Emails were then distributed to those trainees who registered interest which contained all the study information. Where it was not possible to attend regional study days, emails were distributed to all hospital based trainees via the regional training organisers. These emails explained the research and included the participant information sheet and letter of invitation as attachments. Trainees were encouraged to email the lead researcher (JT) with any questions or to register their interest in taking part.

The intention was to recruit pre-registration trainees from a range of regions across the UK, Universities and both training sectors (hospital and community). This ensured that a wide pool of trainees was approached.

## 5.7 Google Drive

For both the pilot study and the main study, Google Drive was used to link all components of the study together to make it more efficient to complete. No negative comments were received during the pilot study (Chapter 6) relating to this method and so it was used for the main programme of work.

Trainees who consented to participate in the study were sent a Google Drive link to the electronic consent form via email. Individuals were required to sign and date this consent form electronically to be able to participate and access the study components. All questions relating to participation in this study had to be answered 'yes', otherwise trainees were unable to take part. Participants were provided with a participant number to uphold anonymity, which remained the same throughout the study. A copy of the consent form was provided to the participants at the end of the study during debriefing. A separate consent form was provided for the telephone interviews to re-obtain consent and reconfirmation for use of quotes was obtained verbally at the end of the interview.

The programme of work was carried out over six months and was associated with many different components (see figure 5-1). Google Drive was used to try and prevent drop-outs and loss-to-follow up of participants, which may have occurred from confusion caused by consecutive emails with information and links to the different study components. Having a single link to Google Drive which allowed progression through all required study components, in a timely and standardised manner, was hoped to improve overall participation rates.

## 5.8 Avatar Case Study Design

Case studies were designed and created specifically for this study by the research and animation teams at Keele University School of Pharmacy. A case study is a simulation of a real or life-like scenario which describes a wide range of patient factors and other information to encourage critical thinking (Marriott, 2007a). They focus on problems which individuals are likely to encounter in practice to increase relevance to and motivation of learning. The case study topics for this research were chosen by the research team after review of the literature and conversations between the lead researcher (JT), the PhD supervisors and first year qualified pharmacists to address areas where further support may be desired during the pre-registration training year. Experiences had by pre-registration trainees can vary considerably and are dependent on a number of factors including: sector of training, training site, tutor support and individual initiative (as discussed in Chapter 1, section 1.4.1). The case studies were designed to cover various knowledge and skills essential to pre-registration training and future practice, and included areas which trainees may find it difficult to show their competence in due to training variations. The range of topics also allowed the diversity and abilities of the VP programme to be illustrated by utilising different avatars, simulation backgrounds, interactions between the avatars and users and multimedia within the simulations.

The case study topics decided upon were: emergency hormonal contraception (EHC), renal function and childhood illness.

The next step was case scripting and design. This was led by the research team and guided by the animation team to determine how the learning objectives for each case should be met and to ensure case design was within the realms of the software. Developing simulations around pre-defined learning objectives exposed all trainees to equivalent experiences, although their learning may have differed depending on individual decisions and the path taken through the decision tree.

The VP technology used in this research, as outlined by Bracegirdle and Chapman (2010), had three key parts that are associated with, and essential to its design: an electronic database, a computer generated graphic and a system to link the two together. The electronic database is classed as the 'brain' of the avatar and is based on a Markov Model design, which uses a decision tree to map progress of a case (Appendix 14). As a user progresses through a case, the database monitors the path through the decision tree and collates the positive and negative feedback to be given at the end of the simulation. The avatars used in this research were designed to 'speak' to the user about the decisions they made during the case; the avatar was animated to provide verbal and textual delivery of feedback to increase its interactivity and realism.

The computer-generated graphic is referred to as the 'body' of the avatar and is the 3-dimensional (3D) character created for each case. The avatars created for this research consisted of adult and child patients and a doctor who were all able to express audio and visual responses. The avatars were animated to portray realistic expressions and gestures to make the interaction feel more lifelike. Users interacted with the avatars via multiple choice questions and free-text typed questions, which allowed multiple skills and levels of knowledge to be assessed.

The final part of the system is the 'heart' which carries information from the 'brain' to the 'body' allowing a real-time, immediate response to the user's input. Each case was pre-populated with

specific questions and keywords which were matched to an appropriate response from the avatar. As discussed throughout Chapter 6 to Chapter 10, it was difficult to estimate the range of questions or keywords which may have been inputted by users, leading to the risk of unrecognised inputs. The technology does have the ability to 'learn' from those inputs which were not recognised by manually matching them to an appropriate response already in the system (Bracegirdle and Chapman, 2010). This may allow for relatively quick updating to 'fill' the question bank when new questions are asked or new phrases are entered by users.

A major benefit of clinical avatars is their reusability. In this research, once the case study topics had been decided upon, the lead researcher (JT) was able to 'browse' the library of avatars and pre-made simulation environments. From this, the avatars could be created specifically for the learning objectives for each case study or existing avatars modified for certain characteristics, ages and genders. Virtual avatars also provided the opportunity for users to visualise tools or objects, for example the integration of prescriptions, hospital notes or drug charts to improve the realism and interactivity of the simulations.

The specific case studies created for this research are discussed in further detail below.

### 5.8.1 Emergency Hormonal Contraception

The aim of this case study was to provide pre-registration pharmacists with an opportunity to practice an emergency hormonal contraception (EHC) consultation (Figure 5-2).

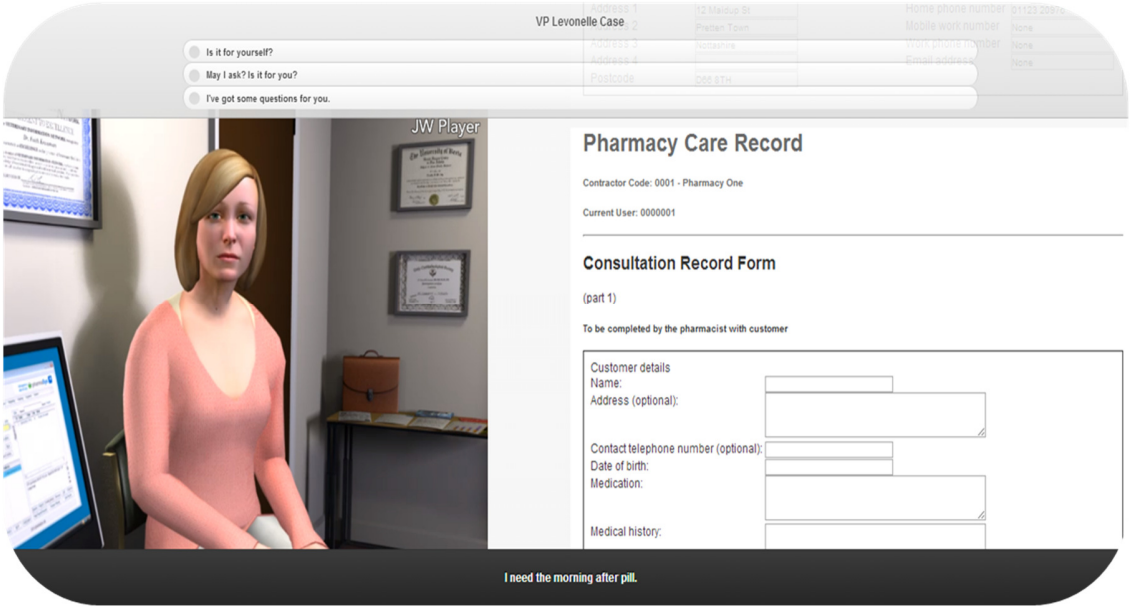



**Figure 5-2 Still image from the EHC virtual patient simulation. The avatar is the young woman who has come into the community pharmacy to request EHC. At this point in the simulation, the avatar has been invited into the consultation room to ensure privacy. Multiple choice questions can be seen at the top of the image and the EHC consultation form on the right is similar to those used in practice to aid the consultation. See Appendix 15 for more images associated with the EHC VP consultation. See link to case study in Appendix 9.**

The main learning objectives for the case were to:

- Practice communicating with a patient requesting EHC in an appropriate, professional manner
- Demonstrate effective understanding of the information that needs to be obtained from a patient to ensure safe provision of EHC
- Demonstrate effective understanding of the main counselling points associated with EHC
- Describe the different options available for EHC
- Identify the reference sources available for more information regarding EHC

Interacting with a patient requesting EHC requires a sensitive approach to allow rapport to develop. Research investigating the use of VPs in sensitive situations is limited. Those studies which have evaluated VPs in these contexts have identified positive results, with user's knowledge improving in many areas, including: mental illness, trauma, refugees and health promotion interventions (Kenny *et al.*, 2008; Guise, Chambers and Välimäki, 2012; Pantziaras *et al.*, 2012; Parsons *et al.*, 2008; Fleming *et al.*, 2009; Ekblad *et al.*, 2013). Pre-registration trainees may not have the experiences to develop the necessary skills to confidently interact with such patients, thus simulating an EHC consultation with a VP provides an opportunity for individuals to practice interacting with a patient in a sensitive, non-judgemental manner.

The simulation was designed to improve pre-registration trainee's knowledge of the options available for EHC. The EHC case primarily covered Levonelle® because, at the time of creation, it was the only oral EHC licensed to be purchased or provided under a patient group direction (PGD). EllaOne® was included in the pre- and post-MCQs to ensure trainees were aware of it as a new option for EHC, and since the time of the study, it is now included in community pharmacy PGDs and can be sold without a prescription.

The VP simulation incorporated a consultation guide, similar to those used in practice, which users should have worked through to aid their questioning and advice relating to EHC. This was hoped to improve individuals' knowledge on EHC and understand the counselling points to ensure they can provide appropriate treatment to patients when they are qualified pharmacists. The simulation was constructed such that both multiple-choice input and free-text input were utilised. This was to help develop individuals' communication skills (i.e. how questions are asked) and knowledge of EHC. Previous research has found pharmacists have variable knowledge relating to the pharmacological action and adverse effects of EHC (Seston *et al.*, 2001; Triola *et al.*, 2006; Cooper *et al.*, 2008).

Individuals completing their pre-registration training in a hospital may be less likely to see or be actively involved in an EHC consultation, than those in the community sector. Providing educational resources to address these areas is an important step in the teaching of EHC. The interactive practice of an EHC consultation using the VP may especially be useful, as role-play has been identified as an effective teaching method for pharmacists in conducting EHC consultations and face-to-face role-plays are not always appropriate (Bacon *et al.*, 2003).

Information for preparation of the case was gathered from the following resources: British National Formulary 65 edition (Joint Formulary Committee, 2013), Summary of Product Characteristics for Levonelle® (eMC, 2014b) and EllaOne® (eMC, 2014a), Medicines Ethics and Practice Edition 36 (RPS, 2012), The Centre for Pharmacy Postgraduate Education EHC e-learning (2012) and The Faculty of Sexual & Reproductive Healthcare Clinical Guidance (2012). Information from all of the above resources was collated to develop the script for the VP case and inform the pre- and post-MCQs.

This VP simulation was piloted (see Chapter 6) and amendments were made before its use in the main study.

## 5.8.2 Renal Function

The aim of this case study was to provide pre-registration pharmacists with calculations practice and experience of a hospital pharmacists daily ward round (Figure 5-3).

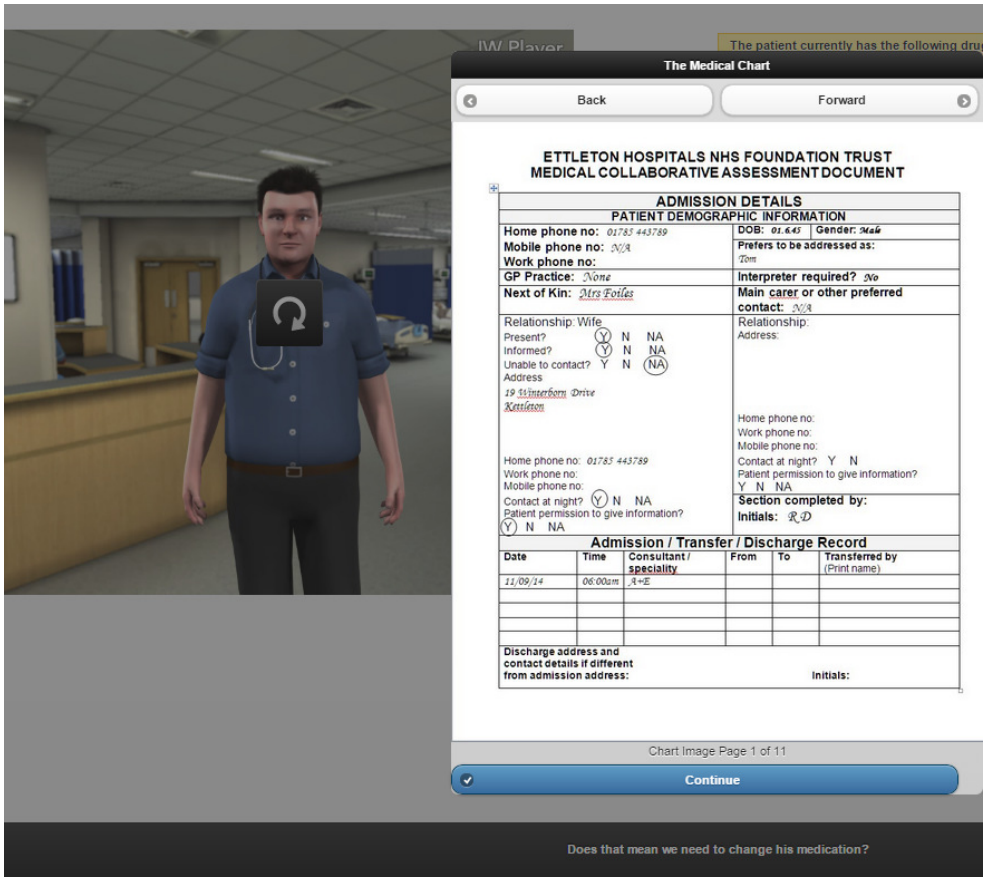



**Figure 5-3 Still image from the renal function VP simulation. The 'pop-up' hospital notes on the screen can be flipped through and contain the same information as in a real set of hospital notes, including blood results and medication history. The avatar of the doctor can be seen behind the chart; this is who the user interacts with in this simulation. See Appendix 16 for more pictures of the renal function VP simulation. See link to case study in Appendix 9.**

The learning objectives for this case study were to:

- Practice calculating renal function
- Demonstrate an improvement in calculation skills
- Explain the various ways in which renal function can affect drug doses

- Practice modifying drug dosages accurately
- Identify the reference sources available for more information regarding renal function

Calculations are a fundamental part of a pharmacists' role which was a prime reason for the inclusion of a Cockroft and Gault renal function calculation ((140-age) x weight x constant / serum creatinine) in the case study itself and also the incorporation of calculations into the pre- and post-MCQs. Previous research has identified that pharmacy students struggle with calculations (Vyas, Bhutada, *et al.*, 2012; Sheaffer and Addo, 2013; Vyas *et al.*, 2014). Simulations have been identified as an effective teaching method of calculation skills in pharmacy students (Vyas *et al.*, 2014), thus it was hoped that the interactive nature of the VP would promote experiential learning and aid development in preparation for the pre-registration exam and future practice.

Hospital pharmacists may calculate renal function and adjust affected drug doses more often than community pharmacists. This may also indicate that hospital pre-registration trainees may have increased opportunities to develop this knowledge and practice these specific calculation skills than trainees in the community sector. Renal function calculations have been established as a primary area for prescribing errors and it is therefore important for pharmacists to understand how renal function can affect drug doses and work with prescribers to ensure patients get the best care (Dean *et al.*, 2002; Ridley *et al.*, 2004; NPSA, 2007). This case study required trainees to use the VP's blood results to calculate their renal function, thus hoping to improve their skills before they go into practice.

The VP simulation integrated hospital notes and a drug chart which individuals needed to look through and use to complete the simulation. Trainees were expected to look at the drug chart and amend it based on the VP's reduced renal function. Trainees could adjust the dose of any of the VP's medications and they were told of the appropriateness of their choice in the feedback. This is a key

part of pharmacists' role and the simulation provided a chance for pre-registration trainees to practice clinically checking a prescription, in a safe environment, before qualifying. The drug chart also contained an interaction based on advice issued by the Medicines and Healthcare Products Regulatory Agency (MHRA) (2012). This was aimed to raise awareness of the MHRA bulletins and help trainees understand the importance of keeping their knowledge up-to-date to ensure patient safety and promote continuing professional development (CPD), as well as understanding what action should be taken upon identification of a drug interaction.

The case and associated multiple choice questions were created by collation of information from the following resources: British National Formulary 65 edition (Joint Formulary Committee, 2013), Martindale Online (Brayfield, 2014) Summary of Product Characteristics of Enoxaparin (eMC, 2015), The Renal Drug Handbook (Ashley and Currie, 2008) and Introduction to Pharmaceutical Calculations (Rees *et al.*, 2010).

This case was piloted by review with two members of staff, as well as the supervising team and amendments were made from comments received.

### 5.8.3 Child Illness

The aim of this case study was to provide pre-registration trainees with an opportunity to practice a consultation to diagnose and treat a child with a specific illness (Figure 5-4).

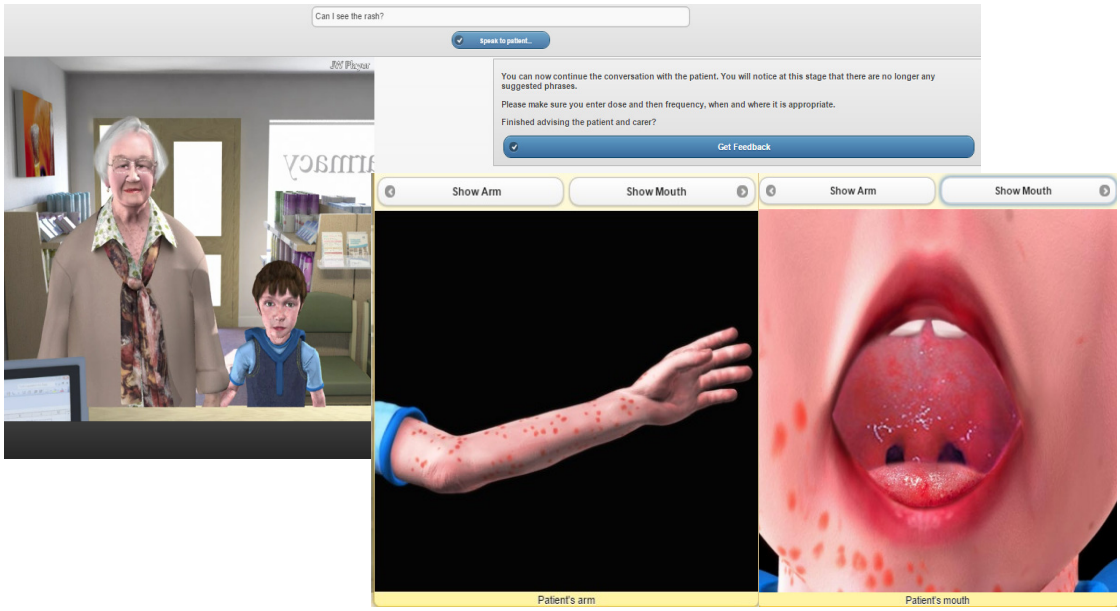



**Figure 5-4 Still image from the childhood illness VP simulation. The pop-up images display the child's rash on their arm and the Koplik Spots in the mouth. These images remain available to view throughout the simulation, once the user has asked to see them. The avatars in this simulation are the grandmother and the child. The 'free-text' question bar can be seen at the top of the page. See Appendix 17 for more pictures of the childhood illness VP simulation. See link to case study in Appendix 9.**

The learning objectives for this case study were to

- Demonstrate an improvement in knowledge of common childhood conditions
- Describe the differences between several childhood conditions
- Explain the options available for OTC treatment in children
- Identify the reference sources available for more information regarding childhood conditions

Many childhood conditions are associated with a rash and this case study encouraged pre-registration trainees to use their current knowledge and develop new knowledge to differentiate between the various types of rash and their associated symptoms. Although measles is a condition which may not be seen regularly seen in community pharmacies, the prevalence of it is increasing, which led to the research team believing that pre-registration trainees should be able to distinguish it from other childhood conditions (WHO, 2015). In this simulation, the child presented with measles and the VP case was designed such that, when users asked to view the rash an image of the child's arm enlarged, and when asked to check inside the mouth an image of the oral cavity appeared (Figure 5-4). Once these questions had been asked, the images could be viewed multiple times during the simulation to allow the user to inspect the visible symptoms before making a diagnosis. Utilising the animations in this way provided an opportunity to demonstrate the abilities and realism of the VP technology; rather than taking stock images of these symptoms from the internet or textbooks.

In the VP simulation, once trainees had identified the condition as measles, they were required to provide the grandmother with appropriate treatment and advice for the child. Treatment of children is different to that of adults because their physiology differs, which affects the pharmacokinetics and pharmacodynamics of medicines (Stephenson, 2005; Fernandez *et al.*, 2011; Batchelor and Marriott, 2013). Pre-registration trainees should understand the medicines which are licensed for use in children, appropriate self-care advice for children and when children should be referred to an alternate healthcare provider. The VP simulation drew on the MHRA guidance on paracetamol, ibuprofen and cough and cold treatments in children (MHRA, 2009, 2011). Prior to the creation of this case in 2014, the doses of ibuprofen and paracetamol in children had been recently updated and it was considered appropriate for trainees to be aware of this change and be able to advise on the current recommended doses in practice. Simulation has been identified as an effective means of teaching paediatric care to pharmacy students (Tofil *et al.*, 2010), thus it was hoped that similar positive results would be identified in this research.

The case and associated multiple choice questions were created by collation of information from the following resources: BNFc (Paediatric Formulary Committee, 2014) CPPE Responding to Minor Ailments (CPPE, 2012b), NHS Choices Measles (NHS, 2014f), NHS Choices Meningitis (NHS, 2014g), NHS Choices Croup (NHS, 2014d), NHS Choices Chicken Pox (NHS, 2014a), NHS Choices Mumps (NHS, 2014h), NHS Choices Impetigo (NHS, 2014e), NHS Choices Cold Sore (NHS, 2014b), NHS Choices Colic (NHS, 2014c), NHS Choices Whooping Cough (NHS, 2014i).

This case was piloted by review with two members of staff, as well as the supervising team and amendments were made from comments received.

## 5.9 Non-Interactive Case Study Design

The NI case studies acted as the control measure. At University and during pre-registration training, students/trainees commonly use paper-based clinical case studies to aid their learning. These often consist of an introductory paragraph summarising the case followed by a set of questions. The NI case studies in this research were designed to be similar to these paper-based cases, however users were provided with immediate feedback after completing them. Real world paper-based case studies may not be associated with immediate feedback, making these NI case studies a better control for the VP cases; as the provision of individualised feedback is a component of the VP simulations. However, this may have reduced the likelihood of finding a statistically significant difference between the two learning tools.

The NI case studies were created as a 'Google Form' on Google Drive. At the beginning of each case study, the individual learning objectives associated with that case study were listed along with an introductory paragraph to summarise the case study. This was then followed by a number of questions and associated text-boxes, in which trainees were required to write their answers before submitting them. Feedback was then provided by displaying the 'textbook' or 'model' answer for

each of the questions, an explanation of the correct answer and signposting to resources for further reading. Users were required to enter text in each of the textboxes, otherwise they were unable to submit their answers and progress to the feedback.

Although the case studies were created on Google Drive, they were still considered to be non-interactive as, apart from answering questions, there was no interactivity between the user and the learning tool. As Google Drive was used for the pre-and post-MCQs and the questionnaires, the NI case studies were also created as Google Documents as it was considered the most appropriate method to provide participants with the cases. Google Drive also allowed for the immediate delivery of feedback or 'textbook' answers which may not have been as streamlined had paper-based cases been created and emailed out individually. The immediate feedback may have increased the use of the NI case studies and potentially reduced the difference in perceived benefit between them and the VP cases.

The topics of the NI cases were the same as the VP cases (EHC, renal function and childhood illness) to allow for a direct comparison of learning tools (see Appendices 10, 18 and 19). The cases were created by the research team in line with the learning objectives described in section 5.8. The extra NI case studies (mentioned in section 5.3) that were provided to those participants who completed both questionnaires can be seen in Appendices 20, 21 and 22. These case studies were on the topics of anticoagulants, drug interactions and cardiovascular disease and were chosen as they were considered further topics which may be useful for pre-registration trainees to have more experiences on.

## 5.10 Data Collection

### 5.10.1 Pre- and Post-MCQs

Quantitative data was obtained from the pre- and post-MCQs associated with each case study (Appendices 8, 23, 24). For each case study, the pre- and post-MCQs consisted of the same 20 questions which were related to the specific case study topics. The pre- and post-MCQs were created using the resources as discussed in sections 5.8.1, 5.8.2 and 5.8.3 and were used to assess any knowledge improvement within and between the VP and NI groups. Each question was associated with one mark, in terms of scoring knowledge. Using the same or similar questions on pre- post-tests has been shown as an effective way of monitoring knowledge improvement from educational interventions in the literature (Duque *et al.*, 2008; Benedict and Schonder, 2011; Seybert and Kane-Gill, 2011; Battaglia *et al.*, 2012; Ray *et al.*, 2012; Branch, 2013; Douglass *et al.*, 2013).

### 5.10.2 Questionnaire

The aim of the questionnaire was to obtain a standardised measure of pre-registration trainees' reported views on the VP and NI case studies, using Likert statements, to allow for comparisons to be made. Open-ended questions were included to obtain further insight into trainees' thoughts on the case studies and allow for triangulation with the data obtained from the telephone interviews.

After reviewing the literature, it was apparent that evaluative questionnaires are an established tool to compare thoughts on different learning tools (Watson, Norris, *et al.*, 2006; Cohen *et al.*, 2007; Cook and Triola, 2009; Salter *et al.*, 2014). In particular, Likert scales have been effectively used to obtain thoughts and opinions which can provide context for more qualitative data (Fuhrman Jr. *et al.*, 2001; Hussein and Kawahara, 2006; Zary *et al.*, 2006; Orr, 2007; Basit, 2010; Gallimore *et al.*, 2011; Gormley *et al.*, 2011; Benedict *et al.*, 2013; Douglass *et al.*, 2013). Rather than attempting to

construct an evaluative questionnaire for use in this research, it seemed more appropriate to consider using one that had already been created and validated. However, a review of the literature identified a lack of validated instruments which have been used to evaluate VPs as a learning tool (Kardong-Edgren *et al.*, 2010).

The development of a questionnaire, when done correctly, is a resource and time intensive task (Oppenheim, 1998; Sapsford, 1999; Cohen *et al.*, 2007). Questions must be carefully crafted for their utility and comprehension and one must also bear in mind the length of time respondents may take to answer questions (Sapsford, 1999). Thus, when creating the questionnaire for this research, it seemed appropriate to adopt questions from validated evaluation instruments which were present in educational literature or instruments used in published VP literature (Appendix 25) (Abdo and Ravert, 2006; Lambton *et al.*, 2008; Leng *et al.*, 2009; Kardong-Edgren *et al.*, 2010). The paper by Kardong-Edgren *et al.* (2010) was a review article and was primarily used to find published instruments, thus is not included in Appendix 25.

The validity and reliability of the questionnaire needed to be measured to ensure it was appropriate to use and the results able to be show a meaningful effect. As previously pointed out in section 4.6.2, the concept of validity concerns whether a test measures what it claims to measure (Sapsford, 1999; Cohen *et al.*, 2007; Bryman, 2012; Braun and Clarke, 2013). The questionnaire created for this research was piloted (Chapter 6), the results from which, and a review of the questionnaire by the supervisory team and two other practicing pharmacists ensured the content validity of the tool.

As previously discussed in section 4.6.1, reliability is the reproducibility of a measure and is linked to error; such that a test with high reliability will be accurate, and produce less measurement error than a test that is not reliable (Sapsford, 1999; Braun and Clarke, 2013). When scales are intended to measure a single construct, internal consistency in responses across items, as reflected by an index such as Cronbach's coefficient alpha (α), is an appropriate measure of reliability (Cronbach, 1951;

Frey and Edwards, 2001; DeVellis, 2003). It essentially measures the correlation between items on a questionnaire (Bland and Altman, 1997). The number of items in a scale can influence the result of α, but a commonly used cut-off point for acceptable internal consistency is a Cronbach's α of 0.7 (Campbell *et al.*, 2007; Field, 2009). Cronbach's alpha reliability coefficient normally ranges between 0 and 1; the higher the score (the closer the coefficient is to 1.0) the greater the internal consistency of the items in the scale (Gliem and Gliem, 2003). Cronbach's α was used to measure the internal consistency of the created questionnaire, the results of which are presented in Chapter 6 (section 6.8.2) and Chapter 8 (section 8.3).

Quantitative data was obtained from the Likert ranking scale in the questionnaire. Each statement was associated with a 5-point Likert scale on which participants had to rank their agreement, on which 1 related to 'strongly disagree' and 5 related to 'strongly agree' with the middle-point (3) being 'undecided'. A 5-point scale was chosen to allow for this neutral point to be included as it was considered appropriate to provide trainees with the option to be undecided. The inclusion of a neutral point is debated in the literature with some believing it should not be provided as individuals should be forced to make a decision (Kalton *et al.*, 1980; Krosnick *et al.*, 2002). In contrast, Fowler Jr (1995) has stated the importance of including a neutral point as some individuals may not feel they have enough information to either agree or disagree with a particular statement and forcing them to have an opinion may reduce the reliability of the data collected (Converse and Presser, 1986; Oppenheim, 1998).

The same questionnaire was provided to trainees in the VP and NI groups so a direct comparison of Likert statement agreement between the groups could be made (Appendix 6). The 20 statements on the Likert scale are listed in Chapter 6 (section 6.8.3). No changes were made to the questions after the pilot study as they were reported as being worded appropriately by all participants. The 20 statements covered areas of realism, enjoyment, ease of use, developing skills and knowledge,

improving confidence and overall enhancement of learning. Qualitative data was obtained from the open-ended questions on the questionnaires. The open-ended questions were based on those used in evaluative questionnaires in the literature, and concentrated on trainee's likes and dislikes of the cases, improvements to the case studies and their inclusion into the pre-registration training year (Gordon *et al.*, 2001; Wrzesien and Alcañiz Raya, 2010; Hurst and Marks-Maran, 2011; Aebersold *et al.*, 2012; Kononowicz *et al.*, 2012; Seybert *et al.*, 2012).

The questionnaires were electronic and were created as a Google Drive document. All questions were made compulsory to answer and trainees were unable to submit the questionnaire without selecting a response for each statement on the Likert scale or typing in each open-question answer box. This ensured an abundance of data was obtained but also may have reduced the reliability of the results, as individuals may have only given an answer because they were required to or may have given specific answers based on what they thought the researcher wanted to find out.

### 5.10.3 Telephone Interviews

A semi-structured interview guide was created to obtain an in depth, qualitative exploration of trainees' perspectives on the learning tools (Appendix 7). The question guide for the interviews was initially based on the literature review and objectives for the study but was further tailored to each individual participant based on the quantitative and qualitative results obtained from the questionnaire. The discussion points included: perspectives on VPs (or the NI case studies) as a training tool, perspectives on trainees support during pre-registration training and perspectives on the use of VPs as an OSCE tool.

In brief, the discussion point based upon perspectives on VPs as a training tool covered trainees' overall thoughts on the VP or NI case studies (dependent on which group they were allocated to and whether they had used the VP technology). It also explored the case studies which they found most

useful and why. Trainee's individual development from completing the case studies was investigated; such as their knowledge base on the particular topic areas, any skills (e.g. communication, consultation, calculation) and their general competency development in relation to their evidence portfolio. Questions relating to their enjoyment and inclination to study using the learning tools were asked. Questions also included whether trainees felt they would use the learning tools again for future training. Trainees' thoughts on improvements and barriers to use of the learning tools were also explored.

The topic on perspectives on their support during pre-registration training covered trainee's individual support levels from their training site or tutor. This was to establish the variation in the levels of support and whether the integration of other learning tools (such as the VP) may provide practice in areas they may not experience during the training year. Trainees' thoughts on areas where they would have liked more support were explored, including other case study topics which may be useful for pre-registration training. The integration of the learning tools into the training year was also explored.

Pre-registration trainee perspectives on the use of VPs as an OSCE tool were explored to determine if this was an area where individuals felt the learning tool may offer benefit. Trainees were asked about their experiences of OSCEs during the training year to determine variation within and between the sectors. Their thoughts were also explored on the use of VP case studies in place of paper-based OSCE case studies, or as a preparation tool.

The interview was directed by the trainees to allow expression of their thoughts and opinions in their own words. Although a question guide was created, the semi-structured nature of the interview allowed for a more flexible approach to be taken (as discussed in Chapter 4, section 4.5.3). As interviews were conducted over the phone, an extra effort was made to ask open questions to help build rapport. However, it was important that some structure remained in the interview and if

specific issues which were included in the interview guide were not covered, these questions were asked at a later stage (Britten, 2000).

Consent was obtained prior to the interview to allow for digital recording of the interviews. These recordings were then transcribed verbatim for analysis. In addition, reflective notes were made during and after each interview. This encouraged the noting down of any important comments or information which could have been missed in the transcribing process. It also allowed for the reflection on the interview process itself, regarding the flow of questions, wording of questions and how responsive participants were to certain questions.

## 5.11 Data Analysis

### 5.11.1 Pre- and Post-MCQs

Answers on the MCQs were marked as being 'correct' or 'incorrect'. Statistical tests were conducted to assess any knowledge improvement within or between the groups for each case study. The data was first screened for completeness and violations of assumptions (Brick and Kalton, 1996). Those trainees who did not complete each set of pre- and post MCQs were excluded from further analysis - e.g. if a participant completed the pre- and post-MCQs for case study 1 but only the pre-MCQs for case study 2, they were included in the analysis for case study 1 but excluded from the rest of the study and thus any further analysis.

Field (2009) was used to identify the most appropriate statistical tests for analysis of the scores obtained from the pre- and post-MCQs. Firstly, descriptive statistical tests were done on the scores obtained from the MCQs for each case including the means, standard deviations, modes, medians and ranges of scores. Descriptive statistics allow for the presentation of data to establish patterns but they do not allow any conclusions to be drawn from the data (Harris and Taylor, 2004).

Inferential statistical tests were also carried out on the MCQ scores to determine any significant differences between the variables (learning tool group, sector of training, gender of participants) (Sullivan and Artino Jr, 2013). Quantitative analysis was carried out using Microsoft Excel and IBM SPSS Statistics v21 (2016). Dependent t-tests (paired t-tests) compare the means of two related groups to determine any statistically significant difference and were used to assess individual trainee's knowledge improvement from pre- to post-MCQs, for all case studies (Salkind, 2011; Field, 2009). Independent t-tests compare the means of two unrelated groups to determine any statistically significant difference and were performed to determine any difference in knowledge between each group, sector of training and participant's gender (Salkind, 2011; Field, 2009). In this research, three different variables potentially affecting knowledge improvement scores were considered (learning tool group, sector of training and gender). Multiple regression is an analysis technique used to determine the relationship and predict an outcome from two or more variables and thus, it was used to determine any relationships between the three variables and the resulting knowledge improvement score (Salkind, 2011; Field, 2009). Two-tailed hypothesis testing was used with a significance level ($\alpha$) set at 5% ($p \leq .05$) to determine if there was a positive or negative change in trainees' knowledge from using the VP rather than the NI learning tool.

The normality of data distribution was assessed using the Shapiro-Wilkes test and Q-Q plots (Field, 2009). For the three different case studies, the results of the Shapiro-Wilkes test were found to be both significant (data was not normally distributed) and non-significant (data was normally distributed). The visual distribution of data using the Q-Q plots was assessed and found to be normal. Differences in normality distribution are associated with sample size, as in larger sample sizes (>30), significant results are commonly found even in the case of small deviations from normality, although this small deviation will not affect the results of a parametric test (Field, 2009; Ghasemi and Zahediasl, 2012). As a result, parametric tests were used to analyse the data. Parametric tests are inherently stronger than non-parametric tests but they are only valid if data distribution is normal. If

non-parametric tests are used, they usually require a larger sample size to find a significant difference between groups because they are less powerful (Fowler *et al.*, 2002; McCrum-Gardner, 2008; Salkind, 2011; Sullivan and Artino Jr, 2013).

### 5.11.2 Questionnaire

Scores on the Likert ranking statements underwent descriptive statistical analysis for both the VP group and the NI group. The data was first screened for completeness and violations of assumptions (Brick and Kalton, 1996). Trainees who didn't complete the questionnaire were excluded from the rest of the study. Missing data from the questionnaire was not a problem because each question was required to have a response, thus every questionnaire which was submitted was completed in full (although some responses were not as appropriate, as discussed in Chapter 8).

The median score for each statement was calculated. Likert scales produce ordinal data (McCrum-Gardner, 2008) and as such, it has been identified that the mean (and standard deviation) are inappropriate at representing the data and, instead, the median or mode may be a more appropriate measure of central tendency (Jamieson, 2004). The response categories in a Likert scale have a rank order, but the intervals between values cannot be presumed equal, thus it cannot be assumed that differences between responses are equidistant. Finding an 'average' or mean agreement score may not accurately portray the data that is obtained, especially if responses are clustered at the extreme ends of the scale (Jamieson, 2004). This led to median scores being calculated. Percentage distribution of agreement for each statement in the Likert scale was also calculated and tabulated as this has been identified as a suitable method for illustrating Likert responses (Jamieson, 2004; Sullivan and Artino Jr, 2013).

Within the literature, conflicting views are reported on the use of parametric or non-parametric tests to analyse ordinal data, such as that obtained from Likert scales. It has been argued that ordinal data cannot be analysed using parametric tests due to the lack of specific and measurable intervals between the ranks (Jamieson, 2004; McCrum-Gardner, 2008; Sullivan and Artino Jr, 2013). In contrast, it has been argued that parametric tests are appropriate to analyse ordinal data if the sample size is large enough and the data follows a normal distribution (Jamieson, 2004). In 2010, de Winter and Dodou investigated whether a t-test (parametric) or Mann-Whitney U test (non-parametric) was more appropriate at analysing Likert scale data. They found that there were no significant differences between the two and concluded that researchers should feel able to use whichever methods of data analysis they believe are most appropriate based on the data collected, research questions, sample size and distribution of data. As a result, Mann-Whitney U tests were conducted on the median scores to determine any significant differences in reported thoughts of the VP case studies versus the NI case studies. Parametric tests, such as independent t-tests, were not chosen as a statistical analysis technique because the Likert scale had been created without any numbers attached to the categories of agreement and it was not considered appropriate to assume that individuals distinguished the intervals between the categories as equal; which would be required for an independent t-test.

The open-ended questions from the questionnaire were analysed using content analysis due to the flexibility of the method (Wilkinson, 2000). Comments from questionnaires traditionally are more limited in their richness than compared to, for example, interview transcripts, which makes content analysis an appropriate technique. Content analysis involves converting the qualitative data into a quantitative form by counting the number of responses in each category and then summarising the number or percentages of responses for each category in tabular form.

All comments provided by respondents were imported into a Microsoft Excel spreadsheet for coding. Comments were received on a range of issues, which led to a more inductive approach initially to ensure all relevant comments were included in the analysis, before comments were categorised into themes deductively (Pope and Mays, 1995). Comments were coded to allow counts of themes to be summed to derive frequencies, which related to the number of times themes were present in the data (Wilkinson, 2000).

The process of content analysis was followed to allow the identification, organisation and indexing of text to provide frequencies of coded themes succinctly in tables. The broad themes generated from the content analysis related to the usability of the VP, the design of the case studies and the usefulness of the VP as a learning tool.

### 5.11.3 Telephone Interviews

The recordings of the telephone interviews were transcribed verbatim by an experienced transcriber. The transcripts were then checked for accuracy by the lead researcher (JT) by comparing with the recorded interviews to allow any discrepancies to be caught and amendments to be made where appropriate.

The framework analysis approach was used to analyse the qualitative data from the telephone interviews as described by Pope *et al.* (2000) and Gale *et al.* (2013). It has been noted that "good qualitative analysis is able to document its claim to reflect some of the nature of a phenomenon by reference to systematically gathered data," thus the rigorous and structured approach of the framework analysis was adopted (Fielding, 2008). The framework approach sits within the family of thematic analysis methods and, as such, is a flexible tool that can be adapted for use with many types of data or qualitative approaches and is not aligned with a particular epistemological, philosophical, or theoretical approach, which was considered beneficial for the mixed methods approach adopted in

this thesis (Gale *et al.*, 2013). A framework analysis approach reflected the inductive background work and early theme derivation from the questionnaires but also developed deductively from the study aim and objectives (Pope *et al.*, 2000).

There are typically five stages in the framework approach. These were used to identify and collate the interview data into themes and subthemes. The five stages are: familiarisation, identifying a thematic framework, indexing, charting, mapping and interpretation (Pope *et al.*, 2000). All stages are closely connected and result in coherent themes being identified which represent the data. The five steps of the technique can be briefly outlined as follows:

1. Familiarisation - The researcher familiarises themselves with the data by listening to audio recordings, reading through transcripts, studying reflective notes and generally immersing themselves in the data.
2. Identifying a thematic framework -The researcher identifies the key issues, concepts and themes by which the data can be analysed to create a thematic framework. This is developed through a priori theories and the data itself (more inductively) from which the data can be coded.
3. Indexing – The researcher 'indexes' the transcripts through applying the thematic framework to the data. This includes annotating all transcripts with the relevant codes to ensure all important data is identified appropriately.
4. Charting – The researcher creates a data matrix chart for each theme with subtheme headings making up the columns and participants used as rows. An abstracted and synthesised version of the coded text is then placed into a cell within the chart and the source of the text is referenced.
5. Mapping and Interpretation - The researcher begins to pull together the key characteristics of the data and interpret the data set as a whole. This includes identifying and understanding the different concepts, associations and explanations of phenomena from the data.

A process of constant comparison was adopted throughout the framework analysis (Pope and Mays, 1995; Pope *et al.*, 2000; Gale *et al.*, 2013). This involved the constant reading and re-reading of the interview transcripts in order to attempt to really understand and become familiar with the data and concepts that were expressed. Interview transcripts were compared with each other to establish analytical categories and allow identification of similarities or differences of opinions. It was an inclusive process and thus, views which differed from the majority were coded and included in the thematic framework (Pope *et al.,* 2000). Additionally, field notes were kept which allowed a discussion about emerging themes with the PhD supervisors.

## 5.12 Confidentiality and Data Protection

In the interests of patient confidentiality, all personally identifiable information collected during the course of the research was protected according to the Data Protection Act 1998. All electronic consent forms, questionnaires and interview recordings were stored on password-protected, encrypted media that only the lead researcher (JT) had access to. Hardcopies of this documentation were kept secure in a locked cupboard that only the lead researcher (JT) had access to. All information was stored, analysed and published using participant numbers instead of names, and only the author knew the identity of the individuals. Interviews were done over the telephone but it was made sure they were done in a private office with only the lead researcher (JT) present. Care was taken to ensure that information has not been included in any reports, publications or this thesis which could result in identification of individuals. All participants were informed in the Participant Information Sheet before giving their consent that these measures would be adhered to. At the end of the study all data and documents containing personally identifiable information were destroyed and made irretrievable.

## 5.13 Chapter Summary

This chapter outlined the methods used in this study. The overall aim of the study was to evaluate the effectiveness of VPs at supporting pre-registration training when compared to a non-interactive learning tool. This was achieved by using both quantitative and qualitative data collection and analysis methods. Purposive sampling methods were used to identify and recruit pre-registration trainees to the research.

The virtual patient technology itself has been explained, including the role of the research team and animation team in the design process. The specific avatar and non-interactive case study topics were emergency hormonal contraception, renal function and childhood illness; each of these has been discussed in detail, including the reasoning for choosing these topics.

The data collection procedures have been discussed in relation to the different kinds of data obtained from this research. Quantitative data was obtained from the pre- and post-MCQs and the Likert scale on the questionnaire. Qualitative data was obtained from the open-ended questions on the questionnaire and the telephone interviews. The use of both quantitative and qualitative methods of data analysis have also been discussed with particular reference to the use of parametric tests, content analysis and framework analysis. The mixed methods used in this research allowed for both the effectiveness of the VP and NI case studies as learning tools to be assessed and further exploration of pre-registration trainee's perspectives on the tools themselves.

The study components were evaluated in a feasibility pilot study, which will be presented and discussed in Chapter 6.

# 6. Pilot Research

## 6.1 Introduction

This chapter describes the pilot study that was undertaken to refine the methodology, methods and data collection instruments.

This chapter begins with the aims and objectives of the pilot study (section 6.2). The study design is then described in section 6.3 and the ethical approval procedures in section 6.4. The sampling approach and recruitment of participants are discussed in section 6.5 before explaining the data collection (section 6.6) and data analysis (section 6.7) procedures. The key findings are presented in section 6.8 and discussed in section 6.9. The chapter ends with a summary of the key points in section 6.10.

## 6.2 Aim and Objectives

The overall aim of a pilot study is to obtain data to learn about the research process, questions, techniques and yourself as the researcher (Glesne, 2011). As discussed in Chapter 4 (section 4.6), validity and reliability are important methodological considerations and a pilot study can enhance the validity and reliability of a research study by allowing for multiple aspects of the proposed research process to be tested and the research statement and questions to be clarified if necessary (Glesne 2011).

The aim of this pilot study was to evaluate one virtual patient case study, one non-interactive case study, their associated multiple-choice questions and the evaluative questionnaire which were created for use in the main study.

The objectives of the pilot study were to:

1. Review the design of the VP case study, including ease of use and accessibility
2. Review the wording of the NI case study, the MCQs and questionnaire for their difficulty level (appropriate for pre-registration trainees), ambiguity and relevance
3. Test whether the questionnaire allowed for user's thoughts on the VP technology to be collected and compared with thoughts on the NI learning tool
4. Identify any improvements which may increase the usability of the learning tools in the main study

## 6.3 Study Design

An exploratory study was conducted, which utilised a questionnaire to collect quantitative and qualitative data. Previous pilot studies evaluating simulation tools have used similar exploratory designs which provided the researchers with an opportunity to test the components for their research (i.e. their usability) and also to determine whether users' thoughts on the learning tools could be successfully collected by the questionnaire (Kurtz et al. 2007; Zary et al. 2006; Forsberg et al. 2011; Lin et al. 2013; Yang et al. 2013).

In this pilot study, participants were asked to work through a VP case study on the knowledge and law of supplying emergency hormonal contraception (EHC) and a NI case study to calculate an infusion rate. The case study topics were chosen by the research team and the cases were written and developed by the research and animation teams at Keele University, School of Pharmacy. The justification for the EHC case study was provided in Chapter 5 (section 5.8.1) and related to pharmacists' variation in knowledge of EHC. The justification for the inclusion of a calculations-based case study was provided in Chapter 5 (section 5.8.2), although this related to the renal function case study, the research regarding pharmacy students' calculations skills remained the prominent reason.

Both case studies included MCQs for participants to complete which were being evaluated for the appropriateness of their wording and difficulty for pre-registration trainees. A questionnaire consisting of Likert scale ranking statements and a series of open-ended questions was provided for participants to complete after each case study. This would allow the research team to determine if the questionnaire was suitable to collect and compare user's thoughts on the two learning tools (as discussed in Chapter 5). The questionnaire was also reviewed for wording, ambiguity and relevance of questions by use of an evaluative survey (Appendix 27).

## 6.4 Ethical Approval

An application to conduct the pilot research was submitted to the Keele University Ethical Review Panel in December 2013; approval for this was granted in February 2014 (Ref: ERP1178) (Appendix 28).

The application was accompanied by the invitation letter (Appendix 29) participant information sheet (Appendix 30), consent form (Appendix 31), the multiple-choice questions (Appendix 26), questionnaire and evaluative survey (Appendix 27).

## 6.5 Sampling and Recruitment

A small purposive sample was used to test and refine the proposed methods for the main study. Purposive sampling was used because the pilot study did not require generalisable data, it was simply to determine if any changes needed to be made to the research components (Henry, 1990). Purposive sampling was used to recruit pre-registration trainees and newly qualified pharmacists (NQPs) to this pilot study. The main study was evaluating VPs with pre-registration trainees, thus pre-registration trainees were recruited for the pilot study; to determine if the case studies and data

collection tools were appropriate for their level of training. NQPs were also invited to participate as they would be in the early stages of their career, having just finished pre-registration training, and thus may provide helpful comments regarding the case studies or data collection tools.

Overall 30 pre-registration trainees and NQPs who were Keele alumni (n=10) and members of the British Pharmaceutical Students' Association (BPSA) (n=20) were invited to participate over social media (Appendix 32). Social media was used to recruit participants because it provided high accessibility for the purposive sample. A representative sample of all pre-registration trainees or first year qualified pharmacists in the UK was not required and social media provided access to a variety of participants for a pilot study. When invited to take part, participants were presented with a copy of the participant information sheet. Those who decided to participate were provided with a Google Drive link to the electronic consent form. Individuals were unable to participate in the pilot study if they did not provide their consent by electronically signing and dating the consent form. Participants were then provided with a participant number to uphold anonymity. All the study components were linked together via Google Drive as this method was proposed for the main study, thus the pilot study provided an opportunity to test this.

## 6.6 Data Collection

The questionnaire which was created for use in the main study, was provided for participants to complete after each case study. Questions on both questionnaires (for the VP case study and NI case study) were the same to determine the appropriateness of use for both groups in the main study and whether views on the two learning tools could be collected. The design of the questionnaire has been discussed previously in Chapter 5 (section 5.10.2). The questionnaires consisted of 20 Likert ranking scale statements (5 = strongly agree, 1 = strongly disagree) and open-ended questions to explore participant thoughts on likes, dislikes and improvements for the case studies and VP technology.

A separate evaluative survey was created for this pilot study. This survey consisted of closed and open-ended questions to collect data on the wording, ambiguity and relevance of questions on the questionnaire and MCQs.

## 6.7 Data Analysis

Descriptive statistical analysis was carried out on the scores from the Likert ranking scale to determine whether the questionnaire was an appropriate tool to identify differences in thoughts between the learning tools. The number of participants agreeing with each statement and frequency distributions of the spread of data on the Likert ranking scales for each case study was determined.

Qualitative data obtained from the questionnaires and evaluative survey were analysed via content analysis (Chapter 5, section 5.11.2). Comments from the questionnaires and survey were coded into themes before being counted to determine the frequency of responses for each theme. The small sample size in this pilot study and the use of questionnaires rather than more exploratory interviews, led to the decision that content analysis would be the most appropriate analytical technique (Wilkinson, 2000; Hsieh and Shannon, 2005).

## 6.8 Key Findings

### 6.8.1 Demographic Results

Table 6-1 provides demographic data of the participants involved in the pilot study. Ten participants consented to take part in the pilot study; four pre-registration trainees and six first year qualified pharmacists. An equal number of participants came from hospital and community.

| Demographic Information | | Number of participants (%) |
|---|---|---|
| **Gender** | Female | 7 (70%) |
| | Male | 3 (30%) |
| **Age** | 20-25 | 100% |
| **Ethnicity** | White | 7 (70%) |
| | Indian | 1 (10%) |
| | Chinese | 2 (20%) |
| **Level of Training** | Pre-registration Trainee | 4 (40%) |
| | Newly Qualified Pharmacist | 6 (60%) |
| **Sector of work** | Community | 5 (50%) |
| | Hospital | 5 (50%) |
| **Previous VP Experience** | Yes | 4 (40%) |
| | No | 6 (60%) |

**Table 6-1 Illustrates the demographic details of the participants in the pilot study.**

### 6.8.2 Internal consistency

As explained previously in Chapter 5 (section 5.10.2), Cronbach's α was used to measure the internal consistency of the questionnaire.

An overall Cronbach α score of 0.95 was obtained for the VP survey and 0.87 for the NI survey from the pilot study sample. This led to an average Cronbach α score of: 0.91 which demonstrated good reliability of the survey; as the closer the coefficient is to 1 the greater the internal consistency of the items in the scale (Gliem and Gliem, 2003). Resulting from the high level of internal consistency, the questionnaire was used with no changes in the main study.

### 6.8.3 Quantitative Results

The Likert statements were ranked as strongly agree (5) to strongly disagree (1).

The statements from the Likert ranking scales, and their descriptions are provided in Table 6-2.

| Statement (S) Number | Statement description |
|---|---|
| 1 | The simulations provided a realistic patient simulation |
| 2 | When completing the simulations I felt as if I were the pharmacist caring for this patient |
| 3 | When completing the simulations I felt I had to make the same decisions as a pharmacist would in real life |
| 4 | The simulations were interesting |
| 5 | The simulations were enjoyable |
| 6 | The difficulty of the simulations were appropriate for my level of training |
| 7 | The feedback I received was adequate for my needs |
| 8 | The objectives for the simulations were clear and easy to understand |
| 9 | I was able to access the simulations at my convenience |
| 10 | The simulations helped develop my clinical reasoning skills |
| 11 | The simulations helped develop my problem-solving and decision-making skills |
| 12 | The simulations have helped me to put theory into practice |
| 13 | I am confident I am developing skills from the simulations that will be required in practice |
| 14 | I am confident I am gaining knowledge from the simulations that will be required in practice |
| 15 | It is my responsibility to learn what I need to know from the simulations |
| 16 | Completing the simulations has improved my confidence for the pre-registration exam |
| 17 | I feel better prepared to care for real-life patients |
| 18 | I feel more confident about collaborating with patients and other healthcare professionals |
| 19 | The simulations have increased my confidence about practicing as a pharmacist |
| 20 | Overall, the experience has enhanced my learning |

**Table 6-2 The statements included on the Likert scale.**

Figure 6-1 (page 167) illustrates the percentage distribution of agreement for each of the statements on the Likert ranking scale for the VP case. When using the VP case, the majority of participants ranked themselves as either 5 or 4 on the scale for all statements (strongly agree, agree). Fewer participants ranked themselves as 'undecided' and only on five occasions did participants 'disagree' with a statement. No participants ranked themselves as a 1 ('strongly disagree') for any statement.

Figure 6-2 (page 168) illustrates the percentage distribution of agreement for statements on the Likert ranking scale for the NI case. When completing the survey for the NI case study, participants also ranked themselves as 5 or 4 on the scale (strongly agree and agree) for the majority of the

statements. Few participants felt they were 'undecided' with any statements and there were seven responses overall disagreeing with the statements. Again, as with the VP case, there were no participants who 'strongly disagreed' with any of the statements.

The median agreement of each statement on the Likert ranking scales was calculated for the VP and NI cases to identify the measure of central tendency (Figure 6-3) (page 169). Figure 6-3 illustrates that median agreement was higher for ten statements on the Likert scale regarding the VP case compared to the NI case. These included: realistic patient experience (4.5 vs 4.0), interesting (4.5 vs 4.0), enjoyable (4.5 vs 4.0), feeling like a pharmacist caring for a patient (5.0 vs 4.0), making the same decisions as a pharmacist does in real life (4.5 vs 4.0), adequate feedback (5.0 vs 4.0), being able to access the simulations at their convenience (5.0 vs 4.0), developing clinical reasoning skills (4.5 vs 4.0), putting theory into practice (4.5 vs 4.0) and increasing confidence at collaborating with patients and other healthcare professionals (HCPs) (4.0 vs 3.5). Four statements had higher median agreement for the NI case: appropriate difficulty (5.0 vs 4.0), developing skills that will be required in practice (5.0 vs 4.0), gaining knowledge that will be required in practice (5.0 vs 4.5) and improving confidence for the pre-registration exam (5.0 vs 4.0). For six of the statements, the median agreement was the same for the VP case study and the NI case study: having clear objectives (4.0), developing problem-solving skills (4.0), user's responsibility to learn what they need to (5.0) feeling better prepared for caring for patients in real life (4.0) increasing confidence about practicing as a pharmacist (4.0) and overall enhancement of learning (4.5).

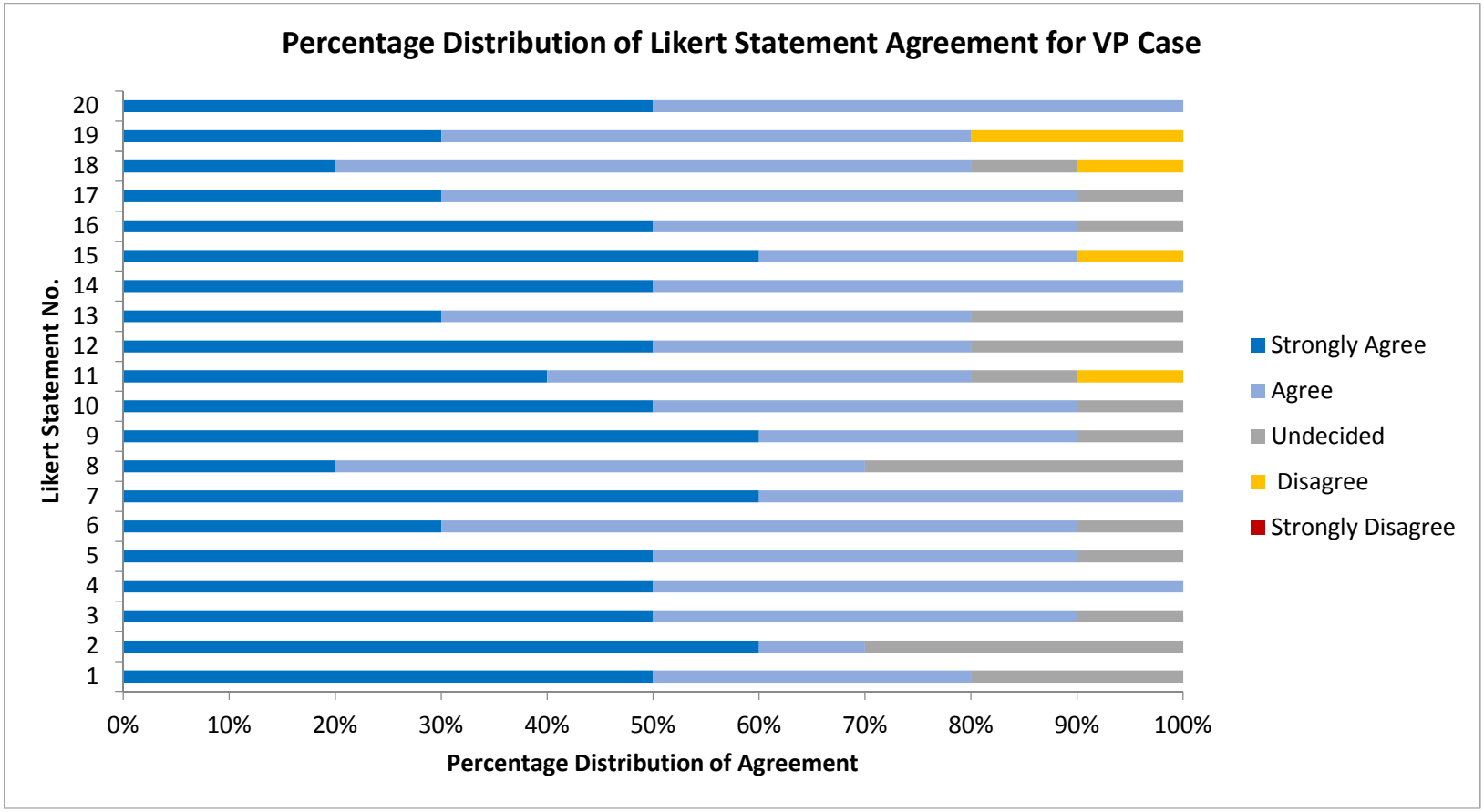



**Figure 6-1 Illustrates the percentage of participants (n=10) in each agreement category for the Likert Ranking Statements for the VP case.**

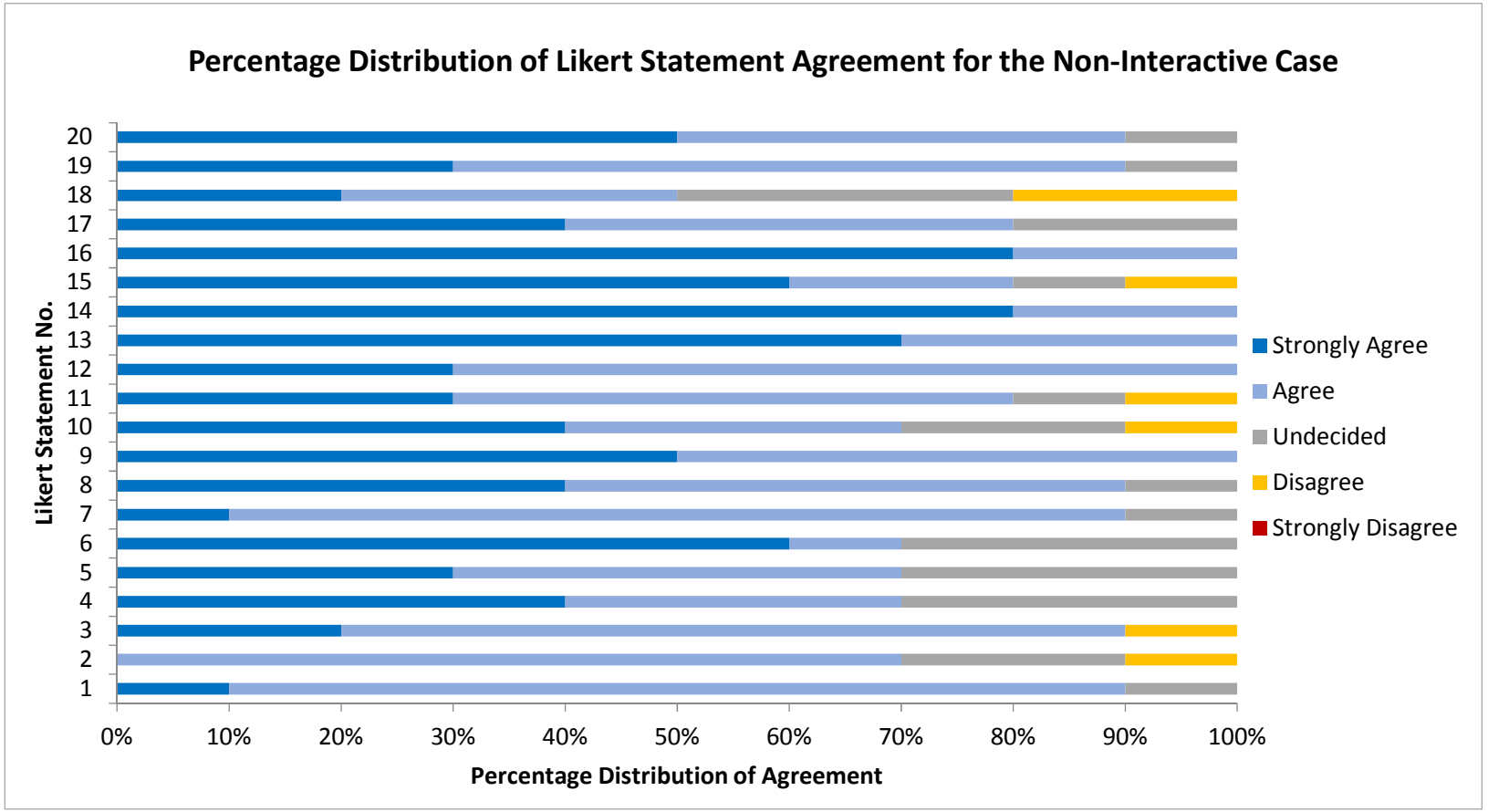



**Figure 6-2 Illustrates the percentage of participants (n=10) in each agreement category for the Likert Ranking Statements for the NI case.**

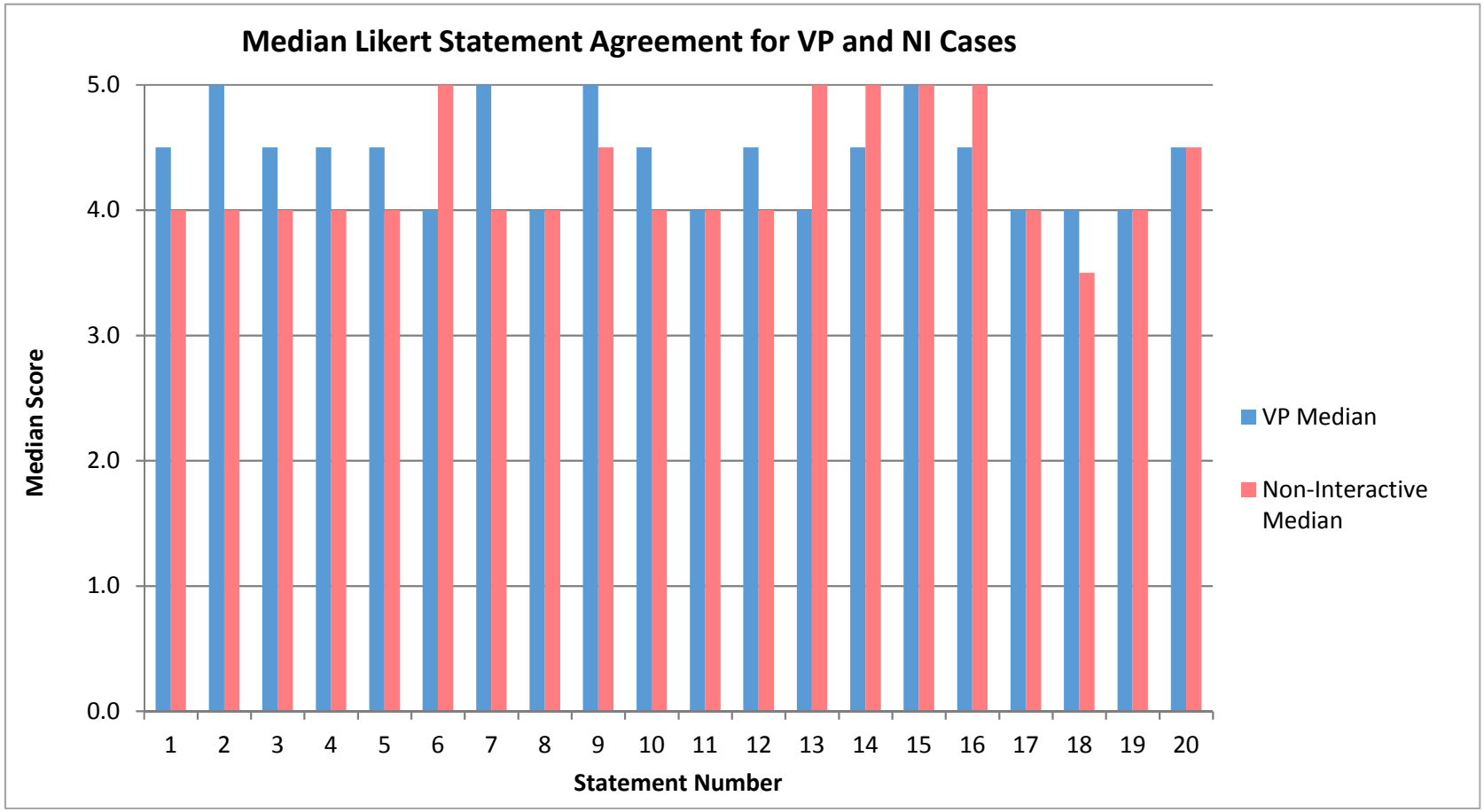



**Figure 6-3 Representation of the median agreement for each statement on the Likert Ranking Scales for both the VP and the NI case. The scale was ranked 5 (strongly agree) to 1 (strongly disagree), therefore the higher the median score, the greater the agreement.**

Further review of the data identified differences in reported agreement between pre-registration trainees and NQPs. Both pre-registration trainees and NQPs reported that the VP case was more realistic (4.5 vs 4.0) and enjoyable (pre-reg 4.5 vs 3.5, NQP 4.5 vs 4) than the NI case study. Both sets of participants also reported that they felt more like the pharmacist caring for the patient in the VP case study (pre-reg 5.0 vs 4, NQP 4.5 vs 3.5) and that they were making the same decisions as they would need to in real life (pre-reg 4.5 vs 4, NQP 4.5 vs 4.0). Pre-registration trainees and NQPs also both reported that the feedback provided from the VP case study was better than the feedback provided at the end of the NI case (pre-reg 4.5 vs 4, NQP 5.0 vs 4.0). Both sets of participants reported that they felt more confident about collaborating with patients and other healthcare professionals after completing the VP simulation than the NI case study (4.0 vs 3.5).

Pre-registration trainees reported that the VP simulation was more interesting (4.5 vs 3.5) whereas NQPs reported both styles of case study to be equally interesting (4.5). Pre-registration trainees perceived the VP case study as easier to access than the NI case study (4.5 vs 4.0) whereas NQPs reported no difference between the two cases and strongly agreed they could access both at their convenience. Pre-registration trainees reported that the VP was better at helping them develop clinical reasoning skills (5.0 vs 4.0) and putting theory into practice (5 vs 4) whereas NQPs reported no difference between the learning tools for these statements (4). Overall, pre-registration trainees perceived the VP case study to enhance their learning to a greater extent (4.5 vs 4.0) whereas NQPs reported that the NI case study enhanced their learning to a greater extent (5 vs 4.5).

Both sets of participants reported that the NI case study was of more appropriate difficulty (pre-reg 4.5 vs 4, NQP 5 vs 4) and the associated objectives were easier to understand (pre-reg 4.5 vs 4, NQP 4 vs 3.5). Pre-registration trainees reported the NI case study improved their confidence for the pre-registration exam to a greater extent than the VP case study (4.5 vs 4.0) and made them feel better prepared to care for real-life patients (4.5 vs 4.0) whereas NQPs reported no differences between the

learning tools (confidence for the exam 5, confidence to care for patients 4). NQPs reported that the NI case study allowed a greater development of skills (5.0 vs 4.5) and knowledge (5.0 vs 4.5) for practice whereas pre-registration trainees reported no difference between the learning tools in these developments (4.5).

The remaining three statements had no differences reported between the learning tools by pre-registration trainees or NQPs. Both sets of participants believed the two case studies aided their development of problem-solving and decision-making skills (pre-reg 4.5, NQP, 4), increased their confidence about practicing as a pharmacist (pre-reg 4.5, NQP 4) and they identified that it was their responsibility to learn what they needed to (pre-reg 4.5, NQP, 5). Despite the differences between the pre-registration trainees and NQP's, median agreement for all statements on both cases was in the 'strongly agree', 'agree' or 'undecided' categories.

### 6.8.4 Qualitative Results

Content analysis of the open-ended questions on the questionnaire led to the identification of four key topics with a series of themes within them:

- Use of the case studies as learning tools, which included comments relating to the design and usability of VP and NI case studies
- Utilisation of the case studies in the pre-registration training year, which included comments regarding where users felt the case studies would be most beneficial in the training year
- Limitations of the case studies
- Suggestions for improvements of the case studies

As the comments relating to the two learning tools were so diverse from one another, these are presented in Table 6-3 (VP case study) and Table 6-4 (NI case study). The tables display the themes

derived from the comments, the number of times they were present across the comments (pre-registration and NQP's split) and an example quote relating to each theme.

| Theme | Number of participants expressing theme | | Quote |
|---|---|---|---|
| | Pre-registration Trainees | NQPs | |
| Use of the case studies as learning tools | | | |
| Novelty | 2 | 3 | *"…different to any other learning format previously experienced by myself."* P1, NQP |
| Realism | 3 | 4 | *"I liked that there was a selection of answers to reply to the patient, more than just a 'yes' and 'no' … I feel this is how I would communicate with a patient politely, and it made the experience a lot more realistic."* P4, Pre-reg |
| Experiential Learning | 4 | 4 | *"'It helps put learned knowledge into practice… in a safe and non-pressured environment." P2, Pre-reg* |
| Feedback | 4 | 2 | *"I especially liked the breakdown of what was 'good' and what I 'should have done' at the end of the scenario."* P8, Pre-reg |
| Utilisation of the case studies in the pre-registration training year | | | |
| Revision Aid | 2 | 4 | *"…useful for pre-registration students to have access to such case studies at home to be used as a revision aid."* P1, NQP |
| Group Learning | 3 | 1 | *"…pre-regs could discuss the case between themselves to share learning …. after a regional day covering EHC for NHS pre-regs…"* P5, NQP |
| OSCE Station | 1 | 2 | *"This case study would fit well in an OSCE scenario...more realistic than a written station and you wouldn't need to bring in an SP!"* P7, NQP |
| Limitations of the case studies | | | |
| Free-Text section was confusing | 4 | 5 | *"At the end of the case study where I had to ask questions. I didn't realise that this section could also be used to counsel and give advice to the patient. I felt this wasn't made clear."* P3, NQP |
| Recognition problems | 2 | 4 | *"It was difficult to enter information as the programme often didn't recognise these. It became frustrating thinking how to reword things to make the programme recognise them."* P5, NQP |

| Suggestions for improvements of the case studies | | | |
|---|---|---|---|
| Example VP Case | 2 | 1 | *"…an example of how to use the free-text section."* P8, pre-reg |
| 'Help' Button | 2 | 3 | "*The main improvement I would suggest is to have help … someone to help with the technical issues and guide the individual using it."* P2, pre-reg |
| Key Points | 1 | 3 | *"Following the pre-test it might be useful to have a fact sheet highlighting key points to provide some background information before commencing the case study."* P6, NQP |
| Increase the question bank | 2 | 5 | *"Have a bigger question bank so the simulation can recognise what you are asking and make it easier to progress through the case."* P9, Pre-reg |

**Table 6-3 Displays the themes, number of times commented upon and an example for the open-ended questions relating to the VP case study.**

| Theme | Number of participants expressing theme | | Quote |
|---|---|---|---|
| | Pre-registration Trainees | NQPs | |
| Use of the case studies as learning tools | | | |
| Easy to complete | 3 | 3 | *"Set out clearly and easy to follow."* P1, NQP |
| Calculation practice | 4 | 4 | *"I liked that the calculations were real life, and were questions that are used in practice."* P2, Pre-reg |
| Utilisation of the case studies in the pre-registration training year | | | |
| Revision Aid | 3 | 2 | *"Easy to do at home and it was good to practice calculations because they are so important for us…"* P8, Pre-reg |
| Group Learning | 2 | 3 | *"These types of cases could be done as a seminar every week…you could cover lots of things and get trainees to feed back to each other."* P5, NQP |
| Limitations of the case studies | | | |
| Quiz questions too indirectly related | 2 | 4 | *"Objectives relating to the treatment of an MI were not addressed by the case study … if this is the case, need to provide extra resources or signposting."* P10, NQP |
| Not engaging | 4 | 5 | *"The case study could have been presented in a more interesting way."* P9, Pre-reg |
| Suggestions for improvements of the case studies | | | |
| Key Points | 1 | 2 | *"Information to be provided for the other objectives … so equipped with the knowledge needed to answer the post-case quiz."* P10, NQP |

**Table 6-4 Displays the themes, number of times commented upon and an example for the open-ended questions relating to the NI case study.**

## 6.9 Evaluative Survey

From evaluating the wording of the MCQs and questionnaire it was found that 100% of participants thought the multiple-choice questions were of suitable difficulty and 80% thought they would be able to assess knowledge improvement. All participants thought the questions and Likert statements were clearly written and were not ambiguous.

The main comments received regarding the MCQs related to the lack of answers provided:

> *"No marks were given for the pre- and post- quizzes and so it wasn't obvious as to whether your knowledge had improved following completion of the case study."* P1, NQP

This is something which will be considered before the main study.

## 6.10 Chapter Discussion

As previously stated, the aim of the pilot study was not to asses any knowledge improvement of participants from completing the case studies. It was to test whether the case studies and MCQs were of an appropriate level for pre-registration trainees, determine if the questionnaires were appropriate to evaluate the learning tools and identify any changes or improvements to the study components before the main study. The objectives set out in section 6.2 were successfully met through this pilot study. The design of the VP itself was reviewed and comments were received regarding improvements for the ease of use of the technology. The wording of the NI case study, MCQs and questionnaire were reviewed using the evaluative survey, with no changes required for the main study, and the questionnaires themselves were reliable (good Cronbach α scores) and able to collect and compare thoughts on the two learning tools.

The demographics of participants illustrated an equal number of participants from the hospital and community sectors which lent itself well to the different (clinical vs non-clinical) case studies that

were created. Four participants reported previous VP experience, whereas six participants reported no previous VP experience. This may have resulted from a number of the participants being Keele University alumni and thus they may have used the VP technology in their undergraduate education. However, results from the pilot study were not designed to be generalisable to a wider population and this previous VP experience was accounted for in the analysis.

The quantitative results obtained from this pilot study identified differences in perspectives between the VP case and the NI case, and differences in perspectives between pre-registration trainees and NQPs. Median scores on the Likert ranking scales indicated that both the pre-registration trainees and NQPs believed the VP case gave a more realistic patient experience. This may be due to the interactivity of the system and the ability of the VP to respond to individual user inputs; which was expressed by participants on the open-ended questions. The median scores also indicated that the VP case was more interesting and enjoyable than the NI case, with pre-registration trainees reporting stronger agreement than NQPs. This, again, could result from the interactivity of the system but may also be attributed to the novelty of the learning tool. A greater number of the NQPs were from Keele University which may imply previous use of VP technology and explain the reduced interest. However, the comments received on the questionnaire regarding the different topics chosen for the two case studies may be more likely to account for these differences, as NQPs reported that calculations were of particular importance for pre-registration trainees.

There was little difference in median agreement scores regarding the development of skills and knowledge for the two learning tools; although NQP's reported the NI case study was more effective at this. This, again, may have been as a result of the different case study topics. Many of the NQP's worked primarily in the hospital sector and they may have felt this case study was more appropriate for their area of work. Additionally, the integration of calculations into the NI case study (and not into the VP case study) may have led to the increased agreement scores from NQPs as they may

understand to a greater extent the importance of effective calculation skills in practice. It is likely that pre-registration trainees had lower levels of knowledge and skills related to both of the case study topics (than NQPs) which may explain their increased development from both case studies without assuming greater importance of one over the other.

When looking at specific skills, there appeared to be no difference between the two case studies in aiding development of problem-solving or decision-making skills, but differences between the learning tools were found for the development of clinical reasoning skills. Pre-registration trainees reported that the VP case study was better at improving their clinical reasoning skills than the NI case study, but no difference between the two was found for the NQPs. Pre-registration trainees also reported that the VP allowed them to put theory into practice to a greater extent than NQPs. These differences could be attributed to the level of training. Qualified pharmacists will probably have more experience, may have carried out both EHC consultations and infusion rate calculations in real life and thus may feel their skills to be at a high level already. Whereas pre-registration trainees are only able to observe consultations and should not make patient-care related decisions (such as EHC supply or infusion rate calculations). Additionally, VPs have been shown to provide experiential learning which may have promoted a greater development of clinical reasoning skills than was able from the NI case study (Ker and Bradley, 2010; Hussainy *et al.*, 2012; Foronda, Godsall, *et al.*, 2013).

The final statement on the Likert scale was a measure of agreement on user's overall enhancement of learning from completing the two case studies. The overall median score illustrated no difference between the learning tools, however upon further inspection it was identified that pre-registration trainees reported that the VP case study enhanced their learning to a greater extent whereas NQPs reported that the NI case study did. The differences in agreement for this statement may also be due to the case study topics chosen. Although the NI case study was focused around calculations, an essential component of the pre-registration exam, pre-registration trainees may have felt simulating

an EHC consultation to be of greater value. There are many different learning tools available which can be used to practice calculations, whereas an EHC simulation may provide a unique opportunity to practice conducting a consultation before qualification.

Differences relating to the quality of feedback provided by the cases was also identified. Previous literature has established that immediate and adequate feedback is a large factor in the utility of educational applications (Ende, 1983; Issenberg *et al.*, 2005; Jungnickel *et al.*, 2009; Botezatu, Hult and Fors, 2010). Feedback provided by the VP was interactive and more individualised than that from the NI case; due to the VP mapping progress through the decision tree and providing feedback specific to user inputs. Whereas the NI case feedback consisted of 'textbook' answers, explanations and signposting to useful resources. Both pre-registration trainees and NQPs agreed that the feedback from the VP case was more useful; NQPs reported greater agreement which may be due to the training requirements once qualified. Pre-registration trainees have a designated pre-registration tutor to support them throughout the year and they will be more likely to receive feedback for the activities which they undertake throughout the year. However, once qualified, learning is more of an independent activity, and receiving immediate, individualised feedback may have been especially beneficial to the NQPs.

The open-ended questions identified a number of limitations of the VP case. The first was related to the recognition of the VP system. The VP was pre-populated with specific questions and keywords related to the case study, however it was hard to estimate all ways in which a question may be asked or advice may be given and it was therefore difficult to pre-populate the system fully. The software does have the ability to 'learn' and be manually updated based on user inputs, thus the more the simulation is the completed, the fuller the question bank will become. As such, this problem was expected to lessen with greater usage in the main study as the question bank was enhanced.

A second limitation of the VP case was difficulty with understanding how to complete the simulation. Both pre-registration trainees and NQPs reported that the objectives of the VP case were harder to understand than those of the NI case due to insufficient instructions. As a result, instructions at the beginning of the case were made more explanatory, a web-link to a demonstration of the technology was added and an explanation of how to use and complete the free-text part of the simulation was included. A 'frequently asked questions' section was also included with a 'help' email address to encourage users to contact the lead researcher (JT) with any technical problems.

The case study MCQs were reported to be of suitable difficulty for the level of pre-registration training. They were also reported to be written unambiguously, therefore the wording of the questions was not changed for the main study. Comments were received regarding the answers to the questions not being provided, therefore the answers with explanations (where required) and signposting to other resources was subsequently added to the post-MCQs so users were able to understand how well they performed and what resources may further aid their learning.

## 6.11 Chapter Summary

This pilot study evaluated the research components which identified suggestions for improvements before use in the main study. These were implemented and can be found in Table 6-5.

| Suggestion | Changes made to VP case for main study |
|---|---|
| Increase the size of the question bank | User inputs which did not receive a VP response in the pilot study were matched to an appropriate VP response by the lead researcher (JT) and animation team. |
| More explanatory instructions | A pop-up screen was created and would be displayed to users when they loaded the VP case. This included:<br>• clearer learning objectives for each case study<br>• instructions on how to complete the case study (i.e. MCQs, free-text input)<br>• information on any additional elements in the case study (i.e. Consultation Record Form in the EHC simulation to guide questioning)<br>• resources to use whilst completing the case study |
| Demonstration of VP technology | A link was provided to a 'Virtual Patient Demonstration' video. |
| Inclusion of a 'Help' button | A list of frequently asked questions (FAQ's) was included in the VP case study which included answers to common questions (i.e. saving progress in VP case, computer crashing). Within the FAQ's a help email address was provided for users to get technical help. |

**Table 6-5 List of changes made to the VP case study before use in the main study based on suggestions from the pilot study.**

The different topics chosen for the VP and NI case studies may have impacted on participants' thoughts, thus, to make responses more comparable, the same case study topics were decided to be used for the VP and NI cases in the main study. This would ensure individuals were asked to work through three case studies which differed only in their presentation (i.e. VP or NI).

The results from the main study will be presented and discussed in the next three chapters (Chapters 7, 8 and 9).

# 7. Quasi-Experimental Results

## 7.1 Introduction

One of the study objectives was to determine if use of either learning tool improved knowledge (Chapter 5, section 5.2). To achieve this, participants were asked to complete a set of pre- and post-MCQs for each case study. It was hypothesised that pre-registration trainees in the VP group would show a greater improvement in knowledge than those in the NI group. This chapter presents the quantitative results from each case study and their statistical analyses.

Section 7.2 reports the response rates for each stage of the study. Participant demographics are presented in section 7.3. The quantitative results for case study one, two and three are reported in sections 7.4, 7.5 and 7.6, respectively. Section 7.7 illustrates the pre-registration examination pass rates and their relation to the participants in this study. Key points are discussed in section 7.8 and then summarised in section 7.9.

## 7.2 Response Rates

The quasi-experimental evaluation took place over a three month period; three case studies were created and distributed to participants one month at a time. Response rates (RRs) were calculated to compare any differences between the intervention and control group (see Table 7-1).

| | No. of participants (% RR) | | |
|---|---|---|---|
| | **VP Group** | **NI Group** | **Overall** |
| **Consented** | 83 | 82 | 165 |
| **Case 1 Completion** | 60 (72% RR) | 66 (80% RR) | 126 (76% RR) |
| **Case 2 Completion** | 42 (51% RR) | 47 (57% RR) | 89 (54% RR) |
| **Case 3 Completion** | 27 (33% RR) | 36 (44% RR) | 63 (38% RR) |
| **Questionnaire Completion** | 24 (29% RR) | 32 (39% RR) | 56 (34% RR) |

**Table 7-1 Illustrates the overall response rates for each part of the study as well as the response rates for the VP and NI groups individually.**

A steady decline in the response rate for each case was observed; similar declines in RR were found for both groups. The NI group showed higher completion rates throughout the study with 44% of trainees completing all of three case studies compared to 33% in the VP group. The overall response rate for the questionnaire was 34% but, as only those individuals who completed the third case study were invited to complete the questionnaire, an actual response rate of 89% was obtained.

## 7.3 Participant Demographics

Demographics of the participants who consented to participate were obtained prior to commencement of the research study and are summarised in Table 7-2 below.

Table 7-2 illustrates that the majority of participants were female (71.5%) and in their early twenties, (mean age of 23). Participants were from a range of ethnic backgrounds but the most common were White British (43%) and Asian Indian (14%). Participants had studied their MPharm degree at one of the 26 UK-based Universities accredited by the GPhC to offer an MPharm degree. A further three Universities have since been accredited by the GPhC, but they had no graduates at the time of the research and thus there are no participants from these Schools of Pharmacy. The majority

of participants (69%) reported no previous VP experience. More than half of the participants (56.4%) were undertaking their training in community pharmacy. Three pre-registration trainees reported themselves as training in more than one sector; two participants were completing community:hospital split training and one participant was completing industry:hospital split training.

| | | N (%) | | | N (%) |
|---|---|---|---|---|---|
| **Gender** | Female | 118 (71.5%) | **School of Pharmacy** | Aston | 13 (7.9%) |
| | Male | 47 (28.5%) | | Bath | 11 (6.7%) |
| | | | | Bradford | 4 (2.4%) |
| **Age** | 20-25 | 145 (87.9%) | | Brighton | 3 (1.8%) |
| | 26-30 | 17 (10.3%) | | Cardiff | 4 (2.4%) |
| | 31-35 | 0 | | De Montfort | 4 (2.4%) |
| | >36 | 3 (1.8%) | | Hertfordshire | 1 (0.6%) |
| | | | | Huddersfield | 5 (3%) |
| **Ethnicity** | White British | 71 (43%) | | Keele | 22 (13.3%) |
| | White Scottish | 13 (7.9%) | | King's College London | 3 (1.8%) |
| | White Irish | 5 (3%) | | Kingston | 4 (2.4%) |
| | White Other | 3 (1.8%) | | Liverpool John Moores | 5 (3%) |
| | Black British | 1 (0.6%) | | Manchester | 4 (2.4%) |
| | Black Caribbean | 1 (0.6%) | | Medway | 2 (1.2%) |
| | Black African | 2 (1.2%) | | Nottingham | 10 (6.1%) |
| | Asian British | 8 (4.8%) | | Portsmouth | 10 (6.1%) |
| | Asian Indian | 23 (13.9%) | | Queens University | 3 (1.8%) |
| | Asian Pakistani | 14 (8.5%) | | Reading | 4 (2.4%) |
| | Asian Other | 1 (0.6%) | | Robert Gordon | 16 (9.7%) |
| | Asian Other | 1 (0.6%) | | Strathclyde | 14 (8.5) |
| | Chinese | 12 (7.3%) | | Sunderland | 6 (3.6%) |
| | Other | 10 (6.1%) | | UCLAN | 4 (2.4%) |
| | | | | UEA | 8 (4.8%) |
| **Previous VP Use** | Yes | 51 (30.9%) | | Ulster | 1 (0.6%) |
| | No | 114 (69.1%) | | UCL | 1 (0.6%) |
| | | | | Wolverhampton | 3 (1.8%) |
| **Sector of Training** | Community | 93 (56.4%) | | | |
| | Hospital | 69 (41.8%) | | | |
| | Split | 3 (1.8%) | | | |

**Table 7-2 Displays the demographics of pre-registration trainees who consented for the research study (total no. 165).**

## 7.4 Case Study One Results

### 7.4.1 Descriptive Statistics

Knowledge scores from the pre- and post-MCQs for case study one (EHC) were measured for the VP and NI groups and are presented in Table 7-3. Pre-registration trainees in the VP group had slightly lower mean baseline knowledge scores of EHC compared with the NI group (10.1 vs 10.2), and their knowledge improved a greater amount on the post-MCQs (11.6 vs 11.5). The range of knowledge scores varied dramatically, with participants in the VP group answering a maximum of 18 questions correctly and a minimum of 5 questions correctly, compared with a maximum of 18 and a minimum of 7 in the NI group. The median and mode scores for both groups were 10 on the pre-MCQs and 12 on the post-MCQs indicating no difference between the groups in the most common number of questions being answered correctly by trainees.

| | | No. of Correct Questions | | | |
|---|---|---|---|---|---|
| | | **Mean (SD)** | **Median** | **Mode** | **Range** |
| **VP Group** | **Pre-MCQs** | 10.1 (2.35) | 10 | 10 | 5-15 |
| | **Post- MCQs** | 11.6 (2.25) | 12 | 12 | 5-17 |
| **NI Group** | **Pre- MCQs** | 10.2 (2.42) | 10 | 10 | 5-15 |
| | **Post- MCQs** | 11.5 (2.25) | 12 | 12 | 7-18 |

**Table 7-3 Displays the descriptive statistics relating to the number of correctly answered questions on the pre- and post-MCQs for the VP and NI groups.**

### 7.4.2 Dependent and Independent T-Tests

Dependent t-tests found that pre-registration trainees performed significantly better on the post-MCQs, after using the VP ($t_{(59)} = 4.973$, $p<0.001$) or completing the NI case studies ($t_{(65)} = 4.132$, $p<0.001$). The experimental hypothesis was accepted and it was determined that completing either type of case study improved pre-registration trainee's knowledge of EHC by something other than chance.

Independent t-tests found no significant difference in knowledge improvement between the VP and NI case study groups ($t_{(100)} = 0.183$, $p>0.05$) or between genders ($t_{(100)} = 1.152$, $p>0.05$). A statistically significant result was obtained for sector of training, in which hospital-based trainees knowledge improved more than community-based trainees from baseline ($t_{(72)} = 1.898$, $p<0.05$). These results imply that sector of training had a significant impact on knowledge improvement but the intervention (learning tool) participants received or their gender did not. Thus, the experimental hypothesis that the VP would be superior at improving knowledge compared to NI case was rejected for the EHC case study.

### 7.4.3 Correlation and Regression

Results were controlled for knowledge improvement over 0, as some trainees answered more questions incorrectly on the post-MCQs which produced negative results. For the regression and correlation to be calculated appropriately, only positive results were included.

Pearson's correlation coefficients were calculated to test for correlations between knowledge improvement and the independent variables: intervention group, sector of training and gender. Non-significant correlations were found for the intervention group ($r_{(100)} = 0.18$, $p>0.05$) or trainee's gender on knowledge improvement ($r_{(100)} = 0.11$, $p>0.05$). The sector which trainees were completing their training in found a small and statistically significant correlation with their knowledge improvement ($r_{(100)} = 0.2$, $p=0.02$).

Medium to high strength correlations were also found regarding the number of questions answered correctly at baseline (pre-MCQs) and knowledge improvement (see Table 7-4). Correlations between the independent variables and knowledge improvement were negative and statistically significant, indicating that those with a lower baseline knowledge had a greater knowledge improvement.

| | R2 | r |
|---|---|---|
| **VP Group** | 0.29 | -0.54* |
| **NI Group** | 0.27 | -0.52* |
| **Hospital** | 0.5 | -0.71* |
| **Community** | 0.12 | -0.34* |
| **Female** | 0.38 | -0.62* |
| **Male** | 0.15 | -0.38* |

**Table 7-4 Results are based on a 2-tailed Pearson's correlation test, *p<0.01.**

The goal of determining the effects of the intervention group, training sector or gender on knowledge improvement scores was explored by performing multiple regression. Table 7-5 illustrates these results. A non-significant regression equation was calculated ($F_{(3, 06)}$ = 0.099, p>0.05, R2 0.003).

| | Unstandardised Beta | Unstandardised Beta Standard Error | Standardised Beta |
|---|---|---|---|
| **Constant** | 1.962 | 1.102 | |
| | | | |
| **Group** | 0.139 | 0.442 | 0.031* |
| **Sector** | -0.223 | 0.528 | -0.041* |
| **Gender** | -0.089 | 0.441 | -0.019* |

**Table 7-5 Multiple regression results. R2 0.003, *p=n.s**

### 7.4.4 Performance on Individual Questions

The pre- and post-MCQs for case study one can be found in Appendix 8. Individual questions were analysed for correctness on the pre- and post-MCQs for the VP and NI groups (see Table 7-6). Trainees' knowledge in both groups generally improved on the post-MCQs suggesting that completing either style of case study aided their learning related to the supply of EHC.

Analysis found ≥10% improvement on the post-MCQs for the following question topics in both groups: EllaOne® licensing (question 2 (Q2)), EllaOne® effectiveness (Q7), IUD licensing (Q10) and vomiting after Levonelle® or EllaOne® (Q's 13 and 14). The NI group showed ≥10% improvement on Q9 regarding IUD as emergency contraception. The VP group showed ≥10% for questions relating to EHC counselling (Q11) and the use of EHC in a cycle (Q's 16 and 17).

Analysis also illustrated areas where trainees in the VP and NI groups did not perform better after completing the case study (pre- and post-MCQ scores were the same). Trainees in the NI group showed no improvement on Q1 (Levonelle® licensing) and Q16 (use of EllaOne® in a cycle) from baseline. Although, at baseline 65 of the 66 pre-registration trainees in the NI group correctly answered Q1; thus there was only one trainee from the NI group who could not answer this question correctly after completion of the case. Pre-registration trainees who completed the VP simulation study showed no improvement on Q12 (side effects of Levonelle®), Q18 (EHC before UPSI) and Q6 (contraindications for EllaOne® supply). A 100% fail rate was found for Q6 (contraindications of EllaOne®) in the VP group (pre- and post) and a 100% fail rate (pre-) and 92% fail rate (post) was found in the NI group.

For both groups, there were areas where trainees' knowledge did not improve ≥10% and areas where it worsened after completion of the case studies. The main area of poor knowledge retention was with questions relating to interactions with EHC; questions 3, 5 and 6 were all associated with >90% of trainees incorrectly answering. Questions 3 and 5 had more trainees in the VP group answer incorrectly on the post-MCQs than at baseline. A second area where trainees struggled were questions regarding the effectiveness of EHC (questions 7 and 8); >50% of trainees in each group incorrectly answered these on the post-MCQs. Pre-registration trainees in both groups also had difficulty with question 12 (side effects of Levonelle®) with 78% of trainees in the VP group and 68% in the NI group incorrectly answering this question on the post-MCQs.

| Question Number (Q) | Question Description | Knowledge Change Pre–Post No. of trainees (%) | |
|---|---|---|---|
| | | VP Group | NI Group |
| 1 | Levonelle® licensing | 1 (1.7%) | 0 (0%) |
| 2 | EllaOne® licensing | 8 (13.3%) | 12 (18.2%) |
| 3 | Medicines affecting absorption of Levonelle® | -1 (-1.7%) | 3 (4.5%) |
| 4 | Sale of Levonelle® | 5 (8.3%) | 1 (1.5%) |
| 5 | Contraindications of Levonelle® | -1 (-1.7%) | 4 (6.1%) |
| 6 | Contraindications of EllaOne® | 0.00 (0) | 5 (7.6%) |
| 7 | Effectiveness of EllaOne® | 8 (13.3%) | 8 (12.1%) |
| 8 | Effectiveness of Levonelle® | 5 (8.3%) | 4 (6.1%) |
| 9 | Type of intrauterine device (IUD) available as emergency contraception | 5 (8.3%) | 8 (12.1%) |
| 10 | Emergency contraceptive IUD licensing | 14 (23.9%) | 15 (22.7%) |
| 11 | Counselling points for EHC | 9 (15%) | 6 (9.1%) |
| 12 | Side effects of Levonelle® | 0 (0%) | 3 (4.5) |
| 13 | Vomiting when taken Levonelle® | 7 (11.7%) | 9 (13.6%) |
| 14 | Vomiting when taken EllaOne® | 9 (15%) | 12 (18.2%) |
| 15 | Levonelle® use per cycle | -3 (-5%) | 1 (1.5%) |
| 16 | EllaOne® use per cycle | 8 (13.3%) | 0 (0%) |
| 17 | Levonelle® and EllaOne® use in the same cycle | 6 (10%) | -4 (6.1%) |
| 18 | EHC prior to unprotected sexual intercourse (UPSI) | 0 (0%) | 2 (3%) |
| 19 | Cerazette and EHC | 4 (6.7%) | -3 (-4.5%) |
| 20 | Allergies to Levonorgestrel | 4 (6.7%) | -2 (-3%) |

**Table 7-6 Illustrates knowledge improvement from pre- to post-MCQs for each question for case study one (EHC).**

### 7.4.5 Engagement with the Case Study

Another objective of the research was to determine any differences in inclination to study of pre-registration trainees when using the VP compared to the NI case studies (Chapter 5, section 5.2). This was measured by trainee's answering a question on the post-MCQs regarding how many times they completed the VP or NI case study (Figure 7-1). Pre-registration trainees in the VP group completed the EHC simulation significantly more times than those in the NI group ($t_{(124)} = 3.176$, p=0.01). Figure 7-1 illustrates that all trainees in the NI group (100%) and the majority of trainees in the VP group (85%) reported completing the case study 0-2 times. Seven trainees in the VP group reported completing the simulation 3-5 times (11.7%) and two reported completing it 6-8 times (3.3%). In the VP group, females reported completing the simulation more than males (two females completed it 6-8 times compared to zero males). Trainees in hospital and community reported completing the simulation a similar number of times.

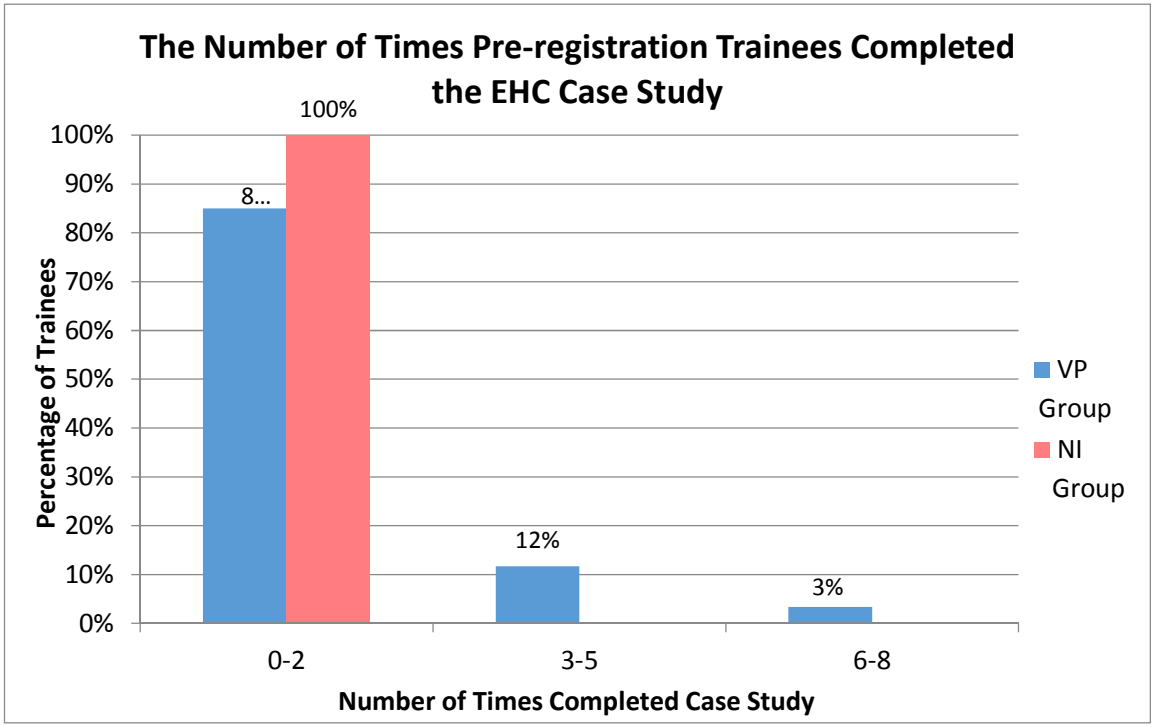



**Figure 7-1 Illustrates the number of times the EHC case was completed by pre-registration trainees in the VP and NI case study groups**

### 7.4.6 Timestamp Analysis

The time between individuals completing the pre-MCQs and post-MCQs was analysed to determine any effects on knowledge improvement scores (see Figure 7-2). The majority of pre-registration trainees in both groups completed the pre- and post-MCQs within a single 24-hour period (44% VP, 53% NI). Pre-registration trainees in the NI group completed the post-MCQs up to 25 days after completing the baseline MCQs (9% completed 21+ days after baseline) whereas those in the VP group completed the post-MCQs up to 20 days after the baseline questions (8% completed 16-20 days after), with no trainees in the VP group completing them 21+ days after. There was no significant difference between the groups in the mean number of days (mean VP = 5.6, mean NI = 4.8) that pre-registration trainees took to complete the post-MCQs ($t_{(124)} = 0.601$, $p>0.05$).

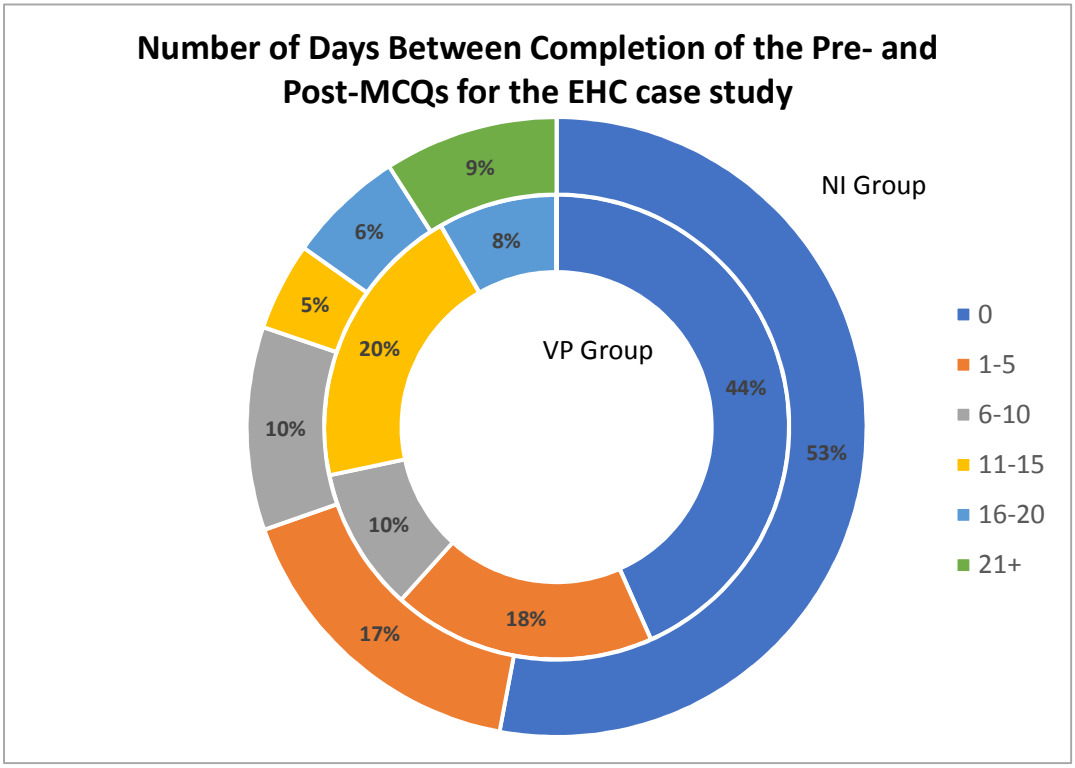



**Figure 7-2 Illustrates the number of days between completion of the pre- and post-MCQs for both case study groups. The outer circle displays the percentage of pre-registration trainees from the NI group and the inner circle displays the percentage of pre-registration trainees from the VP group.**

## 7.5 Case Study Two Results

### 7.5.1 Descriptive Statistics

Knowledge scores from the pre- and post-MCQs for case study two (renal function) were measured for the VP and NI case study groups and are displayed in Table 7-7. Pre-registration trainees in the NI group had lower mean baseline knowledge regarding calculations and renal function (12.9 vs 13.7 in the VP group). Pre-registration trainees in the VP group had more correct answers on the post-MCQs than the NI group (14.3 vs 13.6). The range of knowledge scores varied; in the VP group the maximum number of questions answered correctly was 18 and the minimum was 10, compared to a maximum of 19 and minimum of 2 in the NI group. The median and mode scores were both higher for the VP group than the NI group (15 vs 14) indicating the correct answers being more commonly selected by trainees in the VP group.

| | | No. of Correct Questions | | | |
|---|---|---|---|---|---|
| | | **Mean (SD)** | **Median** | **Mode** | **Range** |
| **VP Group** | **Pre-MCQs** | 13.7 (2.09) | 15 | 15 | 10-18 |
| | **Post- MCQs** | 14.3 (2.04) | 15 | 15 | 10-18 |
| **NI Group** | **Pre- MCQs** | 12.9 (3.04) | 14 | 14 | 3-17 |
| | **Post- MCQs** | 13.6 (3.23) | 14 | 14 | 2-19 |

**Table 7-7 Presents the descriptive statistics of knowledge scores on the pre- and post-MCQs for the renal function case for the VP and NI groups.**

### 7.5.2 Dependent and Independent T-Tests

Dependent t-tests found that pre-registration trainees performed significantly better on the post-MCQs after using the VP ($t_{(41)} = 2.156$, $p=0.05$) or completing the NI case studies ($t_{(45)} = 2.192$, $p=0.05$). The experimental hypothesis was accepted and it was determined that completing either type of case study improved pre-registration trainee's knowledge of renal function by something other than chance.

Independent t-tests found no significant difference of knowledge improvement between trainees in the VP and NI case study groups ($t_{(63)}$ = -0.429, p>0.05) or between genders ($t_{(63)}$ = 0, p>0.05). A statistically significant result was obtained for sector of training, in which community-based trainee's knowledge improved more significantly than hospital-based trainee's from baseline ($t_{(63)}$ = -0.249, p<0.01). These results imply that sector of training had a significant impact on knowledge improvement but the intervention (learning tool) participants received or their gender did not. Thus, the experimental hypothesis that the VP would be superior at improving knowledge compared to NI case was rejected for the renal function case study.

### 7.5.3 Correlation and Regression

As with case study one, results were controlled for knowledge improvement over 0, as some trainees answered more questions incorrectly on the post-MCQs which produced negative results. Pearson's correlation coefficients were calculated to test for correlations between knowledge improvement and the independent variables: intervention group, sector of training and gender. Non-significant correlations were found for the intervention group ($r_{(63)}$ = 0.054, p>0.05) or trainee's gender on knowledge improvement ($r_{(63)}$ = 0, p>0.05). The sector which trainees were completing their training in found a small and statistically significant correlation with their knowledge improvement ($r_{(63)}$ = 0.233, p=0.03).

Medium to high strength correlations were also calculated regarding the number of questions answered correctly at baseline (pre-MCQs) (see

Table 7-8). Correlations between the intervention group, sector of training and female pre-registration trainees with knowledge improvement were negative and statistically significant, indicating that trainees in those groups had a lower baseline knowledge and a greater knowledge

improvement. Male participants were associated with a positive correlation which indicated those with a higher starting knowledge also had a greater knowledge improvement.

| | R2 | R |
|---|---|---|
| **VP Group** | 0.29 | -0.54* |
| **NI Group** | 0.15 | -0.38** |
| **Hospital** | 0.1 | -0.31** |
| **Community** | 0.15 | -0.38* |
| **Female** | 0.33 | -0.58* |
| **Male** | 0.1 | 0.3*** |

**Table 7-8 Displays results based on a 2-tailed Pearson's correlation test, *p<0.01, **p<0.05, ***p=n.s.**

The goal of determining the effects of the intervention group, training sector or gender on knowledge improvement scores was explored by performing multiple regression. Table 7-9 presents the results. A non-significant regression equation was obtained ($F_{(3, 76)}$ = 0.028, p>0.05, R2 0.001). None of the independent variables had a significant effect on knowledge improvement scores (p>0.05).

| | Unstandardised Beta | Unstandardised Beta Standard Error | Standardised Beta |
|---|---|---|---|
| **Constant** | 1.001 | 1.155 | |
| **Group** | 0.088 | 0.467 | 0.022* |
| **Sector** | -0.123 | 0.484 | -0.30* |
| **Gender** | -0.28 | 0.556 | -0.006* |

**Table 7-9 Multiple regression results. R2 0.001, *p=n.s.**

### 7.5.4 Performance on Individual Questions

The pre-and post-MCQs for case study two can be found in Appendix 23. Individual questions were analysed for correctness of scores on the pre- and post-MCQs for the VP and NI case studies (Table 7-10). The results indicate a mixed knowledge improvement for trainees in both groups.

Analysis found ≥10% improvement in both groups on the post-MCQs for Q8 (heparin-induced thrombocytopenia). The VP group showed ≥10% improvement on Q1 (resources available). The NI

group showed ≥10% improvement on Q2 (stage 4 eGFR), Q4 (dose adjustment when CrCl <30ml/min), Q6 (side effects of LMWH) and Q15 (paediatric daily dose of a liquid calculation).

Analysis also illustrated areas where trainees in the VP and NI groups did not perform better after completing the case study (pre- and post-MCQ scores were the same). Trainees in the VP group did not improve on Q3 (drugs which can cause acute kidney injury), Q14 (quantity of a liquid calculation) and Q20 (injection dose calculation). Trainees in the NI case study group showed no improvement on Q13 (w/w cream calculation) and Q18 (controlled drug equivalent calculation).

For both groups, there were areas where trainees' knowledge did not improve ≥10% and areas where it worsened after completion of the case studies. The question with the largest non-improvement was Q3 (drugs which can cause acute kidney injury), which was associated with a 100% fail rate in the VP group (pre- and post) and a 98% fail rate (pre) and a 96% fail rate (post) in the NI group. In the VP group >75% of trainees answered Q4 (dose adjustment when CrCl <30ml/min) incorrectly on the post-MCQs; although this was a 4.8% improvement from baseline. There was a ≥10% improvement on this question in the NI group, but >70% of trainees still answered this question incorrectly. Trainees in both groups also performed poorly on question 5 (factors which require LMWH to be adjusted) with more trainees incorrectly answering this question on the post-MCQs compared to the pre-MCQs; 93% (39) trainees in the VP group and 81% (33) trainees in the NI group.

Questions 10 to 20 were all calculation based questions, eight of which were associated with negative knowledge improvement scores in at least one of the case study groups (VP or NI).

| Question number (Q) | Question Description | Knowledge Change Pre–Post N (%) | |
|---|---|---|---|
| | | VP Group | NI Group |
| 1 | Resources available for information on drug doses and renal function | 7 (16.7%) | 3 (6.4%) |
| 2 | eGFR for severe (stage 4) renal function | 3 (7.2%) | 10 (21.3%) |
| 3 | Drugs which can cause acute kidney injury | 0 (0%) | 1 (2.1%) |
| 4 | Drugs which require a dose adjustment when renal function <30ml/min | 2 (4.8%) | 5 (10.6%) |
| 5 | Conditions which require a low molecular weight heparin (LMWH) adjustment | -3 (-7.2%) | -1 (-2.1%) |
| 6 | Bleeding with a LMWH | 3 (7.2%) | 5 (10.6%) |
| 7 | Heparin and hypokalaemia | 3 (7.2%) | 3 (6.4%) |
| 8 | Heparin induced thrombocytopenia | 9 (21.4%) | 8 (17%) |
| 9 | eGFR as an accurate measure of renal function | -3 (-7.2%) | 3 (6.4%) |
| 10 | eGFR values in those under 18 | 2 (4.8%) | 1 (2.1%) |
| 11 | Percentage strength of a solution calculation | 1 (2.4%) | -3 (-6.4%) |
| 12 | Intravenous infusion calculation | -3 (-7.2%) | -3 (-6.4%) |
| 13 | Weight/weight cream calculation | -2 (-4.8%) | 0 (0%) |
| 14 | Quantity of a liquid calculation | 0 (0%) | -1 (-2.1%) |
| 15 | Paediatric daily dose of a liquid calculation | 3 (7.2%) | 5 (10.6%) |
| 16 | Weight/volume solution calculation | 4 (9.5%) | 3 (6.4%) |
| 17 | Quantity of tablets calculation | -1 (-2.4%) | -2 (-4.3%) |
| 18 | Controlled drug equivalent calculation | -1 (-2.4%) | 0 (0%) |
| 19 | Citalopram tablets to drops calculation | 3 (7.2%) | -3 (-6.4%) |
| 20 | Injection dose calculation | 0 (0%) | -1 (-2.1%) |

**Table 7-10 Illustrates the number and percentage of trainees in the VP and NI case study groups and their knowledge improvement from pre- to post-MCQs for the renal function case study.**

### 7.5.5 Engagement with Case Study

As with case study one, any differences in inclination of pre-registration trainees to study using the VP compared to the NI case studies was determined (see Figure 7-3). Pre-registration trainees in the VP group reported completing the renal function simulation significantly more times than trainees reported completing the NI case study ($t_{(87)} = 3.759$, p=0.01). The majority of trainees in both groups reported completing the case study 0-2 times (71% VP, 98% NI). Trainees in both groups also reported completing the case study 3-5 times; a greater proportion of trainees in the VP group reported this compared to the NI group (29% vs 2%). In the VP group, females reported completing the simulation

more than males (30% completed 3-5 times compared to 13%). In the NI group, 100% of males and 98% of females reported completing the simulation 0-2 times, with 2% of females reporting completing it 3-5 times. There was a similar split between the sectors of training; 70% of community-based trainees and 72% of hospital-based trainees reported completing the VP simulation 0-2 times, with the remaining trainees reporting completing the VP simulation 3-5 times (30% community, 28% hospital). In the NI group, 100% of community-based trainees reported completing the case study 0-2 times, whereas 93% of hospital-based trainees reported completing the case study 0-2 times and the remaining 7% of trainees reported completing it 3-5 times.

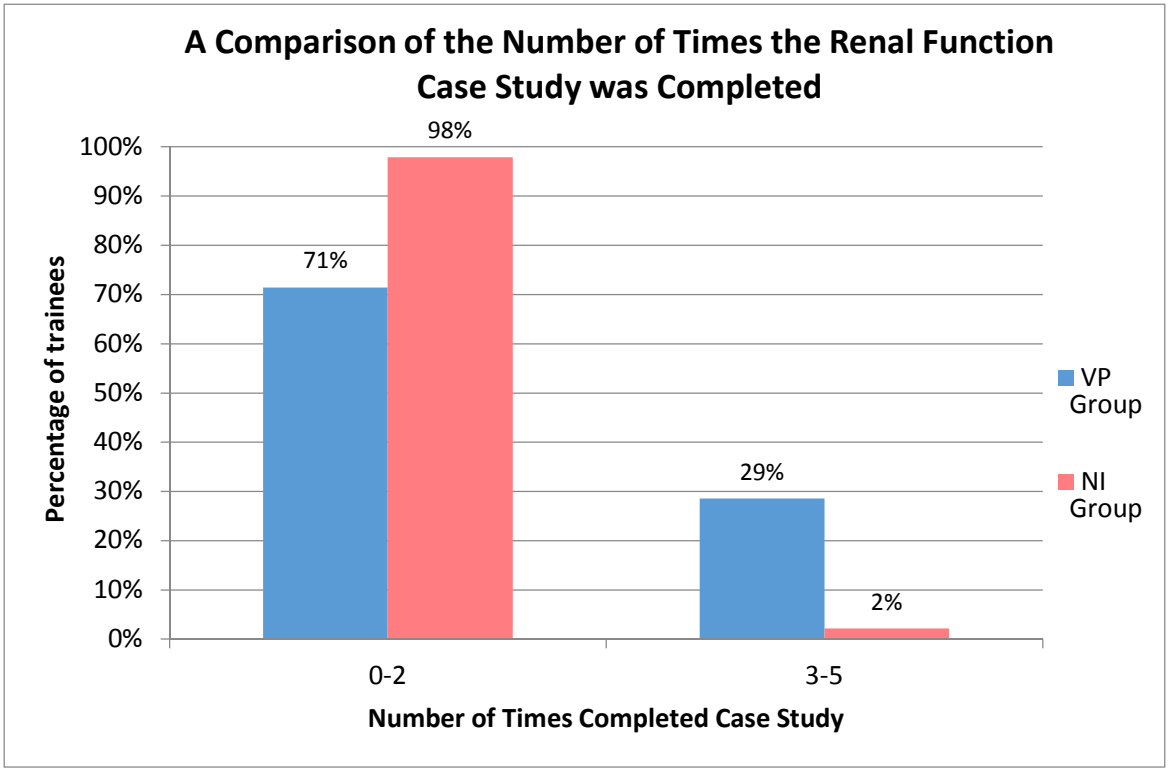



**Figure 7-3 Illustrates the number of times the renal function case study was completed by pre-registration trainees in the VP and NI case study groups.**

### 7.5.6 Time Stamp Analysis

As with case study one, the time between individuals completing the pre- and post-MCQs was analysed to determine any effect this may have had on knowledge improvement scores (see Figure 7-4). The majority of pre-registration trainees in both groups completed the pre- and post-MCQs within a single 24-hour period (46% VP, 58% NI). Pre-registration trainees in both groups completed the post-MCQs 21+ days after the baseline questions; trainees in the VP group completed them up to 30 days after and trainees in the NI group completed them up to 29 days after. There was no significant difference between the groups in the mean number of days (mean VP = 5.1, mean NI = 4.1) that pre-registration trainees took to complete the post-MCQs ($t_{(87)} = 0.528$, $p>0.05$)

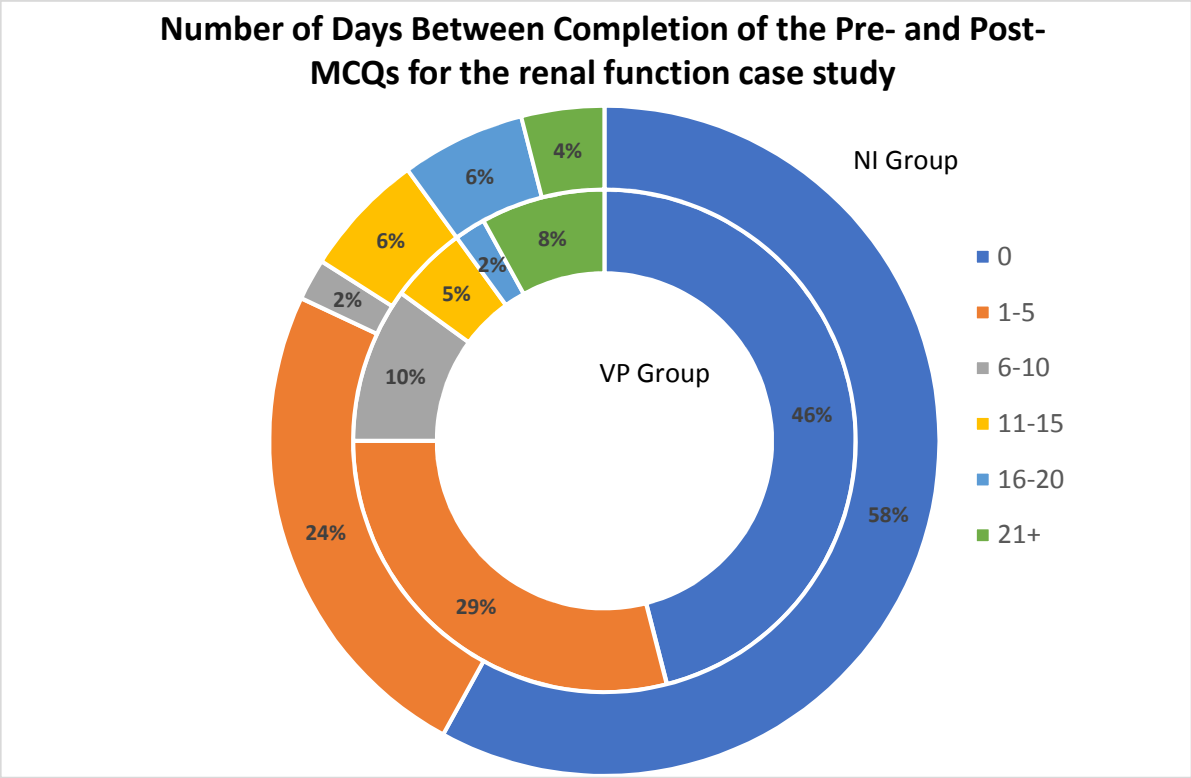



**Figure 7-4 Illustrates the number of days between completion of the pre- and post-MCQs for the NI and VP groups for the renal function case study. The outer circle displays the percentage of pre-registration trainees from the NI group and the inner circle displays the percentage of pre-registration trainees from the VP group.**

## 7.6 Case Study Three Results

### 7.6.1 Descriptive Statistics

Knowledge scores from the pre- and post-MCQs for case study three (childhood illness) were measured for the VP and NI case study groups and are displayed in Table 7-11. Both groups had similar baseline knowledge of childhood illnesses; both groups answered a mean of 14 questions correctly. After completion of the case study, trainees in the VP group improved their knowledge to a greater extent than the NI group (14.78 vs 14.3) and the SD for the NI group was higher than for the VP group (3.15 vs 1.74), indicating a greater variance in knowledge scores. The range of knowledge scores varied greatly, with a maximum of 19 questions answered correctly in the VP group and a minimum 12, compared with a maximum of 19 and a minimum of 9 in the NI group. The median and mode scores for both groups were the same (pre-MCQs median 14, post-MCQs median 15, pre-MCQs mode 12, post-MCQs mode 16) indicating no difference between the groups in the most common number of questions being answered correctly by trainees.

| | | No. of Correct Questions | | | |
|---|---|---|---|---|---|
| | | **Mean (SD)** | **Median** | **Mode** | **Range** |
| **VP Group** | **Pre-MCQs** | 14 (2) | 14 | 12 | 12-19 |
| | **Post- MCQs** | 14.78 (1.74) | 15 | 16 | 12-19 |
| **NI Group** | **Pre- MCQs** | 14.03 (2.52) | 14 | 12 | 9-18 |
| | **Post- MCQs** | 14.30 (3.15) | 15 | 16 | 9-19 |

**Table 7-11 Displays the descriptive statistics relating to the number of correctly answered questions on the pre- and post-MCQs for the VP and NI groups for the childhood illness case study.**

### 7.6.2 Dependent and Independent T-Tests

Dependent t-tests found that pre-registration trainees performed significantly better on the post-MCQs, after using the VP ($t_{(26)}$ = 2.451, p=0.05). Dependent t-tests also found that, although pre-registration trainees did perform better on the post-MCQs, after completing the NI case study, this

was not statistically significant ($t_{(35)}$ = 0.535, p=0.6). These results indicate that completing the VP case study did improve trainee's knowledge of childhood illnesses by something other than chance, but completing the NI case study did not and any changes in trainee's knowledge may be due to chance.

Independent t-tests found no significant difference in knowledge improvement between the VP and NI case study groups ($t_{(46)}$ = -1.665, p>0.05) or between genders ($t_{46)}$ = 0.747, p>0.05). A statistically significant result was obtained for sector of training, in which community-based trainees knowledge improved more significantly than hospital-based trainees from baseline ($t_{(46)}$ = -1.824, p<0.05). These results imply that sector of training had a significant impact on knowledge improvement but the intervention participants received and their gender did not. Thus, the experimental hypothesis that the VP would be superior at improving knowledge compared to NI case was rejected for the childhood illness case study.

### 7.6.3 Correlation and Regression

As with case studies one and two, results were controlled for knowledge improvement over 0, as some trainees answered more questions incorrectly on the post-MCQs which resulted in negative results. Pearson's correlation coefficients were calculated to test for correlations between knowledge improvement and the independent variables: intervention group, sector of training and gender. Significant correlations were found for the intervention group ($r_{(46)}$ = 0.24, p=0.05) and the sector of training ($r_{(46)}$ = 0.26, p0.04) with knowledge improvement. Trainee's gender had no significant correlation with knowledge improvement ($r_{(46)}$ = -0.11, p>0.05).

Results also found medium to high strength correlations regarding the number of questions answered correctly at baseline (pre-MCQs) and knowledge improvement (Table 7-12). The only significant correlation was found between the VP group and knowledge improvement (p<0.05). Those trainees in the VP group, who were community-based or male resulted in negative correlations indicating that

those with a lower baseline knowledge had a greater knowledge improvement. Whereas, trainees in the NI group, hospital-based or female had positive correlations indicating that the trainees in these groups who had a higher baseline knowledge showed a greater knowledge improvement on the post-MCQs.

| | R2 | r |
|---|---|---|
| **VP Group** | 0.23 | -0.48* |
| **NI Group** | 0.03 | 0.17** |
| **Hospital** | 0 | 0.05** |
| **Community** | 0.02 | -0.13** |
| **Female** | 0 | 0.07** |
| **Male** | 0.11 | -0.34** |

**Table 7-12 Results are based on a 2-tailed Pearson's correlation test, *p<0.05, **p=n.s.**

The goal of determining the effects of the group trainees were randomised to, their training sector and their gender on knowledge scores was explored by performing multiple regression. Table 7-13 illustrates these results. A non-significant regression equation was obtained ($F_{(3, 57)} = 1.793$, $p>0.05$, R2 0.086). None of the three variables showed a significant effect on knowledge improvement scores.

| | Unstandardised Beta | Unstandardised Beta Standard Error | Standardised Beta |
|---|---|---|---|
| **Constant** | 4.43 | 1.92 | |
| **Group** | 0.082 | 0.812 | 0.013* |
| **Sector** | -1.14 | 0.813 | -0.18* |
| **Gender** | -1.86 | 1.00 | -0.24* |

**Table 7-13 Multiple regression results. R2 0.086, *p=n.s.**

### 7.6.4 Performance on Individual Questions

The pre- and post-MCQs for case study three can be found in Appendix 24. Individual questions were analysed for correctness of scores on the pre- and post MCQs for the VP and NI case studies (Table 7-14). The results indicate a mixed improvement on the post-MCQs for both groups.

Analysis found ≥10% improvement in both groups on the post-MCQs for Q19 (fifth disease symptoms), with 26% more trainees in the VP group and 11% more trainees in the NI group answering this correctly. The VP group showed ≥10% improvement on Q1 (paracetamol dosing), Q3 (measles symptoms), Q4 (white spots in the mouth), Q12 (cold sore virus) and Q13 (colic symptoms). The NI group showed ≥10% improvement on Q11 (chicken pox virus).

Analysis also illustrated areas where trainees in the VP and NI groups did not perform better after completing the case study (pre- and post-MCQ scores were the same). Trainees in the VP group showed no improvement on Q9 (mumps symptoms), Q10 (impetigo symptoms), Q15 (whooping cough terminology), Q16 (aspirin and Reye's syndrome) and Q20 (mebendazole licensing). Trainees in the NI group showed no improvement for question 16 (aspirin and Reye's syndrome).

For both groups, there were areas where trainees' knowledge did not improve ≥10% and areas where it worsened after completion of the case studies. This included Q7 (symptoms of croup) which 22.2% more trainees in the VP group and 13.9% more trainees in the NI case study answered incorrectly post-case study. Trainees in both groups also performed worse on questions regarding the licensing of medicines in children: Q17 (chloramphenicol licensing) and Q18 (loperamide licensing). Trainees in the VP group also performed worse on Q11 (chicken pox virus). Trainees in the NI group performed worse on: Q2 (ibuprofen dosing), Q3 (measles symptoms), Q6 (medicines for children under 16 years of age), Q10 (impetigo symptoms), Q12 (cold sores virus), Q14 (penicillin allergy) and Q15 (whooping cough).

| | | Knowledge Change Pre–Post N (%) | |
|---|---|---|---|
| **Question number (Q)** | **Question Description** | **VP Group** | **NI Group** |
| 1 | Paracetamol dose for a 3 year old child | 4 (14.8%) | 3 (8.3%) |
| 2 | Ibuprofen dose for an 11 year old child | 2 (7.4%) | -2 (-5.6%) |
| 3 | Measles symptoms | 4 (14.8%) | -3 (-8.3%) |
| 4 | White spots in the mouth associated with measles | 3 (11.1%) | 2 (5.6%) |
| 5 | Meningitis symptoms | 2 (7.4%) | 3 (8.3%) |
| 6 | Medicines for children under 16 years of age | 2 (7.4%) | -2% (-5.6%) |
| 7 | Croup symptoms | -6 (-22.2%) | -5 (-13.9%) |
| 8 | Chicken pox symptoms | 1 (3.7%) | 1 (2.8%) |
| 9 | Mumps symptoms | 0 (0%) | 2 (5.6%) |
| 10 | Impetigo symptoms | 0 (0%) | -1 (-2.8%) |
| 11 | Chicken pox and the herpes zoster virus | -2 (-7.4%) | 4 (11.1%) |
| 12 | Cold sores and the human papilloma virus (HPV) | 3 (11.1%) | -1 (-2.8%) |
| 13 | Colic symptoms | 3 (11.1%) | 1 (2.8%) |
| 14 | Allergy to penicillin | 1 (3.7%) | -2 (-5.6%) |
| 15 | Whooping cough terminology | 0 (0%) | -1 (-2.8%) |
| 16 | Aspirin and Reye's syndrome | 0 (0%) | 0 (0%) |
| 17 | Chloramphenicol licensing | -1 (-3.7%) | -1 (-2.8%) |
| 18 | Loperamide licensing | -1 (-3.7%) | -3 (-8.3%) |
| 19 | Fifth disease symptoms | 7 (25.9%) | 4 (11.1%) |
| 20 | Mebendazole licensing | 0 (0%) | 1 (2.8%) |

**Table 7-14 Illustrates the number and percentage of trainees in the VP and NI case study and their knowledge improvement from pre- to post-MCQs for the child illness case study.**

### 7.6.5 Engagement with Case Study

Any differences in inclination of pre-registration trainees to study using the VP compared to the NI case studies were determined (see Figure 7-5). Pre-registration trainees in the VP group completed the childhood illness simulation more times than the NI case study group but this was not significant ($t_{(61)} = 1.158$, $p>0.05$). Figure 7.5 illustrates all trainees in the NI group reported completing the case study between 0-2 times and the majority of trainees in the VP group (96%) also reported completing the simulation between 0-2 times, with 4% reporting completing it 3-5 times. Within the VP group, females reported completing the simulation more than males (96% 0-2 times, 4% 3-5 times vs 100% of males 0-2 times). All community-based trainees (100%) within the VP group reported completing

the simulation 0-2 times and the majority (94%) of hospital-based trainees also reported completing it 0-2 times, with the remaining 6% of trainees reporting completing it 3-5 times.

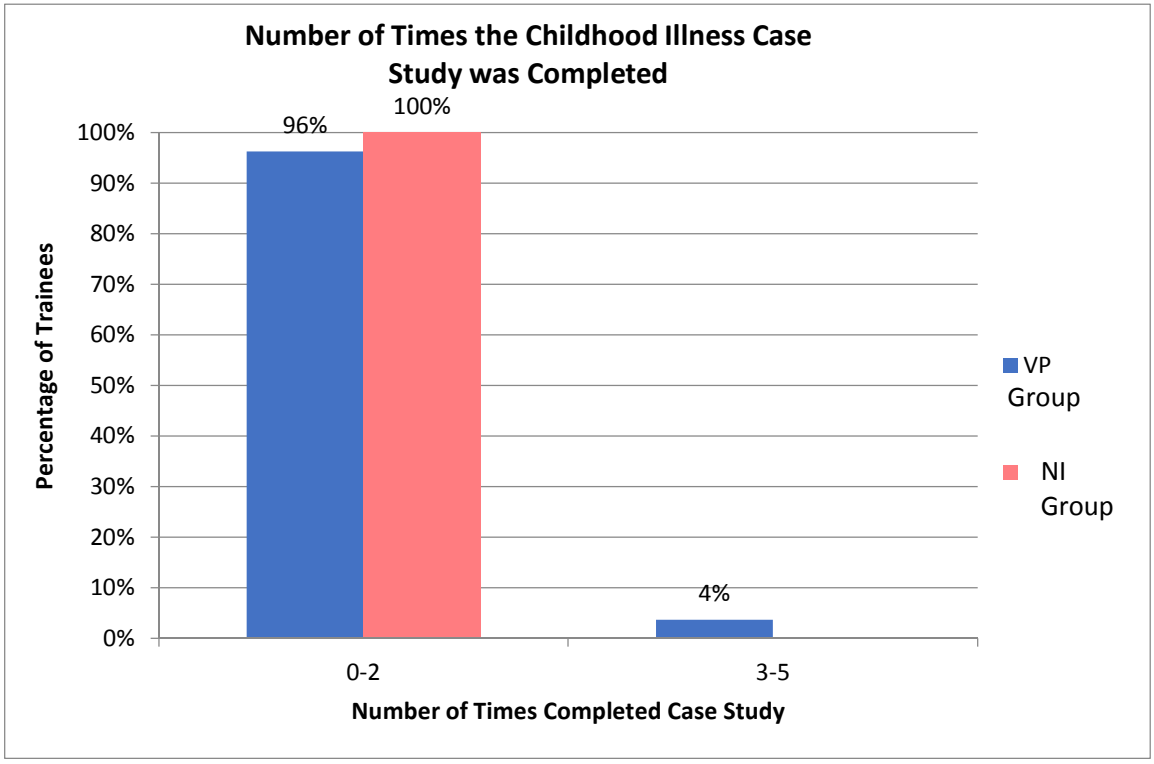



**Figure 7-5 Illustrates the number of times the childhood illness case was completed by pre-registration trainees in the VP and NI case study groups.**

### 7.6.6 Timestamp Analysis

As with the previous two case studies, the time between individuals completing the pre- and post-MCQs was analysed to determine any effect this may have had on knowledge improvement scores (see Figure 7-6). The majority of pre-registration trainees in both groups completed the pre- and post-MCQs within a single 24-hour period (78% VP, 75% NI). Pre-registration trainees in the NI group completed the post-MCQs up to 28 days after completing the baseline-MCQs whereas those in the VP group completed the post-MCQs up to 14 days after, with no trainees completing it after 21+ days.

There was no significant difference between the groups in the mean number of days (mean VP = 1.9, mean NI = 3.7) that pre-registration trainees took to complete the post-MCQs ($t_{(61)}$ = -1.009, p>0.05)

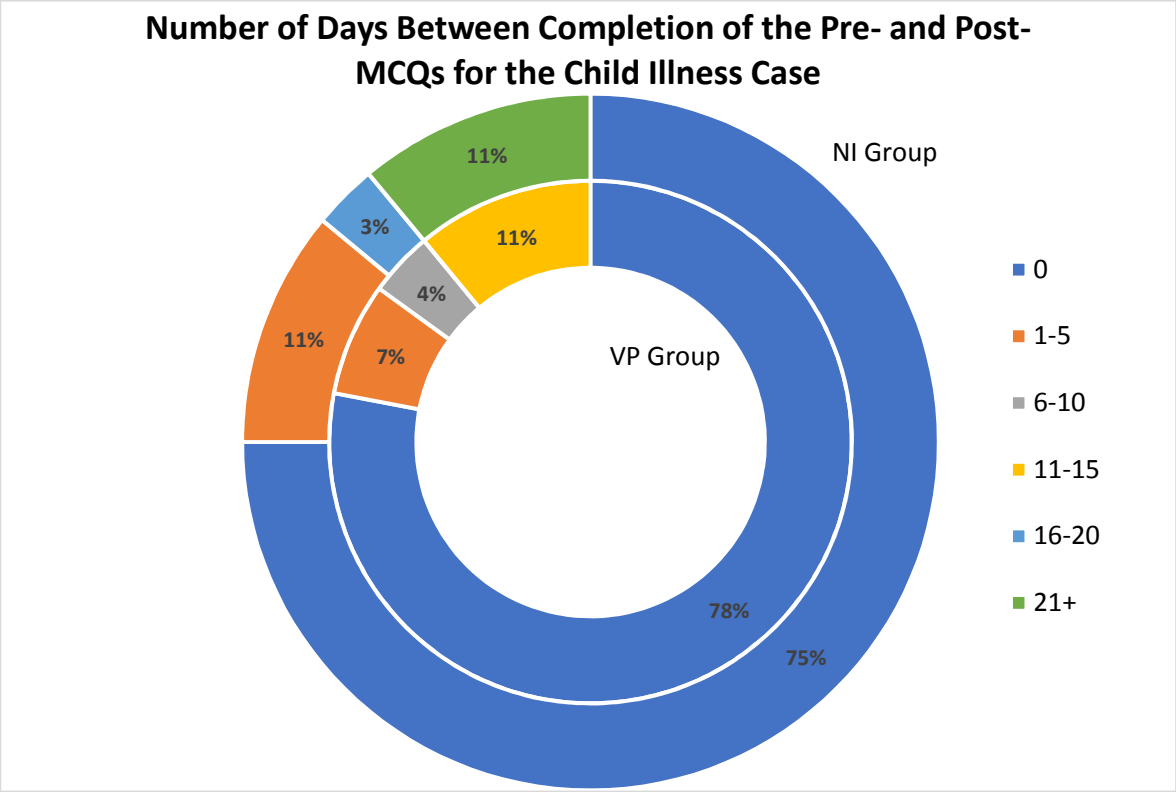



**Figure 7-6 Illustrates the number of days between completion of the pre- and post-MCQs for the NI and VP groups for the childhood illness case study. The outer circle displays percentage of pre-registration trainees from the NI group and the inner circle displays the percentage of pre-registration trainees from the VP group.**

## 7.7 Pre-registration Examination Results

Overall, 2811 pre-registration trainees sat the pre-registration examination in the UK in June 2015. Of those, 2077 passed and 734 failed; establishing a pass rate of 74%.

Results of the pass rate were analysed in relation to the pre-registration trainees who participated in this research study to determine if there was any difference between those who completed the VP simulations or NI case studies. Descriptive statistics can be seen in Table 7-15.

| | Number of pre-registration trainees (%) | | |
|---|---|---|---|
| | **Overall** | **VP Group** | **NI Group** |
| **Pass** | 54 (85.7%) | 26 (96.3%) | 28 (77.8%) |
| **Fail** | 9 (14.3%) | 1 (3.7%) | 8 (22.2%) |

**Table 7-15 Displays the number and percentage of pre-registration trainees who passed and failed the pre-registration examination on the first attempt. The number relates to the pre-registration trainees who completed all three case studies; individuals who didn't were excluded from this analysis.**

Of those trainees who completed all three cases, a greater percentage from the VP group passed the pre-registration examination on the first attempt (96.3%) compared to the NI group (77.8%). The NI group was associated with a much higher fail rate (22%) than the VP group (13%). These results were found to be statistically significant for a 1-tailed, independent t-test ($t_{(52)} = -2.331$, $p=0.01$) indicating that the VP had a greater impact than the NI case studies on pre-registration trainees knowledge and, thus may have had an effect on trainee's abilities to pass the pre-registration examination.

Overall, 28 trainees from the hospital sector completed all three cases and 35 trainees from the community sector completed all three cases. A significantly higher percentage of trainees from the community sector failed (22.9%) compared to the hospital sector (3.6%). Only one of the community-based trainees who failed was from the VP group, the rest of the trainees were from the NI group.

## 7.8 Chapter Discussion

Overall, the findings showed varying statistical significance when the independent variables (intervention group, sector of training and gender) were analysed against knowledge improvement scores for the three case studies. For all three cases, trainees in both groups answered more questions correctly on the post-MCQs than at baseline and these results were statistically significant (except for the NI group in case 3). Therefore, it can be stated that completing either type of case study was effective at improving pre-registration trainee's knowledge on the topic areas.

One of the primary objectives of this thesis was to establish whether VPs were more effective than NI learning tools at improving the knowledge of pre-registration trainees. The findings illustrated no significant differences between the groups for any of the case study topics, indicating that the VP technology was not a superior learning tool. However, both the VP and NI case studies were an additional resource to standard training and the immediate feedback from both types of case study is different to standard paper-based case studies (or 'usual practice') which may have impacted individuals' learning. No significant differences were found between genders, indicating that this factor had no effect on learning tool use and knowledge development. In contrast, significant improvements in knowledge were found between the training sectors. Case study one (EHC) identified hospital-based trainee's knowledge improved more significantly, whereas case studies two (renal function) and three (child illness) identified more significant improvement of community-based trainee's knowledge. Explanations to understand these significant findings are expressed below.

Case study one was on the topic of EHC which is a community-based scenario. Hospital-based trainees may have had less exposure to EHC and the consultations which take place, therefore they may have found the case study more useful (in either form of learning tool). Case study two was more hospital focused which may have led to community-based trainees finding it more useful. Based on this premise it would be expected that, as case study three is more community orientated, hospital-based trainees would have found it most useful. However, the findings indicate that community-based trainee's knowledge improved to a greater extent. Childhood conditions may be an area which trainees in either sector had limited experience with due to the specialist nature of paediatrics (Stephenson, 2005; Batchelor and Marriott, 2013). Community-based trainees may be more likely to come across the childhood conditions included in this case study as they were considered more minor-ailment based conditions requiring OTC treatment or self-care advice, thus community-based trainees may have found the case study more useful as a preparatory tool for practice.

As presented in sections 7.4.4, 7.5.4 and 7.6.4, there were areas in all three case studies which pre-registration trainees performed poorly on. The questions on the pre- and post-MCQs were not all directly related to the case studies; trainees were encouraged to undertake self-directed reading to enhance their learning. The findings indicate that this opportunity may not have been taken up by a large proportion of the participants, resulting in a poor performance on the post-MCQs. Completion of the pre- and post-MCQs was automatically timestamped by Google Drive which led to the presentation of the number of days between completion of the two for all participants. For all case studies, the majority of pre-registration trainees in both groups completed the pre- and post-MCQs in a 24-hour period, which may have indicated a lack of extra reading around the topic areas and an associated lack of improvement of knowledge scores. In addition to knowledge based questions, case study two integrated calculations into the pre- and post-MCQs. The findings indicated that pre-registration trainees may have ineffective calculation skills and may not be confident in their abilities (shown by trainees being unable to correctly answer the same calculations on two occasions). This is correlational with both the literature, which expresses a need for pharmacy students to have more calculations-based practice (Malcolm and Mccoy, 2007; Vyas, Bhutada, *et al.*, 2012; Sheaffer and Addo, 2013; Vyas *et al.*, 2014), and the comments that were received in the interviews in the latter part of this research (Chapter 9).

In addition to knowledge improvement, an objective of this quasi-experimental evaluation was to determine any differences of pre-registration trainee's engagement with the learning tools. For all three cases, trainees in the VP group reported engaging more than those in the NI group; this finding was statistically significant for the EHC and renal function cases but not the childhood illness case. To determine trainees' engagement, a question was included on the post-MCQs associated with each case study asking them how many times they completed that case study, thus there is no way to definitively establish their engagement. This issue was further explored in the telephone interviews (see Chapter 9). Pre-registration trainees could have been provided with a specific login to access

each case, which may have increased the reliability of these results, but the research team felt this would reduce the flexibility of learning which the VP offers.

An aim of quantitative research is to produce generalisable findings. The profile of respondents from the quasi-experimental evaluation was diverse, increasing the generalisability of the findings to a wider population (i.e. UK-based pre-registration trainees not included in this study). The gender split of pre-registration trainees who consented to participate was similar to the gender split and increasing 'feminisation of the pharmacy workforce' as seen on the GPhC pharmacist register (Hassell, 2012). Additionally, the ethnic diversity of pre-registration trainees in this study was consistent with the distribution of pharmacists in practice and the growing distribution of ethnic minorities entering the pharmacy profession (Willis *et al.*, 2006; Seston and Hassell, 2009; Hassell, 2012). The mean age of pre-registration trainees in this research was 23, which is consistent with other work carried out into pre-registration trainees (Jee et al. 2016; Blenkinsopp et al. 2015). In practice, there is a greater proportion of pharmacists who work in the community sector than the hospital sector (Phelps *et al.*, 2014). Previous research has identified the community:hospital split to be in the ratio of 70:30, whereas this research had an almost 60:40 split (community:hospital). This may have resulted from the recruitment process and the greater number of presentations which were done at hospital training days and perhaps less involvement from the community sector; with the exception of one of the large pharmacy multiples.

Upon participant consent, there was at least one pre-registration trainee from each accredited University offering the MPharm degree in the UK, which indicated a wide pool of trainees were recruited. The greatest proportion of participants were from Keele University (13.3%) which may have resulted from the presence of the lead researcher (JT) in this School of Pharmacy and the presentation that was delivered to the fourth-year students before they entered pre-registration training. Additionally, Universities within close proximity to the regional study days which

presentations were delivered at, showed a higher proportion of trainees who consented for the research. For example, the presentation at the West Midlands study day in Birmingham may have led to 8% of trainees in this research coming from Aston University, 6% from Nottingham University and also contributed to the 13% from Keele University. Over two thirds (69%) of the pre-registration trainees reported no previous VP use (similar findings to the pilot study, Chapter 6). The wide pool of participants (i.e. minimum of one trainee consent per UK University) indicated that technological advances and uptake in the undergraduate curriculum are low.

The overall response rate (RR) for the quasi-experimental evaluation was low (38%) but this is in line with other research that utilises prolonged testing periods with multiple data collection components (Smith *et al.*, 2014; Farrell *et al.*, 2015). The first case study had a RR of 76% which may have resulted from the study starting four months post-sign up, thus some trainees may have decided not to participate. The steady decline in RRs over the three-month period may be partly attributed to the intensity of the pre-registration training year and participants feeling over-loaded with work and time pressures. Additionally, trainees may have not found the case studies useful and thus may have decided to not carry on with the research. The overall RR in the VP group was lower than the NI group, which was unexpected due to the novelty of the VP learning tool. Those trainees who did not continue with the research were not followed up but problems with the VP technology were explored in the questionnaire and telephone interviews (Chapters 8 and 9) and may be attributed to the lower RR. Despite the RR, the sample size at the end of the quasi-experimental evaluation was 63 which, based on the sample size calculation in Chapter 5 (section 5.5.1) enabled a statistically significant result to be found (if there was one present).

## 7.9 Chapter Summary

Findings from the quasi-experimental evaluation were obtained from a diverse participant demographic, which increases their generalisability. Using either learning tool significantly improved pre-registration trainee's knowledge on the topic areas. The VP was not found to be significantly superior at improving knowledge when compared to the NI learning tool for the case studies in this research. Significant results were found regarding the use of the VP and passing the pre-registration examination on first attempt, which may indicate the potential superiority of the VP as a learning tool. The main significant difference in knowledge improvement was found for sector of training and may be an area for further exploration. The VP tool was also found to increase reported engagement with learning compared to the NI case studies.

The findings from this quasi-experimental evaluation are purely quantitative and do not provide any explanations. Results from the questionnaires and telephone interviews will be presented and discussed in the next two chapters (Chapters 8 and 9) before triangulation of all results in the overall discussion chapter (Chapter 10).

# 8. Questionnaire Results

## 8.1 Introduction

All participants who completed the three case studies were asked to complete a questionnaire based on the learning tool they used (as discussed in Chapter 5, section 5.10.2). They were then given the opportunity to utilise the other style of case study and asked to complete a second questionnaire to obtain a detailed comparison of views. This chapter will report the analysis of the quantitative and qualitative (free-text) data obtained from the questionnaires.

The demographics of the participants who completed the questionnaires are presented in section 8.2. Section 8.3 reports the internal consistency of the questionnaires used. The descriptive and inferential statistical analysis of the Likert statements are presented in section 8.4. Graphical representation of the quantitative results obtained from the Likert statements are presented in section 8.5. Comparable Likert agreement scores for those trainees who used both types of learning tools and completed both questionnaires are presented in section 8.6. Content analysis of the free-text questions is presented in section 8.7. The overall findings from the questionnaires are discussed in section 8.8 and a summary of the chapter is provided in section 8.9.

## 8.2 Participant Demographics

Of the 63 participants who competed all three case studies, 56 completed the questionnaire (24 from the VP group and 32 from the NI group). The demographics of these participants are presented in Table 8-1 below. A similar gender split for the VP and NI groups was found (83% female, 17% male VP group; 84% female, 16% male NI group). The VP group had a greater proportion of hospital-based trainees complete the questionnaire (58% vs 31% in the NI group) and the NI group had a greater

proportion of community-based trainees complete the questionnaire (69% vs 42% in the VP group). Two participants from the VP group completed both types of case study and both questionnaires, and four trainees from the NI group completed both types of case study and both questionnaires (see section 8.6).

| | | Number of trainees (%) | |
|---|---|---|---|
| | | **VP Group** | **NI Group** |
| **Gender** | **Female** | 20 (83%) | 27 (84%) |
| | **Male** | 4 (17%) | 5 (16%) |
| **Sector** | **Hospital** | 14 (58%) | 10 (31%) |
| | **Community** | 10 (42%) | 22 (69%) |

**Table 8-1 Displays the percentage and number of participants related to the specific demographics.**

## 8.3 Internal Consistency

As explained previously in Chapter 5 (section 5.10.2), Cronbach's α was used to measure the internal consistency of the questionnaires. An overall score of 0.94 was obtained for the VP questionnaire and a score of 0.96 for the NI questionnaire from this main study. This led to an average Cronbach α score of 0.95 indicating very good reliability of the questionnaire.

Likert statements were then grouped into categories to determine if they correlated well with one another and a further Cronbach's α measurement was done to assess the reliability of these smaller subgroups of questions. The subgroups and their associated α-scores are presented in Table 8-2. As already noted in section 5.10.2, the higher the score (the closer the coefficient is to 1.0) the greater the internal consistency of the items in the scale, thus all subgroups showed good to very good reliability.

| | Cronbach α | | |
|---|---|---|---|
| | **VP** | **NI** | **Overall** |
| **Features (5 items)** | 0.81 | 0.86 | 0.84 |
| **Usability (5 items)** | 0.78 | 0.9 | 0.84 |
| **Development (10 items)** | 0.95 | 0.95 | 0.95 |

**Table 8-2 Presents the Cronbach α scores for the grouped Likert statements on the VP questionnaire, NI questionnaire and an overall average score.**

## 8.4 Descriptive and Inferential Statistics

As discussed in section Chapter 5 (section 5.11.2), the median was determined to be the most appropriate measure of central tendency for the agreement of the Likert statements. Mann-Whitney U tests were considered the most appropriate non-parametric test to calculate any significant differences in agreement for each of the statements on the two questionnaires. These results are displayed in Table 8-3. Four statements had different median agreement scores between the VP group and NI group: statements 1, 2, 15 and 17.

Analysis of the findings illustrated no significant differences between the median VP scores and median NI scores for any of the statements. One of the hypotheses presented in Chapter 5 (section 5.2) theorised that the VP would be superior at increasing reported enjoyment compared with the NI case studies, however the inferential analysis illustrated no significant difference between trainee's enjoyment at completing the VP cases or NI cases (p=0.1 based on 1-tailed Mann-Whitney U test).

| Statement Number | VP Median Score | NI Median Score | p-value |
|---|---|---|---|
| **1** | 4 | 3 | 0.25 |
| **2** | 4 | 3 | 0.21 |
| **3** | 4 | 4 | 0.2 |
| **4** | 4 | 4 | 0.25 |
| **5** | 4 | 4 | 0.22 |
| **6** | 4 | 4 | 0.65 |
| **7** | 4 | 4 | 0.98 |
| **8** | 4 | 4 | 0.26 |
| **9** | 4.5 | 4.5 | 0.85 |
| **10** | 4 | 4 | 0.31 |
| **11** | 4 | 4 | 0.55 |
| **12** | 4 | 4 | 0.28 |
| **13** | 4 | 4 | 0.97 |
| **14** | 4 | 4 | 0.19 |
| **15** | 5 | 4.5 | 0.31 |
| **16** | 3 | 3 | 0.93 |
| **17** | 4 | 3 | 0.22 |
| **18** | 3 | 3 | 0.94 |
| **19** | 3 | 3 | 0.89 |
| **20** | 4 | 4 | 0.74 |

**Table 8-3 Results are based on a 2-tailed Mann-Whitney U test.**

## 8.5 Percentage Distribution of Agreement Scores

In addition to the descriptive and inferential statistical analyses, the percentage distribution of agreement for each statement on the Likert scales was calculated. This has been identified as a suitable method for illustrating Likert statement agreement (Chapter 5, section 5.11.2).

Figure 8-1 to Figure 8-20 illustrate the percentage distribution of agreement for each of the Likert statements.

### 8.5.1 Statement 1

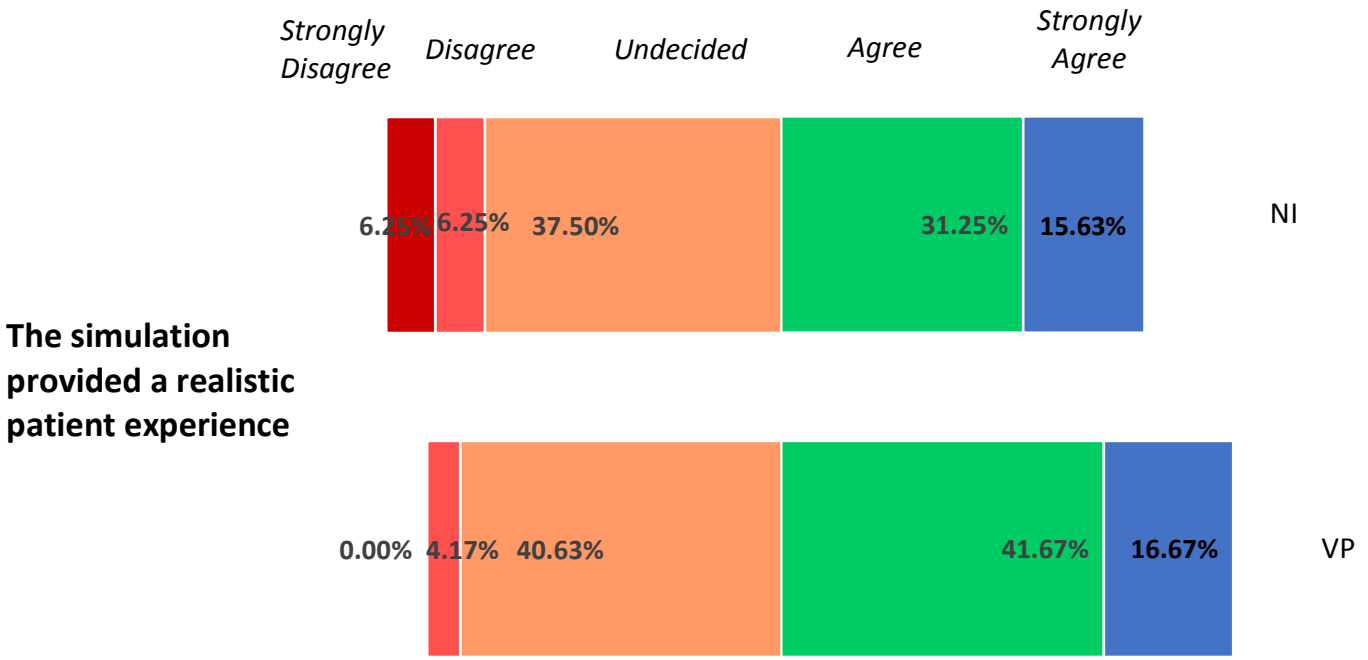



**Figure 8-1 Illustrates that a greater proportion of trainees in the VP group (58.3%) either 'agreed' or 'strongly agreed' that the simulation provided a realistic patient experience compared to the NI group (46.9%). The NI group had a small proportion of trainees (6.3%) who 'strongly disagreed' that the case studies were realistic compared to zero trainees in the VP group.**

### 8.5.2 Statement 2

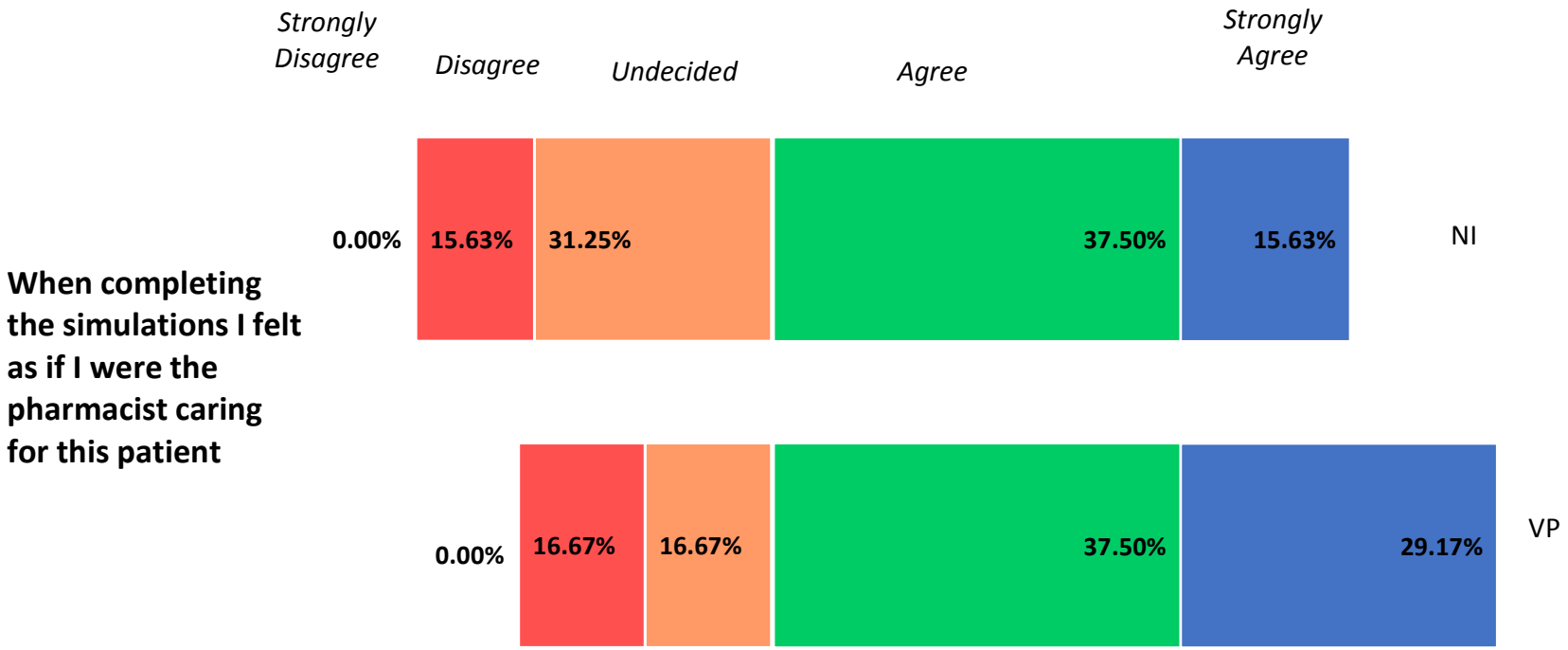



**Figure 8-2 Over half the trainees in both groups either 'agreed' or 'strongly agreed' that the simulations allowed them to feel like they were the pharmacist caring for the patient (66.7% VP group, 53.1% NI group). Nearly double the proportion of trainees were 'undecided' in the NI group (31.3%) compared to the VP group (16.7%).**

### 8.5.3 Statement 3

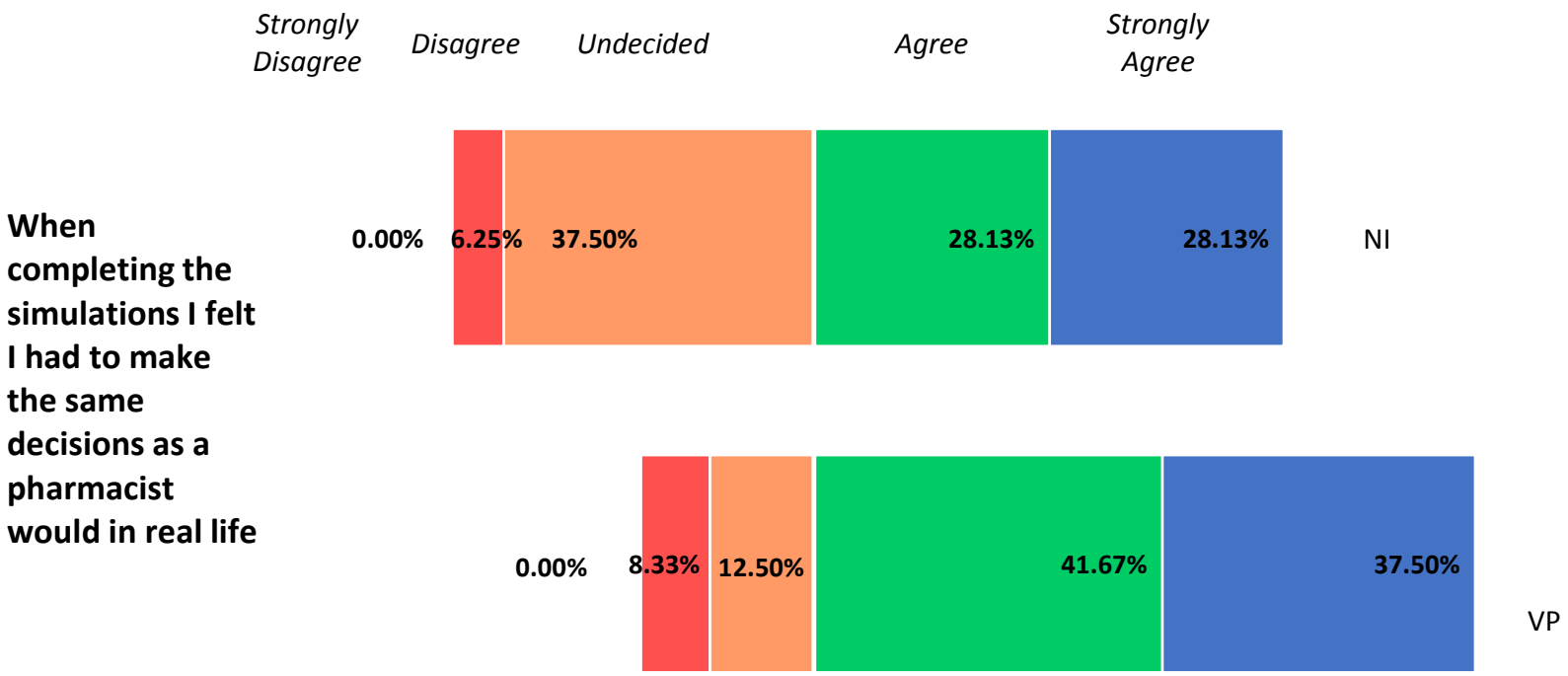



**Figure 8-3 Illustrates that over half of the trainees in the NI group (56.3%) and over three-quarters of trainees in the VP group (79.2%) either 'agreed' or 'strongly agreed' that the simulation made them feel like they were making the same decisions as they would have to when working as a pharmacist. The greatest proportion of trainees in the VP group 'agreed' with the statement, whereas the majority of trainees in the NI group were 'undecided'.**

### 8.5.4 Statement 4

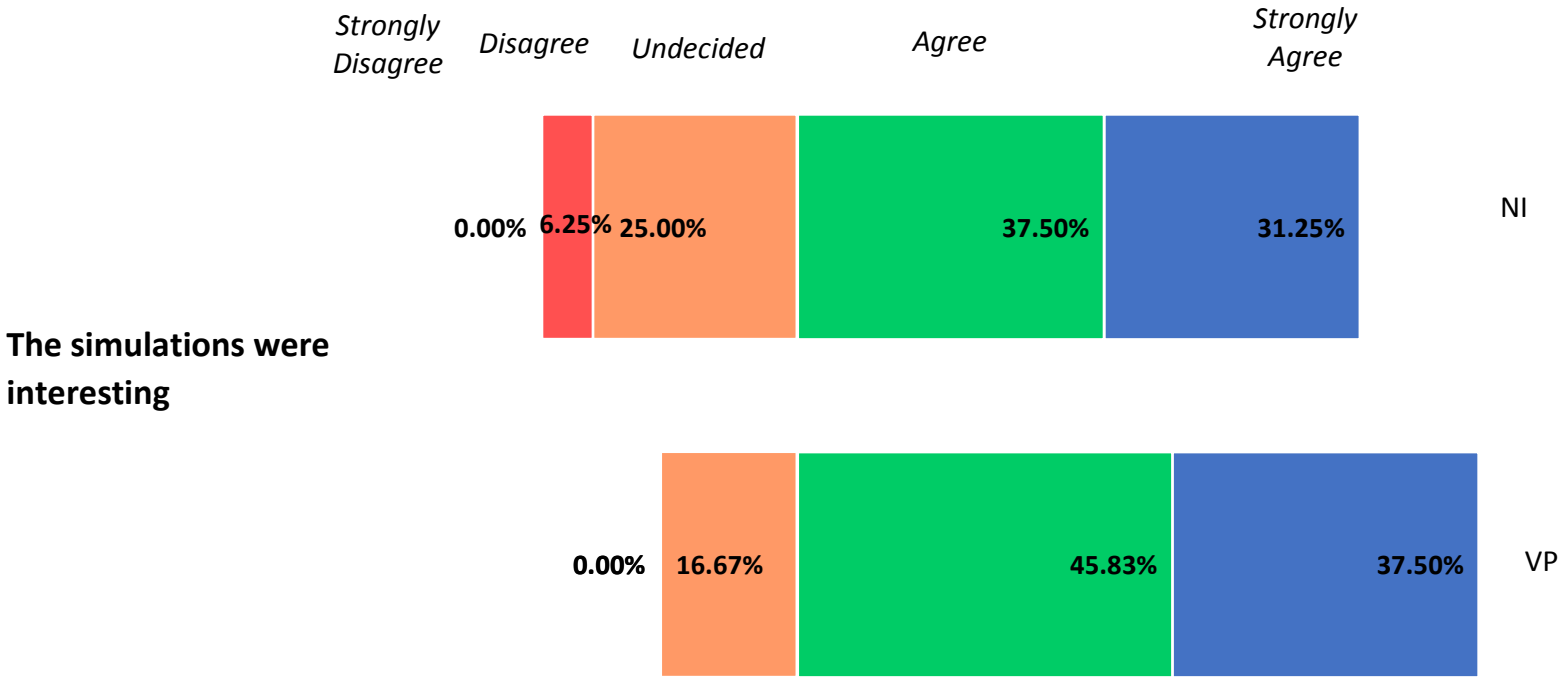



**Figure 8-4 Illustrates the majority of participants in both groups 'agreed' or 'strongly agreed' that the simulations were interesting; 68.8% of trainees in the NI group and 83.3% of trainees in the VP group. A small proportion of trainees in the NI group (6.3%) disagreed that the case studies were interesting, whereas zero trainees in the VP group disagreed with this statement.**

### 8.5.5 Statement 5

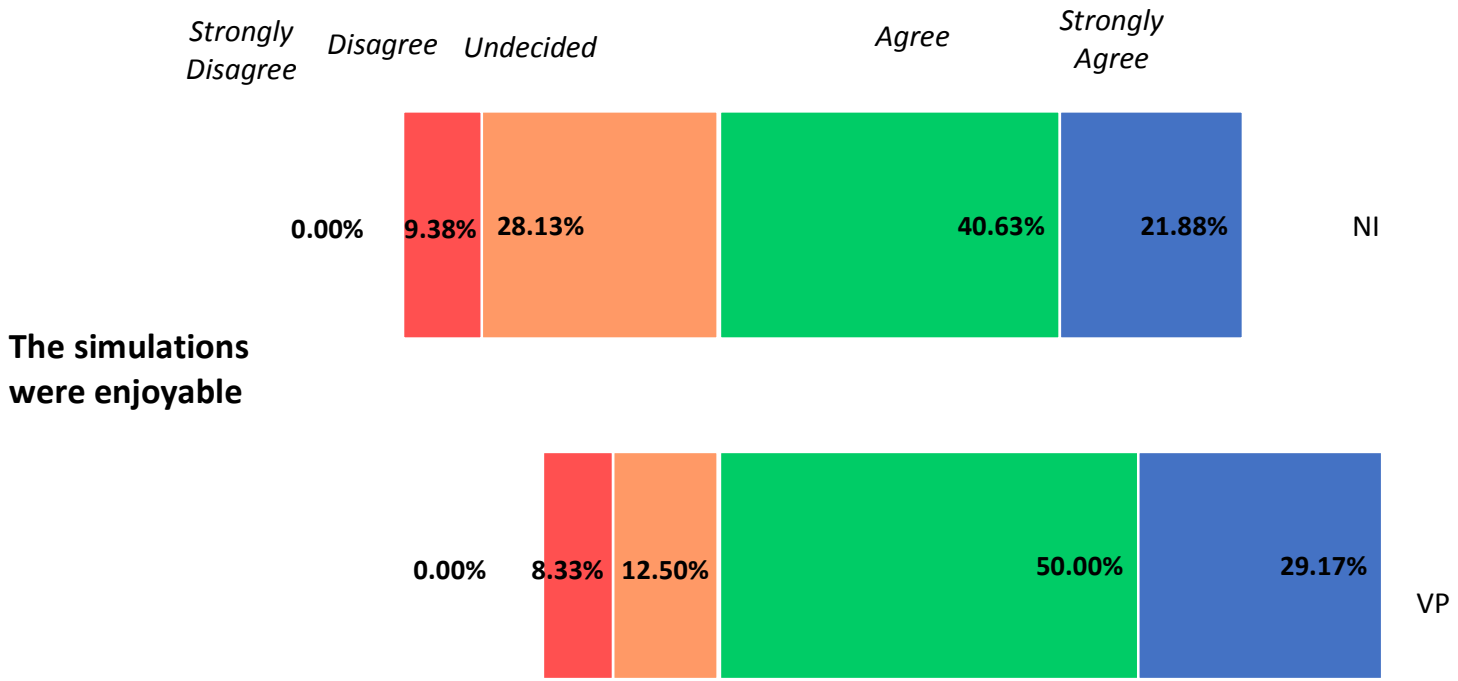



**Figure 8-5 shows that, overall, the majority of trainees in both groups either 'agreed' or 'strongly agreed' that the simulations were enjoyable (79.2% VP group, 62.5% NI group). More trainees from the NI group were 'undecided' than those in the VP group regarding their agreement (28.1% NI group, 12.5% VP group).**

### 8.5.6 Statement 6

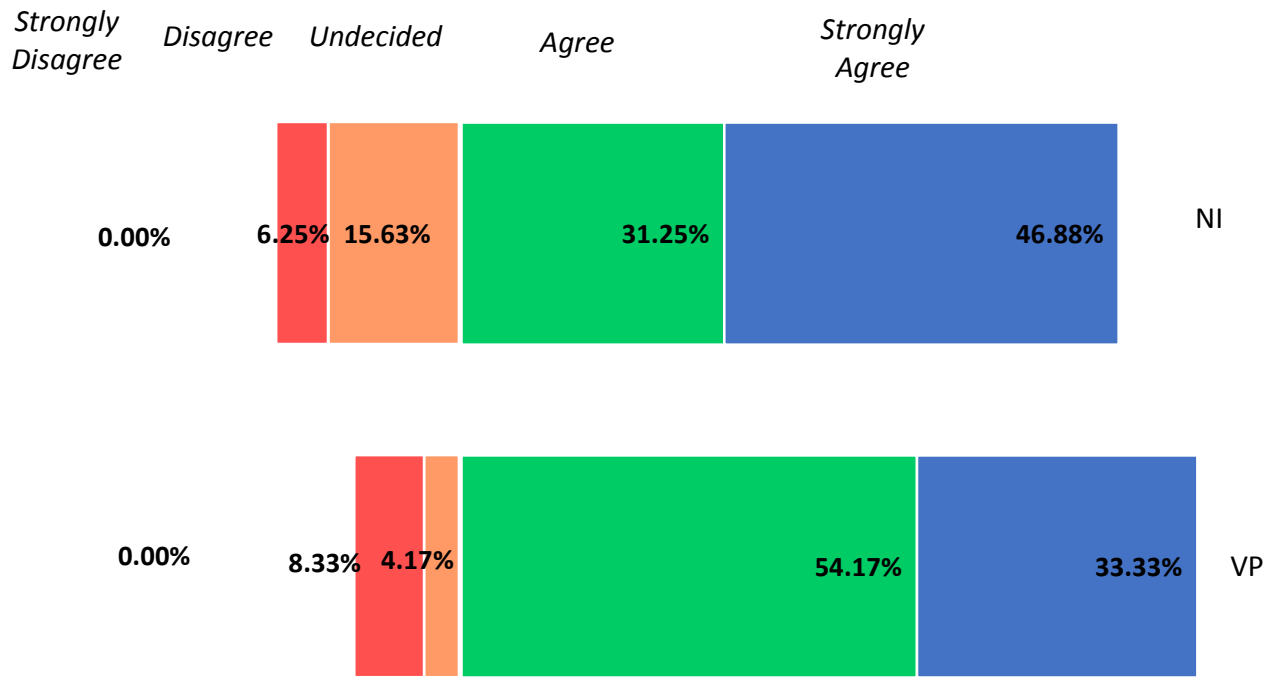



**Figure 8-6 For both groups, the greatest proportion of trainees 'agreed' or 'strongly agreed' that the simulations were of appropriate difficulty for their level of training (87.5% VP group, 78.1% NI group). Both groups had a proportion of trainees who were 'undecided' regarding their agreement with this statement, but this proportion was three times bigger in the NI group than the VP group (15.6% NI group, 4.1% VP group).**

### 8.5.7 Statement 7

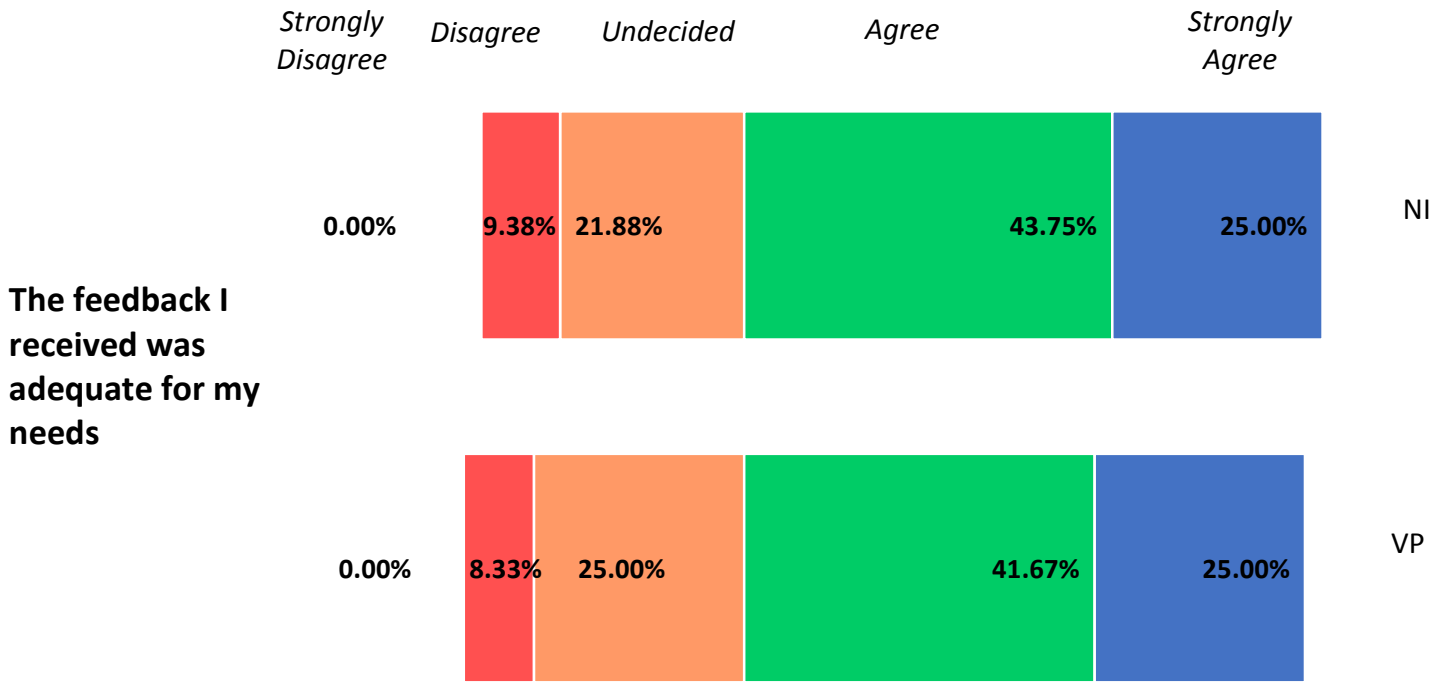



**Figure 8-7 Overall, there was similar agreement in both groups for the adequacy of the feedback for the case studies. The greatest proportion of trainees either 'agreed' or 'strongly agreed' that the feedback was adequate (66.7% VP group, 68.8% NI group).**

### 8.5.8 Statement 8

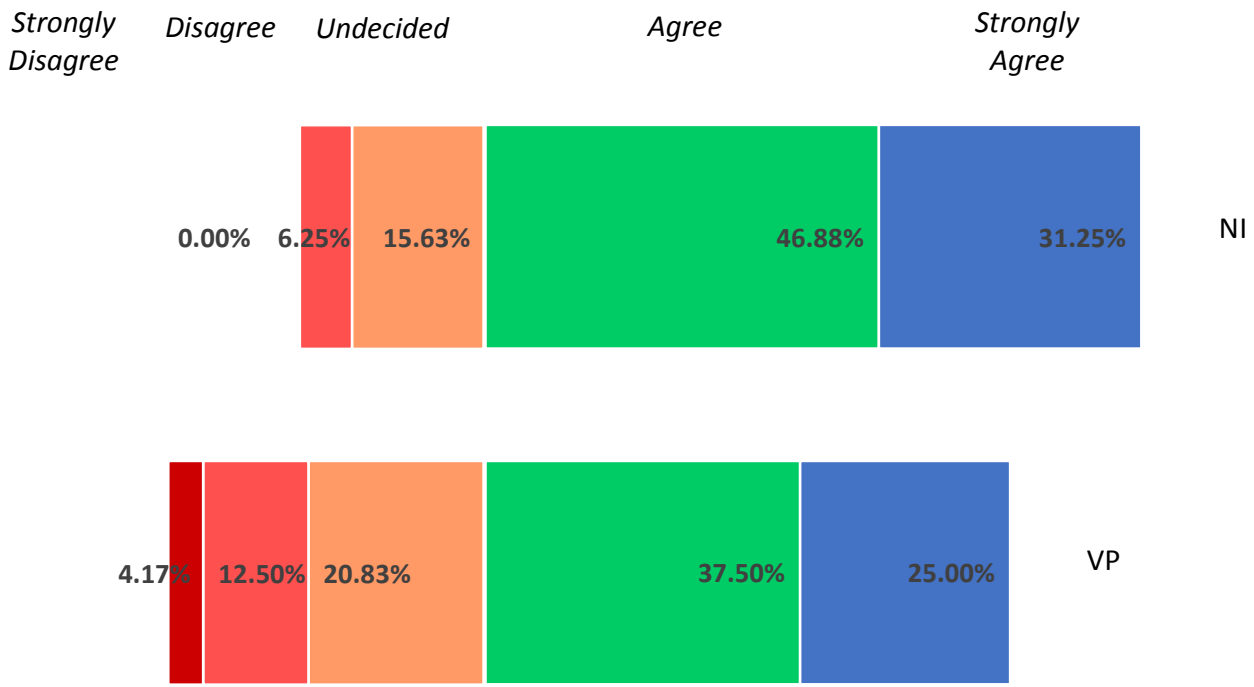



**Figure 8-8 The majority of trainees in both groups either 'agreed' or 'strongly agreed' that the objectives for the simulation were clear and easy to understand (62.5% VP group, 78.1% NI group). The VP group had a small proportion of trainees who 'strongly disagreed' with this statement (4.2%) whereas the NI group had zero trainees who 'strongly disagreed'.**

### 8.5.9 Statement 9

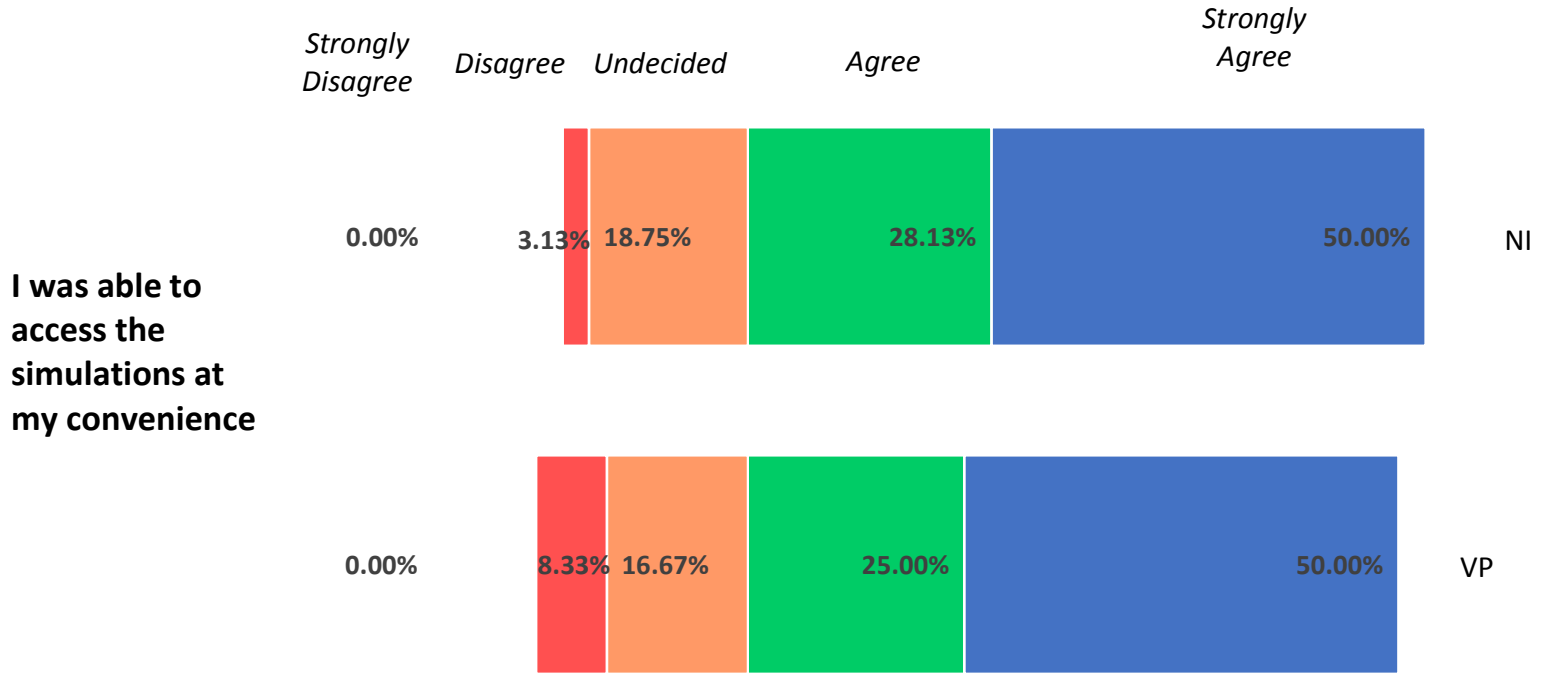



**Figure 8-9 Illustrates similar levels of agreement for both groups. Most trainees either 'agreed' or 'strongly agreed' that they could access the simulations at their convenience (75% VP group, 78.1% NI group).**

### 8.5.10 Statement 10

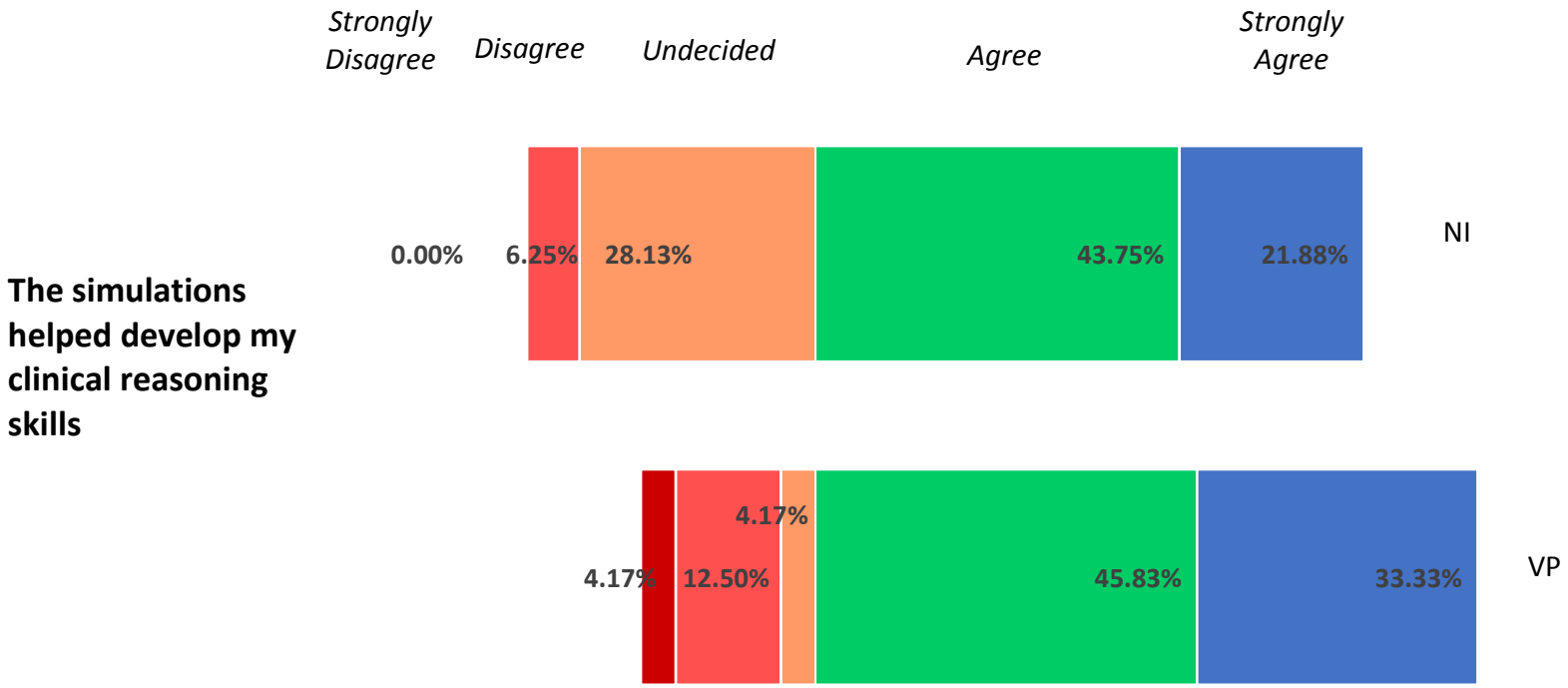



**Figure 8-10 Illustrates that the majority of trainees in both groups either 'agreed' or 'strongly agreed' that the simulations helped develop their clinical reasoning skills (79.2% VP group, 65.6% NI group). A smaller proportion of trainees in the VP group were 'undecided' compared to the NI group (4.2% vs 28.1%). Both groups had trainees who 'disagreed' with the statement, but this proportion was double in the VP group compared to the NI group (12.5% vs 6.3%). The VP group also found 4.2% of trainees 'strongly disagreed' with this statement whereas zero trainees in the NI group 'strongly disagreed'.**

### 8.5.11 Statement 11

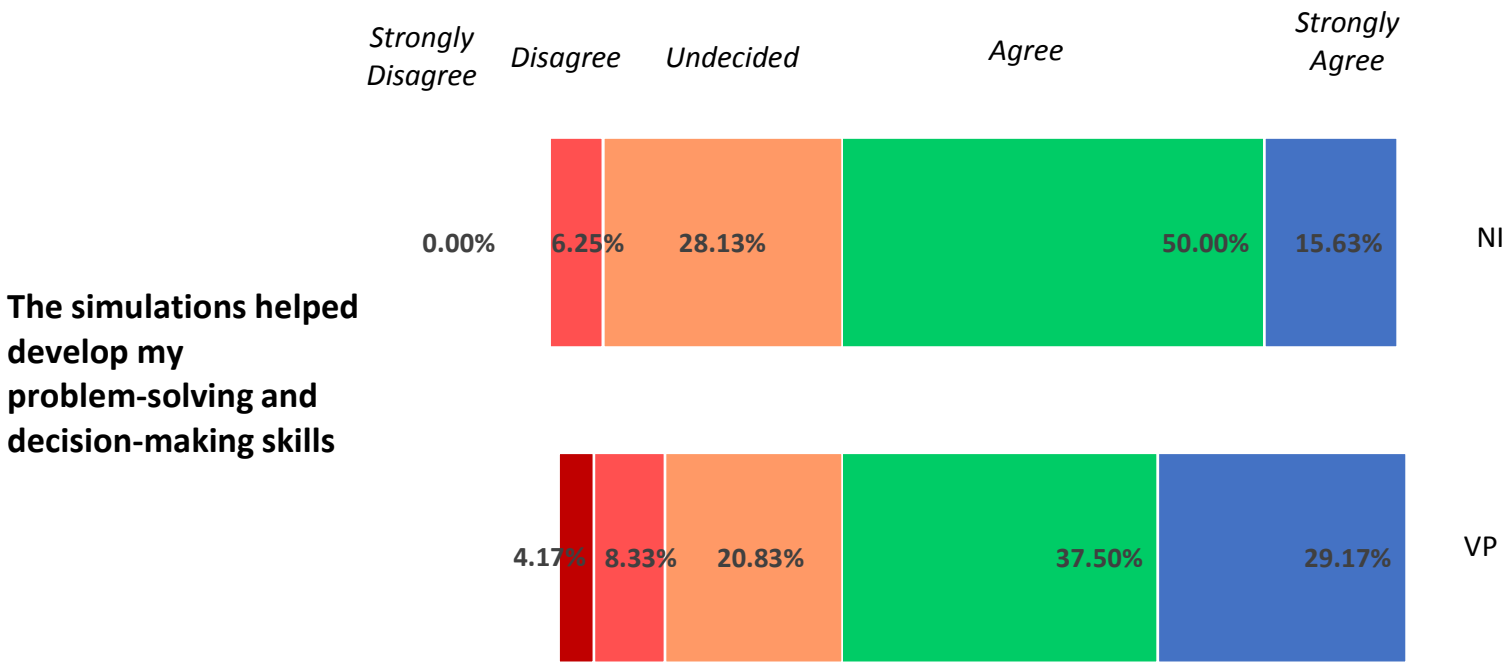



**Figure 8-11 Shows similar results for the NI and VP groups. Over half the trainees in both groups 'agreed' or 'strongly agreed' that the simulations helped develop their problem-solving and decision-making skills (66.7% VP group, 65.6% NI group). A small proportion of trainees in the VP group (4.2%) 'strongly disagreed', whereas zero trainees in the NI group 'strongly disagreed' with this statement.**

### 8.5.12 Statement 12

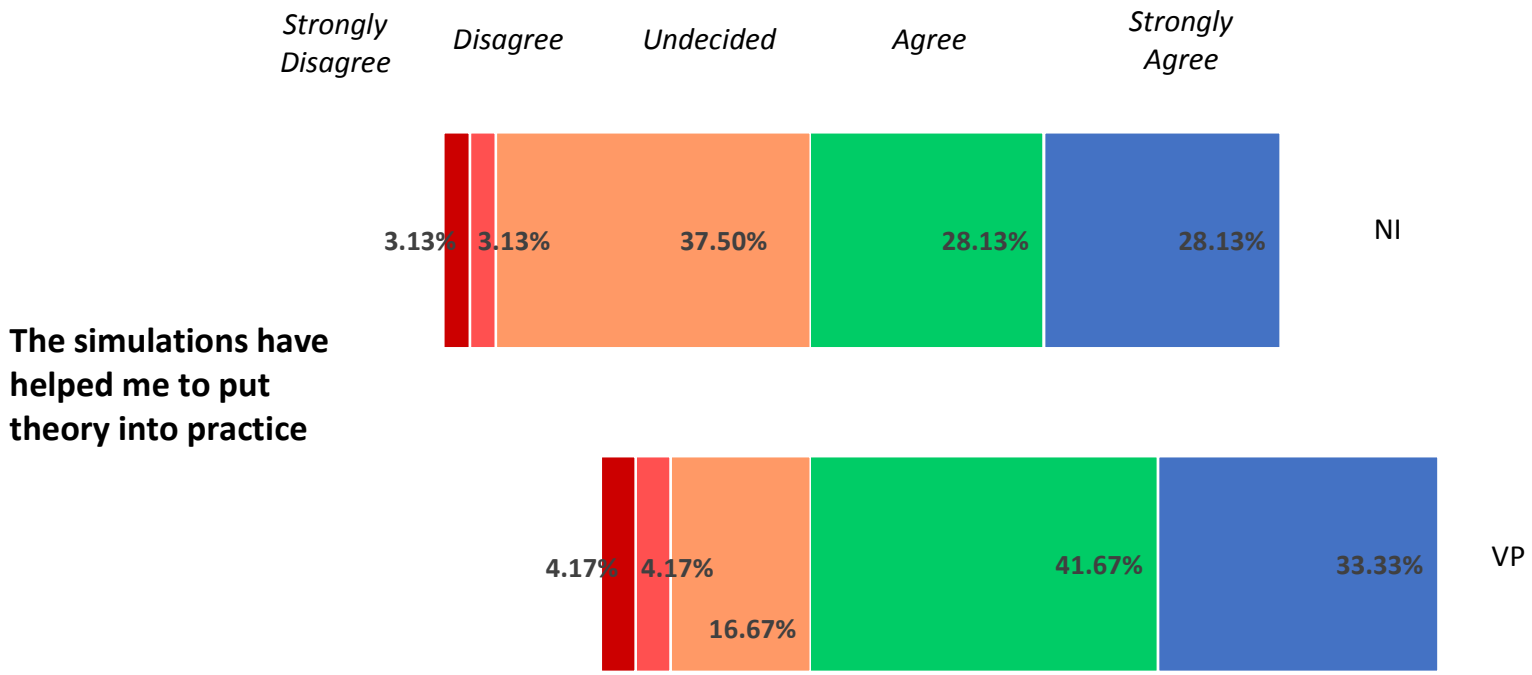



**Figure 8-12 Both groups showed over half of trainees 'agreed' or 'strongly agreed' that the case studies helped them put theory into practice (75% VP group, 56.3% NI group). In the NI group, the majority of trainees appeared 'undecided' in their agreement (37.5%), whereas the largest proportion of trainees in the VP group 'agreed' with the statement (41.7%).**

### 8.5.13 Statement 13

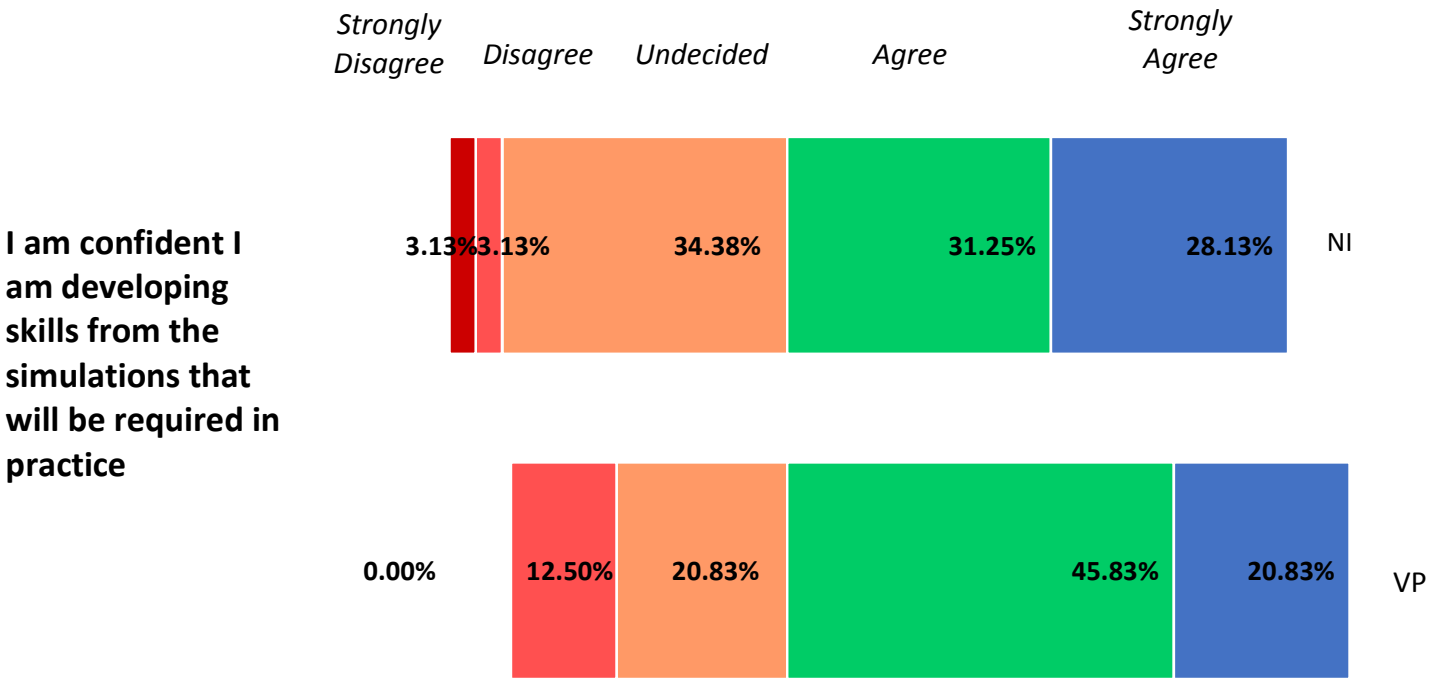



**Figure 8-13 Overall, 66.7% of trainees in the VP group 'agreed' or 'strongly agreed' that they were developing skills from the simulations compared to 59.4% of trainees in the NI group. The NI group had the greatest proportion of trainee's report that they were 'undecided' regarding this statement (34.4%), whereas the VP group had the most trainees 'agree' with the statement (45.8%).**

### 8.5.14 Statement 14

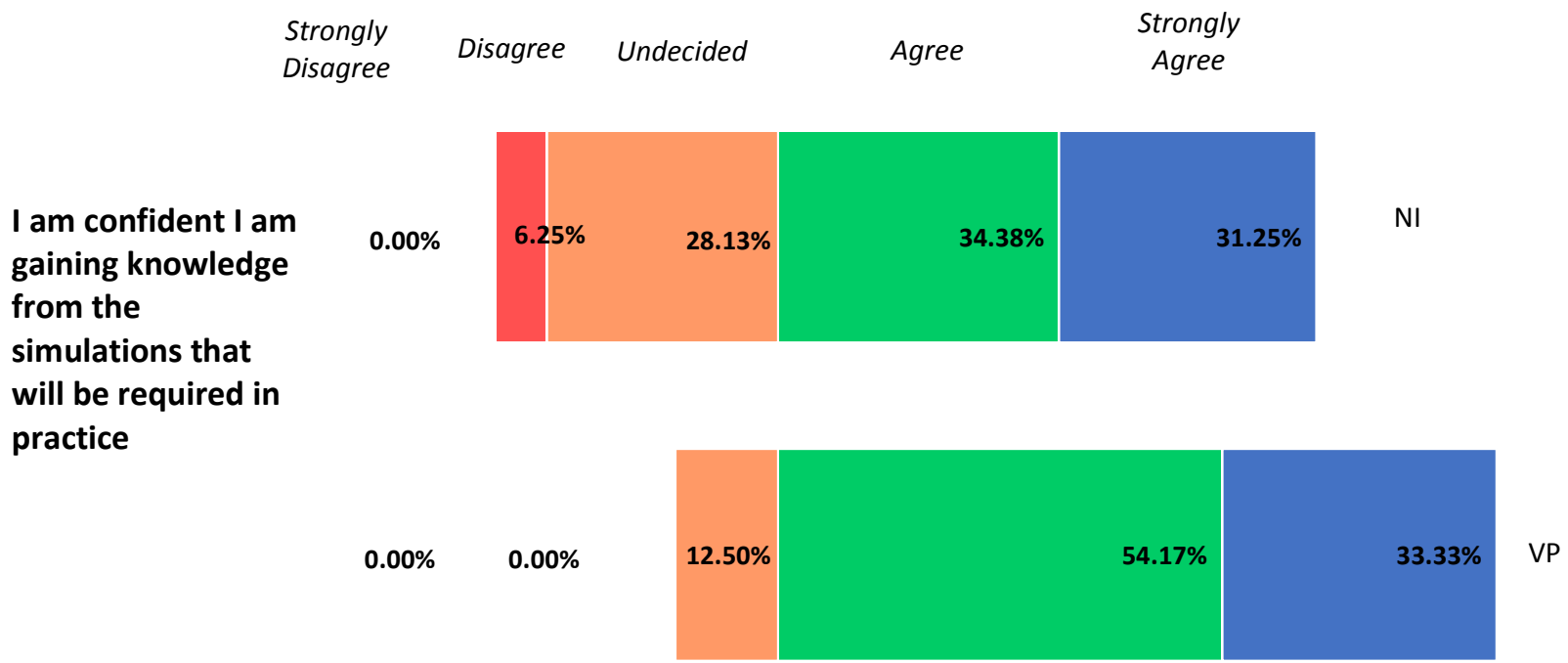



**Figure 8-14 Illustrates varied agreement between the two groups, however, both groups reported the majority of trainees either 'agreed' or 'strongly agreed' that they were gaining knowledge from the simulations that would be required in practice (87.5% VP group, 65.6% NI group). The NI group had over double the proportion of trainees who were 'undecided' compared with the VP group (28.1% NI group vs 12.5% VP group).**

### 8.5.15 Statement 15

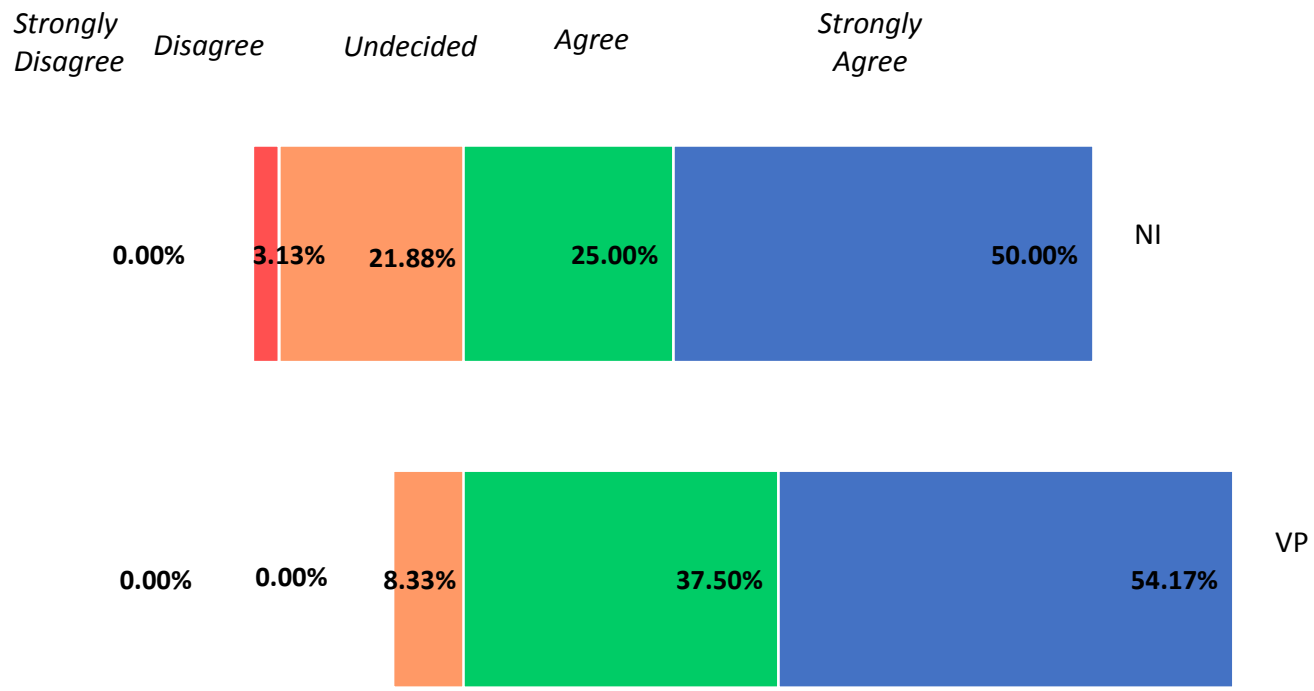



**Figure 8-15 Illustrates that the majority of trainees in both groups either 'agreed' or 'strongly agreed' that it was their own responsibility to learn what they needed to from the simulations (91.7% VP group, 75% NI group). Over half the trainees in both groups 'strongly agreed' with this statement. A small proportion of trainees in the NI group 'disagreed' with this statement (3.1%) whereas this was not reported in the VP group.**

### 8.5.16 Statement 16

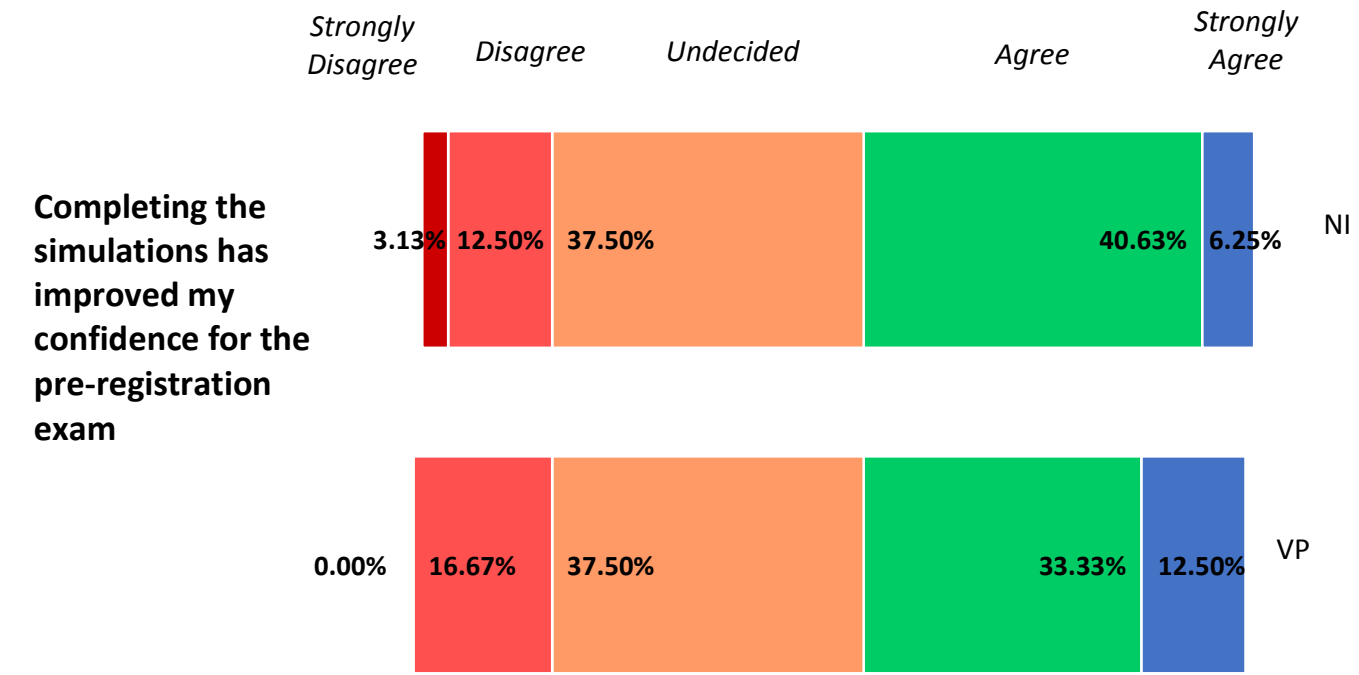



**Figure 8-16 Illustrates varied distribution of agreement scores regarding the simulations improving confidence for the pre-registration exam. The largest proportion of trainees in the NI group 'agreed' with the statement (40.6%), followed by being 'undecided' (37.5%). In the VP group, most of the trainees were 'undecided' (37.5) followed by 'agreeing' with the statement (33.3%). The NI group had a small proportion of trainees who 'strongly disagreed' with the statement (3.1%) whereas zero trainees in the VP group 'strongly disagreed'.**

### 8.5.17 Statement 17

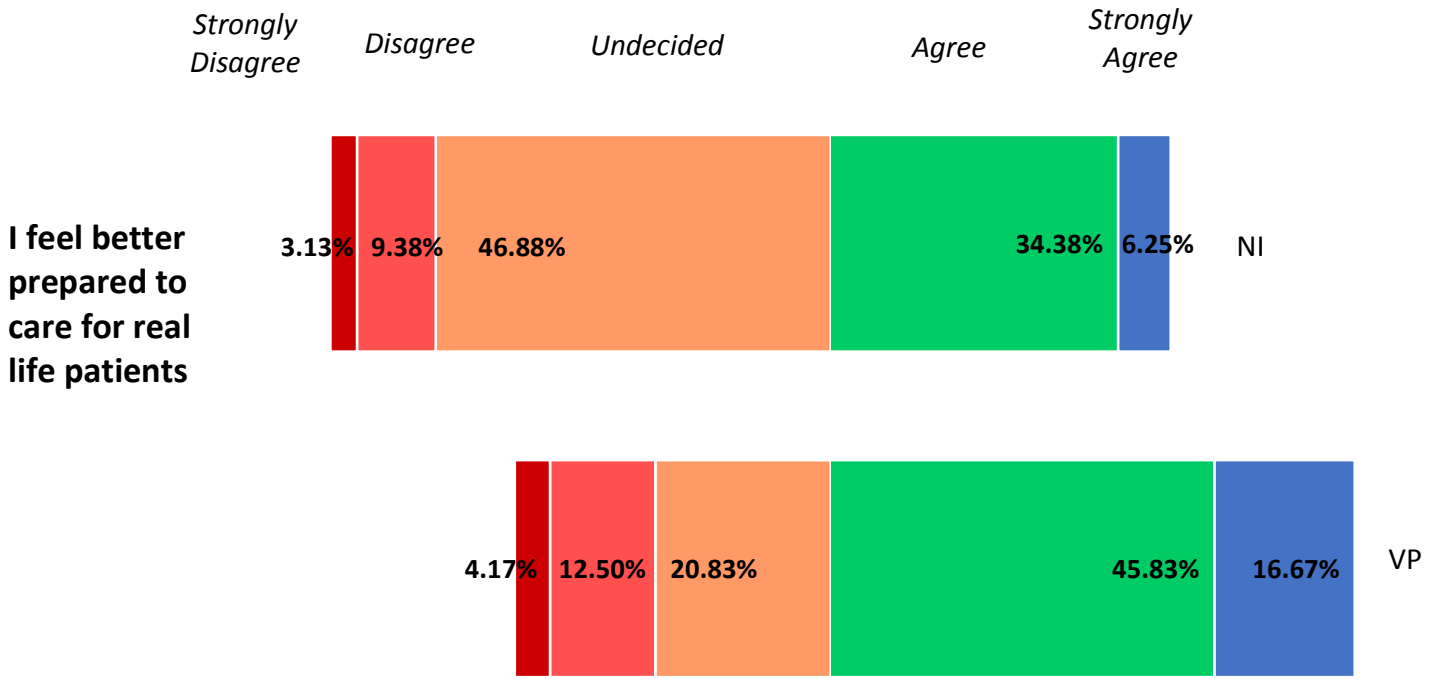



**Figure 8-17 Overall, there was a greater agreement from trainees in the VP group than trainees in the NI group that they felt better prepared to care for real life patients. The largest proportion of trainees in the VP group 'agreed' or 'strongly agreed' (62.5%) compared to the NI group (40.6%). The NI group had the largest proportion of trainees report they were 'undecided' regarding the statement (46.9%) compared to 20.8% in the VP group.**

### 8.5.18 Statement 18

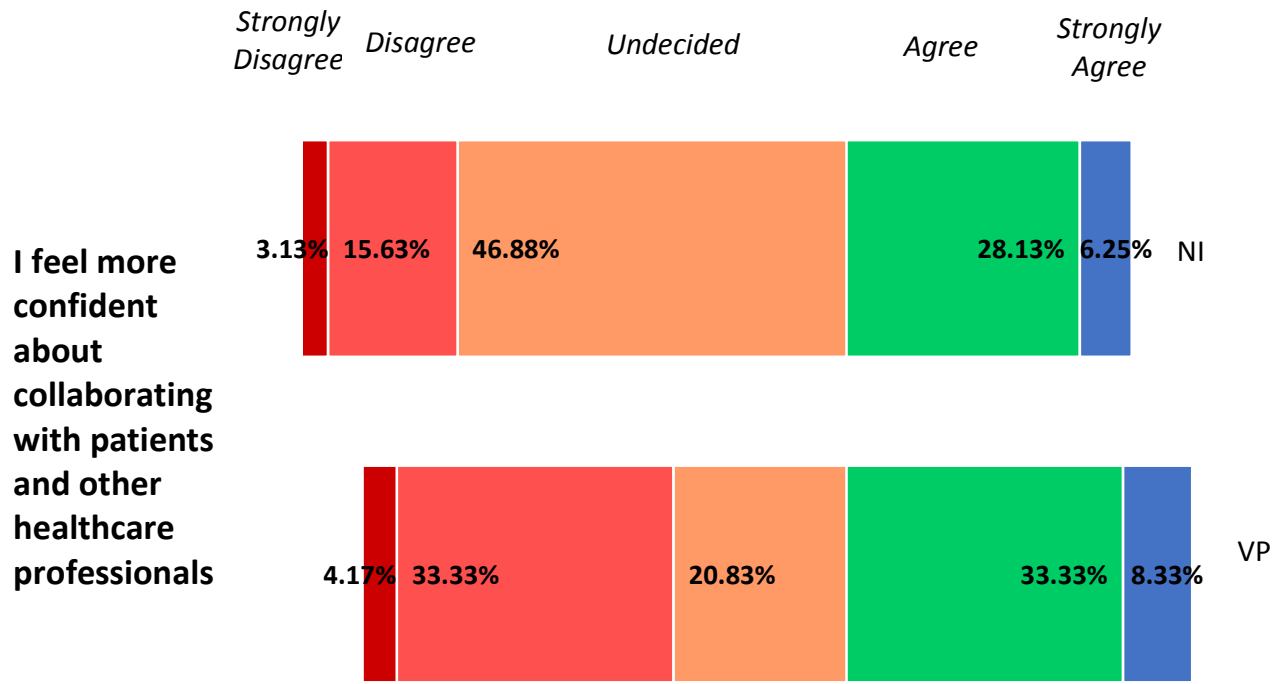



**Figure 8-18 Illustrates that the NI group had the largest proportion of trainees who were 'undecided' regarding their agreement (46.9%), whereas the VP group had the largest proportion of trainees who 'agreed' or 'strongly agreed' (41.7%) that their confidence for collaborating with patients and other healthcare professionals had improved. The VP group had over double the number of trainees 'disagree' compared to the NI group (33.3% vs 15.6%).**

### 8.5.19 Statement 19

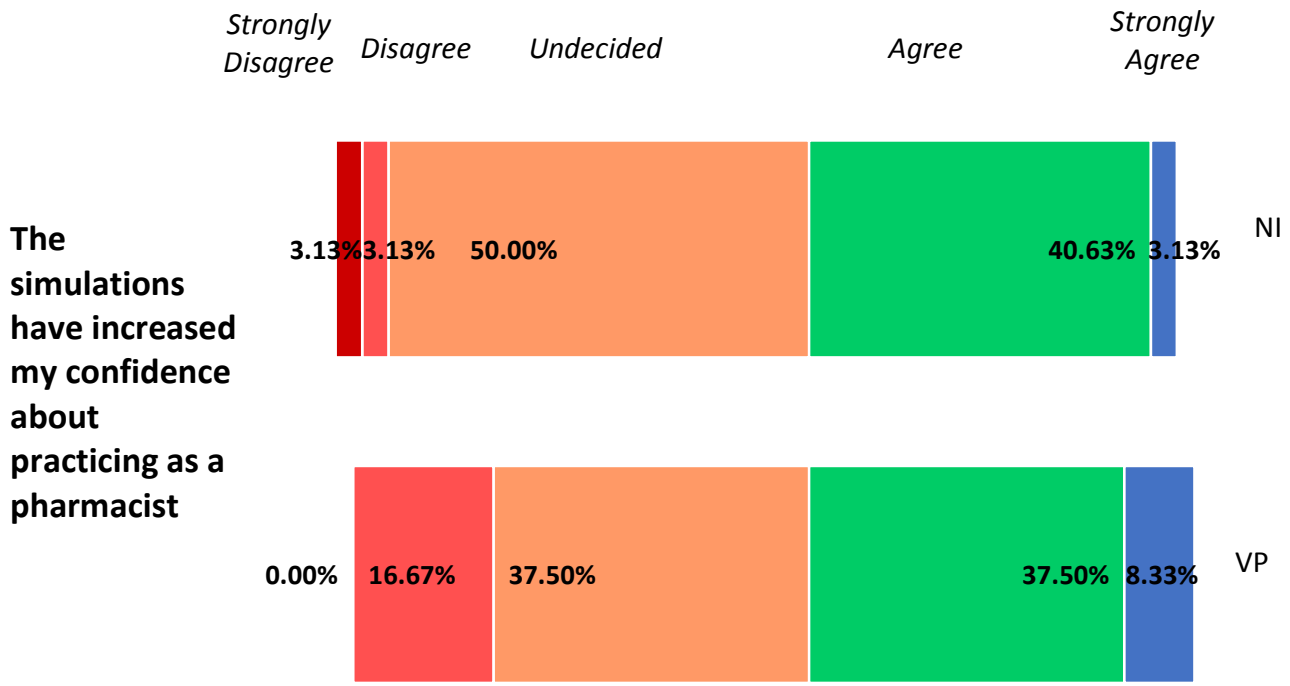



**Figure 8-19 Illustrates the greatest proportion of trainees in the NI group were 'undecided' regarding the case studies increasing their confidence about practicing as a pharmacist (50%). The VP group also had a large proportion of trainees who were 'undecided' (37.5%) but the greatest proportion of trainees either 'agreed' or 'strongly agreed' with the statement (45.8% VP group vs 43.8% NI group). The VP had a much greater proportion of trainees who disagreed with the statement compared to the NI group (16.7% vs 3.1%).**

### 8.5.20 Statement 20

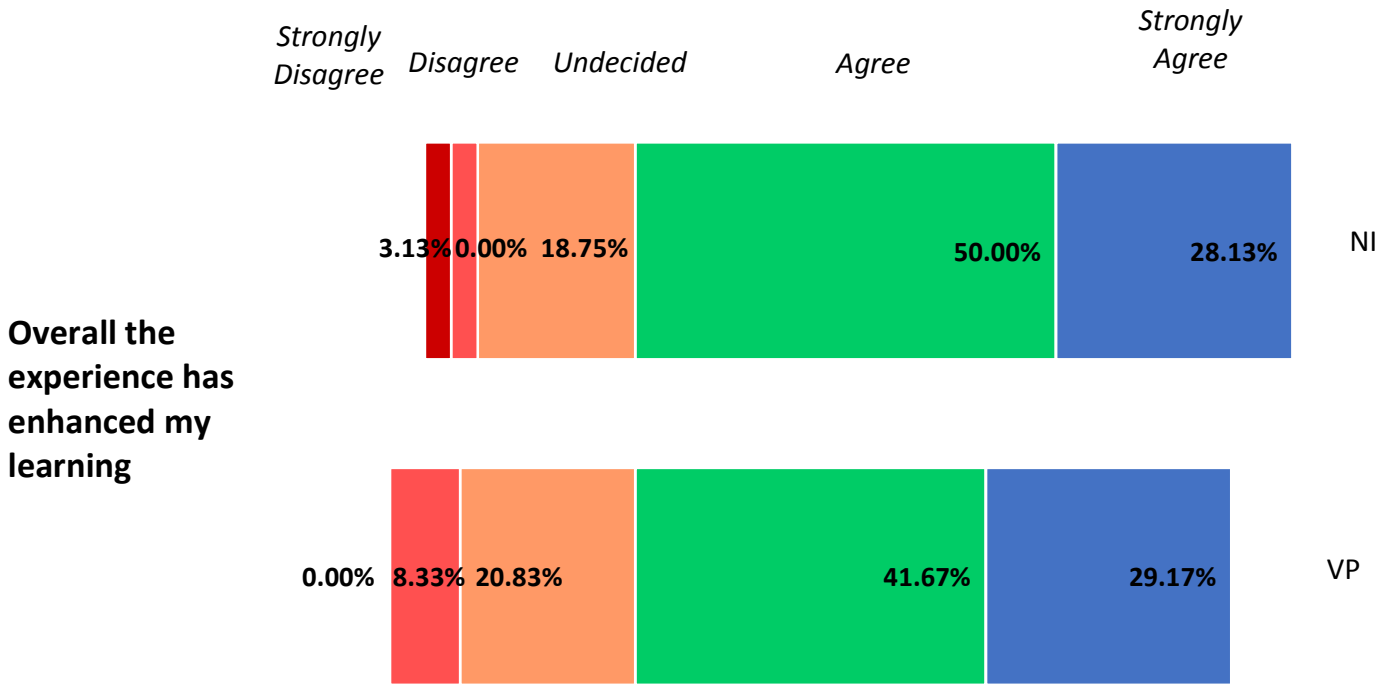



**Figure 8-20 Shows that the majority of trainees in both groups either 'agreed' or 'strongly agreed' that completing the case studies enhanced their learning (70.8% VP group, 78.1% NI group).**

## 8.6 Comparison of Agreement Scores

Of the 24 trainees in the VP group who completed the questionnaire, two trainees also used the NI case studies and completed the second questionnaire. Of the 32 trainees in the NI group who completed the questionnaire, four trainees went on to use the VP case studies and completed the second questionnaire. Comparative agreement scores for each of the Likert statements are shown below in Table 8-4.

The findings illustrate that all six of the trainees reported that the VP simulations were more realistic than the NI case studies, with four of the trainees reporting the VP simulations allowed them to feel more like they were pharmacists caring for a patient. All trainees reported that the VP simulations were more enjoyable and interesting than the NI case studies. The findings also illustrated that four of the trainees believed the VP gave more adequate feedback. The VP simulations were reported by five trainees to aid the development of clinical reasoning skills, problem-solving and decision-making skills more than the NI case studies. Four trainees reported the VP better developed required skills for practice and all six reported the VP better aided knowledge development. All six trainees reported that the VP simulations allowed them to put theory into practice to a greater extent than the NI case studies. Five of the trainees reported that the VP simulations increased their confidence more for the pre-registration exam than the NI case studies and all trainees reported that the VP prepared them better to care for real life patients. The VP case studies were also associated with higher agreement scores regarding collaborating with patients and other healthcare professionals and practicing as a pharmacist; as reported by four trainees. Overall, four trainees reported that the VP case studies enhanced their learning to a greater extent than the NI case studies.

In contrast, trainees reported greater agreement towards the NI case studies regarding the more practical Likert statements. Four trainees reported that the objectives for the NI cases were clearer and easier to understand and that they were easier to access.

| Statement | VP Group | | | | NI Group | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Participant 14 | | Participant 36 | | Participant 96 | | Participant 107 | | Participant 123 | | Participant 149 | |
| | VP | NI | VP | NI | VP | NI | VP | NI | VP | NI | VP | NI |
| The simulation provided a realistic patient simulation | 5 | 4 | 5 | 4 | 4 | 3 | 5 | 4 | 5 | 4 | 5 | 4 |
| When completing the simulations I felt as if I were the pharmacist caring for this patient | 5 | 2 | 5 | 3 | 4 | 3 | 4 | 4 | 5 | 5 | 5 | 2 |
| When completing the simulations I felt I had to make the same decisions as a pharmacist would in real life | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 5 | 4 | 5 | 4 |
| The simulations were interesting | 5 | 2 | 5 | 4 | 5 | 4 | 5 | 4 | 5 | 4 | 5 | 4 |
| The simulations were enjoyable | 5 | 2 | 5 | 3 | 5 | 4 | 5 | 4 | 5 | 4 | 5 | 3 |
| The difficulty of the simulations was appropriate for my level of training | 5 | 5 | 5 | 5 | 4 | 5 | 4 | 4 | 4 | 5 | 4 | 5 |
| The feedback I received was adequate for my needs | 5 | 2 | 5 | 2 | 5 | 5 | 5 | 4 | 5 | 4 | 4 | 4 |
| The objectives for the simulations were clear and easy to understand | 5 | 5 | 4 | 5 | 4 | 5 | 4 | 5 | 5 | 4 | 4 | 5 |
| I was able to access the simulations at my convenience | 3 | 5 | 5 | 5 | 3 | 5 | 4 | 5 | 5 | 4 | 4 | 5 |
| The simulations helped develop my clinical reasoning skills | 5 | 3 | 5 | 4 | 5 | 5 | 5 | 4 | 5 | 4 | 5 | 3 |
| The simulations helped develop my problem-solving and decision-making skills | 5 | 4 | 5 | 4 | 5 | 5 | 5 | 4 | 5 | 4 | 5 | 4 |
| The simulations have helped me to put theory into practice | 5 | 2 | 5 | 3 | 5 | 4 | 5 | 4 | 5 | 4 | 5 | 3 |
| I am confident I am developing skills from the simulations that will be required in practice | 5 | 3 | 5 | 4 | 5 | 5 | 4 | 4 | 5 | 4 | 5 | 4 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I am confident I am gaining knowledge from the simulations that will be required in practice | 5 | 4 | 5 | 4 | 5 | 4 | 5 | 4 | 5 | 4 | 5 | 4 |
| It is my responsibility to learn what I need to know from the simulations | 5 | 5 | 5 | 5 | 4 | 4 | 4 | 4 | 5 | 5 | 5 | 5 |
| Completing the simulations has improved my confidence for the pre-registration exam | 5 | 2 | 4 | 3 | 4 | 4 | 4 | 3 | 4 | 3 | 5 | 4 |
| I feel better prepared to care for real life patients | 5 | 2 | 5 | 3 | 5 | 4 | 5 | 3 | 5 | 4 | 5 | 3 |
| I feel more confident about collaborating with patients and other healthcare professionals | 5 | 3 | 5 | 3 | 4 | 4 | 4 | 4 | 5 | 3 | 4 | 3 |
| The simulations have increased my confidence about practicing as a pharmacist | 5 | 3 | 5 | 4 | 4 | 4 | 4 | 4 | 5 | 4 | 5 | 4 |
| Overall the experience has enhanced my learning | 5 | 4 | 5 | 4 | 4 | 4 | 4 | 4 | 5 | 4 | 5 | 4 |

**Table 8-4 Displays the individual agreement scores for each Likert statement for the trainees in both groups who completed both types of case study.**

## 8.7 Qualitative Results

The open-ended questions on the questionnaire covered: trainees likes and dislikes towards the case studies, improvements that could be made to the case studies and where the case studies could be utilised within the pre-registration training year. As discussed in Chapter 5 (section 5.11.3) a content analysis was carried out on the findings from the questionnaire. Five main topics emerged from the data, with a series of themes within them:

- Case study design features, which included comments relating to the novelty of the learning tools, their interactivity and realism, the level of feedback and structure of the case studies.
- Usability of the learning tools, which included comments relating to the level of instructions provided, the accessibility of the case studies and recognition problems associated with the case studies.
- Use of the case studies as learning tools, which included comments regarding the ability of the case studies to improve knowledge, aid skill development, promote the application of knowledge and the integration of pre- and post-MCQs to self-assess knowledge improvement.
- Case study topics, which included comments relating to the relevance of the topics chosen and future topics which may be useful in pre-registration training.
- Integration of the case studies into pre-registration training, which included comments relating to their use as individual or group learning tools and to aid cross-sector or competency development.

| Theme | Number of trainees | | Quote |
|---|---|---|---|
| | VP Group | NI Group | |
| **Case Study Design Features** | | | |
| Novelty | 22 | 0 | *"It is virtual 21st century technology…I have not used anything like this before."* P58[2], VP Group |
| Realism | 18 | 2 (from the trainees who used both types of learning tool) | *"The actual simulation of the patient in terms of the voice and movement was really good…very realistic."* P39, VP Group<br><br>*"I like the more real-life nature of the [VP] scenarios compared to the paper cases."* P149, NI Group |
| Feedback | 11 | 9 | *"…instant feedback and the end summary was very helpful to find out weaknesses and areas needed for revision."* P65, VP Group<br><br>*"The answers and feedback provided was also easy to understand and the references included were useful for further reading."* P69, NI Group |
| Interactivity | 10 | 12 | *"[I liked] the ability to ask questions to a patient and they responded like a real-life consultation…made me think about the language and phrases I would use."* P42, VP Group<br><br>*"I feel more detail and stimulation is required to prepare for real life situations…input more images and colour to make it more interactive and more interesting to complete."* P144, NI Group |
| Structure | 6 | 7 | *"The final case study had an almost 'autocomplete' feel with the drop-down options for the questions. This made it much easier but almost like cheating."* P154, VP Group |

[2] P = participant number. The numbers were provided to participants upon consenting to take part in the study and each individual kept this participant number throughout the research study.

| | | | |
|---|---|---|---|
| | | | *''They [the cases] were well structured and easy to complete…the cases had clear objectives and the answer sections were broken down to help engagement."* P74, NI Group |
| **Usability of the Learning Tools** | | | |
| Recognition aspects | 16 | 0 | *"I found that a number of times I had responded with a correct/relevant answer (which appeared in the feedback) however the system had not picked up on this. Due to this I found it quite frustrating to complete."* P93, VP Group<br><br>*"More options for what we could ask the patient would have helped us more easily obtain the information we needed. A broader range of wording of the required questions would make the simulations easier to use."* P39, VP Group |
| Accessibility | 8 | 4 | *"I couldn't access them [the cases] on my iPad, iPhone or certain computers which made it difficult and inconvenient…."* P148, VP Group<br><br>*"They were easy to access…I liked that I could do bits as and when, instead of feeling overloaded."* P74, NI Group |
| Instructions provided | 7 | 5 | *"The interface was not always intuitive to use…could have provided clearer instructions while using the system."* P96, NI Group (comment made regarding VP case)<br><br>*"There wasn't enough information on the reason for each part of the study and what was required..."* P123, NI Group |
| **Case Study Topics** | | | |
| Relevance | 18 | 19 | *"They were real-to-life scenarios which I could easily come across therefore it helped me to focus on what I need to know and think about how I would answer queries."* P93, VP Group<br><br>*"They [the case studies] concerned aspects of pharmacy that I will need to know as a professional pharmacist and scenarios that I will commonly come across during my career."* P67, NI Group |

| | | | |
|---|---|---|---|
| Improvements | 10 | 15 | *"…make them [the case studies] a bit lengthier and covering a wider range of issues within the case…a bit more complex as you progress through pre-reg."* P147, VP Group<br><br>*"A few case studies could be made to fit around each section of the BNF or responding to symptoms textbook…integrate learning together."* P107, NI Group |
| **Use of the Case Studies as a Learning Tool** | | | |
| Skill development | 10 | 11 | *"[The cases] emphasised clinical responsibility and gave practice at decision making."* P148, VP Group<br><br>*"They [the case studies] gave me the opportunity to go away and utilise my own resources to gather appropriate information…"* P6, NI Group |
| Knowledge development | 16 | 12 | *"There were questions that I wouldn't have known to ask, relating to a specific diagnosis, and it was useful to see those as a learning opportunity."* P154, VP Group<br><br>*"The case studies provided me with the opportunity to think about potential scenarios and develop my knowledge."* P158, NI Group |
| Applying learning to practice | 19 | 3 | *"The cases gave me a chance to practice in a safe environment…and ever since I have completed each case, I have applied that learning to day-to-day real-life practice to reinforce my knowledge."* P75, VP Group<br><br>*"I liked the way that there was a pre-quiz and a post-quiz as this allowed you to apply the knowledge you had gained from the case."* P74, NI Group |
| Use of pre- and post-MCQs | 5 | 13 | *"The pre- and post-quizzes were exactly the same so it wasn't allowing you to see what you had learnt, just how well you could answer the same questions."* P136, VP Group<br><br>*"I like the way that, for the questions, you could choose more than one answer; this not only made it more difficult but made you think much more as you* |

| | | | |
|---|---|---|---|
| | | | *weren't able to automatically rule out other options on your knowledge of only one being correct."* P74, NI Group<br><br>*"I would have preferred a before and after score so I could see what progress I had made."* P36, VP Group |
| **Integration of the Case Studies into Pre-registration Training** | | | |
| Individual revision aid | 18 | 25 | *"I think doing weekly modules like these would be extremely beneficial to all pre-reg pharmacists. It would give more structure to learning and revision."* P123, NI Group |
| Group learning | 15 | 13 | *"Some of them were on the same topics as study days and these would fit in well as resources to use on the day or in preparation."* P139, VP Group |
| Cross-sector development | 6 | 0 | *"Having case studies of situations that occur in both sectors of pharmacy can help with cross-sector placements…and those who don't get much patient facing experience (such as those in industry)."* P148, VP Group |
| Competency development | 8 | 0 | *"They [the case studies] would be well suited for appraisals to ensure the trainee is competent in certain areas and as a measure of progress throughout the year."* P50, VP Group |

**Table 8-5 presents the content analysis of the free-text responses indicating numbers of pre-registration trainees in both groups who made a comment relating to the sub-theme. Sub-themes are associated with one or more quotes depending upon the difference of views from pre-registration trainees and the richness of comments obtained.**

At the end of the questionnaire, there was a free-text box for trainees to enter any other comments they wished to express. Fourteen trainees from the VP group entered comments (zero trainees provided negative comments) and seven trainees from the NI group provided comments (four trainees provided positive comments and three provided negative comments); as presented in Table 8-6 below:

| | VP Group | NI Group |
|---|---|---|
| **Positive Comments** | 'Thank you for involving me in this study … I have found it really interesting and useful. It has definitely helped my development and attributed to my preparation for the exam…I've found the virtual cases really useful alongside my pre-reg training…' P154<br><br>'It was a good, unique learning experience and I enjoyed completing the virtual scenarios. I think I have learnt new things from them which will improve my practice as a pharmacist.' P94<br><br>'Overall, the simulations were a useful and valuable revision tool…although sometimes the scenarios felt a little 'fake' as if they wouldn't happen in real life…but from a clinical point of view, they were excellent.' P148 | 'I think these studies benefitted my learning greatly. Case studies are a great way to find out what you need to learn about, in addition being able to apply knowledge to practice. They were particularly useful as I learn well by practicing skills, rather than reading the information and they gave me the opportunity to experience situations that would be useful for the exam which we may not have had the chance to experience during our training due to time constraints.' P45<br><br>Overall, the case studies helped my learning on topics that I do not come across often in hospital pharmacy. Therefore, I was very grateful for the extra practice.' P133 |
| **Negative Comments** | | 'Now I am very keen to try the interactive cases. I feel that they would suit my learning needs much more appropriately.' P6<br><br>'From speaking to people that had the interactive case studies; I think they would have been more beneficial as they would have been more realistic.' P158 |

**Table 8-6 Presents a selection of the general comments received by pre-registration trainees.**

## 8.8 Chapter Discussion

The findings from the questionnaires illustrate differences in trainee perspectives of the two types of case studies. The quantitative analysis of the Likert scales (as based on the Mann-Whitney U tests) demonstrated no statistical significance between trainees' views of the VP and the NI cases, whereas the more in-depth qualitative results demonstrated a preference for the VP.

The demographics of the participants illustrated that more trainees from the NI group completed the questionnaire than from the VP group, however the response rate for both groups was 89% (24/27 trainees in the VP group and 32/36 trainees in the NI group completed the questionnaire who had completed all three case studies). Pre-registration trainees were required to complete the questionnaire to obtain access to all of the case studies and MCQs (both types of learning tool), plus three extra NI case studies on new topics created to incentivise trainees to complete the questionnaire; which may provide justification for the high response rate of 89% (section 5.9). The questionnaires were designed such that all questions were compulsory to answer and trainees were unable to submit the questionnaire without completing all of them, to provide an abundance of data for analysis. Upon review, this was not as successful as proposed; the majority of trainees answered the questions appropriately but some trainees entered 'N/A' (or similar) into the free-text boxes which allowed for submission but did not add anything to the analysis. Therefore, the comments obtained were from a sample smaller than the 56 who submitted the questionnaire.

From the analysis, one of the main reported differences between the two learning tools was the increased realism of the VP cases compared to the NI cases. Pre-registration trainees reported that the interactivity of the VP simulation increased the realism, promoted experiential learning and allowed them to feel more immersed within the case studies to really feel like the pharmacist in the scenario. By contrast, the lack of interactivity of the NI cases was reported by the pre-registration trainees to affect their ability to apply their learning from the case studies to real-life practice. The

increased interactivity and greater sense of realism of the VP may have increased the enjoyment and interest that trainee's reported. The VP was a 'novel' resource which the majority of participants had not used before (as identified in section 7.3), thus it may have been perceived as more enjoyable than the NI case studies, which were used as the control measure.

Both types of learning tool were reported to improve knowledge and promote self-directed learning but the percentage distribution of agreement illustrated that the VP case studies were superior in aiding knowledge development for future practice. This, again, may relate to the interactivity of the VP simulations as analysis of the free-text comments found trainee's reported that the ability to ask the VP questions expanded their knowledge base. Trainee's perspectives of the VP technology as a learning tool were more favourable regarding the development of real-life complex skills and aspects of learning, compared to simple skills or knowledge; which have previously been shown to be developed successfully from 'rote learning' (Salinitri *et al.*, 2012). No significant differences in knowledge improvement were found between the two groups (as presented in Chapter 7), but trainees in the VP group did report feeling like their knowledge had improved a greater amount. Effectiveness of learning tools is not only evaluated by their ability to improve knowledge but also on user's perceptions of the tool, which justifies the mixed methods approach in this research (Wild *et al.*, 2002; Liaw *et al.*, 2007; Lee, 2010; Lucardie, 2014).

Many of the comments received related to the case study topics themselves. Pre-registration trainees commented on the relevance of the topics chosen and the ability to relate them to real-life patients or scenarios they had experienced during their pre-registration training year. This, again, may have resulted in trainees reporting their application of knowledge. Trainees also expressed a desire for more case studies on a wider range of topics; both clinical and OTC areas with the possibility of a greater integration with their other pre-registration learning tools, such as the BNF or pre-registration syllabus. These comments indicated that trainees saw a benefit to the introduction of case studies as

a resource into the pre-registration training year. Further exploration of trainee's thoughts on the case studies and future topics occurred in the telephone interviews (Chapter 9).

Multiple areas for case study utility in the pre-registration training year were proposed. The primary area where trainees reported their use was as individual revision tools. Trainees reported that the case studies promoted self-directed learning and, although some trainees commented that having different questions or including scores on the pre-and post-MCQs would have been useful, overall the case studies were believed to self-assess and improve knowledge. Trainees also suggested the integration of the case studies into (or as preparation) for study days, thus utilising them in a group learning setting. Showing promise as both individual and group learning tools increases the scope for the two learning tools and may allow for the development of other skills (e.g. teamwork) which weren't evaluated in this research. Other areas were also reported for utilisation of the VP case studies, including cross-sector support and competency development. Topics specific to community and hospital pharmacy could be integrated into a VP case study to promote experiential learning of opportunities which individuals may not otherwise have. Upon recruitment, trainees were encouraged to use the case studies as evidence to meet their competencies. Trainees in the VP group reported the use of the case studies for appraisals and competency development; the extent of which was further explored in the telephone interviews (Chapter 9).

To improve the usefulness of the learning tools as individual revision aids, the limitations of the case studies (particularly those related to the VP technology) would need to be fixed. The main source of negative comments in the VP group stemmed from software issues, specifically related to keyword recognition and question bank size in the EHC case (case study one). This problem was previously discussed in the pilot research (Chapter 6) and, although the question bank had been increased (by inputting more keywords and matching these to a pre-programmed response), the recognition issue still arose in the main study. Despite this problem, trainees reported that their knowledge improved,

thus further exploration of trainee's thoughts into whether the software recognition was a barrier to learning occurred in the telephone interviews, the results of which are presented and discussed in Chapter 9.

The difficulties associated with keyword recognition may have impacted on the perceived 'ease of completion' of the VP case studies. Trainees in the VP group reported that the case study objectives were not as easy to understand as those trainees in the NI group. One of the suggestions from the pilot study was to provide clearer instructions on how to complete the VP simulations; this was acted upon and a 'pop-up' screen was created to provide users with instructions on how to complete the simulation, the intended learning objectives for each case and other useful information which they may require (as reported in Chapter 6, section 6.11). Trainees also reported that they would have liked access to the second-style of case study (which they were provided with). These comments may indicate a lack of conscientious behavior of the pre-registration trainees when being provided with information. However, these findings also indicate a requirement for clear instructions to be provided to users and considerations will be made to provide clear, concise instructions in future work.

Accessibility issues with the VP case studies may have also affected their usability. Trainees reported that the NI case studies were easier to access than the VP case studies. On occasion, trainees reported that they were unable to access the VP case studies on specific electronic devices or web browsers. During the study, when trainees emailed the 'help' email address with accessibility problems, they were advised to try opening the cases on Google Chrome. This was identified as an appropriate web browser for using the VP cases and all trainees found this to be an effective solution. Technical barriers exist to e-learning tools and these need to be considered when they are designed (Sun *et al.*, 2008; Bryant, 2012; Hammersley *et al.*, 2013). It may not always be appropriate for users to have to download a specific web browser to use an application, and thus efforts need to be made to establish why the accessibility issues arose and if they can be overcome.

Resulting from the recognition problems with the free-text input in the pilot study, multiple input styles for the VP cases were created to determine any preferences. Findings from the questionnaire indicated that trainees did not perceive the 'free-text with prompting' input in case study three to be the most useful. This input style required users to type free-text, and as they did, a drop-down list appeared with pre-inputted questions which could be asked – thus trainees essentially had to input a keyword before being presented with a list of questions associated to that keyword. Trainees reported this felt like 'cheating' as it did not require trainees to engage with the self-directed learning to the same extent as case studies one and two (which did not utilise this input style). The different input styles were explored further in the interviews, and will be discussed in greater depth in Chapter 9.

## 8.9 Chapter Summary

Trainees reported that both case studies improved their learning but the VP was reported to aid the development of real-life complex skills and aspects of learning, compared to more simple skills or knowledge associated with the NI case studies. The VP technology was reported to help trainees develop a wide and strong knowledge base and enhance their clinical reasoning skills, whereas simple skills, such as problem-solving, showed little difference in development between the two types of case study. Trainees reported that the VP was better at preparing them for real-life practice, as identified by greater agreement that the VP simulations made them feel like a pharmacist, like they were making the same decisions as they would have to in practice and overall feeling better prepared to care for real-life patients. Trainees reported that the realism and interactivity of the VP promoted the application of knowledge and allowed them to put theory into practice to much greater extent than the NI case studies. Trainees valued the safe environment which was provided by the VP and believed it would be a useful tool in many areas of the pre-registration training year. Technological

problems were reported by the trainees relating to the recognition of the VP software and the accessibility of these simulations, which may need to be further improved to understand the full utility of the tool.

Comments received on the open-ended question were confirmed in the telephone interviews; further exploration of trainee's perspectives were sought which are reported and discussed in Chapter 9. Findings from the questionnaires were triangulated with data from the quasi-experiment and telephone interviews, and are further discussed in Chapter 10.

# 9. Telephone Interview Results

## 9.1 Introduction

The aim of the telephone interviews was to obtain a deeper understanding of pre-registration trainee's perspectives on the use of VPs and NI case studies as learning tools. Chapter 9 will report and discuss pre-registration perspectives on these two types of learning tools.

Section 9.2 presents demographics of the pre-registration trainees who consented for a telephone interview. The first main topic to be identified from analysis of the interviews is reported in section 9.3 as perspectives on the design of the case studies. The themes within this topic are reported in their relevant sections: novelty (section 9.3.1), realism (section 9.3.2), input (section 9.3.3), feedback (section 9.3.4), recognition (section 9.3.5) and accessibility (section 9.3.6).

Section 9.4 reports the comments related to the second main topic of perspectives on the usefulness of the case studies as a training tool. This begins with comments related to learning by doing (section 9.4.1) and applying learning to practice (section 9.4.2). Comments relating to skill development are then reported: communication skills (section 9.4.3) and calculation skills (section 9.4.4). Participant comments relating to knowledge development are reported (section 9.4.5) followed by comments related to improvements in trainee's confidence (section 9.4.6).

The next main topic was support in pre-registration training, which is reported in section 9.5. This begins with comments relating to the novelty, flexibility and reputability of the learning tools (sections 9.5.1, 9.5.2 and 9.5.3, respectively). Comments relating to the importance of feedback from resources is reported in section 9.5.4 and those relating to the changing pre-registration examination are reported in section 9.5.5. Section 9.5.6 reports comments relating to pre-registration training variation.

The final topic which is reported is participant perspectives on the utility of the learning tools in section 9.6. This begins with comments relating to their use as an individual revision tool (section 9.6.1), use as a group learning tool (section 9.6.2) and comments relating to their use in OSCE's (section 9.6.3). Comments relating to the use of the learning tools towards competency development and the future are reported in sections 9.6.4 and 9.6.5.

The findings from the telephone interviews are discussed in section 9.7 and key points are summarised in section 9.8.

## 9.2 Participant Demographics

Pre-registration trainees who completed one or both of the questionnaires were invited to a telephone interview. Demographics of the participants who consented are displayed in Table 9-1. Nine trainees in the VP group and eleven trainees in the NI group participated in a telephone interview. Three trainees from the NI group and one trainee from the VP group reported that they had tried both types of cases.

In the VP group, 56% (5/9) of trainees were from the hospital sector and 44% (4/9) were from the community sector. In the NI group, 55% (6/11) of trainees were from the community sector and 45% (5/11) were from the hospital sector. Both groups had more female participants (VP group: 82% female, 18% male; NI group: 91% female, 9% male).

| VP Group | | | NI Group | | |
|---|---|---|---|---|---|
| **Participant Number** | **Sector** | **Gender** | **Participant Number** | **Sector** | **Gender** |
| 50 | Hospital | Female | 4 | Community | Female |
| 56 | Community | Female | 16 | Community | Female |
| 58 | Hospital | Male | 17 | Hospital | Female |
| 61 | Hospital | Female | 24* | Hospital | Male |
| 64 | Hospital | Female | 38 | Hospital | Female |
| 75* | Community | Female | 45 | Hospital | Female |
| 93 | Community | Female | 52* | Hospital | Female |
| 136 | Hospital | Male | 60 | Community | Female |
| 154 | Community | Female | 96* | Community | Female |
| | | | 144 | Community | Female |
| | | | 158 | Community | Female |

**Table 9-1 Displays the demographics of trainees who participated in the telephone interviews. Those respondents with a * indicated those who had looked at both types of case study and thus questions were asked about the VP and NI cases.**

Framework analysis of the telephone interviews led to the development of four major topics which were consistent with trainees in the VP group and the NI group. The four main topics were:

- Perspectives on the design of the case studies
- Perspectives on the usefulness of the case studies as a training tool
- Support in pre-registration training
- Perspectives on the utility of the learning tools

At the beginning of the interview, participants were asked if they had used the second style of case study (which they were not initially randomised to) and questions were tailored based on their response. Trainees who had used both types of case study were asked questions regarding both to obtain comparative views, whereas those who had only used one learning tool were asked questions specific to that one.

## 9.3 Perspectives on the Design of the Case Studies

Comments on the case study design were received and will be presented below. Pre-registration trainees were first asked a general open-question to obtain their thoughts on the case studies which they completed. This led to the identification of themes relating to the novelty (section 9.3.1) and realism of the learning tools (section 9.3.2). Those trainees who completed the VP case studies were asked further specific questions relating to the interaction with the VP and the different input styles (section 9.3.3), their thoughts on the recognition of the tool (9.3.5) and ease of accessibility of the tool (9.3.6) as these were reported as problems on the questionnaire. Trainees in both groups were asked questions relating to the feedback from the learning tools, if this was not reported without prompting (section 9.3.4).

### 9.3.1 Novelty

The first theme to be identified from the interviews was the novelty of the VP technology. As presented in Chapter 7 (section 7.3), 69% of pre-registration trainees who consented for the research had not previously used VP technology. The theme of novelty was originally expressed in the questionnaire (Chapter 8, section 8.7) and further comments were received in the interviews when trainees were asked their overall thoughts on the VP tool.

All trainees in the VP group expressed their enthusiasm for using a novel learning tool and reported that it allowed them to learn in a different way.

> *"…I was glad I got the virtual cases because I haven't used anything like this before…it's up-and-coming technology and I think I got more out of it than with just the normal one [the NI cases]…the interactive way was a good way, a different way of learning…it's not*

*just sitting there and reading, it actually sticks in your mind."* [Participant 75: community, female]

No comments were received from trainees in the NI group regarding the novelty of the non-interactive case style. The three trainees from the NI group who used both types of learning tools commented on the 'uninteresting' nature of the non-interactive cases.

*"…I did find the virtual cases much more interesting…I think the paper cases are just a bit boring…"* [Participant 96: community, female]

### 9.3.2 Realism

The topic of realism encompassed views about three parts of the case studies; the topics, the design and the interactivity. Suggestions were also made to improve the realism of the case studies.

A major theme that was expressed by participants in both groups (7 from the VP group and 6 from the NI group) related to the realism of the scenarios which were created, particularly regarding their relevance to the pre-registration training year and future practice.

*"They were all topics really relevant to practicing as a pharmacist….the emergency contraception one, that was really useful…and also the children's health one where we were trying to work out what was wrong with the child...overall, they were all topics that we should be aware of for the future."* [Participant 56: community, female]

Comments were also received regarding the realism of the case study design. Five trainees in the VP group reported that the way the case studies were created with different patients and settings added to the realism of the simulations. One trainee in the VP group specifically commented on the EHC case being the most realistic in design.

> *"I think the first one [EHC case study] was my favourite…I thought it worked really well with, like the way it was set up in the consultation room with a patient. That one felt real. It's something I'll come across in the future so it was useful to see and practice a request for EHC."* [Participant 75: community, female]

Three pre-registration trainees in the NI group also reported that the design of the non-interactive cases increased their realism as they were able to put into practice what they were learning.

> *"…it's good because patients aren't going to be textbook patients…I think it's good to have them written for different patient settings because then you can read the topic and try to apply it to a particular patient or patient subgroup…"* [Participant 17: hospital, female]

Trainees also commented on the realistic nature of the case studies because of the interactivity of the learning tools. In addition to the design of the VP simulations, three trainees also reported that being able to 'talk' to a patient and ask them questions, whilst receiving pre-programmed responses, added to their realism.

*"It was really good how you could talk to the patient and they'd respond to you…you've got to interact with the patients in order to complete the case so they keep you interested and you have to end the consultation or something like you would do in real practice, instead of just submitting a form with your answers on. It actually made me think about the kinds of things I would say to a patient in real life."* [Participant 154: community, female]

One trainee also reported that the NI cases were interactive which increased their enjoyment at completing the case studies.

*"…I liked that it was interactive, I was able to choose from different answers and at the end I could see which questions I'd got right or wrong and could see which reference sources they came from."* [Participant 4: community, female]

Comments were received regarding improvements which could be made to the case studies to improve their realism. The most common improvement was suggested by four trainees from the VP group and six trainees from the NI group which related to increasing the difficulty or number of problems within a case to reflect a more realistic patient.

"*…throwing in complications might help, although it might seem too complex for pre-reg…instead of it just being a straight forward case, it could be say, pulling up*

*interactions or making you think in a way that's not just simple WWHAM questions…not just there's the problem, there's the diagnosis and that's the answer…it's sort of like having that, then also a patient saying "well I'm under this consultant for this" or "we've got a family history of this" and just pulling in more information."* [Participant 50: hospital, female]

Further improvements suggested by trainees in both groups included the use of more visual aids in the case studies and enabling interactivity with medicines, prescriptions or other items that you would use daily in a pharmacy.

*"I think if it was a bit more interactive [the NI case] it would have been better…so like for the measles one put up a picture of the rash or having a prescription there and being able to analyse it and work from that would be more beneficial and easier to relate to real practice."* [Participant 38: hospital, female]

### 9.3.3 Input

Comments were received specifically from trainees in the VP group regarding the different ways they interacted with the VPs in the three case studies (i.e. via free-text, multiple choice and free-text with prompting). The majority of trainees (6) expressed their preference towards the free-text input but this style was also associated with the most problems.

*"I'd probably say just inputting it yourself and seeing what it [the patient] comes back with. I know it didn't work particularly well with what I was typing in, but that kind of idea…I would prefer that because that's what you would actually do in practice and it shows what you are thinking, instead of picking through options and pre-selected thoughts."* [Participant 93: community, female]

The multiple-choice input was preferred by three trainees, and the main reason for this was because it reflected the question style of the pre-registration exam, although it was expressed that this wasn't representative of real life.

*"…I'd probably say multiple-choice would be top because, like, that's kind of what you're going to get in the pre-reg exam, but then you're not going to have multiple-choice in real-life..."* [Participant 58: hospital, male]

This participant then went onto express their feelings regarding the free-text with prompting input style from the childhood illness case.

*"I liked the measles one because when you started typing something, you kind of knew if you were on the right lines and that was kind of useful…even if you put it in your own words, the system could still detect it…"* [Participant 58: hospital, male]

This comment contrasted with three trainees who believed that having the predicted drop-down box made the case study too easy and they felt they didn't gain as much from the case as they may have done otherwise.

> *"I think having the question box is a little bit annoying because you type a question in and a list of questions already inputted came up so it kind of does the thinking for you…it just made it a bit too easy."* [Participant 136: hospital, male]

One trainee suggested an improvement to help the free-text input work better, reduce the number of recognition issues which were reported when using it and remove the requirement of the predicted drop-down box of questions which some trainees reported finding too easy.

> *"It would be better if it [the system] recognised the question that you're asking but didn't show you the questions…so maybe if you typed in a question and then it kind of links to a 'did you mean…' and gave you options to choose from…*" [Participant 154: community, female]

### 9.3.4 Feedback

Feedback has previously been identified as a key component of effective learning when using simulations (Issenberg, 2005), thus trainee's thoughts on the level and usefulness of the feedback received after each case study were explored.

All trainees in the VP group reported that the animated, individualised feedback provided by the VP was useful to their learning.

> *"I think when it [the feedback] was really specific it was the best for me, because then it showed me exactly what I'd missed. I think I preferred the EHC one, like how the patient told me what I'd done well and what I need to do to improve…when I repeated it [the case], I probably wasn't thinking about it as much because I kind of knew what I should be saying but I was able to practice how to say it and what phrases to use…"* [Participant 75: community, female]

All trainees from the NI group also reported that they found the immediate feedback they received when completing the case studies useful.

> *"I did appreciate the answers coming right back because again, referencing to pre-reg, you don't have much time and if you're doing something study wise like with these case studies, it's easier for you to get the answers straight away."* [Participant 4: community, female]

Improvements to the NI case study feedback were suggested by five trainees. They reported that it may have been useful to have their individual answers as well as the model answer provided in the feedback to allow them to directly compare the two. Trainees also believed having the feedback presented in a format which they could easily save and go back to at a later date would have been more useful for their learning.

*"…I guess the answers to the cases could have been a little clearer with the way they were set out…maybe provide a link to a word document with the way the feedback is given, just so it's a bit clearer than a page you probably won't see again, whereas if it was a word document you could go back to it and think 'okay, this is where I went wrong…'."* [Participant 52: hospital, female]

### 9.3.5 Recognition

One of the main problems associated with the VP technology was the recognition of user inputs when using free-text. This was reported in the pilot research (Chapter 6), the questionnaire (Chapter 8) and by seven trainees during the telephone interviews.

*"…if the question wasn't in the system then there was no answer from the patient… it's quite advanced technology but if you try and have a conversation you're almost limited because there's already a programmed set of questions which you can ask."* [Participant 136: hospital, male]

Although the recognition problems were reported as a significant issue to some pre-registration trainees, two participants reported no negative impact on their learning and still finding the feedback useful.

*"…we're all saying the same information, we've just got different ways of saying it…at the end I could see that I was on the right track…I don't think it impacted on my learning…I still got to see the point that I should have been making."* [Participant 75: community, female]

### 9.3.6 Accessibility

A problem which was previously reported on the questionnaire (Chapter 8) and further explored in the telephone interviews was the issues of accessibility of the case studies. This was a problem specific to the VP studies, with no trainees reporting difficulties accessing the NI case studies.

Two trainees from the VP group reported having problems accessing the simulations on certain web browsers.

*"It [the technology] didn't seem to work with all my devices…I think it might have been the internet browsers because, I think when I just switched to like Chrome it was working but if I used Opera it wouldn't load up and work properly…"* [Participant 56: community, female]

## 9.4 Perspectives on the Usefulness of the Case Studies as a Training Tool

Comments relating to the usefulness of the VP and NI case studies as training tools will be presented below. Pre-registration trainees were asked how useful they found the different case studies and whether they helped in the development of skills and knowledge. This led to the creation of themes

relating to learning styles of individual trainees (section 9.4.1) and being able to apply learnt knowledge to practice (section 9.4.2). The main skills which were reported as being developed from the case studies were communication (section 9.4.3) and calculations (9.4.4). Pre-registration trainees commented on the development of their knowledge from the cases (section 9.4.5), with the majority using the case studies to identify gaps in their knowledge. The impact from using the learning tools on pre-registration trainee's confidence for the pre-registration examination and future practice was explored (section 9.4.6).

### 9.4.1 Learning by Doing

Comments relating to learning styles were received from trainees in both groups. All trainees in the VP group reported that they learnt better through practice and not by reading and memorisation.

> *"…. it's better to do something virtual than just answer questions…I am quite happy to read a book and learn but I struggle to just recall it if I don't put it into practice and this let me learn in a more interactive way…it's much easier to develop your consultation skills by using them rather than just answering questions…"* [Participant 136: hospital, male]

No specific comments relating to the NI cases and learning styles were received. Pre-registration trainees who used both types of case studies reported that the VP was more suitable to their individual learning needs.

*"…these were different and let me learn in a more hands-on way which I find works better for me."* [Participant 93: community, female]

### 9.4.2 Applying Learning to Practice

On the questionnaire, trainees reported that the VP case studies allowed greater application of knowledge and this was further explored in the telephone interviews.

All trainees in the VP group reported that the VP cases allowed them to apply their learning.

*"…I think it [case 2] was quite useful because it made me think over a bigger scale…thinking as an actual pharmacist and not just as a student where there is only one problem and one answer…it [the VP] was another way to utilise my skills and practice what I'm learning before having to go out as a qualified pharmacist."* [Participant 136: hospital, male]

Three trainees from the NI group reported that the non-interactive cases allowed them to apply their learning.

*"I think that they [the case studies] helped to provide a deeper learning and helped to apply my learning into case study scenarios…"* [Participant 52: hospital, female]

One pre-registration trainee explicitly mentioned how completing the NI case studies had allowed them to use the knowledge they developed in practice with real patients.

*"…over the course of my pre-reg I'd say I used the information from that case [EHC] a lot and I even referred a patient to get EllaOne when she was more than 3 days over, so I actually used what I'd learnt in your case studies in practice.*" [Participant 60: community, female]

Comments were also received by trainees regarding the VP providing a safe environment to practice, develop and apply their knowledge and skills before going out into practice as the responsible pharmacist.

*"These virtual patients are a 21st century learning tool and are as close as you can get to real life, to situations you will have to deal with every day when you qualify and are on your own…it gives you confidence because you've done it virtually and if you make a mistake in the simulation you haven't killed anyone and you can try again…"* [Participant 58: hospital, male]

Pre-registration trainees were asked their level of engagement with the case studies. All trainees in the VP group reported that they completed each simulation more than once to get the most out of the experience, whereas thoughts were split regarding the usefulness of completing the NI case studies multiple times. One trainee from the NI group reported that they found it useful to be able to access the case studies as many times as they wanted.

*"…it was good that you could go back if you wanted to; if you wanted to try the cases again or do the quizzes then you could do…go back and look at them later for revision…"* [Participant 60: community, female]

A contrasting view was also obtained, with one trainee reporting that they did not complete the NI cases multiple times due to the immediate provision of feedback. They did however believe that they would have completed the VP case studies multiple times.

*"…It was nice having the answers straight away because you would know if you got them right or wrong but I never did the scenarios again because I did already know the answers to it…it might be different with the virtual patient because you get different responses and things from what you say so I'd use those cases again…probably not just in pre-reg either but to practice when I qualify."* [Participant 38: hospital, female]

### 9.4.3 Communication Skills

Pre-registration trainees were asked their thoughts on how effective the case studies were at developing knowledge and skills. The most common skill which trainees in the VP group reported developing was their communication. Over half of the trainees in the VP group (5) reported that the VP helped improve their communication skills.

*"…it's confidence more than anything, of being able to ask the right questions… you can't re-do it if it's with a real patient…it's [the virtual patient] definitely good to help*

*you learn what questions to ask, what advice to give and how particular words and phrases may prevent a good rapport with a patient.*" [Participant 50: hospital, female]

There were no comments received from trainees who used the NI case studies relating to their communication skills. In fact, one trainee who had used both types of case study commented that the VP cases were useful at developing communication skills but the non-interactive cases had no impact on this.

*"I think it [communication] ties in more with the virtual cases when you're actually asking the questions, the way you ask the questions as well…but for the paper cases you've just got to type your answers in. I think the virtual cases did help me think about how I was going to phrase my sentence when I speak to a patient…so they don't feel anxious and they are comfortable talking with me because I'll be facing patients in real life, every day…"* [Participant 96: community, female]

### 9.4.4 Calculation Skills

When pre-registration trainees were asked about their skill development from using the case studies, a second area to emerge was the development of calculation skills. This was not as commonly reported as communication skills but was reported as a second skill.

There were no trainees in the VP group who reported calculation skills as an area of development. Two trainees from the NI group reported that the cases allowed them to practice their calculation skills.

*"The renal [case] I really liked…the calculations were manageable and came at just the right time when I was practising my calculations for the exam so that was spot on…you can never have too many calculations; it's such a major part of the exam! Being able to calculate the renal function for a patient based on their bloodwork and then use that to adjust drug doses...I don't do anything like that here, so it was really useful to practice."* [Participant 4: community, female]

### 9.4.5 Improving Knowledge

Pre-registration trainees were asked whether completing the case studies improved their knowledge. Trainees in both groups reported that the case studies directly improved their knowledge, identified areas for improvement and promoted self-directed learning. Pre-registration trainees also commented on learning from the pre- and post-MCQs.

All trainees in the VP group reported that completing the cases helped them identify gaps in their knowledge of that topic area.

*"The cases definitely did [impact learning]…when doing the cases there were things that I wasn't aware of or things that I thought 'oh hang on, I need to look that up or look into more depth on that' …the post-quizzes definitely helped me identify things that I was struggling with…"* [Participant 56: community, female]

All trainees in the NI group reported identifying gaps in their knowledge and learning more indirectly from the case studies.

> *"It was more indirect learning because even though I looked up a lot of stuff in the reference sources that I came up with, when the answers came back and I saw the reference sources that were used, it broadened my knowledge a lot… I wouldn't have thought to go and look in some of those resources to get the answers…"* [Participant 4: community, female]

Less commonly reported was the view of learning directly from the cases studies themselves. Four trainees in the VP group felt they learnt directly from the case studies.

> *"EHC was a good one to do, it was the most in depth one… sometimes it can be difficult to remember the rules when you should give it and when you shouldn't be giving it and what advice to tell a patient…I learnt it all from the case and doing it practically just solidified the knowledge in my head…"* [Participant 61: community, female]

Seven trainees from the NI group also reported learning directly from the case studies.

> *"…there were points in the case studies that I found helped me learn specifically; answering the questions helped me remember the information…"* [Participant 16: community, female]

Most trainees in the VP group (6) and almost half of the trainees in the NI group (5) reported that the pre-and post-MCQs were useful for knowledge acquisition. On the questionnaire, comments were received regarding the questions on the pre- and post-MCQs being the same, which was explored further in these telephone interviews. Comments from trainees in both groups were split regarding the same questions being used.

> *"I liked the quizzes, I think it's probably good that the questions were the same because it's more of an accurate representation...it was still really challenging but allowed me to see how I was progressing and they just made me realise that I had bits that I needed to read up on."* [Participant 75: community, female]

> *"…I think I would have preferred different questions…. then you're not doing it based on your memory but doing it based on your knowledge and understanding. When it comes to pre-reg, the more you test us the better!"* [Participant 45: community, female]

One trainee from the NI group did not feel the quizzes were related to the case studies enough, something which was previously mentioned in the pilot research (Chapter 6).

> *"…I thought they were good but sometimes I felt as though the questions didn't relate to the actual scenarios… I didn't really learn the answers for the quizzes from the cases themselves so I spent a lot of time going away and trying to find the correct resources to be able to answer the questions."* [Participant 38: Hospital, Female]

### 9.4.6 Confidence

Pre-registration trainees in both groups were asked whether completing the case studies improved their confidence for the pre-registration examination or for future practice.

All trainees in the VP group and five trainees in the NI group reported that completing the VP cases improved their confidence for the pre-registration exam.

> *"They [the cases] definitely helped for preparation [for the pre-reg exam]. There were questions on the exam to do with EHC and measles and I definitely felt confident answering them."* [Participant 75: community, female]

Trainees from the VP group also reported feeling confident for future practice, but this was reported by less trainees (5) than those who reported feeling confident for the exam.

> *"I definitely feel more confident in general. It gives you that extra practice, especially for when I'll be starting out, with like the confidence to speak to doctors and what questions to ask and where to find information. Some of the resources I didn't know about, so that's been really helpful and I won't feel as vulnerable starting work as a pharmacist…I feel like I'll have done something a bit extra to some other pre-regs and that has helped me feel more confident."* [Participant 64: hospital, female]

There were no comments received from trainees in the NI group regarding confidence for future practice.

## 9.5 Support in Pre-registration Training

Another main topic to be identified from the interviews was the need for more support during the pre-registration training year. Trainees were asked, in general, how much support they felt they had received during the year and if they would have benefitted from other resources.

Overall, the majority of trainees reported that they received a moderate amount of support during the training year (8), and the same number of trainees reported receiving a lot or a little support (6 and 6, respectively). However, no matter the level of support reported, all trainees reported that more support and access to other resources would have been beneficial during the pre-registration training year.

Pre-registration trainees were asked about the kind of resources they would have found useful during the pre-registration training year. Comments received related to resources being: novel (section 9.5.1), flexible (section 9.5.2) and reputable (section 9.5.3). Pre-registration trainees also commented on the level of feedback they believed was the most useful to aid learning (section 9.5.4). Furthermore, trainees reported the desire for resources to correlate with the changing pre-registration examination (section 9.5.5) and help with the variation between pre-registration training sectors (9.5.6).

### 9.5.1 Novel Resources

When pre-registration trainees were asked about the kinds of resources they would want access to during the training year, all trainees in the VP group and six trainees in the NI group reported wanting something ‘novel’.

*"I've used some other resources, like I've done some CPPE courses…but there's nothing virtual like what this is so I definitely wouldn't mind doing some kind of virtual learning packs…some of the CPPE ones that I've done have been very useful but some have been long and difficult to navigate and confusing, a bit old school, so this is a new thing and it works!"* [Participant 136: hospital, male]

Pre-registration trainees also reported that different types of resources would be useful for individuals to work out how they learn best. They could then choose the most effective resource based on their time constraints and learning needs.

*"…there are a lot of resources out there but I think you have to kind of like put it on yourself to go and use them…a lot are events or study days which you don't always have time to go to…I think it's good to have these virtual cases as an option. It won't work for everyone but I think if everyone gets a chance to play with the system, they can see if they do prefer it as a way of learning."* [Participant 75: community, female]

One trainee reported that the VP could be used as an alternative to role plays with a tutor, colleague or a patient.

*"…if you role-play with someone or when somebody's watching you talk to a patient you just feel like you're being tested. But with the scenarios, the virtual scenarios, I think you'd be a bit more relaxed and sort of learn from it rather than feeling embarrassed…. you need that interaction with patients as well, but especially starting*

*off, it's good to learn what questions to ask and what points to consider and stuff…"*

[Participant 64: community, female]

### 9.5.2 Flexible Resources

The time constraints of pre-registration training were reported by four trainees (2 VP, 2 NI). Comments related to the flexibility of resources to ensure greater utilisation throughout the training year.

*"…having the flexibility to go and use an online resource makes it easier, because we're so busy in pre-reg but you can actually say to your tutor "oh, I'm going to go and do that virtual learning now" and you could fit it into your schedule quite nicely."* [Participant 136: hospital, male]

### 9.5.3 Reputable Resources

When asked about important elements of resources, two trainees reported that it was important for resources to be reputable, up-to-date and grounded in a solid evidence-base.

*"…I think it's difficult to find reputable resources…there's a lot of textbooks and online questions…which can be out-of-date, or past papers, which again are so old now…having virtual cases which are easy to access, are up-to-date, are what we need…we can be assured that the information we're getting is correct which makes it a much better revision aid…"* [Participant 50: hospital, female]

### 9.5.4 Appropriate Feedback from Resources

A specific area which trainees reported current resources could be improved upon was related to their level of feedback. Eight trainees from the VP group reported that specific feedback was essential for their learning.

> *"I think that the more specific it is, the better…you're learning so much that understanding exactly where you're going wrong is important…doing something and then being able to immediately go and change your behaviour based on the feedback was really useful."* [Participant 61: community, female]

In contrast, one trainee from the VP group reported that more generalised feedback would be better for their learning.

> *"I think generalised feedback of the topic as a whole would be quite useful… a page document following what you'd done just saying as a generalised statement 'when looking at cases of poor renal function it's really important to learn…'…"* [Participant 136: hospital, male]

Although comments regarding the level of feedback differed, all trainees reported that immediate feedback was useful in aiding their learning. Pre-registration trainees also commented on having feedback that signposted to other resources was useful (three trainees from the VP group, seven trainees from the NI group).

*"…if you get something wrong then having an explanation and where you would go to maybe find the information, so you could find it for yourself…there are so many resources out there which I wasn't familiar with but have found to be so helpful since doing the cases…and we're so busy in pre-reg that being given links to other, useful resources was really helpful."* [Participant 58: hospital, male]

### 9.5.5 Alignment with the Pre-registration Examination

Trainees reported that resources which matched the changing pre-registration exam would be useful. Two trainees from the VP group and two trainees from the NI group reported that implementing a case study based learning tool would be useful.

*"…I think with the format that it [the exam] is going to be next year, where it's a lot more scenario based, then I think they [case studies] would definitely help with the exam…"* [Participant 52: hospital, female]

### 9.5.6 Pre-registration Variation

Another theme to be identified from the interviews was the variability of pre-registration training. The variation in experiences and levels of support was referenced by all trainees in the VP group and NI group.

*"…everybody has such different experiences and support…speaking to some of my community friends, I definitely felt more prepared for the exam… my cross-over was*

*only for a couple of weeks and I think there was maybe only one EHC in that time….so to see a real one and practice a virtual one was good…it's really good to practice things you might not otherwise see."* [Participant 58: hospital, male]

Pre-registration trainees commented on the types of scenarios and topics which they felt would be useful to integrate into case studies. Further examples are presented below and in Table 9-2. Comments were primarily received regarding a mixture of community-based and hospital-based topics to allow individuals to practice areas they are not familiar with and increase confidence in areas where they may see themselves working in the future.

*"…those who are working in a hospital setting, it's really good for them to have over the counter queries and cases because they obviously don't have all that exposure in the hospitals…and it will be really good for those who don't work in a hospital setting to have that kind of case study on like renal function or liver function…."* [Participant 96: community, female]

Overall, six trainees who worked in community specifically reported that integrating community-based case studies would be useful.

*"Probably over the counter stuff because even though I'm in community I haven't had a lot of support on topics and over the counter things, apart from what I've gone and done on my own, so a few cases during the pre-reg of over the counter problems and recommending products would help to improve that knowledge…I'm hoping to stay in*

*community as well so some extra help on over the counter problems would be helpful."* [Participant 16: community, female]

Eight community based trainees also reported that more clinical case studies would be beneficial for their training.

*"More case studies to build on clinical knowledge would be good because it can be daunting in community as you don't get than much clinical training and then you're qualified and if you don't know it, it's going to be pretty scary!"* [Participant 4: community, female]

All ten trainees who completed their training in hospital reported that the integration of community-based case studies would be beneficial for their training.

"O*ver the counter ones I think are really important…especially if they're targeted at hospital pre-reg's because we don't get a lot of that experience…"* [Participant 136: hospital, male]

It was also reported by eight of the hospital-based trainees that clinical case studies would be useful.

*"…having that virtual training around the big clinical areas would be helpful…so cases on anything like endocrine, asthma or COPD, infections or treatment regimens...."* [Participant 136: hospital, male]

Specific topics were suggested by trainees where they felt more support would be useful during the training year (see Table 9-2). The most popular topics to be reported were 'clinical' and 'over the counter (OTC)' which were suggested by 16 different trainees. These topics covered a range of sub-topics; some of which were only suggested by one trainee but all were considered important areas as pre-registration training and pharmacy practice covers a wealth of skills and knowledge.

| Topic Area | | VP Group | NI Group |
|---|---|---|---|
| **OTC** | General | 7 | 7 |
| | Women's Health | 1 | 0 |
| | Skin | 3 | 2 |
| | Headlice | 1 | 0 |
| | Childhood conditions | 1 | 0 |
| | Gastrointestinal | 0 | 1 |
| | Ophthalmic | 0 | 1 |
| | Travel Health | 0 | 1 |
| | Hayfever | 0 | 1 |
| | Total no. of participants | 7 | 9 |
| **Clinical** | General | 5 | 7 |
| | Endocrine | 3 | 4 |
| | Respiratory | 2 | 1 |
| | Cardiovascular Disease | 0 | 2 |
| | IV Medications | 0 | 2 |
| | Hepatic | 0 | 2 |
| | Cytotoxic medicines | 0 | 1 |
| | Narrow Therapeutic Index medicines | 0 | 1 |
| | Palliative Care | 0 | 1 |
| | Central Nervous System | 0 | 1 |
| | Gastrointestinal | 0 | 1 |
| | Paediatrics | 0 | 1 |
| | Total no. of participants | 9 | 7 |
| **Services** | General | 1 | 0 |
| | Medicine Use Review (MUR) | 3 | 0 |
| | New Medicines Service (NMS) | 2 | 0 |
| | Smoking Cessation | 1 | 1 |
| | Medicines Optimisation | 1 | 0 |
| | Patient Group Directions (PGD) | 1 | 0 |
| | Total no. of participants | 5 | 3 |
| **Professional Practice** | Law | 2 | 2 |
| | Complaints | 1 | 0 |
| | Controlled Drugs | 1 | 0 |
| | Fitness to Practice | 1 | 0 |
| | Substance Misuse | 0 | 1 |
| | Total no. of participants | 3 | 2 |
| **Skills** | Interdisciplinary | 5 | 5 |
| | Using resources | 1 | 0 |
| | Extemporaneous dispensing | 1 | 0 |
| | Drug Interactions | 0 | 1 |
| | Calculations | 0 | 1 |
| | Total no. of participants | 5 | 6 |

**Table 9-2 Displays the frequency of topics suggested by trainees which they felt they could have had more support on during the pre-registration year. Each overall topic is subdivided into more specific topics which were reported by trainees. The 'total number of participants' illustrates the overall number of different participants who commented on that topic area.**

## 9.6 Perspectives on the Utility of the Learning Tools

Pre-registration trainees were asked their thoughts on the utility of the case studies in pre-registration training. Comments were obtained on the questionnaire relating to the integration of the case studies in the pre-registration year and the telephone interviews acted as a means to confirm and further explore these findings.

The areas where trainees felt the VP or NI case studies could be utilised included: as an individual revision tool (section 9.6.1), as a group learning tool (section 9.6.2), as a tool to be used in preparation for or as a station in an OSCE (section 9.6.3) or to aid competency development (section 9.6.4). Pre-registration trainees also commented on the possible future use of the tools once qualified (section 9.6.5).

### 9.6.1 Individual Revision Tool

The majority of trainees in the VP group (7) and NI group (8) reported that the case studies were most useful as an individual revision aid.

> *"I think what it made me do is just revise that topic at the time …it prompted the reading and helped me approach my revision early because it's so easy to just leave stuff until May, June sort of time but realistically you need to be doing stuff throughout the year and these cases allowed me to logon in my own time and prompted me to do the work…"* [Participant 61: hospital, female]

One of the participants who had used both types of case study reported on the usability of both tools as revision aids.

*"…it [the non-interactive cases] does help with revision because you actually need to find the information and refresh your knowledge about that area…when you did the virtual patient case, it actually looked more like a marking scheme for me when I got the feedback, but then I used it as part of my revision, just to look at what I'd missed off and what I could look more into, to revise and improve my depth of knowledge…"*

[Participant 96: community, female]

### 9.6.2 Group Learning Tool

A second area which was reported by two trainees from the VP group was the use of the VP simulations as a group learning tool. No comments were received from trainees in the NI group regarding use as a group learning tool.

*"…we could do them as a group and I think it would work really well…I think sometimes working in a group and getting different ideas on how to approach situations is quite good for learning, especially as everyone has such different experiences so they might have come across this patient before and can talk you through what they did…"*

[Participant 58: hospital, male]

### 9.6.3 OSCE Tool

Pre-registration trainees were also asked about their thoughts on the use of the case studies as an OSCE tool. No comments were received regarding the use of the NI case studies as an OSCE tool. The majority of trainees from the VP group (6) were positive regarding the use of the VP simulations as an

OSCE practice tool, whereas only 3 trainees believed it should be incorporated into an OSCE as a real station.

> *"As a practice, I'd say that's fine…one of the points of an OSCE is actual human interaction, being able to tell another person your answer… I don't know if I'd want a computer station OSCE because I don't think I would feel that was an OSCE if that makes sense? I would welcome it as a practice though, something other than a role play with your tutor which gets you into the OSCE mode without getting too overly nervous…"* [Participant 136: hospital, male]

All four participants who used both styles of case studies were confident regarding the use of the VP as an OSCE station.

> *"…I think it would be good as part of an OSCE…because OSCEs, to me, just feel really fake…I think that an interactive version is just as good to see your consultation skills and stuff like that. I think it should be part of the OSCEs, not replace it, because I think obviously having the pressure of doing OSCEs is kind of good because that's what it's going to be like when you're with a patient, you're going to be a bit uncomfortable, but I definitely think having a virtual station included would be good and could replace some of the written stations…"* [Participant 75: community, female]

### 9.6.4 Competency Development

Four trainees in the VP group reported using the cases towards their evidence for competency sign off.

> *"…that first one I took to my tutor because in my two weeks in community I didn't see any EHC and I was like "yes, from what I've done I can talk you through it" and I used it in that way for my appraisal."* [Participant 50: hospital, female]

The majority of trainees (8) in the NI group also reported using the case studies as evidence towards their competency sign off.

> *"I've used them as a whole [for evidence]…it was for A5.3, to make full use of learning and development opportunities."* [Participant 38: hospital, female]

The remaining trainees in both groups did not use the case studies towards their evidence as they had enough learning opportunities provided, but they all reported that they would have if they had needed to.

### 9.6.5 Future Use

Trainees were asked during the telephone interviews if they would use the case studies again in the future. All trainees from the VP and NI groups reported that they would use the learning tools in the

future. The most common use, as reported by five trainees in the VP group and seven trainees in the NI group, was for CPD.

> *"I used the EHC case to do a CPD cycle and I'd definitely use them in the future for that; you can use the cases to learn and to identify what knowledge is missing…"* [Participant 50: hospital, female]

> *"…I think as a pharmacist you could do it as part of a CPD cycle so you do the learning and then you do like a patient case scenario on top of that and then that's a really good CPD because you've got the knowledge, you've tried to apply it before you actually go out there to use it in practice…I think there is room for that as a qualified pharmacist."* [Participant 52: hospital, female]

Other comments for future use included as a resource to support changing work sectors and towards diploma work or other courses, such as prescribing.

> *"If I was looking into locuming or something I would definitely have a look at the EHC one and when you get put on certain wards for a rotation; if you get put on a renal speciality ward, just looking over that before you start…they will help with like SMART objectives and finding resources before you start the rotation…"* [Participant 38: hospital, female]

## 9.7 Chapter Discussion

The comments received from the telephone interviews varied for the VP simulations and the NI case studies. Not all themes were commented on by trainees from both groups; the main differences related to the usability of the VP technology.

Consistent with the questionnaire results (Chapter 8), it appeared that a greater proportion of trainees who used the VP believed the simulations were more realistic than the NI case studies. Pre-registration trainees reported that the design and interactivity of the VP increased its realism. Trainees reported that being able to ask the 'patient' questions and receiving verbal and textual responses engaged them and improved their learning because they had to think about the questions to ask or advice to give to proceed through the simulation. Trainees who only used the NI cases reported that they were interactive and allowed them to apply their learning, although this was to a lesser extent than those who used the VP cases. Trainees who used both types of case study reported that the NI cases were not interactive, or particularly engaging compared to the VP simulations.

The interactive nature of the VPs may have promoted experiential learning (Kenny *et al.*, 2009; Cendan and Lok, 2012; Bateman *et al.*, 2013). All trainees from the VP group and a number of trainees from the NI group commented on their learning style, with regards to them 'learning better by doing'. These individuals may develop skills and knowledge to a greater extent from the VP simulations than other, non-interactive learning tools. Kolb's experiential learning theory (Chapter 1) explains that learning from experiences promotes progression through all four stages of the cycle resulting in effective learning (Kolb, 1984). This indicates that the interactivity of the VP may have led to and thus promoted more effective learning than the NI cases.

Trainees in both groups reported that the topics chosen for the case studies were relevant for pre-registration training and future practice. This improved the realism of the case studies as trainees could relate the skills and knowledge to real life. One suggestion provided by trainees in both groups

to improve the realism of the scenarios was to increase the complexity of the case studies by incorporating multiple morbidities. In practice, a large proportion of the population have multiple long-term conditions, which is predicted to increase over the coming years, therefore it may have been useful to reflect population demographics in the case studies to improve trainees' readiness to practice (DOH, 2012). Simulations with varying levels of difficulty have been identified to promote effective learning and this may encourage greater utility of the learning tools throughout the pre-registration training year (Issenberg *et al.*, 2005).

Repetitive practice in a controlled environment has been identified as a feature of effective learning for simulation. Pre-registration trainees in the VP group reported completing the simulations more times than those in the NI group, which may have been attributed to the individualised patient outcomes which allow trainees to see how their actions could affect patient care. A 'safe environment' was reported by trainees when completing the VP simulations which related to an acceptance of making and learning from mistakes. In contrast, the majority of trainees did not report any benefits from multiple completion of the NI case studies, due to receiving the model answer upon submission. This illustrated an increased engagement with the VP tool and the reinforcement of results from Chapters 7 and 8 which also reported increased engagement with the VP over the NI case studies. Creating resources which are engaging and allow the application of learnt knowledge may also improve readiness to practice (Gordon *et al.*, 2001; Adamo, 2003; Vyas, Bhutada, *et al.*, 2012; Foronda and Bauman, 2014).

The increased engagement with the VP simulations may also be associated with the novelty of the tool itself. All trainees reported that the VP was a 'novel' learning tool for pre-registration training, whereas no comments were received regarding the novelty of the NI case study style. Trainees compared the NI case studies to resources which are currently available, which were not reported to be as enjoyable and useful as the VP cases in this research. The VP cases were described as different,

quicker to complete and more flexible than current resources which increased the ease of individuals fitting them into their training schedule. Additionally, the VP was described as a 'reputable' resource, which can be difficult to ensure due to the updating of guidelines and regulations. Trainees also believed both types of learning tool would integrate well with the changing pre-registration exam; this was reported as an important aspect to increase utilisation throughout the training year. The telephone interviews indicated that creating resources which are easy to use, enjoyable and evidence-based are fundamental elements for their use.

A key theme which emerged from the interviews was the desire for more support and resources throughout the training year. The variability of pre-registration training has been well-documented by the GPhC, who have identified variation in trainee's perceptions of support, experiences and supervision between the different sectors and regions of training (Blenkinsopp *et al.*, 2013, 2015). This was also evidenced in these interviews. Providing access to a resource which can promote experiential learning of a range of topics may be beneficial in pre-registration training and have the potential to bridge the variation gap (Cook and Triola, 2009; Dewhurst *et al.*, 2009; Poulton and Balasubramaniam, 2011; Douglass *et al.*, 2013; Foronda, Godsall, *et al.*, 2013).

Pre-registration trainees reported favourably on the concise and variable nature of the case study topics; with trainees referencing that both clinical and non-clinical (OTC) scenarios were important to provide a range of practice. During the interviews, trainees were asked about topic areas for future case studies which are presented in Table 9-2. The most common topic areas suggested were 'over-the-counter' or 'clinical', with trainees from both sectors believing that case studies which related to their current sector of training or the opposite sector of training would be useful. A pharmacist's knowledge should cover all medicines and medical conditions, thus, it was unsurprising that trainees suggested these broad topic areas. The VP was reported to provide an opportunity for trainees to practice in a safe environment, and while they may not be 'real-life' interactions, they were perceived

as more realistic and interactive than the NI case studies which ultimately increased the practical application of knowledge.

Pre-registration trainees reported that both types of case study were useful revision aids. Trainees also reported that the VP simulations could be integrated into study days for group learning. Comments were also received regarding the integration of the VP into OSCE's. Most trainees agreed that VPs would be useful as a practice tool for OSCE's but were less enthusiastic regarding their use in real OSCE's. The trainees who used both kinds of case study reported that the VP would have value as a station in a real OSCE and felt it could replace the written stations due to their increased realism and application of learning. The main criticism regarding the inclusion of the VP into an OSCE was the need for real person interaction to develop both verbal and non-verbal communication skills, which are essential for future practice as a pharmacist. In the interviews, trainees did believe the VP aided development of communication skills, but trainees may not have made the connection between this isolated skill and use in an OSCE.

By the end of the pre-registration training year, trainees should be at the 'does' step in Millers Triangle for the performance standards set out in their training manual (Miller, 1990; GPhC, 2013). This can be difficult for all trainees due to the variability of pre-registration training, as they may not be able to show their competence in all areas due to having limited real-life experiences. VP case studies can allow for trainees to show their competence at some of these experiences; for example, one trainee in the interviews reported using the EHC case study to show their tutor that they could competently carry out a consultation. It was reported that the VP case studies reduced the requirement for role-plays with tutors, which can be unrealistic, and allowed the practice of certain scenarios before interacting with real patients, which can risk patient-harm if trainees are unconfident.

Twelve trainees reported using the case studies as a resource to show competence against certain performance standards (four from the VP group and eight from the NI group). Of these trainees, there were only a handful who specified what competencies they linked the case studies to, however, both styles of case studies could be linked to several standards, as displayed in Table 9-3.

| Competency Number | Competency Description |
|---|---|
| A.2.4 | Use resources effectively |
| A.5.1 | Identify and prioritise your own learning and development needs |
| A.5.2 | Develop your own plans to meet identified needs, using SMART learning objectives |
| A.5.3 | Make full of use of learning and development opportunities |
| A.5.5 | Identify further learning needs |
| A.5.7 | Apply learning to practice |
| B.1.1 | Communicate effectively in English* |
| B.1.4 | Elicit all relevant information by the use of appropriate questions* |
| C.1.5 | Perform calculations correctly |
| C.1.7 | Supply extemporaneously prepared products according to the correct formula* |
| C.1.10 | Respond appropriately to requests to dispense prescription only items without a prescription* |
| C.2.4 | Construct medication histories using a range of sources |
| C.2.7 | Recognise possible adverse drug reactions, evaluate risks and take action accordingly |
| C.2.8 | Provide appropriate information and advice on the managements of minor and common ailments |

**Table 9-3 Presents a list of the performance standards which both case studies could link to, taken from the GPhC Pre-registration Manual (2013). Those with an * are the standards which only the VP case studies link to, based on comments received in the interviews.**

Both types of case study were reported to allow trainees to apply their learning, which is illustrated by standard A.5.7. Although only specifically mentioned by one trainee from the NI group, the case studies could be linked to standard A.5.2 and the creation of SMART objectives. Completing the case studies could be a method of meeting a SMART objective, especially the VP cases, by providing practical experience or application of specific skills or knowledge. One trainee in the VP group reported that the VP simulations could integrate the theory and practice of extemporaneous supply, allowing a link to standard C.1.7. This can be a difficult standard for trainees to meet due to the reduced amount of extemporaneously created products in current pharmacy practice, especially in

community, therefore creating a resource which can help trainees display their competence may offer unique benefits. Standard C.1.10 and the provision of medicines without a prescription can be a difficult standard for hospital-based trainees to meet, which was one of the primary reasons for the creation of the EHC case study in this research. Many trainees reported that creating case studies related to OTC medicines and minor ailments would be especially useful, which may help show competence at standard C.2.8.

Trainees reported that the case studies were better for knowledge acquisition rather than skill development, however there were specific skills which trainees reported the VP improved. Trainees reported that using the VP improved their communication skills, which was not reciprocated by trainees who completed the NI cases. This implies that the VP case studies could be linked to standard B.1.1. They could also be linked to standard B.1.4 due to the interactive nature of the VP tool, particularly the free-text input in which users may have to reword questions for the 'patient' to understand and respond appropriately. The importance of effective communication skills in pharmacy was described in Chapter 1 (section 1.3.1), and the reported ability of the VP to improve this skill is an area for further exploration.

A second skill which pre-registration trainees reported the learning tools improved was their calculation skills; which could link to standard C.1.5. In the interviews, this skill was only reported by trainees from the NI group but both case studies and sets of MCQs integrated the same calculations so it is unclear why this skill wasn't reported by trainees in the VP group. It may be that trainees in the VP group commented on the development of other skills during the interviews which they hadn't previously expressed, whereas comments relating to calculation skills were received on the questionnaire (Chapter 8) and thus trainees may have not felt the need to repeat this.

In addition to skill and knowledge development, trainees also commented on their improved self-confidence from using the VP and NI case studies. All nine trainees from the VP group and five

trainees from the NI group reported feeling more confident for the pre-registration exam after completing the case studies. Trainees from the VP group also commented on feeling confident for future practice, but no comments relating to this were received from trainees in the NI group. Self-confidence has been identified as a factor for effective working (Hicks et al., 2009) and the ability of the VP to improve confidence for future practice is, again, something that needs to be researched in more depth, but may offer great potential as a learning tool to both pre-registration trainees and qualified pharmacists.

Trainees commented on the potential uses of the VP post-qualification. The main area which trainees reported the VP would show use was as a tool for CPD. Future topics were reported by participants, which included more practical aspects of a pharmacist's role such as: inhaler technique, insulin injection technique and blood glucose monitoring. With the pharmacy profession advancing and new roles becoming more prominent, case studies which integrate the management of long-term conditions, pharmacist-led clinics, medicines optimisation and polypharmacy may be beneficial (NHS England, 2014a). Many comments received were focused on the pre-registration exam itself and not post-qualification, which is unsurprising due to the importance of successfully passing the pre-registration examination. Comments relating to future use of the case studies primarily came from those individuals in the VP group who believed they were developing skills, knowledge and confidence for real-practice and perhaps indicated greater utility for the VP case studies.

The main aim of this research was to evaluate how useful VPs were as a training tool in pre-registration training and receiving suggestions to increase utility was an important component of the research. The most significant problem with the VP technology, as previously mentioned in the pilot study (Chapter 6) and the questionnaire (Chapter 8), was the limited question bank and associated recognition issues (particularly with the EHC case study). There were no such issues reported by trainees from the NI case study group. Two trainees did mention that, although frustrating, the

recognition problems associated with the VP did not impact their learning and they compared what they wanted to ask the patient with the individualised feedback which explained areas they had missed. However, the majority of trainees did report that the recognition issue affected their learning; this problem therefore needs addressing before future cases are created to ensure users get the most from the learning opportunity. Questions which trainees asked the patient during the EHC consultation are stored in a database and can be matched to a specific patient response to ensure the question bank is more inclusive. Before future use, the question bank will be looked at by the research team and registered pharmacists, and further questions will be inputted to ensure the question bank contains as many variations of questions as possible to hopefully avoid the frustration which occurred in this research.

A potential limitation of the telephone interviews was the sample size. Although the response rates of trainees who were invited to participate and those who consented were high, and the demographics of the participants were well matched between the two groups, the sample size was relatively small at 20. However, data saturation seemed to occur by interview 15, where no new relevant data regarding the broad themes was obtained which would bring more depth to the analysis. As the rest of the interviews were scheduled, they were continued and all 20 interviews were conducted. This allowed for greater cementing of themes from the interviews.

The decision to conduct telephone interviews rather than face-to-face interviews was discussed in Chapter 4 (section 4.5.3). Having conducted the telephone interviews and reflecting upon them, the discussion will now turn to their successfulness. The choice to conduct telephone interviews may have influenced the number of trainees who consented and the responses that were obtained. Individuals may have felt less inclined to consent for a telephone interview as it can be difficult to create rapport over the phone as less social cues are available (Irvine *et al.*, 2013). Some of the interviews gathered more in-depth data than others, with few trainees providing limited comments

and not expanding when questioned, which may have resulted from the lack of rapport. Although not all participants spoke freely during the interviews, most did and provided insightful comments which were honest and included criticisms of the tools or their pre-registration training; which may not have been received if the interviews were conducted face-to-face. Overall, the telephone interviews flowed well and the level of information received from trainees was sufficient for the analysis; it would not appear that conducting the interviews over the telephone caused a significant barrier.

Conducting interviews over the telephone meant there was no control over the environment of the interviewee. The interviews were conducted at a time that suited the pre-registration trainees, thus they were carried out during work, after work and at weekends. It was difficult to ensure that trainees were concentrating on the interview and may account for some of the limited responses (Novick, 2008). Two interviews were conducted during the trainees' work hours, which resulted in shorter and less in-depth content. One interview was particularly difficult to conduct due to the participant's phone system not working correctly and having to conduct the interview whilst the trainee was on the shop floor. This was difficult due to other members of staff overhearing and resulted in very short and generic answers from the participant. The questions surrounding the topic of support was a difficult subset of questions which were not fully asked due to the interviewee not providing more than one or two-word answers. A benefit of semi-structured interviews is that there is a questioning guide but the interview is driven by the participant and their responses; this interview focused more on the case study specific questions and future topics for support.

The lack of non-verbal cues may have affected the way the data was viewed by researcher during the analysis. To prevent this, notes were made throughout the interviews of participant's comments and non-verbal inferences (i.e. pauses or background noise which may indicate distractions) to ensure contextualisation upon transcription. Hall and Callery (2001) noted that "although the systematic recording of pauses and non-verbal communication can contribute to detailed descriptions it alone is

not sufficient to provide a meaningful description of the interaction between the researcher and the participant". Therefore, it must be remembered that the interpretation of the spoken and unspoken cues may not fully represent trainees' perspectives which they portrayed in the interviews.

In any kind of interview, there is the risk that participants may respond in a way which they think the interviewer wants them to; which should be remembered during data analysis. Comments received are not definite thoughts and opinions, they are socially contingent based on the environment of the interviewee, the time of the interview and who the interviewer was, amongst other factors. Pre-registration trainees who were recruited from study days had seen the lead researcher (JT) and were aware that she had just finished her pre-registration training year and qualified as a pharmacist. This may have affected the results obtained. Participants may have responded honestly because they related to the researcher (similar age and stage in profession) or they may have viewed the researcher as an academic and responded in a way which they thought they should be perceived. Additionally, at the time of the interviews, trainees were not yet aware of their performance on the pre-registration examination and their individual thoughts on how the exam went may have influenced their comments regarding the support they received, their confidence or the exam and future practice.

Qualitative analysis is subjective and a reflexive stance was taken throughout the research, with particular awareness during the telephone interviews (Chapter 4, section 4.6.3). The lead researcher (JT) tried to remain objective and present the participant's perspectives in an open and honest manner, but the analysis is a result of an interaction between the researcher, the pre-registration trainees and a variety of factors (e.g. environment and time of interview) which are recognised as potential influences. The interview transcripts were read and re-read, with constant updating and rearranging of themes to result in the analysis reported above.

## 9.8 Chapter Summary

Overall, the VP case studies were reported to provide a more realistic, interactive and enjoyable way to learn. Many of the trainees reported learning better 'by doing' and the VP allowed trainees to apply their learnt knowledge and practice skills in a safe environment which improved confidence for practice. The NI case studies were reported as a useful and engaging learning tool but the novelty, interactivity and realistic nature of the VP simulations led to a better learning experience.

Variation in pre-registration training was a prime reason given by pre-registration trainees for wanting more support. Providing these case study based resources during the year was valued by all participants. The VP was described as a novel resource and was different to anything currently available. Trainees were favourable regarding the incorporation of VP simulations into the pre-registration training year and believed they would be beneficial as individual or group learning tools. The ability of VPs to promote experiential learning of a variety of topics may be a possible way to bridge the gap in variation between pre-registration training sectors and provide a fun, new resource to help trainees learn.

The key findings from this research and the overall significance of them in relation to previously published literature will be discussed in Chapter 10.

# 10. Discussion

## 10.1 Introduction

This final chapter focuses on the findings from the programme of work undertaken and their contribution to Pharmacy Practice research. The key findings from this thesis in relation to the study objectives set out in the methods chapter are discussed in section 10.2. The findings are then discussed in the context of the published literature throughout sections 10.3, 10.4 and 10.5. Strengths and limitations of the thesis are discussed in section 10.6 and the practice of reflexivity is revisited in section 10.7. Areas for future research are identified in section 10.8 and concluding remarks are presented in section 10.9.

## 10.2 Key Results

The overall aim of the research was to evaluate the effectiveness of interactive clinical avatars in supporting pre-registration training when compared to a non-interactive learning tool. This was met using a variety of objectives, against which the research findings will be discussed.

### 10.2.1 Design Objectives

The first two study objectives related to the design of the case studies:

- To determine topics or areas of pre-registration training where extra support or learning may be useful

- To develop interactive clinical avatars and non-interactive case studies to meet specific learning objectives relevant to these topics or areas

The discussion of meeting these objectives took place in Chapter 5 (i.e. why the topic areas were chosen and how the VP and NI case studies were created).

The qualitative findings indicate that the topic areas chosen were useful, as pre-registration trainees reported their improved knowledge on these topics after engaging with the learning tools. Pre-registration trainees noted that designing a variety of case studies relating to their current sector of training or the opposite sector of training would be useful to aid their learning, as they could think practically about experiences they may not otherwise have.

It was reported that trainees felt more confident answering questions related to the case study topic areas on the pre-registration exam, indicating that the learning objectives for the individual case studies had been met. One trainee also reported that they had used their learning in practice when a patient requested EHC, which they associated with completing the case study and having that practice.

Pre-registration variation was also reported as a problem, as it can affect the experiences individuals have during the training year, which may impact on their confidence for the pre-registration examination and, ultimately, their preparedness to practice as a pharmacist. Pre-registration trainees reported case studies on a variety of topics relating to pharmacy law, ethics and practice would be useful as they would encompass a range of knowledge, skills, attitudes and values which are required for future practice. Pre-registration trainees also reported positively at having more clinical case studies, which may reflect the changing pre-registration examination and expansion of pharmacist roles.

### 10.2.2 Knowledge-based Objectives

One of the study objectives related to the statistical analysis of knowledge improvement scores:

- To quantitatively assess the ability of interactive clinical avatars to enhance the knowledge base of pre-registration pharmacists compared to the NI case studies

The results from the quasi-experiment were presented and discussed in Chapter 7. For (nearly) all three cases, trainees in both groups answered significantly more questions correctly on the post-MCQs than at baseline (except the NI group in case study three). There were no statistical differences in knowledge improvement scores between the VP group and NI group for any of the case studies. This may have been because trainees in both groups were provided with resources above what they would receive in normal pre-registration training and the immediate feedback from the NI case studies was different from standard, paper-based case studies. Thus, both groups were provided with an additional resource to impact their learning; if the VP was compared with no control (i.e. normal practice), significant results between the groups may have been identified. Significant statistical differences were found between the sectors. Case study one identified hospital-based trainee's knowledge improved to a greater extent and case studies two and three identified a more significant improvement in community-based trainee's knowledge scores.

Of those trainees who completed all three case studies, a significantly greater percentage in the VP group passed the pre-registration examination on the first attempt (96.3%) compared to the NI group (77.8%). It was also identified that a significantly higher proportion of trainees from the community sector failed the pre-registration exam (22.9%) compared to those from the hospital sector (3.6%). Only one trainee from the VP sector failed (community-based), with the majority of these coming from the NI group. Although pre-registration training contains many variables which may affect one's examination pass mark (such as tutor support, exposure to experiences, individual inclination of learning opportunities), the results illustrate that completing the VP case studies as opposed to the NI

case studies may have had an impact on the pre-registration trainee's abilities and thus, overall examination pass mark.

### 10.2.3 Perspective-based Objectives

One of the objectives related to pre-registration trainee's perspectives of the case studies:

- To identify reported differences in usefulness or enjoyment of the learning tools or any differences in the inclination of trainees to use either ICA or NI case studies as part of pre-registration study

This objective incorporated the findings from the questionnaires and telephone interviews.

The case study topics chosen were perceived as being useful by pre-registration trainees because they were relevant to areas of current or future practice, and completing them reportedly enhanced their learning on these topic areas. Both types of case study were reported to improve knowledge by allowing individuals to identify gaps in their knowledge, promote self-directed learning and learn directly from the case studies. Four trainees from the VP group and seven trainees from the NI group reported learning directly from the case studies but differing opinions were obtained on the requirement to expand upon their knowledge using other resources. Some individuals believed all the information should come from the case studies themselves, whereas others valued using additional resources as they felt they had to more actively engage in the learning process. In addition to learning from the case studies, individuals reported learning from the MCQs which surrounded each case study (pre-post) and thought these were a useful way to self-assess knowledge.

The VP case studies appeared to be better at promoting skill development than the NI case studies, in particular to improve communication and clinical reasoning skills. Trainees reported that the VP helped them to think about how to phrase questions in a patient-friendly way, whereas the NI case

studies were not associated with improving communication skills. In contrast, the NI case studies were reported as improving trainee's calculation skills. Pre-registration trainees reported that the VP was better at allowing them to apply their learning to practice than the NI case studies and reported the usefulness of having a resource which promoted experiential learning. Individual's learning styles were commented upon and the VP was found to be useful for those who 'learn by doing'.

Usefulness of the VP simulations was limited by the problems associated with the question bank and input recognition by the 'patients'. This was particularly prominent with the EHC simulation. After the pilot study, more keywords and phrases were inputted into the question bank but comments from the main study showed that further increases may be necessary to improve the usefulness and utilisation of the tool. Problems related to the accessibility of the VP case studies were also expressed. The NI case studies usefulness was reportedly reduced by the lack of interactivity associated with them. Pre-registration trainees expressed that more detail and interactivity within a case study was required to help them prepare for real life situations. However, these limitations did not detract from the learning outcomes of the case studies.

The VP was reported to provide a more realistic patient experience, encouraged individuals to feel more like they were the pharmacist caring for the patient and were making the same decisions as a pharmacist would have to in real life. This increased realism promoted reflective practice. In contrast to the NI case studies, trainees who used the VP case studies reported completing the simulations multiple times and varying their questions and advice based on previous attempts and further reading around the topic area. There was little difference between user's perceived thoughts on the feedback being adequate for their needs in either the VP or NI cases, which reinforces the importance of providing feedback no matter what the learning tool is. The individualised feedback provided by the VP encouraged trainees to engage with the simulations more than the feedback provided from the NI

case studies. Pre-registration trainees reported that receiving immediate feedback was most helpful as they were able to identify how they performed.

Pre-registration trainees believed that the learning tools could be utilised in a variety of areas of pre-registration training. They were thought of being most useful as an individual revision aid but could also potentially be used as a group learning tool and as a practice for OSCE scenarios. Thoughts were mixed regarding the use of VPs in an OSCE, but some trainees reported they could be used to replace the standard written stations which would increase the realism. All trainees reported that human interaction is important in OSCE's and thus, the VP should not take the place of these stations, but could be used as an adjunct. No trainees commented upon the inclusion of the NI case studies in an OSCE station, however the current written stations are similar to the NI case studies in this research.

The increased realism and interactivity of the VP led to it being perceived as a more enjoyable learning tool than the NI case studies. Pre-registration trainees reported that the NI case studies 'felt like work' and were not enjoyable to complete. They also reported that the safe environment which the VP provided, along with the experiential learning, encouraged them to learn from their mistakes and re-use the simulations to improve their confidence in the particular topic areas. Results from the Likert scale indicated little difference between the groups regarding confidence for the pre-registration examination or future practice. However, upon further exploration in the interviews, a greater proportion of trainees from the VP group reported that completing the simulations increased their confidence for both compared to trainees who used the NI cases. Additionally, a much greater proportion of trainees who used the VP reported their confidence to work with other healthcare professionals and patients had improved, compared to those who used the NI cases.

### 10.2.4 Triangulation-based Objective

The final objective related to the triangulation of the results from the quasi-experimental evaluation, questionnaires and telephone interviews:

- To triangulate all the results and compare pre-registration trainee's perspectives on the ICAs and NI case studies with the statistical results obtained

Although no significant differences in knowledge improvement scores between the VP and NI case study groups were identified, individuals in the VP group did perceive that they were gaining knowledge from the simulations that will be required in practice more than the trainees in the NI group. Significant differences in knowledge improvements were found between the sectors, which may explain why trainees felt having case studies relating to either their current or opposite sector of training would be useful to aid their learning. Incorporating experiences which trainees may not have due to their sector of training was felt to be useful to ensure individuals get to practice and apply their learning in these scenarios. As important though, are simulations which do relate to their sector of training, either to improve confidence at common scenarios before qualification or to provide practice at rare but important scenarios (such as identification of measles as in case study 3).

As discussed previously in Chapter 7, for all case studies there were areas where the majority of trainees performed poorly on the MCQs. The completion of the pre- and post-MCQs for each case study was automatically timestamped by Google Drive and for all case studies, the majority of pre-registration trainees in both groups completed the pre- and post-MCQs in a 24-hour period. This indicated a lack of further reading on the topic and perhaps the desire to have access to the next case study, which was only available if the pre- and post-MCQs were completed within the month, outweighed the knowledge improvement assessment. Although, pre-registration trainees reported that they learnt from the MCQs thus, some trainees may have completed the pre- and post-MCQs in close succession to receive the answers and signposting to other resources to aid their learning.

For all three cases, trainees in the VP group reported engaging more than those in the NI group; this difference was statistically significant for the EHC and renal function cases but not for the childhood illness case. To determine trainee's engagement, they were asked how many times they used the case studies on the post-MCQs. It has already been identified that trainees completed the pre- and post-MCQs in close succession, thus individuals' self-declaration of engagement may not be reliable. These results were confirmed in the interviews as trainees reported using the VP cases multiple times, which was not reciprocated with the NI case studies.

Although differences in engagement between the two groups have been established, there was little difference between overall response rates for the two groups and, if anything, the VP group had less trainees completing all three case studies than the NI group. The majority of trainees from the VP group who dropped out, did so after the first case study, which may have been due to the problems associated with the technology. Although there were limitations with both case studies, both were perceived as useful learning tools with 38% of trainees completing all three case studies.

A further discussion of these results in relation to previous literature on VPs and simulation is set out in sections 10.3 to 10.5. New findings will be highlighted and similarities with previous work will be noted; both of which add to the under-researched area of VPs in pharmacy education. Having similarities with previous work adds strength to this thesis, because the findings are substantiated by those in published literature.

## 10.3 Trainee Development

The first part of this discussion focuses on pre-registration trainee's knowledge and skill development. Trainee development in respect to their knowledge is discussed in section 10.3.1 and the various skills are discussed in section 10.3.2.

As expressed in section 10.2.2, one of the research objectives was to determine how pre-registration trainee's knowledge changed when using the two learning tools. Any statistically significant improvement in knowledge between the trainees who used the VP and those who used the NI case studies was considered an important finding from this research, as this may indicate superiority of a learning tool. Exploring trainee's knowledge change was determined as a prominent part of the research as specialised knowledge in a variety of areas is an essential requirement to be a competent pharmacist (GPhC, 2011a; Smith and Darracott, 2011; RPS, 2017).

In addition to having a well-established knowledge base, pharmacists also need to encompass a wide skill-set, such as: clinical reasoning, communication and calculation skills (WHO, 1997; GPhC, 2017; RPS, 2017). Developing skills normally requires practical application, thus it was of interest to the researchers to note trainees' thoughts on whether these could be developed from completing VP or NI case studies.

The analysis of trainee's knowledge and skill development drew on results from the MCQs (Chapter 7), the questionnaire (Chapter 8) and comments made during the interviews (Chapter 9).

### 10.3.1 Clinical Knowledge

Although no significant differences in knowledge improvement were found between those who used the VP cases and those who used the NI cases, using the tools themselves did improve trainee's knowledge post-MCQ, indicating they were both effective learning tools. The VP and NI case studies provided trainees with an extra learning opportunity over regular practice and the provision of immediate feedback is not associated with regular, paper-based case studies. Thus, it was unsurprising that trainees' knowledge improved when using either type of case study. Had the VP been compared with regular practice (i.e. no NI case studies), significant findings between the groups

may have been found as only one group would have been provided with an extra, evidence-based resource.

When VPs have been evaluated alone, significance of knowledge improvement has been found (Al-Dahir et al, 2014; Battaglia et al, 2012; Benedict et al, 2013; Chaikoolvatana and Goodyer, 2003; Lichvar et al, 2016; McFalls, 2013; Smith et al, 2014; Smith et al, 2016; Taglieri et al, 2017; Zlotos et al, 2016). Previous research has found varying results when VPs have been compared with other, more established learning tools. Significant improvements in knowledge have been found with the VP (Botezatu, Hult, Tessma, *et al.*, 2010b; Kononowicz *et al.*, 2012) and non-significant results have been found; similar to those in this thesis (Cook and Triola, 2009; Benedict *et al.*, 2013; Bindoff *et al.*, 2014)

A significant finding from this research was the difference in knowledge improvement between the sectors. This indicates that, perhaps, as long as individuals are pro-active in their learning, the learning tool itself is not important and what is more important is ensuring the topics are relevant to user needs. The majority of previous research into VPs has evaluated their use in undergraduate students, thus these results add to the body of literature regarding VP use in postgraduate pharmacy education and indicates an avenue for further research. Variation in pre-registration training has been established, and these results indicate that providing resources which promote the application of learning may be beneficial at bridging the variation gap between sectors (Blenkinsopp *et al.*, 2013, 2015).

Research in medical students illustrated that real-patient interaction is important for the development and application of clinical knowledge (Diemers *et al.*, 2008, 2011). High fidelity simulations have been identified as effective tools for individuals to identify gaps in their knowledge and promote self-directed learning (Zary *et al.*, 2006; Huwendiek *et al.*, 2009; Benedict *et al.*, 2013). This research has reinforced these findings, as pre-registration trainees reported engaging in self-directed learning to further their understanding of the case study topics. Simulation has also been

found to promote reflective practice which, again, was reported in this research by individuals learning from their mistakes and attempting the VP simulations more than once after improving on their areas of weakness (Murray *et al.*, 2008). In comparison, trainees who completed the NI case studies did not report to engage in this reflective practice, indicating the superiority of VPs in this sense. Tools which encourage individuals to identify gaps in their own knowledge and engage in self-directed learning promote professionalism and a positive attitude to learning which is important for qualified pharmacist's due to CPD requirements (Mills *et al.*, 2005; GPhC, 2011b).

Both this study and the literature report positive user perspectives on the use of VPs to improve their knowledge base (Fuhrman Jr. *et al.*, 2001; Benedict, 2010). A greater proportion of trainees in this study who used the VP expressed that they were developing knowledge which would be important for the future, compared to those who used the NI case studies. Although no statistically significant results were obtained to reinforce this finding, individual's thoughts on the usefulness of a learning tool are important contributors to their overall utilisation. There was a lack of comparative research with VPs and other learning tools in the literature, thus findings from this research which illustrate differences between the two contribute to the body of knowledge.

Although no direct comparison can be drawn between the results of this study and the pre-registration examination pass rate, it was noted that significantly more trainees who completed the VP simulations passed the examination first-time compared to those who used only the NI cases. Additionally, there were more community-based trainees who failed the exam compared to hospital-based trainees, which reinforces the variation in training sectors. The majority of research evaluating VPs has been conducted using undergraduate students, which allows for more control over external variables. This research used pre-registration trainees and, as such, there was less control over external variables which may have affected their learning, such as: tutor support, training experiences and individual training requirements, thus a direct correlation cannot be drawn between VP use and

pass rate. Previous research has found that students who use simulations perform better on examinations than those who use more traditional learning tools, which may indicate that interactive, high-fidelity learning tools can significantly improve knowledge retention (Zary *et al.*, 2006; Botezatu, Hult, Tessma, *et al.*, 2010b; Richardson *et al.*, 2013).

### 10.3.2 Clinical Reasoning Skills

One of the most discussed skills in the literature surrounding healthcare professional's development is their clinical reasoning skills (Levett-Jones *et al.*, 2009; Frankel *et al.*, 2014; Peeters *et al.*, 2016). As the responsible pharmacist, individuals need to be able to "integrate facts and apply logic to make the best clinical decisions" (Gesundheit *et al.*, 2009). In the literature, it is quite common for the terms 'clinical reasoning', 'decision making' and 'critical thinking' to be used interchangeably, however users in this study were specifically asked about their clinical reasoning skills and their decision making/problem-solving skills separately to distinguish between the two and reinforce the more complex nature of clinical reasoning.

The ability of VPs to enhance clinical reasoning skills has been well established in the literature (Cook and Triola, 2009; Cook *et al.*, 2010; Forsberg *et al.*, 2011; Poulton and Balasubramaniam, 2011; Bateman *et al.*, 2012, 2013; Berman *et al.*, 2016). This thesis evaluated whether VPs were able to improve pre-registration trainee's clinical reasoning skills and whether there were any perceived differences to the development of these skills from the NI case studies. Pre-registration trainees who used the VP reported a greater development of clinical reasoning skills compared to those who used the NI cases. The majority of the literature evaluating VP effects on clinical reasoning skills lack comparative learning tools, but one study did find VPs encouraged greater use of clinical reasoning skills when compared with standardised patients (Gesundheit *et al.*, 2009). Findings from this research indicate that VPs are effective as postgraduate learning tools for higher-order skills. VPs can

promote clinical reasoning as user's actions affect patient outcomes and encourage clinical responsibility, which was further reinforced by pre-registration trainees agreeing that the VP made them feel like they were making the same decisions as they would have to when working as a pharmacist in real life (Guise, Chambers, Conradi, *et al.*, 2012; Benedict *et al.*, 2013)(Benedict eta l, 2013; Guise et al, 2012).

### 10.3.3 Communication Skills

Effective communication is essential in ensuring positive health outcomes and best patient care. This was discussed in Chapter 1 (section 1.3.1) (Leonard *et al.*, 2004; O'Daniel and Rosenstein, 2008; Haskard-Zolnierek and DiMatteo, 2009; Taran, 2010). Communication skills are taught extensively at an undergraduate level (GPhC, 2011a) and effective communication skills are included in the pre-registration training competency guidelines (GPhC, 2013). Research has found that after undergraduate education, medical students abilities to communicate may deteriorate as they proceed though postgraduate training (Stevens *et al.*, 2006). If VPs are found to be beneficial in the development of communication skills, their use may help to prevent this deterioration. Pre-registration trainees' communication skill development was explored in the telephone interviews (Chapter 9) and the VP was reported at aiding the development of communication skills, whereas this was not reported by those trainees who used the NI cases. Trainees reported that the VP helped them think about how to phrase patient friendly questions, establish a rapport and ultimately provide better patient care. Previous research has found mixed results regarding the development of communication skills from the use of VPs but this may relate to the type of VP used, with those that are more interactive being reported as more effective at developing communication skills (Sijstermans *et al.*, 2007; Botezatu, Hult and Fors, 2010; Bracegirdle and Chapman, 2010; Bindoff *et al.*, 2014; Pereira and Cavaco, 2014; Ferrone *et al.*, 2017; Taglieri *et al.*, 2017).

The free-text input of the VP cases used in this research was predominantly where communication skills were reported to be developed. This case design required appropriate spellings and language to be inputted to obtain a response from the VP. The pharmacy register is becoming increasingly diverse regarding ethnicities and overseas qualifications and the 'Guidance on Evidence of English Language Skills' (GPhC, 2016a) has led to more stringent controls for those working in Great Britain to have sufficient abilities to communicate; which is why these features were included in the VP design. Little research has investigated VP use in developing communication skills of those individuals whose first language is not English but that which has, as well as the results from this research, indicate it as a possible role of the VP and a proposed advantage over the NI case studies (Orr, 2007).

Non-verbal communication skills have been identified as difficult to develop using VP technology, although research in medical profession training has shown VPs can assist in the development of these elements of communication (Bearman *et al.*, 2001; Bearman, 2003; Stevens *et al.*, 2006; Deladisma *et al.*, 2007; Kleinsmith *et al.*, 2015). Non-verbal communication skills were not evaluated in this research and little work has been done on the ability of VPs to develop non-verbal communication skills in pharmacy, but one study by Bracegirdle and Chapman (2010) did find undergraduate students responded empathetically to asynchronous avatars, illustrating their potential to improve both verbal and non-verbal communication skills.

Over the past few years, there has been an increased emphasis on pharmacists' consultation skills (Smith and Darracott, 2011; RPS, 2014; Jee, Grimes, *et al.*, 2016). This has led to the development of training packages to ensure effective consultations in practice (Jee, Grimes, *et al.*, 2016; CPPE and HEE, 2017). Fleming *et al.* (2009) reported significantly positive results after using a VP programme to improve consultation skills, but there is a lack of other research in the use of VPs for consultation skills training. The successful use of VPs to develop communication skills therefore suggests scope for

future research to ensure effective resources and support is provided once pharmacy students have left undergraduate education.

### 10.3.4 Confidence

Previous research has established that pharmacists lack confidence in their own abilities which can prevent them from providing services, counselling or treatment (Kritikos *et al.*, 2010; Rosenthal *et al.*, 2010; Frankel and Austin, 2013; Bascom *et al.*, 2014; Morton *et al.*, 2014). Using interactive training tools has found to increase pharmacist's and undergraduate student's confidence at providing certain services (Fleming *et al.*, 2009; Battaglia *et al.*, 2012). Self-confidence is a key element in the successful integration of knowledge into practice (Grol and Grimshaw, 2003). This research therefore wanted to determine if the use of the VP could improve confidence of pre-registration trainees and if this was found to be to a greater extent than the NI case studies.

Pre-registration trainee's self-confidence was reported via responses to Likert statements and explored in the telephone interviews. Results from the questionnaire indicated little difference between the VP and NI groups regarding confidence for the pre-registration examination or future practice but the interviews identified a greater proportion of trainees from the VP group who reported an increase in their confidence compared to those from the NI group. The 2013-2014 GPhC pre-registration survey established a lack of confidence amongst trainees for the pre-registration exam, thus the findings from this thesis reflect those previously reported (Blenkinsopp *et al.*, 2015).

In the telephone interviews trainees reported feeling confident for the exam on the topics which related to the case studies. The interviews were conducted after the exam, whereas the questionnaire was completed before the exam which may explain the differing findings from the two data collection tools. Due to the variation of pre-registration training, the wide variety of knowledge and skills included in the pre-registration syllabus and the stress associated with the pre-registration

examination it may have been difficult for trainees to feel confident in their abilities before the examination and qualification (Mills *et al.*, 2013; Davison *et al.*, 2014; GPhC, 2016b; Jee, Schafheutle, *et al.*, 2016a).

Previous research has found VP use improved pharmacists' self-confidence in a range of areas, such as consultation skills, communication skills and overall abilities (Fleming *et al.*, 2009; Douglass *et al.*, 2013; Olin and Cole, 2015; Barnett *et al.*, 2016; McDowell *et al.*, 2016; Lambertsen *et al.*, 2017; Taglieri *et al.*, 2017). Research investigating the use of VPs in medical students has also found significant results regarding the improvement of self-confidence to interact with real-life patients (Parsons *et al.*, 2008; Kenny *et al.*, 2009; Kleinsmith *et al.*, 2015; Moule *et al.*, 2015). The findings from this research add to the body of literature as they confirm that VPs can improve pharmacist pre-registration trainee's confidence regarding their communication skills and abilities to care for real-life patients. Other critical results include improving confidence: for the pre-registration exam, to work with other healthcare professionals and to work as a pharmacist in practice.

The pharmacy profession is becoming more clinically-based and pharmacist roles in multi-disciplinary teams are becoming more established (NHS England, 2014a). Within the literature, there are few studies which utilise non-immersive VPs to help develop interdisciplinary skills. This research found that trainees who used the VP reported feeling more confident at future collaboration with other healthcare professionals than those who completed the NI cases. Interprofessional education using immersive VPs have been shown to be successful (Chapman, 2012; Humphreys *et al.*, 2013) but the reduced capacity for individualised learning associated with immersive environments prevents their widespread use. The positive findings relating to asynchronous avatars and interprofessional education are therefore encouraging.

### 10.3.5 Calculation Skills

One skill which the research team thought it important to evaluate were calculation skills; case study two was designed for this purpose. There has been no current research investigating VPs as a training tool to enhance calculation skills, thus findings from this research are essential to understand their usefulness. The findings from this thesis indicate that pre-registration trainees are not confident in their calculation abilities and lack sufficient calculation skills. This reflects current literature, which expresses a need for pharmacy students to have more calculations training (Malcolm and Mccoy, 2007; Vyas, Bhutada, *et al.*, 2012; Sheaffer and Addo, 2013; Vyas *et al.*, 2014).

Pre-registration trainees reported that integrating calculations into the case study was useful for them to apply their learning to a real-life scenario, as the variability in training and practice means that some trainees may not use these calculations in their everyday work (Mills et al, 2013). Trainees in the VP group reported completing the simulations multiple times, thus if they incorrectly calculated the patient's renal function, they reported trying it again. Whereas trainees in the NI case study group, were immediately provided with the correct answer and did not feel the requirement to complete the calculation within the case study again. Trainees in the NI group reported the inclusion of calculations was useful as they are such a pertinent part of the pre-registration examination, whereas trainees in the VP group saw more benefits for the technology beyond that of the pre-registration exam.

## 10.4 Case Study Design

The case study design was heavily commented on by pre-registration trainees and their perspectives will be discussed below, with particular respect to the novelty (section 10.4.1) and realism (section 10.4.2) of the VP and NI case studies, the level of feedback in aiding development (section 10.4.3) and the usability of the case studies (section 10.4.4).

### 10.4.1 Novelty

Digital learning is a growing phenomenon due to its ability at providing individualised, flexible learning (Dabbagh, 2005; Sun *et al.*, 2008; Fry *et al.*, 2009). It has already been noted that there is no superior instructional method for knowledge retention (Chapter 2) (Childs *et al.*, 2005; Lalley and Miller, 2007). Different instructional tools provide different benefits and thus are useful in combination to provide a blended learning approach (Barr and Tagg, 1995; Dabbagh, 2005; Sun *et al.*, 2008; Fry *et al.*, 2009; Gordon, 2014). It is common for individuals to use technology in everyday life, which leads the way for technology-based learning to be implemented and enjoyed. The relationship between enjoyment and learning has been widely studied since the 1950's, with mixed reports regarding direct correlations between the two variables (Blunsdon *et al.*, 2003). Research which has specifically investigated e-learning and enjoyment has identified that as long as individuals are competent with using the technology and understand the intended outcomes, they enjoy the learning process (Aldrich, 2005; Liaw *et al.*, 2007; Sun *et al.*, 2008; Lee, 2010; Boeker *et al.*, 2013; Hammersley *et al.*, 2013; Farrell *et al.*, 2015). The role of enjoyment has been identified as an important element in adult learners, therefore understanding what types of learning tools are deemed 'interesting', 'enjoyable' or 'fun' may encourage users to learn, promote concentration and help with knowledge retention (Lucardie, 2014).

A recurrent theme within the literature of VP use is related to user enjoyment (Chaikoolvatana and Goodyer, 2003; Marriott, 2007b; Benedict *et al.*, 2013; Douglass *et al.*, 2013; Bindoff *et al.*, 2014; Barnett *et al.*, 2016). Although most research has been conducted without a comparator, those studies which have evaluated virtual learning against more traditional learning tools have reported a greater enjoyment when using virtual learning tools (Leong *et al.*, 2003; Benedict, 2010; Richardson *et al.*, 2013; Barnett *et al.*, 2016). The findings from this research reinforce those previously found, as pre-registration trainees reported that the VP cases were more enjoyable and interesting to complete than the NI case studies.

It has also been stated that an increased enjoyment leads to greater engagement with the learning process (Droege, 2003; Dabbagh, 2005; Black and Plowright, 2010; Bryant, 2012; Williams *et al.*, 2013). This research found that pre-registration trainees reported greater engagement with the VP cases than the NI case studies, as they were able to alter their path through the VP simulations and see how different actions may affect patient outcomes. Pre-registration trainees believed this to be a useful aspect of the VP tool as it provided them with a safe environment to repeatedly practice scenarios, whereas no similar responses were received by trainees who completed the NI case studies. Trainees actually reported finding no value repeating the NI case studies.

Pre-registration trainees may have enjoyed and engaged with the VP more than the NI cases due to the novelty of VPs as learning tools. Expressions of novelty have not been reported by participants in previous research but it was a notable opinion obtained from this research. During the recruitment phase of this research, the majority of pre-registration trainees reported not having any previous VP experience, which reflects the literature that has found a lack of VP use within pharmacy education (Cook *et al.*, 2010; Cavaco and Madeira, 2012; Jabbur-lopes *et al.*, 2012). It was heavily stated throughout this research that pre-registration trainees felt the VP technology was novel, in contrast to the NI cases, which did not receive any comments regarding their novelty. Additionally, those trainees who used both types of case study preferred the VP and found it more interesting than the NI case studies due to it being novel.

Within pre-registration training there are a range of learning tools available, yet no research has been conducted into their effectiveness or to determine what resources trainees actually want. These findings therefore have a place in helping determine resources for future pre-registration trainees. The VP was reported as different to other resources currently available in pre-registration training, and comparisons were drawn which indicated a preference for the VP. The simulations furthered pre-registration trainees' learning and individuals reported greater knowledge retention after using the

VP than after completing the NI case studies; further reinforcing the benefits that novel resources can have in the training year.

Another novel aspect of the VP is the potential for experiential learning, which was reported as especially beneficial for those individuals who 'learn by doing'. The VP simulations provided an opportunity for pre-registration trainees to reach the higher levels of Millers triangle (Miller, 1990) in which they were able to 'show how' and 'do' a range of tasks, which they may have not otherwise had the chance to practice due to training sector variability. Overall, pre-registration trainees must take responsibility for their learning needs but providing resources which promote experiential learning and allow for flexible learning may be beneficial.

### 10.4.2 Realism

A major theme previously identified in the literature and further reinforced in this research is the increased realism of VPs compared with other learning tools (Bergin and Fors, 2003; Huwendiek *et al.*, 2009; Forsberg *et al.*, 2011; Gormley *et al.*, 2011). As explained in Chapter 2 (section 2.8.1) the term 'VP' encompasses a wide range of technological tools which vary in their immersivity and realism. Comments received in this research illustrate that the realism of asynchronous avatars may also be affected by: the topics, the interactivity and imagery of the VP and the ability for users to relate the learning to real patients.

Creating resources which allow users to immerse themselves in a scenario and behave as they would in real practice has been found to be extremely beneficial in aiding the development of knowledge and skills (Herrington, 2006; Ellaway *et al.*, 2008; Dutile *et al.*, 2011; Foronda, Godsall, *et al.*, 2013). In this research, the VPs were reported to provide a more realistic patient experience, a greater sense that pre-registration trainees were the pharmacist caring for the patient and that they were making the same decisions as a pharmacist would have to in real life. This greater sense of responsibility

associated with VP use has been reflected in the literature and has been identified as less apparent from using NI case studies (Zary *et al.*, 2006; Loke *et al.*, 2011; Park and Summons, 2013b). This research has reinforced these previous findings at a postgraduate level and, as little research has evaluated VPs at this stage in pharmacist's career, it is interesting to understand what resources invoke these higher order skills. One pre-registration trainee specifically reported that the VP encouraged them to feel a sense of 'clinical responsibility', which was not mentioned by the trainees who used the NI cases or in previous literature of VP use.

In addition to encouraging clinical responsibility, both types of case study allowed trainees to understand and think about treating those who are not 'textbook patients', which are heavily utilised as learning tools during undergraduate education (Loke *et al.* 2011). VPs allow for physiological abnormalities or visible conditions to be incorporated into simulations which users can see on-screen and is not possible with NI case studies, thus increasing the realism of VPs (Gesundheit *et al.*, 2009; Wendling *et al.*, 2011; Cendan and Lok, 2012; Chapman, 2012). This research utilised this attribute of the VP technology by incorporating the measles rash and Koplik spots in case study three and by programming the VP in case study one to blush upon requesting EHC. There is also the ability to manipulate the setting of the VP to promote user immersion in the simulation and encourage users to apply their knowledge, as if they were really there in practice (Bracegirdle and Chapman, 2010; Cendan and Lok, 2012; Chapman, 2012). This, again, was utilised in this research by simulating both community and hospital based pharmacy settings for the VP case studies. The questionnaire and telephone interviews highlighted that the VP provided a greater opportunity for individuals to apply their learning than the NI cases. Upon review of the literature, it appears there are few studies which evaluate VP simulations based in different settings (e.g. community pharmacy, hospital pharmacy) or with different patient groups (e.g. children, elderly), which have been identified as factors that can affect the realism of a simulation and an individual's learning. The results from this research can

therefore aid in the development of realistic VP simulations for pharmacy students, pre-registration trainees and qualified pharmacists.

An aspect of the VPs in this research which improved their realism over the NI case studies was their interactivity. The interactive element promoted user engagement and helped individuals think about what questions they would ask a patient, how they would phrase these questions and what advice or treatment they would provide to achieve the best patient outcomes (Stevens *et al.*, 2006; Bracegirdle and Chapman, 2010; Battaglia *et al.*, 2012). The VPs integrated a Markov Model design (as described in the Chapter 5, section 5.8), which ensures simulation outcomes are directly determined by user input to encourage user responsibility (Bracegirdle and Chapman, 2010). Pre-registration trainees in this research reported behaving like they would in real practice with regard to the questions they asked and how they communicated with the VPs. The underlying model used has not been specifically discussed in many research papers, but the explanation in this thesis allows for an opportunity to determine how different models can promote learning.

A second aspect of the case studies which increased their realism was the relevance to future practice of the topics chosen. Herrington (2006) explains that 'cognitive realism' is more important than the physical fidelity and interactivity for learning, such as being able to relate learning to real-life scenarios. Trainees in both groups reported the case study topics as realistic, although improvements were suggested to enhance their realism which users believed would ultimately improve their learning experience. Trainees in the NI group believed that improving the visual appeal of the case studies, by increasing the number of pictures or colours, would allow them to retain the information better. Similarities have also been found in the literature, with students believing that more visual aids would deepen their learning (Huwendiek *et al.*, 2009; Botezatu, Hult, Tessma, *et al.*, 2010a). An important element of VP realism, especially those such as asynchronous avatars, is their authenticity involving their appearance, actions and behaviours (Dickerson *et al.*, 2006; Kenny *et al.*, 2009). Pre-

registration trainees who used the VP expressed that the VP's appearance, voice and movements were realistic. These specific attributes are not routinely evaluated in the literature, rather a single statement regarding students' beliefs that the VP was realistic is provided, which can make it difficult for replication and other researchers to understand the specific features of a VP which lead to a realistic learning experience.

Additional suggestions to improve the realism of the case studies related to the difficulty of the case studies. Pre-registration trainees reportedly believed that it would be useful to have case studies of varying difficulties to allow individuals with different levels of knowledge and skills to complete a simulation which was most appropriate for them. Although comments were received regarding the case studies incorporating 'non-textbook patients', improvements were suggested to include patients with multiple comorbidities or problems to improve their realism and allow for greater use of clinical reasoning skills. These types of suggestions haven't been readily expressed within the literature, but Johnsen *et al.* (2005) found that students may find patients of varying difficulty helpful to develop their questioning and history taking skills.

As most previous research has been conducted in undergraduate students, it is interesting to find that individuals in their postgraduate training, who will be experiencing real patients, believe that more detail and interactivity within a case study is required to help them prepare for real life situations. These findings add to the literature by reinforcing previous findings and discussing other features of VPs which may improve the realism of simulations.

### 10.4.3 Feedback

The importance of feedback in the nature of learning has been discussed in Chapter 2, with feedback being identified as an essential component of student learning (Sadler, 1989; Hattie *et al.*, 1996; Black and William, 1998; Yorke, 2003; Pashler *et al.*, 2005). In healthcare education and training, effective

feedback should be clear, specific and promote self-reflection of the individual (Ende, 1983; Nicol and Macfarlane-Dick, 2005; Clynes and Raftery, 2008; Hall *et al.*, 2012; Doan, 2013; Duffy, 2013; Bond *et al.*, 2017).

Within the VP literature, it is noted that an integral part of the VP system is providing user feedback. User perceptions of the quality or usefulness of this feedback is rarely investigated or reported, but that research which has included feedback as an outcome measure has found a positive correlation between feedback and learning (Bearman, 2003; Bergin and Fors, 2003; Stevens *et al.*, 2006; Zary *et al.*, 2006; Ellaway *et al.*, 2008; Fleming *et al.*, 2009; Gallimore *et al.*, 2011; Hurst and Marks-Maran, 2011; Douglass *et al.*, 2013). Issenberg (2005) states that "feedback, knowledge of results of one's performance, is the single most important feature of simulation-based medical education toward the goal of effective learning". Thus, it is imperative that users obtain feedback on their performance in VP simulations, but it is also important to establish what kind of feedback users prefer and find most useful.

Usefulness of different feedback delivery methods has not been researched in relation to VPs, but specific and immediate feedback has been found to aid learning in those engaging with e-learning tools (Galusha, 1998; Tynjälä and Häkkinen, 2005; Sun *et al.*, 2008; Gordon, 2014). There were few differences between user's perceptions on the adequacy of feedback from the VP and NI case studies, which reinforces the importance of providing feedback no matter what the learning tool. Pre-registration trainees reported that the immediate feedback was helpful as it enabled them to identify how they performed whilst the case study was fresh in their mind. These findings reinforce those expressed in the literature regarding the relationship between feedback, user satisfaction and engagement with learning tools (Issenberg *et al.*, 2005; Sun *et al.*, 2008; Cook *et al.*, 2010; Hammersley *et al.*, 2013; Gordon, 2014; Lucardie, 2014).

Another principal finding from this research which has been poorly reported in the literature is how feedback is provided to VP users (Deladisma *et al.*, 2008; Fleming *et al.*, 2009; Benedict, 2010; Gormley *et al.*, 2011; Battaglia *et al.*, 2012; Benedict *et al.*, 2013). It has been made clear in this study that a combination of written and audible feedback was provided to the pre-registration trainees. Similarities are seen with the immersive reality studies by Dickerson *et al.* (2005) and Stevens *et al.* (2006), in which feedback was provided to medical students via a VP, but there is a definitive lack of interactive feedback in pharmacy education research.

### 10.4.4 Usability

Integration of technology into any aspect of training and education can be hindered by barriers associated with its use. As discussed in Chapter 2 (section 2.9), potential barriers include: time for training on use of the technology, low confidence in IT abilities, perceived usefulness of the technology, lack of willingness to use technology, lack of specific learning objectives, lack of accessible equipment or resources and lack of support when using the technology; especially with e-learning tools (Short *et al.*, 2004; Vrasidas, 2004; Savoldelli *et al.*, 2005; Sun *et al.*, 2008; Dieckmann *et al.*, 2012). Using a blended learning approach can potentially reduce the barriers associated with e-learning and allow individuals to utilise a range of tools to enhance their learning (Childs *et al.*, 2005). The use of VPs or other e-learning tools also enables flexible learning as users are able to complete the simulations at a time of their choosing, to make the experience more individualised and encourage users to take responsibility for their learning (Hammersley *et al.*, 2013; Gordon, 2014).

This research did identify potential barriers with the VP technology. Firstly, although users did perceive the VP as easy to use, it wasn't reported to be as easy to use as the NI cases. Results from the questionnaires and interviews illustrated that clearer instructions on how to use the VP technology could have been provided. Varying results have been found in the literature regarding

ease of use of VPs, with some research reporting that users found them easy to use and others reporting the need for more instructions or training (Chaikoolvatana and Goodyer, 2003; Zary *et al.*, 2006; Marriott, 2007b; Fleming *et al.*, 2009; Forsberg *et al.*, 2011; Gormley *et al.*, 2011). Understanding the users of the VP may help to reduce these problems as the simulations and level of instruction can be tailored to their VP needs.

The majority of previous research evaluating VPs in pharmacy has done so using undergraduate students where face-to-face support may be more accessible. Research which has been conducted with other participant groups (i.e. qualified pharmacists) has explained the provision of training before users are expected to use the VP technology alone. It was established that the majority of pre-registration trainees in this research had not used VP technology before (see Chapter 7, section 7.3). Although instructions were integrated in to the VP cases which included the learning objectives for the simulations, a 'how to' guide of completing the simulation, a demonstration of how to use the technology and a 'frequently asked questions' page with a VP support email address, individuals may have had low confidence in using the technology initially (as suggested from the pilot study in Chapter 6). Future use of the VP may require training sessions or more informative instructions to ensure users feel more supported and get the most out of the learning experience. Trainees who completed the NI case studies also reported that further instructions would have been helpful and, as these case studies simply required a typed response to a question in a textbox, it may appear that pre-registration trainees are in the transition from University to working life and require more guidance and support when completing tasks.

The main issue associated with the usability of the VP was the recognition problems of the software when using the free-text input. The majority of pre-registration trainees who completed the VP case studies reported this as an issue and believed it restricted their consultation and affected the realism of the simulation. Although the question bank of the EHC case was expanded after the pilot study

(Chapter 6), it may still not have encompassed all the questions or keywords which individuals may have wanted to ask, resulting in feelings of frustration; which have also been reported in the literature (Bergin and Fors, 2003; Stevens *et al.*, 2006; Parsons *et al.*, 2008). Pre-registration trainees also reported that the recognition problems did not affect their learning and they used it as a resource to think about rewording or rephrasing questions. The only other research which has expressed similar results used an immersive environment rather than asynchronous avatars (Stevens et al, 2006), thus this finding is unique to this research and indicates usefulness of VPs even with technological limitations.

## 10.5 Pre-registration Trainee Support

This next section considers the level of support pre-registration trainees felt they received during their training year and explores the reasons for these results. In particular, discussion turns to the variation of pre-registration training (section 10.5.1) and the specific utilisation of VPs in pre-registration training (section 10.5.2).

### 10.5.1 Pre-registration Variation

The GPhC has conducted surveys to assess pre-registration trainee and pre-registration tutor views of training. The GPhC have not yet released the findings for the 2014/2015 cohort of pre-registration students, thus this discussion will compare views reported in this research with findings from previous surveys.

The variability of pre-registration training has been well established, regarding the quality and level of support trainees receive, the quality of the training experience and how prepared trainees feel for practice (Blenkinsopp *et al.*, 2013, 2015). Significant differences in trainee's perceptions have been

found based on region of training, sector of training and ethnicity (Blenkinsopp *et al.*, 2013, 2015). These findings reinforce the results from this research, in which trainees reported that variations within and between the sectors can impact on the experiences they have, the development of their competencies and confidence for the pre-registration exam and preparedness to practice (Mills *et al.*, 2013; Jee, Schafheutle, *et al.*, 2016a).

The variation of experiences between the sectors is substantial, with some trainees previously reporting a lack of cross-sector experience, further limiting the experiences available. A disparity in the examination pass rate of pre-registration trainees in the different sectors has also been established, which may be a result of the variation in support and training experiences (GPhC, 2015a). Providing a resource which can simulate experiences that pre-registration trainees may not have (such as the VP) is beneficial and was reported as such during the interviews.

Findings from the quasi-experiment showed significant correlations between sector of training and knowledge improvement for all three case studies. Hospital-based trainee's knowledge improved to a greater extent regarding emergency contraception, which may be due to their lack of exposure to EHC. Community-based trainee's knowledge improved to a greater extent regarding renal function and drug dosage adjustments, which similarly may be due to their lack of exposure to this. Community-based trainee's knowledge also improved to a greater extent regarding measles, which may be due to all trainee's lack of exposure to this kind of problem and community-based trainees utilising it more as a beneficial learning experience before qualifying. Resulting from these significant differences in knowledge improvement between training sectors, it may be valuable to investigate multiple VP case studies tailored to hospital and community pre-registration trainees to identify areas of weakness and determine how the VP could be utilised to its full potential.

### 10.5.2 Use of the VP in Pre-registration Training

Pre-registration trainees in this research reported that the VP would be most useful as an individual revision aid. Previous literature has identified that VPs and simulation can promote self-directed learning, illustrating their potential as revision aids (Gormley *et al.*, 2009; Benedict *et al.*, 2013; Zlotos *et al.*, 2016). There are many resources available for trainees, which was commented on in the telephone interviews with individuals reporting that it was difficult to find up-to-date, evidence based resources. Providing evidence based simulations, which can be updated with new guidelines, advice and treatment options, provides a wide scope for the VP as a resource in pre-registration training. Once the avatars are designed, a range of simulations can be created to allow pre-registration trainees to apply their learning in various scenarios. This may be beneficial because trainees reported that VP simulations on a wide variety of topics would be useful, including clinical-based, OTC-based, services-based, law and ethics-based (see Chapter 9, section 9.5.6 for more). They can also aid trainee's revision by reflecting the changing pre-registration examination, therefore increasing confidence for the exam and preparedness to practice.

Pre-registration trainees also reported the use of VPs as a group learning tool. Previous research has evaluated VPs in problem-based group learning with positive results (Poulton *et al.*, 2009, 2014; Benedict, 2010; McFalls, 2013; Al-Dahir *et al.*, 2014). The use of VPs in a group setting may allow for individuals to learn from each other and learn from a tutor, who can also aid with any technical issues and provide help and guidance with completion of the case studies; which may reduce the limitations previously noted.

Little research has been conducted into the use of VPs in OSCE's, but that which has been done has found positive results regarding VP integration (Johnsen *et al.*, 2007; Courteille *et al.*, 2008; Oliven *et al.*, 2011; Lin *et al.*, 2013). No previous research has investigated VP use in OSCE's for pharmacy students, thus it was presented as an idea in the telephone interviews due to the high level of

reliability of VPs and their ability to assess a range of skills and behaviors. Although most pre-registration trainees agreed that the VP would be useful to prepare for an OSCE, less individuals believed it could be integrated as a real station. Trainees reported that human interaction is an important component of OSCE's and thus SPs may be more appropriate than VPs to assess skills, although some trainees did report that VP cases could be included over written stations to improve their realism. Previous work has found that SPs and VPs allow students to develop different skills, which provides a justification for combined use (McRobbie *et al.*, 2006; Nestel *et al.*, 2007; Lin *et al.*, 2013). Incorporating VPs into an OSCE may relieve some of the pressures to those involved in the creation of or participation in the OSCE's (Quizon *et al.*, 2011; Salinitri *et al.*, 2012; Lin *et al.*, 2013).

## 10.6 Strengths and Limitations of the Research

The research undertaken for this thesis adds considerably to the under-researched area of VPs in pharmacy and especially in pre-registration training, with only one previous study assessing the ability of VPs to improve knowledge of pre-registration trainees (Zlotos *et al.*, 2016).

The comparison of VPs and NI case studies also adds to the originality of this thesis. The majority of previously published literature has evaluated VPs alone, with no comparative learning tool, especially within the area of pharmacy. There have been studies which have compared VPs with problem-based learning, lectures and SPs but few have compared with paper-based case studies. This research therefore adds to the very limited literature of VPs and NI case studies, and their use in pharmacy education and training.

This pragmatic study has filled the research gap that existed through the use of a mixed methods approach. The researcher was able to explore, with detailed insight, the usefulness and usability of VPs in pre-registration training. The statistical results obtained regarding knowledge improvement grounded the rest of the findings from this research in the quantifiable use of VPs as learning tools.

The questionnaires obtained a more standardised measure of pre-registration trainee thoughts on the use of VPs. The additional open-ended questions and semi-structured interviews allowed the capture of exploratory views which helped to conceptualise the previous findings from the MCQs and questionnaires.

The majority of research that has investigated VPs in the education and training of healthcare professionals has relied on single methods (primarily either questionnaires or interviews). The research conducted for this thesis used both, with the addition of knowledge-based MCQs. This not only adds to the strength of the results found (as noted above) but also adds to the literature base regarding choice of methodologies available to evaluate the usefulness of VPs. The work itself was ambitious, which required the lead researcher (JT) to adhere to strict timescales for multiple rounds of data collection that took place throughout pre-registration training. A variety of different kinds of data were collected and further triangulated to increase the validity and reliability of the findings.

The participants themselves added to the strengths of the research. Originally, 165 pre-registration trainees consented to participate, who were randomly stratified to two cohorts to receive either the VP case studies or the NI case studies, ensuring that results were more generalisable as demographics between the two groups were similar. There was a wide pool of pre-registration trainees, with at least one trainee per accredited School of Pharmacy consenting to participate. The profile of respondents was diverse regarding their gender, sector of training and ethnicity and these demographics were consistent with the distribution of pharmacists in practice and the growing distribution of ethnic minorities entering the pharmacy profession (Willis *et al.*, 2006; Seston and Hassell, 2009, 2011; Hassell, 2012).

Although there were a number of strengths with the way this research was designed and executed, there were also some limitations which are acknowledged. The first limitation that must be noted is the risk of self-selection bias in the sample of participants, which may have ultimately affected the

interpretation of the findings. Enrolment in the study and completion of the case studies was voluntary and those individuals who agreed to take part may have been more enthusiastic about utilising learning opportunities. Findings, therefore, may not accurately reflect all pre-registration trainees (Collier and Mahoney, 1996).

A second limitation of the research occurred during the recruitment phase. The lead researcher (JT) was limited to recruit only those pre-registration trainees who they were able to contact, which was via regional or individual tutors who supported the research and allowed the researcher to present at study days, send emails or encouraged their trainees to participate. Longitudinal research has been associated with dropouts and at the end of the three-month period, there was a 38% response rate (of completion of the three case studies). The lead researcher (JT) kept in good contact with the pre-registration trainees by sending interim emails and reminders of the case studies, thus it can only be speculated as to why pre-registration trainees did drop out; as it was not possible to chase up these trainees for reasoning. The possible reasons for the low response rate have been previously discussed in Chapters 7 and 9. The case studies were implemented into the training year later than planned due to the increased complexity and thus increased time taken to create them. This may also have contributed to the response rate; trainees initially consented in Summer/Autumn 2014 and the first case study did not go live until December 2014. However, the sample size calculation performed initially suggested a minimum sample of 52 participants would be needed to ensure statistical power for the quantitative aspect of the research (see Chapter 5, section 5.5.1), and a greater number of trainees completed all three case studies (63 trainees), indicating a sample size large enough to obtain statistical significance.

A final limitation of the research was the decision to only include views of pre-registration trainees on the use of VPs as a training tool. There may have been value in including the views of pre-registration tutors, as they could establish how well they felt VPs fit into the training programme and may have

also indicated other areas for utilisation in the year (i.e. appraisals). Tutors could have also helped assess trainee's knowledge improvement on the specific topic areas. Some trainees were completing the pre- and post-MCQs in the same day, which may indicate a lack of further reading and understanding of the topic. However, using tutors in this way would have put undue pressures on both the trainees (online MCQs may be associated with less stress than face-to-face questioning with tutor) and the tutors (added time pressures) and may have affected the response rate of participants. Additionally, the case studies were created as an optional resource for pre-registration trainees and involving pre-registration tutors in this process may have taken away the flexibility that the case studies were designed to offer.

## 10.7 Reflexivity

The theory behind reflexivity in qualitative research has been described in Chapter 4 (methodology) and further discussed in Chapter 9 in relation to the telephone interviews. This section of the thesis will consider the role of the researcher and describe the journey throughout the research programme.

From the outset, the lead researcher (JT) had a keen interest in pharmacy education and, as they had just completed their pre-registration training, had an insight into the methods of the research by understanding possible recruitment procedures. The lead researcher (JT) was aware that both the hospital and community sectors conducted study days; the researcher already had contacts for those associated with the hospital regional training days and colleagues at Keele University provided contacts for those at the larger community pharmacy multiples. The lead researcher (JT) also drew on their own experience during pre-registration training to help decide on case study topics which they believed may supplement the year most effectively, specifically looking at the training standards which trainees may find it difficult to meet based on their sector of training. Understanding the

workload during the pre-registration training year allowed the lead researcher (JT) to promote the research and the VP in a way which was different to the other resources available for pre-registration trainees, and intended the trainees to see it is an educational and novel tool.

Being newly-qualified may have either improved or negatively impacted the researcher's relationship with the pre-registration trainees in the telephone interviews, as briefly discussed in Chapter 9. Pre-registration trainees may have responded in a way in which they thought the researcher wanted, such as providing a lack of critique of the VP tool. However, the interviews received a mix of positive and negative comments, which indicates that a good rapport was built and trainees felt comfortable with the researcher to provide their honest feedback. It is of importance to note that in qualitative research, the data obtained is of a socially contingent nature and the researcher's personal thoughts and feelings regarding pre-registration training may have affected the way the study was run and the results were analysed. Additionally, being a novice researcher and a newly-qualified pharmacist may have resulted in different interpretations and creation of relationships between the data.

Although the benefits of utilising different data collection methods are apparent and were discussed in depth in Chapter 4, this led to a substantial amount of data being collected in the research. The researcher faced many challenges in handling, analysing and interpreting the data whilst sticking to strict deadlines to ensure the next phase of data collection could occur. This may have affected the construction of the data because, although an in-depth analysis of the data occurred, it is theoretically possible that the researcher overlooked relationships between the data or misinterpreted comments that were received.

## 10.8 Future Work

Additional findings to come out of this thesis that require further exploration will be discussed in turn below.

Pre-registration trainees reported that they could see value in use of the VP once qualified, to assist with CPD, diplomas or prescribing courses and to provide training on different work sectors. Integration of pharmacists within the overall healthcare team is now increasingly emphasised within the pharmacy profession and work sectors are also expanding with pharmacists now playing a full role in GP practices in primary care (NHS, 2014). VPs could provide training in pace and scale for pharmacists interested in working in GP practices, to help meet the proposal of having 1,500 clinical pharmacists in general practice by 2020/21 (NHS, 2016). Further research would need to be conducted to understand the usefulness of VPs by qualified pharmacists and with particular respect to their usefulness in training pharmacists to be ready to enter GP practice-based roles.

Additionally, the VP could be used to enhance experiences of pharmacy roles in undergraduate pharmacy education. Currently, not all GP practices have a clinical pharmacist in post so it can be difficult for pharmacy students to obtain experiences in primary care. Providing VP simulations related to this role may allow them to understand the role and receive experiential learning before making the decision of their career path. VPs also have the potential to enhance interprofessional education and teamworking skills. Most research investigating this has used immersive environments or mannequins, but this research found scope for the use of the VP to aid in the development of these skills; specific work would need to be conducted to establish their usefulness.

The increasing clinical roles of pharmacists has led to increased emphasis of their consultation skills. In this thesis, VPs were found to promote the development of communication skills, particularly in case study one (EHC provision) which implemented the free-text input. Creating resources which are able to develop effective communication skills and allow individuals to practice these skills in a safe environment may be beneficial. Further research into how useful qualified pharmacists believe VPs are at enhancing these skills would be required.

This thesis added to the already established literature regarding variation in pre-registration training and it has been discussed how the VP can help with this. The VP may be a beneficial learning tool for the new integrated 5-year course that is becoming accredited at Universities across the UK (Smith and Darracott, 2011). This research found that the VP helped provide experiences trainees may not have had due to their sector of training, which shows the potential for use in the five-year course. It may allow exposure to patient groups and experiences which individuals may not have and also provide an opportunity for experiential learning and to provide 'practice' of scenarios during their time at University. As the 5-year integrated courses are relatively new for most Universities, research into how VPs can assist in the training and development of their students would be useful to see the full potential of the tool.

A final area for future work is the use of VPs in OSCE's for undergraduate or postgraduate pharmacist training. The role of OSCE's in assessing competencies is well established in the literature and there were mixed views regarding the inclusion of VPs in OSCE's. Due to their ability to improve a range of knowledge and skills and their reliability as an assessment tool, there is scope for further research to determine their usefulness in an OSCE scenario in pharmacy education.

## 10.9 Concluding Remarks

This thesis enhances the overall literature base regarding the potential benefits VPs can offer the education and training of healthcare professionals but adds particular value to the under-researched area of VP use in pharmacy postgraduate education.

When compared with NI case studies, there was no superiority of the VP improving the knowledge of pre-registration trainees but their perceptions regarding the usefulness of the tool shows the potential benefits it can offer. Regardless of the lack of significant differences in knowledge between the groups, pre-registration trainees believed that what they were learning from the VP was of more

importance to their future practice. The VP was also reported to be superior at developing a range of skills including communication skills, which were originally thought of only being developed via real-person interactions. The VP was found to provide experiential learning of a range of scenarios which pre-registration trainees enjoyed completing and engaged with more than the NI case studies.

A significant finding was the improvement in knowledge of pre-registration trainees in the different sectors, which indicates the potential ability of the VP to bridge the established gap in variation between the training sectors. The VP can be designed to meet a range of learning objectives and is an evidence-based tool which can be easily updated to ensure users are kept up-to-date with the latest guidelines and to align with the changing pre-registration exam which ensures it never becomes 'unusable'.

Individuals believed that the VP could be integrated into the training year in a variety of ways, which increases the flexibility of the learning tool and may promote a blended learning approach. Improvements need to be made to the VP to ensure full utility, but the promising results from this thesis substantiate the need for further research to be carried out into the full potential VPs can offer pre-registration trainees.

# 11. Bibliography

AAMC (2007) 'Effective Use of Educational Technology in Medical Education. Colloquium on Educational Technology: Recommendations and Guideline for Medical Educators'.

Abdo, A. and Ravert, P. (2006) 'Student satisfaction with simulation experiences', *Clinical Simulation in Nursing*. 2(1), pp. e13–e16.

Aburahma, M. and Mohamed, H. (2015) 'Educational games as a teaching tool in pharmacy curriculum', *American Journal of Pharmaceutical Education*, 79(4).

ACPE (2015) 'Accreditation Standards and Key Elements for the Professional Program in Pharmacy Leading to the Doctor of Pharmacy Degree'.

Adamo, G. (2003) 'Simulated and standardized patients in OSCEs: achievements and challenges 1992-2003', *Medical Teacher*, 25(3), pp. 262–70.

Adkins, L. (2003) 'Reflexivity: Freedom or habit of gender?', *Theory, Culture & Society*, 20(6), pp. 21–42.

Aebersold, M., Tschannen, D. and Bathish, M. (2012) 'Innovative simulation strategies in education', *Nursing Research and Practice*, pp. 1–7.

Agomo, C., Ogunleye, J. and Portlock, J. (2016) 'Strategies enhancing the public health role of community pharmacists: a qualitative study', *Journal of Pharmaceutical Health Services Research*, 7(2), pp. 97–104.

Aiken, L., Clarke, S., Cheung, R., Sloane, D. and Silber, J. (2011) 'Educational levels of hospital nurses and surgical patient mortality', *JAMA*, 290(12), pp. 1617–1623.

Akl, E., Pretorius, R., Sackett, K., Erdley, S., Bhoopathi, P., Alfarah, Z. and Schünemann, H. (2010) 'The effect of educational games on medical students' learning outcomes: A systematic review: BEME Guide No 14', *Medical Teacher*, 32(1), pp. 16–27.

Al-Dahir, S., Bryant, K., Kennedy, K. and Robinson, D. (2014) 'Online virtual-patient cases versus traditional problem-based learning in advanced pharmacy practice experiences', *American Journal of Pharmaceutical Education*, 78(4), pp. 1–8.

Aldrich, C. (2005) 'Learning by Doing: A Comprehensive Guide to Simulations, Computer Games, and

Pedagogy in e-Learning and Other Educational Experiences'. San Francisco, United States of America: Wiley.

Anderson, C. and Thornley, T. (2014) '"It's easier in pharmacy": why some patients prefer to pay for flu jabs rather than use the National Health Service', *BMC Health Services Research*, 14(1), pp. 35.

Armstrong, D., Gosling, A., Weinman, J. and Marteau, T. (1997) 'The place of inter-rater reliability in qualitative research: An empirical study', *Sociology*, 31(3), pp. 597–606.

Arthur, C., Kable, A. and Levett-Jones, T. (2010) 'Human patient simulation manikins and information communication technology use in australian schools of nursing: a cross-sectional survey', *Clinical Simulation in Nursing*. 7(6).

Ashley, C. and Currie, A. (2008) 'The Renal Drug Handbook'. CRC Press.

Attewell, B, Blenkinsopp, A. and Black, P. (2005) 'Community pharmacists and continuing professional development — a qualitative study of perceptions and current involvement', *The Pharmaceutical Journal*, 274, pp. 519–524.

Austin, Z. (2004) 'Development and validation of the Pharmacists' Inventory of Learning Styles (PILS)', *American Journal of Pharmaceutical Education*, 68(2), pp. 1–10.

Austin, Z., Gregory, P. and Tabak, D. (2006) 'Simulated patients vs. standardized patients in Objective Structured Clinical Examinations', *American Journal of Pharmaceutical Education*, 70(5), pp. 119.

Bacon, L., Savage, I., Cook, S. and Taylor, B. (2003) 'Training and supporting pharmacists to supply progestogen-only emergency contraception', *Journal of Family Planning and Reproductive Health Care*, 29(2), pp. 17–22.

Badcock, L., Raj, N., Gadsby, K. and Deighton, C. (2006) 'Meeting the needs of increasing numbers of medical students - A best practise approach', *Rheumatology*, 45(7), pp. 799–803.

Barber, N., Rawlins, M. and Franklin, B. (2003) 'Reducing prescribing error: competence, control, and culture', *Quality and Safety in Health Care*, 12, pp. 29–32.

Barnes, E., Ashraf, I. and Din, A. (2017) 'New roles for clinical pharmacists in general practice', *Prescriber*, 28(4), pp. 26–29.

Barnett, S, Gallimore, C., Pitterle, M. and Morrill, J. (2016) 'Impact of a paper vs virtual simulated patient case on student-perceived confidence and engagement', *American Journal of Pharmaceutical*

*Education*, 80(1), pp. 9–14.

Barr, R. and Tagg, J. (1995) 'From teaching to learning—A new paradigm for undergraduate education', *Change*, 27(6), pp. 13–25.

Barrows, H. (1993) 'An overview of the uses of standardized patients for teaching and evaluating clinical skills. AAMC', *Academic Medicine: Journal of the Association of American Medical Colleges*, 68(6).

Bascom, C., Rosenthal, M. and Houle, S. (2014) 'Are pharmacists ready for a greater role in travel health? An evaluation of the knowledge and confidence in providing travel health advice of pharmacists practicing in a community pharmacy chain in Alberta, Canada', *Journal of Travel Medicine*, 22(2), pp. 99–104.

Basheti, I. (2014) 'The effect of using simulation for training pharmacy students on correct device technique', *American Journal of Pharmaceutical Education*, 78(10), pp. 1–10.

Basit, T. (2010) 'Conducting Research in Educational Contexts'. Continuum International Publishing Group.

Batchelor, H. and Marriott, J. (2013) 'Paediatric pharmacokinetics: Key considerations', *British Journal of Clinical Pharmacology*, 79(3), pp. 395–404.

Bateman, J., Allen, M., Kidd, J., Parsons, N. and Davies, D. (2012) 'Virtual patients design and its effect on clinical reasoning and student experience: a protocol for a randomised factorial multi-centre study', *BMC Medical Education*, 12(62).

Bateman, J., Allen, M., Samani, D., Kidd, J. and Davies, D. (2013) 'Virtual patient design: Exploring what works and why. A grounded theory study', *Medical Education*, 47(6), pp. 595–606.

Battaglia, J., Kieser, M., Bruskiewitz, R., Pitterle, M. and Thorpe, J. (2012) 'An online virtual-patient program to teach pharmacists and pharmacy students how to provide diabetes-specific medication therapy management', *American Journal of Pharmaceutical Education*, 76(7).

Beard, L., Morra, D., Wilson, K. and Keelan, J. (2009) 'A survey of health-related activities on Second Life', *Journal of Medical Internet Research*, 11(2), pp. e17.

Bearman, M. (2003) 'Is virtual the same as real? Medical students' experiences of a virtual patient.', *Academic Medicine*, 78(5), pp. 538–545.

Bearman, M., Cesnik, B. and Liddell, M. (2001) 'Random comparison of "virtual patient" models in the context of teaching clinical communication skills', *Medical Education*, 35(9), pp. 824–832.

Beetham, H. and Sharpe, R. (2007) 'An Introduction To Rethinking Pedagogy For A Digital Age', in Beetham, H. and Sharpe, R. (eds) *Rethinking Pedagogy for a Digital Age*. Routledge.

Bell, H., Maguire, T., Adair, C. and Mcgartland, L. (2001) 'Perceptions of CPD within the pharmacy profession', *The International Journal of Pharmacy Practice*, 9, pp. R55.

Bell, M. (2008) 'Toward a definition of "virtual worlds"', *Journal of Virtual Worlds Research. Virtual Worlds Research: Past, Present & Future*, 1(1), pp. 1–5.

Benedict, N. (2010) 'Virtual patients and problem-based learning in advanced therapeutics', *American Journal of Pharmaceutical Education*, 74(8), pp. 1–5.

Benedict, N. and Schonder, K. (2011) 'Patient simulation software to augment an advanced pharmaceutics course', *American Journal of Pharmaceutical Education*, 75(2).

Benedict, N., Schonder, K. and McGee, J. (2013) 'Promotion of self-directed learning using virtual patient cases', *American Journal of Pharmaceutical Education*, 77(7).

Bergin, R. and Fors, U. (2003) 'Interactive simulated patient—an advanced tool for student-activated learning in medicine and healthcare', *Computers & Education*, 40(4), pp. 361–376.

Berman, N., Durning, S., Fischer, M., Huwendiek, S. and Triola, M. (2016) 'The role for virtual patients in the future of medical education', *Academic Medicine*, 91(9), pp. 1217–1221.

Bindoff, I., Ling, T., Bereznicki, L., Westbury, J., Chalmers, L., Peterson, G. and Ollington, R. (2014) 'A computer simulation of community pharmacy practice for educational use', *American Journal of Pharmaceutical Education*, 78(9).

Black, P. and Plowright, D. (2010) 'A multi-dimensional model of reflective learning for professional development', *Reflective Practice*, 11(2), pp. 245–258.

Black, P. and William, D. (1998) 'Assessment and classroom learning', *Assessment in Education: Principles, Policy & Practice*, 5(1).

Bland, J. and Altman, D. (1997) 'Cronbach's alpha', *BMJ*, p. 572.

Blenkinsopp, A., Marshall, K., McNair, K., Roberts, G. and Wisher, S. (2013) 'General Pharmaceutical Council Survey of 2012/13 Pre-registration Trainees', *The General Pharmaceutical Council*.

Blenkinsopp, A., Marshall, K., Roberts, G., Wisher, S. and McNair, K. (2015) 'General Pharmaceutical Council Survey of 2013/2014 Pre-registration Trainees', *The General Pharmaceutical Council*.

Bliuc, A., Goodyear, P. and Ellis, R. (2007) 'Research focus and methodological choices in studies into students' experiences of blended learning in higher education', *Internet and Higher Education*, 10(4), pp. 231–244.

Blom, L. and Krass, I. (2011) 'Introduction: the role of pharmacy in patient education and counseling', *Patient Education and Counseling*, 83(3), pp. 285–7.

Blunsdon, B., Reed, K., McNeil, N. and McEachern, S. (2003) 'Experiential learning in social science theory: An investigation of the relationship between student enjoyment and learning', *Higher Education Research & Development*, 22(1), pp. 43–56.

Boeker, M., Andel, P., Vach, W. and Frankenschmidt, A. (2013) 'Game-based e-learning is more effective than a conventional instructional method: A randomized controlled trial with third-year medical students', *PLoS ONE*, 8(12), pp. 1–11.

Bond, J., Cheng, A. and Kairuz, T. (2017) 'Relating variance in feedback effectiveness to learning styles', *Pharmacy Education*, 17(1), pp. 8–14.

Botezatu, M., Hult, H., Tessma, M. and Fors, U. (2010a) 'Virtual patient simulation: knowledge gain or knowledge loss?', *Medical Teacher*, 32(7), pp. 562–8.

Botezatu, M., Hult, H., Tessma, M. and Fors, U. (2010b) 'Virtual patient simulation for learning and assessment: Superior results in comparison with regular course exams', *Medical Teacher*, 32(10), pp. 845–50.

Botezatu, M., Hult, H. and Fors, U. (2010) 'Virtual patient simulation: what do students make of it? A focus group study', *BMC Medical Education*, 10(91).

Boulos, M., Hetherington, L. and Wheeler, S. (2007) 'Second Life: An overview of the potential of 3-D virtual worlds in medical and health education', *Health Information and Libraries Journal*, 24(4), pp. 233–245.

Bracegirdle, L. and Chapman, S. (2010) 'Programmable patients: Simulation of consultation skills in a virtual environment', *Bio-Algorithms and Med-Systems*, 6(11), pp. 111–115.

Bradley, P. (2006) 'The history of simulation in medical education and possible future directions', *Medical Education*, 40(3), pp. 254–262.

Branch, C. (2013) ‘Pharmacy students’ learning and satisfaction with high-fidelity simulation to teach drug-induced dyspepsia’, *American Journal of Pharmaceutical Education*, 77(2), pp. 10–30.

Brannan, J., White, A. and Bezanson, J. (2008) ‘Simulator effects on cognitive skills and confidence levels’, *Journal of Nursing Education*, 47(11), pp. 495–500.

Braun, V. and Clarke, V. (2013) ‘Successful Qualitative Research. A Practical Guide For Beginners’. SAGE Publications.

Bray, B., Schwartz, C., Odegard, P., Hammer, D. and Seybert, A. (2011) ‘Assessment of human patient simulation-based learning’, *American Journal of Pharmaceutical Education*, 75(10).

Brayfield, A. (2014) ‘Martindale: The Complete Drug Reference’, *London: Pharmaceutical Press*. Available at: http://www.medicinescomplete.com/. (Accessed 12/03/2014).

Brazeau, G., Meyer, S., Belsey, M., Bednarczyk, E., Bilic, S., Bullock, J., DeLander, G., Fiese, E., Giroux, S., McNatty, D., Nemire, R., Prescott, W. and Traynor, A. (2009) ‘Preparing pharmacy graduates for traditional and emerging career opportunities’, *American Journal of Pharmaceutical Education*, 73(8).

Brick, J. and Kalton, G. (1996) ‘Handling missing data in survey research’, *Statistical Methods in Medical Research*, 5(3), pp. 215–238.

Britten, N. (2000) ‘Qualitative Interviews In Health Care Research’, in Pope, C. and Mays, N. (eds) *Qualitative Research in Health Care*. Second Edi. BMJ Books.

Brown, D., Portlock, J., Rutter, P. and Nazar, Z. (2014) ‘From community pharmacy to healthy living pharmacy: Positive early experiences from Portsmouth, England’, *Research in Social and Administrative Pharmacy*, 10(1), pp. 72–87.

Bryant, P. (2012) ‘The Modern University In The Digital Age’, *The London School of Economics and Political Science*. Greenwich Connect Key Documents, Educational Development Unit, University of Greenwich , London, UK.

Bryman, A. (2006) ‘Integrating quantitative and qualitative research: how is it done?’, *Qualitative Research*, 6(1), pp. 97–113.

Bryman, A. (2012) ‘Social Research Methods’. Oxford University Press.

Del Bueno, D. (2005) ‘A crisis in critical thinking’, *Nursing Education Perspectives*, 26(5), pp. 278–282.

Burke, J., Miller, W., Spencer, A., Crank, C., Adkins, L., Bertch, K., Ragucci, D., Smith, W. and Valley, A.

(2008) ‘ACCP WHITE PAPER Clinical Pharmacist Competencies’, *Pharmacotherapy*, 28(6), pp. 806–815.

Cain, J. and Piascik, P. (2015) ‘Are serious games a good strategy for pharmacy education?’, *American Journal of Pharmaceutical Education*, 79(4).

Calnan, M. (2013) ‘Quantitative Survey Methods in Health Research’, in Saks, M. and Allsop, J. (eds) *Researching Health. Qualitative, Quantitative and Mixed Methods*. Second Edi. SAGE Publications.

Campbell, D. and Fiske, D. (1959) ‘Convergent and discriminant validation by the multitrait-multimethod matrix’, *Psychological Bulletin*, 56(2), pp. 81–105.

Campbell, M., Machin, D. and Walters, S. (2007) ‘Medical Statistics. A Textbook for the Health Sciences’. Wiley.

Carr, E. and Worth, A. (2001) ‘The use of the telephone interview for research’, *Nursing Times Research*, 6(1), pp. 511–524.

Cavaco, A. and Madeira, F. (2012) ‘European pharmacy students ’ experience with virtual patient technology’, *American Journal of Pharmaceutical Education*, 76(6), pp. 1–7.

Caylor, S., Aebersold, M., Lapham, J. and Carlson, E. (2015) ‘The use of virtual simulation and a modified TeamSTEPPS$^{TM}$ training for multiprofessional education’, *Clinical Simulation in Nursing*, 11(3), pp. 163–171.

Cendan, J. and Lok, B. (2012) ‘The use of virtual patients in medical school curricula’, *Advances in Physiology Education*, 36(1), pp. 48–53.

Chaikoolvatana, A. and Goodyer, L. (2003) ‘Evaluation of a multimedia case-history simulation program for pharmacy students’, *American Journal of Pharmaceutical Education*, 67(1), pp. 108–115.

Chapman, S. (2012) ‘The use of simulation technology in the MPharm programme’.

Cheetham, M., Pavlovic, I., Jordan, N., Suter, P. and Jancke, L. (2013) ‘Category processing and the human likeness dimension of the uncanny valley hypothesis: eye-tracking data’, Frontiers in Psychology. 4(108), pp. 1-12.

Childs, S., Blenkinsopp, E., Hall, A. and Walton, G. (2005) ‘Effective e-learning for health professionals and students-barriers and their solutions. A systematic review of the literature-findings from the HeXL project’, *Health Information and Libraries Journal*, 22(s2), pp. 20–32.

Claudio, A., Carmo, M., Pinto, V. and Cavaco, A. (2015) ‘Virtual humans for training and assessment of

self-medication consultation skills in pharmacy students', *Conference Paper -The 10th International Conference on Computer Science & Education*.

Clynes, M. and Raftery, S. (2008) 'Feedback: An essential element of student learning in clinical practice', *Nurse Education in Practice*, 8(6), pp. 405–411.

Cohen, L., Manion, L. and Morrison, K. (2007) 'Research Methods in Education'. Routledge.

Collier, D. and Mahoney, J. (1996) 'Insights and pitfalls: Selection bias in qualitative research', *World Politics*, 49(1), pp. 56–91.

Collingridge, D. and Gantt, E. (2008) 'The Quality of Qualitative Research', *American Journal of Medical Quality*, 23(5), pp. 389–395.

Consorti, F., Mancuso, R., Nocioni, M. and Piccolo, A. (2012) 'Efficacy of virtual patients in medical education: A meta-analysis of randomized studies', *Computers & Education*, 59(3), pp. 1001–1008.

Converse, J. and Presser, S. (1986) 'Survey Questions: Handcrafting The Standardized Questionnaire'. SAGE Publications.

Cook, D., Hatala, R., Brydges, R., Zendejas, B., Szostek, J., Wang, A., Erwin, P. and Hamstra, S. (2011) 'Technology-enhanced simulation for health professions education: A systematic review and meta-analysis', *JAMA*, 306(9), pp. 978–988.

Cook, D. (2005) 'The research we still are not doing: an agenda for the study of computer-based learning', *Academic Medicine: Journal of the Association of American Medical Colleges*, 80(6), pp. 541–8.

Cook, D. (2010) 'One drop at a time: Research to advance the science of simulation.', *Simulation in Healthcare*, 5(1), pp. 1–4.

Cook, D. (2006) 'Where are we with web-based learning in medical education?', *Medical Teacher*, 28(7), pp. 594–598.

Cook, D. (2009) 'The failure of e-learning research to inform educational practice, and what we can do about it', *Medical Teacher*, 31(2), pp. 158–162.

Cook, D., Erwin, P. and Triola, M. (2010) 'Computerized virtual patients in health professions education: a systematic review and meta-analysis', *Academic Medicine*, 85(10), pp. 1589–1602.

Cook, D. and Triola, M. (2009) 'Virtual patients: a critical literature review and proposed next steps',

*Medical Education*, 43(4), pp. 303–11.

Cooper, J. and Taqueti, V. (2004) 'A brief history of the development of mannequin simulators for clinical education and training', *Quality and Safety in Health Care*, 13.

Cooper, R., Bissell, P. and Wingfield, J. (2008) 'Ethical, religious and factual beliefs about the supply of emergency hormonal contraception by UK community pharmacists', *Journal of Family Planning & Reproductive Health Care*, 34(1), pp. 47–50.

Courteille, O., Bergin, R., Stockeld, D., Ponzer, S. and Fors, U. (2008) 'The use of a virtual patient case in an OSCE-based exam - A pilot study', *Medical Teacher*, 30(3), pp. e66–e76.

CPPE (2012a) 'Emergency contraception'. Available at: http://www.cppe.ac.uk/e-learning/emergencycontraception. (Accessed on: 20/02/2014).

CPPE (2012b) 'Responding to Minor Ailments'. (Accessed on: 5/03/2014).

CPPE and HEE (2017) 'Consultation Skills for Pharmacy Practice'. Available at: http://www.consultationskillsforpharmacy.com/. (Accessed on: 10/09/2017).

Crea, K. (2011) 'Practice skill development through the use of human patient simulation', *American Journal of Pharmaceutical Education*, 75(9).

Creswell, J., Plano Clark, V., Gutmann, M. and Hanson, W. (2003) 'Advanced Mixed Methods Research Designs', in Tashakkori, A. and Teddlie, C. (eds) *Handbook of Mixed Methods in Social & Behavioural Research*. First Edit. SAGE Publications.

Creswell, J. (2014) 'Research Design. Qualitative, Quantitative, & Mixed Methods Approaches'. SAGE Publications.

Creswell, J. and Plano Clark, V. (2011) 'Designing and Conducting Mixed Methods Research'. SAGE Publications.

Cronbach, L. (1951) 'Coefficient alpha and the internal structure of tests', *Psychometrika*, 16(3), pp. 297–334.

Cunningham, J. and McCrum-Gardner, E. (2007) 'Power, effect and sample size using GPower: practical issues for researchers and members of research ethics committees', *Evidence Based Midwifery*, 5(4), pp. 132–136.

Custers, E. (2010) 'Long-term retention of basic science knowledge: A review study', *Advances in*

*Health Sciences Education*, 15(1), pp. 109–128.

Dabbagh, N. (2005) 'Pedagogical models for e-learning: A theory-based design framework', *International Journal of Technology in Teaching and Learning*, 1(1), pp. 25–44.

Davison, K., Wassef, C., Orlandi, T. and Moffit, K. (2014) 'How you should prepare for the registration assessment', *Tomorrow's Pharmacist*. Available at: http://www.pharmaceutical-journal.com/publications/tomorrows-pharmacist/how-you-should-prepare-for-the-registration-assessment/11138938.article. (Accessed on: 10/06/2016).

Dean, B., Schachter, M., Vincent, C. and Barber, N. (2002) 'Causes of prescribing errors in hospital inpatients: A prospective study', *Lancet*, 359(9315), pp. 1373–1378.

Deladisma, A., Cohen, M., Stevens, A., Wagner, P., Lok, B., Bernard, T., Oxendine, C., Schumacher, L., Johnsen, K., Dickerson, R., Raij, A., Wells, R., Duerson, M., Harper, G. and Lind, S. (2007) 'Do medical students respond empathetically to a virtual patient?', *American Journal of Surgery*, 193(6), pp. 756–760.

Deladisma, A., Johnsen, K., Raij, A., Rossen, B., Kotranza, A., Kalapurakal, M., Szlam, S., Bittner, J., Swinson, D., Lok, B. and Lind, S. (2008) 'Medical student satisfaction using a virtual patient system to learn history-taking communication skills', *Studies in Health Technology and Informatics*, 132, pp. 101–5.

Dellinger, A. and Leech, N. (2007) 'Toward a unified validation framework in mixed methods research', *Journal of Mixed Methods Research*, 1(4), pp. 309–332.

Denzin, N. and Lincoln, Y. (2005) 'Introduction: The Discipline and Practice of Qualitative Research', in Denzin, N. and Lincoln, Y. (eds) *The Sage Handbook of Qualitative Research*. Third Edit. SAGE Publications.

Derose, K. (2005) 'A brief introduction to the topic what is epistemology?', pp. 1–6.

Deterding, S., Dixon, D., Khaled, R. and Nacke, L. (2011) 'From game design elements to gamefulness: Defining "Gamification"', in *Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments.*

Devane, D., Begley, C. and Clarke, M. (2004) 'How many do I need? Basic principles of sample size estimation', *Journal of Advanced Nursing*, 47(3), pp. 297–302.

DeVellis, R. (2003) 'Scale Development: Theory and Applications'. SAGE Publications.

Dewhurst, D., Borgstein, E., Grant, M. and Begg, M. (2009) 'Online virtual patients - A driver for change in medical and healthcare professional education in developing countries?', *Medical Teacher*, 31(8), pp. 721–4.

Diaz, J., Griffith, R., Ng, J., Reinert, S., Friedmann, P. and Moulton, A. (2002) 'Patients' use of the internet for medical information', *Journal of General Internal Medicine*, 17(3), pp. 180–185.

Dickerson, R., Johnsen, K. and Raij, A. (2006) 'Virtual patients: assessment of synthesized versus recorded speech', *Studies in Health Technology and Informatics*, 119, pp. 114–119.

Dieckmann, P., Friis, S., Lippert, A.and Ostergaard, D. (2012) 'Goals, success factors, and barriers for simulation-based learning: A qualitative interview study in health care', *Simulation & Gaming*, 43(5), pp. 627–647.

Diemers, A., Dolmans, D., Verwijnen, M., Heineman, E. and Scherpbier, A. (2008) 'Students' opinions about the effects of preclinical patient contacts on their learning', *Advances in Health Sciences Education*, 13(5), pp. 633–647.

Diemers, A., Van De Wiel, M., Scherpbier, A., Heineman, E. and Dolmans, D. (2011) 'Pre-clinical patient contacts and the application of biomedical and clinical knowledge', *Medical Education*, 45(3), pp. 280–288.

Doan, L. (2013) 'Is Feedback a Waste of Time? The Students' Perspective', *Journal of Perspectives in Applied Academic Practice*, 1(2), pp. 3–10.

DOH (1998) 'A First Class Service: Quality In The New NHS'. *Department of Health.*

DOH (2003) 'A Vision for Pharmacy in the New NHS'. *Department of Health.*

DOH (2005) 'Choosing Health Through Pharmacy'. *Department of Health.*

DOH (2008) 'Pharmacy in England: Building on Strengths – Delivering The Future'. *Department of Health.*

DOH (2011) 'A Framework for Technology Enhanced Learning'. *Department of Health.*

DOH (2012) 'Long Term Conditions Compendium of Information'. *Department of Health.*

Douglass, M., Casale, J., Skirvin, A. and Divall, M. (2013) 'A virtual patient software program to improve pharmacy student learning in a comprehensive disease management course', *American Journal of Pharmaceutical Education*, 77(8).

Drennan, J. (2013) 'Quasi-experimental and Retrospective Pretest Designs For Health Care Research', in Curtis, E. and Drennan, J. (eds) *Quantitative Health Research Issues and Methods*. First Edit. Open University Press.

Droege, M. (2003) 'The role of reflective practice in pharmacy', *Education for Health*, 16(1), pp. 68–74.

Duffy, K. (2013) 'Providing constructive feedback to students during mentoring', *Nursing Standard*, 27(31), pp. 50–56.

Duque, G., Fung, S., Mallet, L., Posel, N. and Fleiszer, D. (2008) 'Learning while having fun: The use of video gaming to teach geriatric house calls to medical students', *Journal of the American Geriatrics Society*, 56(7), pp. 1328–1332.

Dutile, C., Wright, N. and Beauchesne, M. (2011) 'Virtual clinical education: Going the full distance in nursing education', *Newborn and Infant Nursing Reviews*, 11(1), pp. 43–48.

van Eikenhorst, L., Salema, N. and Anderson, C. (2017) 'A systematic review in select countries of the role of the pharmacist in consultations and sales of non-prescription medicines in community pharmacy', *Research in Social and Administrative Pharmacy*, 13(1), pp. 17–38.

Ekblad, S., Mollica, R., Fors, U., Pantziaras, I. and Lavelle, J. (2013) 'Educational potential of a virtual patient system for caring for traumatized patients in primary care', *BMC Medical Education*, 13(1), p. 110.

Ellaway, R., Candler, C., Greene, P. and Smothers, V. (2006) 'An Architectural Model for MedBiquitous Virtual Patients'. Available at: http://groups.medbiq.org/medbiq/display/VPWG/MedBiquitous+Virtual+Patient+Architecture. (Accessed on:26/10/2016).

Ellaway, R., Poulton, T., Fors, U., McGee, J. and Albright, S. (2008) 'Building a virtual patient commons', *Medical Teacher*, 30(2), pp. 170–4.

Ellaway, R. and Masters, K. (2008) 'AMEE Guide 32: e-Learning in medical education Part 1: Learning, teaching and assessment', *Medical Teacher*, 30(5), pp. 455–473.

eMC (2014a) 'EllaOne 30 mg'. Available at: https://www.medicines.org.uk/EMC/medicine/22280/SPC/ellaOne+30+mg/. (Accessed: 21/02/2014).

eMC (2014b) 'Levonelle 1500 microgram tablet'. Available at:

http://www.medicines.org.uk/emc/medicine/16887. (Accessed: 21/02/2014).

eMC (2015) 'Clexane Forte Syringes'. Available at: http://www.medicines.org.uk/emc/medicine/10054. (Accesed on: 12/08/2014).

Ende, J. (1983) 'Feedback in clinical medical education', *JAMA*, 250(6), pp. 777–781.

Eriksson, P. and Kovalainen, A. (2008) 'Qualitative Methods in Business Research'. SAGE Publications.

Ertmer, P. (1999) 'Addressing first- and second-order barriers to change: Strategies for technology integration', *Educational Technology Research and Development*, 47(4), pp. 47–61.

Farra, S., Miller, E. and Hodgson, E. (2015) 'Virtual reality disaster training: Translation to practice', *Nurse Education in Practice*, 15(1), pp. 53–57.

Farrell, B., Ward, N., Jennings, B., Jones, C., Jorgenson, D., Gubbels-Smith, A., Dolovich, L. and Kennie, N. (2015) 'Participation in online continuing education', *The International Journal of Pharmacy Practice*, pp. 60–71.

Feilzer, M. (2010) 'Doing mixed methods research pragmatically: Implications for the rediscovery of pragmatism as a research paradigm', *Journal of Mixed Methods Research*, 4(1), pp. 6–16.

Feingold, C., Calaluce, M. and Kallen, M. (2004) 'Computerized patient model and simulated clinical experiences: Evaluation with baccalaureate nursing students', *Journal of Nursing Education*, 43(4), pp. 156–163.

Fernandez, E., Perez, R., Hernandez, A., Tejada, P., Arteta, M. and Ramos, J. (2011) 'Factors and mechanisms for pharmacokinetic differences between pediatric population and adults', *Pharmaceutics*, 3(1), pp. 53–72.

Fernandez, R., Parker, D., Kalus, J., Miller, D. and Compton, S. (2007) 'Using a human patient simulation mannequin to teach interdisciplinary team skills to pharmacy students', *American Journal of Pharmaceutical Education*, 71(3).

Ferrone, M., Kebodeaux, C., Fitzgerald, J. and Holle, L. (2017) 'Implementation of a virtual dispensing simulator to support US pharmacy education', *Currents in Pharmacy Teaching and Learning*, 9(4), pp. 511–520.

Field, A. (2009) 'Discovering Statistics Using SPSS'. SAGE Publications.

Fielding, N. (2008) 'Ethnography', in Gilbert, N. (ed.) *Researching Social Life*. Third Edit. SAGE

Publications.

Fingleton, N., Watson, M., Duncan, E. and Matheson, C. (2016) 'Non-prescription medicine misuse, abuse and dependence: a cross-sectional survey of the UK general population', *Journal of Public Health*, 38(4), pp. 722–730.

Finlay, L. (2002) '"Outing" the researcher: The provenance, process, and practice of reflexivity', *Qualitative Health Research*, 12(4), pp. 531–45.

FIP (2000) 'Statement of policy on good pharmacy education practice'. *International Pharmaceutical Federation.*

Fleming, M., Olsen, D., Stathes, H., Boteler, L., Grossberg, P., Pfeifer, J., Schiro, S., Banning, J. and Skochelak, S. (2009) 'Virtual reality skills training for health care professionals in alcohol screening and brief intervention', *The Journal of the American Board of Family Medicine*, 22(4), pp. 387–398.

Fontana, A. and Frey, J. (2005) 'The Interview: From Neutral Stance to Political Involvement', in Denzin, N. and Lincoln, Y. (eds) *The Sage Handbook of Qualitative Research*. Third Edit. SAGE Publications.

Foronda, C., Gattamorta, K., Snowden, K. and Bauman, E. (2013) 'Use of virtual clinical simulation to improve communication skills of baccalaureate nursing students: A pilot study', *Nurse Education Today*, 34(6), pp. 53–57.

Foronda, C. and Bauman, E. (2014) 'Strategies to incorporate virtual simulation in nurse education', *Clinical Simulation in Nursing*, 10(8), pp. 412–418.

Foronda, C., Godsall, L. and Trybulski, J. (2013) 'Virtual clinical simulation: The state of the science', *Clinical Simulation in Nursing*, 9(8), pp. e279–e286.

Forsberg, E., Georg, C., Ziegert, K. and Fors, U. (2011) 'Virtual patients for assessment of clinical reasoning in nursing -- a pilot study', *Nurse Education Today*, 31(8), pp. 757–62.

Fowler, C. and Mayes, J. (1999) 'Learning relationships from theory to design', *Alt-J*, 7(3), pp. 6–16.

Fowler, J., Jarvis, P. and Chevannes, M. (2002) 'Practical Statistics for Nursing and Health Care'. Wiley.

Fowler Jr, F. (1995) 'Improving Survey Questions: Design and Evaluation'. SAGE Publications.

Fox, N., Ward, K. and O'Rourke, A. (2005) 'The "expert patient": Empowerment or medical dominance? The case of weight loss, pharmaceutical drugs and the Internet', *Social Science and*

*Medicine*, 60(6), pp. 1299–1309.

Frankel, G. and Austin, Z. (2013) 'Responsibility and confidence: Identifying barriers to advanced pharmacy practice', *Canadian Pharmacists Journal*, 146(3), pp. 155–61.

Frankel, G., Louizos, C. and Austin, Z. (2014) 'Canadian educational approaches for the advancement of pharmacy practice', *American Journal of Pharmaceutical Education*, 78(7), pp. 143.

Frey, B. and Edwards, L. (2001) 'Strong words or moderate words: A comparison of the reliability and validity of responses on attitude scales', in *The Annual Meeting of the American Educational Research Association*.

Fritz, P., Gray, T. and Flanagan, B. (2008) 'Review of mannequin-based high-fidelity simulation in emergency medicine', *Emergency Medicine Australasia*, 20(1), pp. 1–9.

Fry, A., Ketteridge, S. and Marshall, S. (2009) 'Understanding Student Learning', in Fry, H., Ketteridge, S., and Marshall, S. (eds) *A Handbook for Teaching and Learning in Higher Education: Enhancing Academic Practice*. Second Edi. Kogan Page Limited.

FSRH (2012) 'FSRH Guideline: Emergency Contraception'. Faculty of Sexual and Reproductive Healthcare. Available at: www.fsrh.org. (Accessed on: 26/02/2014).

Fuhrman Jr. L., Buff, W., Eaddy, M. and Dollar, M. (2001) 'Utilization of an integrated interactive virtual patient database in a web-based environment for teaching continuity of care', *American Journal of Pharmaceutical Education*, 65(3), pp. 271–275.

Gaba, D. (2004) 'The future vision of simulation in health care', *Quality and Safety in Health Care*, 13(1), pp. 2–10.

Gale, N., Heath, G. Cameron, E., Rashid, S. and Redwood, S. (2013) 'Using the framework method for the analysis of qualitative data in multi-disciplinary health research', *BMC Medical Research Methodology*, 13(1), p. 117.

Gallimore, C. Thorpe, J. and Trapskin, K. (2011) 'Simulated medication therapy management activities in a pharmacotherapy laboratory course', *American Journal of Pharmaceutical Education*, 75(5).

Galusha, J. (1998) 'Barriers to learning in distance education', *ERIC*, p. 23.

Geertz, C. (1973) 'Thick Description: Toward an Interpretive Theory of Culture', in *The Interpretation Of Cultures*. Vol. 5019. Basic Books.

Gesundheit, N., Brutlag, P., Youngblood, P., Gunning, W., Zary, N. and Fors, U. (2009) 'The use of virtual patients to assess the clinical skills and reasoning of medical students: Initial insights on student acceptance', *Medical Teacher*, 31(8), pp. 739–42.

Ghanbarzadeh, R., Ghapanchi, A., Blumenstein, M. and Talaei-Khoei, A. (2014) 'A decade of research on the use of three-dimensional virtual worlds in health care: A systematic literature review', *Journal of Medical Internet Research*, 16(2).

Ghasemi, A. and Zahediasl, S. (2012) 'Normality tests for statistical analysis: A guide for non-statisticians', *International Journal of Endocrinology and Metabolism*, 10(2), pp. 486–489.

Gilbert, A. and Sliep, Y. (2009) 'Reflexivity in the practice of social action: From self- to inter-relational reflexivity', *South African Journal of Psychology*, 39(4), pp. 468–479.

Glesne, C. (2011) 'Becoming Qualitative Researchers: An Introduction'. Pearson.

Gliem, J. and Gliem, R. (2003) 'Calculating, interpreting, and reporting cronbach's alpha reliability coefficient for likert-type scales', in *Research to Practice Conference in Adult, Continuing, and Community Education*, pp. 82–88.

Gorard, S. and Taylor, C. (2004) 'Combining Methods in Educational and Social Research'. Open University Press.

Gordon, J., Wilkerson, W., Shaffer, D. and Armstrong, E. (2001) '"Practicing" medicine without risk: Students' and educators' responses to high-fidelity patient simulation', *Academic Medicine*, 76(5), pp. 469–472.

Gordon, N. (2014) 'Flexible Pedagogies: Technology-Enhanced Learning', *The Higher Education Academy*.

Gormley, G., Collins, K., Boohan, M., Bickle, I. and Stevenson, M. (2009) 'Is there a place for e-learning in clinical skills? A survey of undergraduate medical students' experiences and attitudes', *Medical Teacher*, 31(1), pp. 6–12.

Gormley, G., McGlade, K., Thomson, C., McGill, M. and Sun, J. (2011) 'A virtual surgery in general practice: evaluation of a novel undergraduate virtual patient learning package', *Medical Teacher*, 33(10), pp. e522-7.

GPhC (2011a) 'Future Pharmacists Standards For The Initial Education And Training Of Pharmacists'. *The General Pharmaceutical Council.*

GPhC (2011b) ‘Plan and Record’. *The General Pharmaceutical Council.*

GPhC (2013) ‘Pre-registration Manual’. *The General Pharmaceutical Council.*

GPhC (2015a) ‘The June 2015 Registration Assessment. Council meeting 10 September 2015’. *The General Pharmaceutical Council.*

GPhC (2015b) ‘Tomorrow’s Pharmacy Team’. *The General Pharmaceutical Council.*

GPhC (2016a) ‘Guidance on Evidence of English Language Skills’. *The General Pharmaceutical Council.*

GPhC (2016b) ‘Roundtable on The Future Of Pre-Registration Pharmacist Training In England: Event Report’. *The General Pharmaceutical Council.*

GPhC (2017) ‘Standards for Pharmacy Professionals’. *The General Pharmaceutical Council.*

Greene, J. and Caracelli, V. (2003) ‘Making Paradigmatic Sense of Mixed Methods Practice’, in Tashakkori, A. and Teddlie, C. (eds) *Handbook of Mixed Methods in Social & Behavioural Research*. First Edit. SAGE Publications.

Greene, J., Caracelli, V. and Graham, W. (1989) ‘Toward a conceptual framework for mixed-method evaluation designs’, *Educational Evaluation and Policy Analysis*, 11(3), pp. 255–274.

Greenhalgh, T. and Peacock, R. (2005) ‘Effectiveness and efficiency of search methods in systematic reviews of complex evidence: Audit of primary sources’, *BMJ*, 331, pp. 1064–1065.

Greenhill, N., Anderson, C., Avery, A. and Pilnick, A. (2011) ‘Analysis of pharmacist-patient communication using the Calgary-Cambridge guide’, *Patient Education and Counseling*, 83(3), pp. 423–431.

Grol, R. and Grimshaw, J. (2003) ‘From best evidence to best practice: Effective implementation of change in patients’ care’, *Lancet*, 362(9391), pp. 1225–1230.

Guba, E. and Lincoln, Y. (1994) ‘Competing Paradigms in Qualitative Research’, in *Handbook of Qualitative Research*. CA: SAGE Publications.

Guest, G., Bunce, A. and Johnson, L. (2006) ‘How many interviews are enough?: An experiment with data saturation and variability’, *Field Methods*, 18(1), pp. 59–82.

Guile, D. and Ahamed, F. (2009) ‘Modernising the Pharmacy Curriculum’.

Guise, V., Chambers, M., Conradi, E., Kavia, S. and Välimäki, M. (2012) ‘Development, implementation

and initial evaluation of narrative virtual patients for use in vocational mental health nurse training', *Nurse Education Today*, 32(6), pp. 683–689.

Guise, V., Chambers, M. and Välimäki, M. (2012) 'What can virtual patient simulation offer mental health nursing education?', *Journal of Psychiatric and Mental Health Nursing*, 19(5), pp. 410–8.

Hagemeier, N., Hess, R., Hagen, K. and Sorah, E. (2014) 'Impact of an interprofessional communication course on nursing, medical, and pharmacy students' communication skill self-efficacy beliefs', *American Journal of Pharmaceutical Education*, 78(10), p. 186.

Hall, M., Hanna, L. and Quinn, S. (2012) 'Pharmacy students' views of faculty feedback on academic performance', *American Journal of Pharmaceutical Education*, 76(1), p. 5.

Hall, W. and Callery, P. (2001) 'Enhancing the rigor of grounded theory: Incorporating reflexivity and relationality', *Qualitative Health Research*, 11(2), pp. 257–272.

Hammersley, A., Tallantyre, F. and Le Cornu, A. (2013) 'Flexible Learning: A Practical Guide For Academic Staff'.

Hanlon, J., Lindblad, C. and Gray, S. (2004) 'Can clinical pharmacy services have a positive impact on drug-related problems and health outcomes in community-based older adults?', *The American Journal of Geriatric Pharmacotherapy*, 2(1), pp. 3–13.

Hanna, L. and Hughes, C. (2012) 'Pharmacists' attitudes towards an evidence-based approach for over-the-counter medication', *International Journal of Clinical Pharmacy*, 34(1), pp. 63–71.

Harasim, L. (2012) 'Learning Theory and Online Technology'. Routledge.

Harder, B. (2010) 'Use of simulation in teaching and learning in health sciences: A systematic review', *Journal of Nursing Education*, 49(1), pp. 23–8.

Hardey, M. (1999) 'Doctor in the house: The Internet as a source of lay health knowledge and the challenge to expertise', *Sociology of Health and Illness*, 21(6), pp. 820–835.

Hargie, O., Morrow, N. and Woodman, C. (2000) 'Pharmacists' evaluation of key communication skills in practice', *Patient Education and Counseling*, 39(1), pp. 61–70.

Harless, W., Drennon, G., Marxer, J., Root, J. and Miller, G. (1971) 'CASE: A compuer-aided simulation of the clinical encounter', *Journal Of Medical Education*, 46, pp. 443–448.

Harris, M. and Taylor, G. (2004) 'Medical Statistics Made Easy'. Taylor and Francis Ltd.

Haskard-Zolnierek, K. and DiMatteo, M. (2009) 'Physician communication and patient adherence to treatment: A meta-analysis', *Med Care*, 47(8), pp. 826–834.

Hassell, K. (2012) 'GPhC Register Analysis 2011', *General Pharmaceutical Council*.

Hattie, J., Biggs, J. and Purdie, N. (1996) 'Effects of learning skills interventions on student learning: A meta-analysis', *Review of Educational Research*, 66(2), pp. 99–136.

Heaton, A., Webb, D. and Maxwell, S. (2008) 'Undergraduate preparation for prescribing: The views of 2413 UK medical students and recent graduates', *British Journal of Clinical Pharmacology*, 66(1), pp. 128–34.

Hege, I., Kononowicz, A., Tolks, D., Edelbring, S. and Kuehlmeyer, K. (2016) 'A qualitative analysis of virtual patient descriptions in healthcare education based on a systematic literature review', *BMC Medical Education*, 16(1).

Henry, G. (1990) 'Practical Sampling'. SAGE Publications.

Henwood, F., Wyatt, S., Hart, A. and Smith, J. (2003) '"Ignorance is bliss sometimes": Constraints on the emergence of the "informed patient" in the changing landscapes of health information', *Sociology of Health and Illness*, 25(6), pp. 589–607.

Herrington, J. (2006) 'Authentic e-learning in higher education: Design principles for authentic learning environments and tasks', in *World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education*, pp. 13–17.

Hicks, F., Coke, L. and Li, S. (2009) 'The effect of high-fidelity simulation on nursing students ' knowledge and performance: A pilot study', *National Council of State Boards of Nursing*.

Higgins, J. and Green, S. (2011) 'Cochrane Handbook for Systematic Reviews of Interventions', *The Cochrane Collaboration*. Available at: www.handbook.cochrane.org. (Accessed on: 12/06/2017).

Hoffman, K., Dempsey, J., Levett-Jones, T., Noble, D., Hickey, N., Jeong, S., Hunter, S. and Norton, C. (2010) 'The design and implementation of an Interactive Computerised Decision Support Framework (ICDSF) as a strategy to improve nursing students' clinical reasoning skills', *Nurse*, 31(6), pp. 587–94.

Hoffman, K., Aitken, L. and Duffield, C. (2009) 'A comparison of novice and expert nurses' cue collection during clinical decision-making: Verbal protocol analysis', *International Journal of Nursing Studies*, 46(10), pp. 1335–1344.

Holcomb, J., Dumire, R., Crommett, J., Stamateris, C., Fagert, M., Cleveland, J., Dorlac, G., Dorlac, W., Bonar, J., Hira, K., Aoki, N. and Mattox, K. (2002) 'Evaluation of trauma team performance using an advanced human patient simulator for resuscitation training', *The Journal of Trauma, Injury, Infection and Critical Care*, 52(6), pp. 1078–1086.

Holt, A. (2010) 'Using the telephone for narrative interviewing: a research note', *Qualitative Research*, 10(1), pp. 113–121.

Howe, K. (1988) 'Against the quantitative-qualitative incompatibility thesis or dogmas die hard', *Educational Researcher*, 17(8), pp. 10–16.

Hsieh, H. and Shannon, S. (2005) 'Three approaches to qualitative content analysis', *Qualitative Health Research*, 15(9), pp. 1277–1288.

Huang, G., Reynolds, R. and Candler, C. (2007) 'Virtual patient simulation at U.S. and Canadian medical schools', *Academic Medicine*, 82(5), pp. 446–451.

Hubal, R., Kizakevich, P., Guinn, C., Merino, K. and West, S. (2000) 'The virtual standardized patient. Simulated patient-practitioner dialog for patient interview training', *Studies in Health Technology and Informatics*, 70, pp. 133–138.

Humphreys, M., Rosenorn-Lanng, D. and Bracegirdle, L. (2013) 'Using a Virtual Learning Environment Within Simulation To Enhance Inter-Professional Team Working Skills', in Michell, V. et al. (eds) *Handbook of Research on Patient Safety and Quality Care through Health Informatics*. First Edit. IGI Global.

Hunt, E., Walker, A., Shaffner, D., Miller, M. and Pronovost, P. (2008) 'Simulation of in-hospital pediatric medical emergencies and cardiopulmonary arrests: Highlighting the importance of the first 5 minutes', *Pediatrics*, 121(1), pp. 34–43.

Hunter, A. and Brewer, J. (2003) 'Multimethod Research in Sociology', in Tashakkori, A. and Teddlie, C. (eds) *Handbook of Mixed Methods in Social & Behavioural Research*. First Edit. SAGE Publications.

Hurst, H. and Marks-Maran, D. (2011) 'Using a virtual patient activity to teach nurse prescribing', *Nurse Education in Practice*, 11(3), pp. 192–198.

Hussainy, S., Styles, K. and Duncan, G. (2012) 'A virtual practice environment to develop communication skills in pharmacy students', *American Journal of Pharmaceutical Education*, 76(10).

Hussein, G. and Kawahara, N. (2006) 'Adaptive and longitudinal pharmaceutical care instruction using

an interactive voice response/text-to-speech system', *American Journal of Pharmaceutical Education*, 70(2).

Huwendiek, S., Reichert, F., Bosse, H., de Leng, B., van der Vleuten, C., Haag, M., Hoffmann, G. and Tönshoff, B. (2009) 'Design principles for virtual patients: a focus group study among students', *Medical Education*, 43(6), pp. 580–588.

Illing, J., Morrow, G., Kergon, C., Burford, B., Spencer, J., Peile, E., Davies, C., Baldauf, B., Allen, M., Johnson, N., Morrison, J., Donaldson, M., Whitelaw, M. and Field, M. (2008) 'How Prepared Are Medical Graduates To Begin Practice ? A Comparison Of Three Diverse UK Medical Schools'.

Illing, J., Morrow, G., Rothwell nee Kergon, C., Burford, B., Baldauf, B., Davies, C., Peile, E., Spencer, J., Johnson, N., Allen, M. and Morrison, J. (2013) 'Perceptions of UK medical graduates' preparedness for practice: A multi-centre qualitative study reflecting the importance of learning on the job', *BMC Medical Education*, 13(1), p. 34.

Inch, J., Porteous, T., Maskrey, V., Blyth, A., Burr, J., Cleland, J., Wright, D., Holland, R., Bond, C. and Watson, M. (2017) 'It's not what you do it's the way that it's measured: Quality assessment of minor ailment management in community pharmacies', *International Journal of Pharmacy Practice*, 25(4), pp. 253–262.

Irvine, A. (2011) 'Duration, dominance and depth in telephone and face-to-face interviews: A comparative exploration', *International Journal of Qualitative Methods*, 10(3), pp. 202–220.

Irvine, A., Drew, P. and Sainsbury, R. (2013) '"Am I not answering your questions properly?" Clarification, adequacy and responsiveness in semi-structured telephone and face-to-face interviews', *Qualitative Research*, 13(1), pp. 87–106.

Issenberg, S., McGaghie, W., Hart, I., Mayer, J., Felner, J., Petrusa, E., Waugh, R., Brown, D., Safford, R., Gessner, I. and Gordon, D. (1999) 'Simulation technology for health care professional skills training and assessment', *JAMA*, 282(9), pp. 861–866.

Issenberg, S., McGaghie, W., Petrusa, E., Lee G. and Scalese, R. (2005) 'Features and uses of high-fidelity medical simulations that lead to effective learning: A BEME systematic review', *Medical Teacher*, 27(1), pp. 10-28.

Jabbur-lopes, M., Mesquita, A., Silva, L., De Almeida Neto, A. and Lyra, D. (2012) 'Virtual Patients in Pharmacy Education', *American Journal of Pharmaceutical Education*, 76(5), pp. 92.

Jamieson, S. (2004) 'Likert scales: How to (ab)use them', *Medical Education*, 38, pp. 1212–1218.

Jarmon, L., Traphagan, T., Mayrath, M. and Trivedi, A. (2009) 'Virtual world teaching, experiential learning, and assessment: An interdisciplinary communication course in Second Life', *Computers & Education*, 53(1), pp. 169–182.

Jee, S., Grimes, L., Desborough, J. and Cutts, C. (2016) 'The national consultation skills for pharmacy practice program in England', *Currents in Pharmacy Teaching and Learning*, 8(3), pp. 442–446.

Jee, S., Schafheutle, E. and Noyce, P. (2016a) 'Exploring the process of professional socialisation and development during pharmacy pre-registration training in England', *International Journal of Pharmacy Practice*, 24(4), pp. 283–293.

Jee, S., Schafheutle, E. and Noyce, P. (2016b) 'Using longitudinal mixed methods to study the development of professional behaviours during pharmacy work-based training', *Health and Social Care in the Community*, 25(3), pp. 975-986.

Jeffries, P., Beach, M., Decker, S., Dlugasch, L., Groom, J., Settles, J. and O'Donnell, J. (2011) 'Multi-center development and testing of a simulation-based cardiovascular assessment curriculum for advanced practice nurses', *Nursing Education Perspectives*, 32(5), pp. 316–322.

John, D., McAteer, S. and Luscombe, D. (2005) 'Views of pre-registration graduates on the transition "from student to professional" and on the role of OSCEs for assessment during the pre-registration year', *Journal of Pharmacy and Pharmacology*, 57, pp. S44–S45.

Johnsen, K., Dickerson, R., Raij, A., Lok, B., Jackson, J., Shin, M., Hernandez, J. Stevens, A. and Lind, D. (2005) 'Experiences in using immersive virtual characters to educate medical communication skills', in *IEEE Proceedings VR 2005 Virtual Reality 2005*, pp. 179–324.

Johnsen, K., Raij, A., Stevens, A., Lind, D. and Lok, B. (2007) 'The validity of a virtual human experience for interpersonal skills education', *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems CHI 07*. Edited by M. Rosson and D. Gilmore. ACM Press (CHI '07), pp. 1049–1058.

Johnson, H. (2013) 'Selling evidence over the counter: Do community pharmacists engage with evidence-based medicine?', *Medical Writing*, 22(4), pp. 275–278.

Johnson, R. and Onwuegbuzie, A. (2004) 'Mixed methods research: A research paradigm whose time has come', *Educational Researcher*, 33(7), pp. 14–26.

Johnson, R., Onwuegbuzie, A. and Turner, L. (2007) 'Toward a definition of mixed methods research',

*Journal of Mixed Methods Research*, 1(2), pp. 112–133.

Joint Formulary Committee (2013) 'British National Formulary'. London: BMJ Group and Pharmaceutical Press.

Jungnickel, P., Kelley, K., Hammer, D., Haines, S. and Marlowe, K. (2009) 'Addressing competencies for the future in the professional curriculum', *American Journal of Pharmaceutical Education*, 73(8).

Kalton, G., Roberts, J. and Holt, D. (1980) 'The effects of offering a middle response option with opinion questions', *The Statistician*, 29(1), pp. 65–78.

Kane-Gill, S. and Smithburger, P. (2011) 'Transitioning knowledge gained from simulation to pharmacy practice', *American Journal of Pharmaceutical Education*, 75(10), pp.210.

Kaplan, R., Bush, J. and Berry, C. (1976) 'Health status: Types of validity and the index of well-being', *Health Services Research*, 11(4), pp. 478–507.

Kardong-Edgren, S., Adamson, K. and Fitzgerald, C. (2010) 'A review of currently published evaluation instruments for human patient simulation', *Clinical Simulation in Nursing*, 6(1), pp. e25–e35.

Karpicke, J. and Roediger, H. (2008) 'The critical importance of retrieval for learning', *Science*, pp. 966–968.

Kassirer, J. (2010) 'Teaching clinical reasoning: Case-based and coached', *Academic Medicine*, 85(7), pp. 1118–24.

Keele University (2014) 'KAVE (Keele Active Virtual Environment)', *KAVE, Virtual Patient, School of Pharmacy, Faculty of Health, School of Pharmacy*. Keele University. Available at: http://www.keele.ac.uk/pharmacy/vp/kave/. (Accessed on: 15/05/2014).

Keele University (no date) 'Library Search'. Available at: https://www.keele.ac.uk/library/. (Accessed on: 20/09/2013).

Kenny, P., Parsons, T., Gratch, J. and Rizzo, A. (2008) 'Evaluation of Justina: A virtual patient with PTSD', in *International Workshop on Intelligent Virtual Agents.* Springer-Verlag, pp. 394–408.

Kenny, P., Parsons, T., Rizzo, A. and Del, M. (2009) 'Human computer interaction in virtual standardized patient systems', in *International Conference on Human-Computer Interaction*, pp. 514–523.

Ker, J. and Bradley, P. (2010) 'Simulation in medical education', in Swanwick, T. (ed.) *Understanding*

*Medical Education: Evidence, Theory and Practice*. First Edit. Wiley.

Kitzinger, J. (2000) 'Focus groups with users and providers of health care', in Pope, C. and Mays, N. (eds) *Qualitative Research in Health Care*. Second Edi. BMJ Books.

Kleinsmith, A., Rivera-Gutierrez, D., Finney, G., Cendan, J. and Lok, B. (2015) 'Understanding empathy training with virtual patients', *Computers in Human Behavior*, 52, pp. 151–158.

Knowles, M. (1975) 'Self-Directed Learning: A Guide For Learners And Teachers'. New York: Cambridge Books.

Knowles, M., Holton, E. and Swanson, R. (1998) 'The Adult Learner: The Definitive Classic in Adult Education and Human Resource Development'. Houston: Gulf Publishing Company.

Kolb, A. and Kolb, D. (2005) 'Learning styles and learning spaces: Enhancing experiential learning in higher education', *Academy of Management Learning and Education*, 4(2), pp. 193–212.

Kolb, D. (1984) 'Experiential learning: Experience as a source of learning and development.' Edited by D. Kolb. Prentice Hall.

Kononowicz, A., Krawczyk, P., Cebula, G., Dembkowska, M., Drab, E., Frączek, B., Stachoń, A. and Andres, J. (2012) 'Effects of introducing a voluntary virtual patient module to a basic life support with an automated external defibrillator course: A randomised trial', *BMC Medical Education*, 12(41).

Kononowicz, A., Zary, N., Edelbring, S., Corral, J. and Hege, I. (2015) 'Virtual patients--what are we talking about? A framework to classify the meanings of the term in healthcare education', *BMC Health Services Research*, 15(11).

Kritikos, V., Reddel, H. and Bosnic-Anticevich, S. (2010) 'Pharmacists' perceptions of their role in asthma management and barriers to the provision of asthma services', *The International Journal of Pharmacy Practice*, 18, pp. 209–216.

Krosnick, J., Holbrook, A., Berent, M., Carson, R., Hanemann, W., Kopp, R., Mitchell, R., Presser, S., Ruud, P., Smith, V., Moody, W., Green, M. and Conaway, M. (2002) 'The impact of "no opinion" response options on data quality: Non-attitude reduction or an invitation to satisfice?', *Public Opinion Quarterly*, 66(3), pp. 371–403.

Krummel, T. (1998) 'Surgical simulation and virtual reality: The coming revolution', *Annals of Surgery*, 228(5), pp. 635–7.

Kurtz, M., Baker, E., Pearlson, G. and Astur, R. (2007) 'A virtual reality apartment as a measure of medication management skills in patients with schizophrenia: A pilot study', *Schizophrenia Bulletin*, 33(5), pp. 1162–1170.

Kynectiv Inc. (2017) 'DecisionSim Technology'. Available at: https://www.kynectiv.com/platform. (Accessed on: 13/07/2017).

Lalley, J. and Miller, R. (2007) 'The learning pyramid: Does it point teachers in the right direction?', *Education*, 128(1), pp. 64–79.

Lambertsen, R., Tang, S., Davies, J. and Morecroft, C. (2017) 'Serious gaming for pharmacy education: Development of a serious games for teaching pharmacist communication and drug administration in a virtual hospital setting', *Proceedings - 2016 9th International Conference on Developments in eSystems Engineering, DeSE 2016*, pp. 151–156.

Lambton, J., O'Neill, S. and Dudum, T. (2008) 'Simulation as a strategy to teach clinical pediatrics within a nursing curriculum', *Clinical Simulation in Nursing*, 4(3), pp. e79–e87.

Landers, R. and Callan, R. (2011) 'Casual Social Games as Serious Games: The Psychology of Gamification in Undergraduate Education and Employee Training', in Ma, M., Oikonomou, A., and Jain, L. (eds) *Serious Games and Edutainment Applications*. Springer.

Langley, C. and Aheer, S. (2010) 'Do pharmacy graduates possess the necessary professional skills?', *Pharmacy Education*, 10(2), pp. 114–118.

Lapkin, S., Levett-Jones, T., Bellchambers, H. and Fernandez, R. (2010) 'Effectiveness of patient simulation manikins in teaching clinical reasoning skills to undergraduate nursing students: A systematic review', *Clinical Simulation in Nursing*, 89, pp. 207–222.

Lay, S., Brace, N., Pike, G. and Pollick, F. (2016) 'Circling around the uncanny valley: design principles for research into the relation between human likeness and eeriness' *i-PERCEPTION*. 7(6), pp.1-11

Lee, M. (2010) 'Explaining and predicting users' continuance intention toward e-learning: An extension of the expectation-confirmation model', *Computers & Education*, 54(2), pp. 506–516.

Leng, B., Huwendiek, S. and Donkers, J. (2009) 'Published Evaluation Instrument for Virtual Patients and for Learning and Teaching Activities with Virtual Patients'. *eVIP.*

Leonard, M., Graham, S. and Bonacum, D. (2004) 'The human factor: The critical importance of effective teamwork and communication in providing safe care', *Quality and Safety in Health Care*, 13,

pp. 85–90.

Leong, S., Baldwin, C. and Adelman, A. (2003) 'Integrating web-based computer cases into a required clerkship: Development and evaluation', *Academic Medicine Journal of the Association of American Medical Colleges*, 78(3), pp. 295–301.

Levett-Jones, T., Hoffman, K., Bourgeois, S., Kenny, R., Dempsey, J., Hickey, N., Hunter, S., Jeong, S., Norton, C., Roche, J., Arthur, C., Lapkin, S. and Jeffrey, K. (2009) 'Clinical Reasoning'. School of Nursing and Midwifery, The University of Newcastle, Australia.

Levett-Jones, T., Hoffman, K., Dempsey, J., Jeong, S., Noble, D., Norton, C., Roche, J. and Hickey, N. (2010) 'The "five rights" of clinical reasoning: An educational model to enhance nursing students' ability to identify and manage clinically "at risk" patients', *Nurse Education Today*, 30(6), pp. 515–520.

Lewis, R. (2009) 'The Effect of Virtual Clinical Gaming Simulations on Student Learning Outcomes in Medical- Surgical Nursing Education Courses'.

Lewith, G. and Little, P. (2013) 'Randomized Controlled Trials', in Saks, M. and Allsop, J. (eds) *Researching Health. Qualitative, Quantitative and Mixed Methods*. Second Edi. SAGE Publications.

Liaw, S., Huang, H. and Chen, G. (2007) 'Surveying instructor and learner attitudes toward e-learning', *Computers and Education*, 49(4), pp. 1066–1080.

Liberati, A., Altman, D., Tetzlaff, J., Mulrow, C., Gøtzsche, P., Ioannidis, J., Clarke, M., Devereaux, P., Kleijnen, J. and Moher, D. (2009) 'The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration', *PLoS Medicine*, 6(7).

Lichvar, A., Hedges, A., Benedict, N. and Donihi, A. (2016) 'Combination of a flipped classroom and a virtual patient case to enhance active learning in a required therapeutics course', *American Journal of Pharmaceutical Education*, 80(10), pp. 175.

Likic, R. and Maxwell, S. (2009) 'Prevention of medication errors: Teaching and training', *British Journal of Clinical Pharmacology*, 67(6), pp. 656–61.

Lin, C., Clinciu, D., Swartz, M., Wu, C., Lien, G., Chan, C., Lee, F. and Li, Y. (2013) 'An integrative OSCE methodology for enhancing the traditional OSCE program at Taipei medical university hospital - a feasibility study', *BMC Medical Education*, 13(1), p. 102.

Lin, K., Travlos, D., Wadelin, J. and Vlasses, P. (2011) 'Simulation and Introductory Pharmacy Practice

Experiences', *American Journal of Pharmaceutical Education*, 75(10), pp. 209.

Lok, B., Ferdig, R., Raij, A., Johnsen, K., Dickerson, R., Coutts, J., Stevens, A. and Lind, D. (2006) 'Applying virtual reality in medical communication education: Current findings and potential teaching and learning benefits of immersive virtual patients a theoretical perspective on VR and virtual character development', *Virtual Reality*, 10(3), pp. 185–195.

Loke, S., Tordoff, J. Winikoff, M., McDonald, J., Vlugter, P. and Duffull, S. (2011) 'SimPharm: How pharmacy students made meaning of a clinical case differently in paper- and simulation-based workshops', *British Journal of Educational Technology*, 42(5), pp. 865–874.

Low, J. (2013) 'Unstructured and Semi-structured Interviews in Health Research', in Saks, M. and Allsop, J. (eds) *Researching Health. Qualitative, Quantitative and Mixed Methods*. Second Edi. SAGE Publications.

Lucardie, D. (2014) 'The impact of fun and enjoyment on adult's learning', *Procedia - Social and Behavioral Sciences*, 142, pp. 439–446.

Lurie, S., Mooney, C., Nofziger, A., Meldrum, S. and Epstein, R. (2008) 'Further challenges in measuring communication skills: Accounting for actor effects in standardised patient assessments', *Medical Education,* 42(7), pp. 662–8.

Lust, E. and Moore, F. (2006) 'Emotional intelligence instruction in a pharmacy communications course', *American Journal of Pharmaceutical Education*, 70(1).

MacDorman, K., Green, R., Ho, C. and Koch, C. (2009) 'Too real for comfort? Uncanny responses to computer generated faces', *Comput Human Behav.* 25(3), pp. 695-710.

Maguire, T. (2002a) 'Barriers to communication - How things go wrong', *The Pharmaceutical Journal*, 268, pp. 246–247.

Maguire, T. (2002b) 'Good communication - How to get it right', *The Pharmaceutical Journal*, 268, pp. 292–293.

Malcolm, R. and Mccoy, C. (2007) 'Evaluation of numeracy skills in first year pharmacy undergraduates 1999-2005', *Pharmacy Education*, 7(1), pp. 53–59.

Marriott, J. (2007a) 'Development and implementation of a computer-generated "virtual" patient program', *Pharmacy Education*, 7(4), pp. 335–340.

Marriott, J. (2007b) ‘Use and evaluation of “virtual” patients for assessment of clinical pharmacy undergraduates’, *Pharmacy Education*, 7(4), pp. 341–349.

Mason, J. (2006) ‘Mixing methods in a qualitatively driven way’, *Qualitative Research*, 6(1), pp. 9–25.

Masters, K. and Ellaway, R. (2008) ‘E-Learning in medical education Guide 32 Part 2: Technology, management and design’, *Medical Teacher*, 30(5), pp. 474–489.

Mauthner, N. and Doucet, A. (2003) ‘Reflexive accounts and accounts of reflexivity in qualitative data analysis’, *Sociology*, 37(3), pp. 413–431.

Maxcy, S. (2003) ‘Pragmatic Threads in Mixed Methods Research in the Social Sciences: The Search for Multiple Modes of Inquiry and the End of the Philosophy of Formalism’, in Tashakkori, A. and Teddlie, C. (eds) *Handbook of Mixed Methods in Social & Behavioural Research*. First Edit. SAGE Publications.

Mays, N. and Pope, C. (2000) ‘Qualitative research in health care: Assessing quality in qualitative research’, *BMJ*, 320(7226), pp. 50–52.

McCrum-Gardner, E. (2008) ‘Which is the correct statistical test to use?’, *British Journal of Oral and Maxillofacial Surgery*, 46(1), pp. 38–41.

McCrum-Gardner, E. (2010) ‘Sample size and power calculations made simple’, *International Journal of Therapy and Rehabilitation*, 17(1), pp. 10–14.

McDowell, J., Styles, K., Sewell, K., Trinder, P., Marriott, J., Maher, S. and Naidu, S. (2016) ‘A simulated learning environment for teaching medicine dispensing skills’, *American Journal of Pharmaceutical Education*, 80(1).

McFalls, M. (2013) ‘Integration of problem-based learning and innovative technology into a self-care course’, *American Journal of Pharmaceutical Education*, 77(6), pp. 1–5.

McGaghie, W., Issenberg, S., Petrusa, E. and Scalese, R. (2010) ‘A critical review of simulation-based medical education research: 2003-2009’, *Medical Education*, 44, pp. 50–63.

McKimm, J., Jollie, C. and Cantillon, P. (2003) ‘ABC of learning and teaching. Web based learning’, *BMJ*, 326(7394), pp. 870–873.

McKinnon, J. (1988) ‘Reliability and validity in field research: Some strategies and tactics’, *Accounting, Auditing & Accountability Journal*, 1(1), pp. 34–54.

McLaren, S. (2013) 'Planning and Conducting Surveys', in Curtis, E. and Drennan, J. (eds) *Quantitative Health Research Issues and Methods*. First Edit. Open University Press.

McLaughlin, J., Roth, M., Glatt, D., Gharkholonarehe, N., Davidson, C., Griffin, L., Esserman, D. and Mumper, R. (2014) 'The flipped classroom: A course redesign to foster learning and engagement in a health professions school', *Academic Medicine*, 89(2), pp. 236–243.

McRobbie, D., Fleming, G., Ortner, M., Bates, I. and Davies, J. (2006) 'Evaluating skills and competencies of pre-registration pharmacists using Objective Structured Clinical Examinations (OSCEs)', *Pharmacy Education*, 6(2), pp. 133–138.

MedBiquitous Consortium (2017) 'Virtual Patient Implementers'. Available at: https://www.medbiq.org/virtual_patient/implementers. (Acccessed on: 12/03/2017).

Menendez, E., Balisa-Rocha, B., Jabbur-Lopes, M., Costa, W., Nascimento, J., Dósea, M., Silva, L. and Lyra Jr, D. (2015) 'Using a virtual patient system for the teaching of pharmaceutical care', *International Journal of Medical Informatics*, 84(9), pp. 640–646.

Mesquita, A., Lyra Jr, D., Brito, G., Balisa-Rocha, B., Aguiar, P. and de Almeida Neto, A. (2010) 'Developing communication skills in pharmacy: A systematic review of the use of simulated patient methods', *Patient Education and Counseling*, 78(2), pp. 143–8.

MHRA (2009) 'Over-the-Counter Cough and Cold Medicines for Children'. *Medicines and Healthcare Products Regulatory Agency.*

MHRA (2011) 'Liquid Paracetamol for Children: Revised UK Dosing Instructions Have Been Introduced'. *Medicines and Healthcare products Regulatory Agency.*

MHRA (2012) 'Simvastatin: Evidence Supporting Recent Advice On Dose Limitations With Concomitant Amlodipine Or Diltiazem'. *Medicines and Healthcare products Regulatory Agency.*

Miller, G. (1990) 'The assessment of clinical skills/competence/performance', *Academic Medicine: Journal of the Association of American Medical Colleges*, 65(9), pp. 63–67.

Mills, E., Laaksonen, R., Bates, I., Davies, G. and Duggan, C. (2005) 'Self-assessment of competence in a community pharmacy setting', *Pharmacotherapy*, 5(3), pp. 29–39.

Mills, E., Blenkinsopp, A. and Black, P. (2013) 'Quality management in pharmacy pre-registration training: Current Practice', *Pharmacy Education*, 13(1), pp. 82–86.

Moraros, J., Islam, A., Yu, S., Banow, R. and Schindelka, B. (2015) 'Flipping for success: Evaluating the effectiveness of a novel teaching approach in a graduate level setting', *BMC Medical Education*, 15(1), p. 27.

Mori, M. (2012) 'The Uncanny Valley: The Original Essay by Masahiro Mori', *IEEE Spectrum.* Available at: https://spectrum.ieee.org/automaton/robotics/humanoids/the-uncanny-valley (Accessed on: 01/05/2018).

Morrison, J., Sullivan, F., Murray, E. and Jolly, B. (1999) 'Evidence-based education: Development of an instrument to critically appraise reports of educational interventions', *Medical Education*, 33(12), pp. 890–893.

Morrow, G., Johnson, N., Burford, B., Rothwell, C., Spencer, J., Peile, E., Davies, C., Allen, M., Baldauf, B., Morrison, J. and Illing, J. (2012) 'Preparedness for practice: The perceptions of medical graduates and clinical teams', *Medical Teacher*, 34(2), pp. 123–35.

Morse, J. (1995) 'The significance of saturation', *Qualitative Health Research*, 5(2), pp. 147–149.

Morse, J. (2003) 'Principles of Mixed Methods and Multimethod Research Design', in Tashakkori, A. and Teddlie, C. (eds) *Handbook of Mixed Methods in Social & Behavioural Research*. First Edit. SAGE Publications.

Morse, J. (2015) 'Critical analysis of strategies for determining rigor in qualitative inquiry', *Qualitative Health Research*, 25(9), pp. 1212–1222.

Morton, K., Pattison, H., Langley, C. and Powell, R. (2014) 'A qualitative study of English community pharmacists' experiences of providing lifestyle advice to patients with cardiovascular disease', *Research in Social and Administrative Pharmacy*, 11(1), pp. 1–13.

Moseley, A. and Whitton, N. (2012) 'Introduction', in Whitton, N. and Moseley, A. (eds) *Using Games to Enhance Learning and Teaching. A Beginners Guide*. Routledge.

Moser, P., Mulder, D. and Trout, J. (1998) 'The Theory of Knowledge. A Thematic Introduction'. Oxford University Press.

Most, I., Betrayal, R. and Popper, K. (1965) 'Three Views Concerning Human Knowledge', *Conjectures and Refutations: The Growth of Scientific Knowledge*. London: Routledge, 3, pp. 97–119.

Moule, P., Pollard, K., Armoogum, J. and Messer, S. (2015) 'Virtual patients: Development in cancer nursing education', *Nurse Education Today*, 35(7), pp. 875–880.

Munoz, L., O'Byrne, C., Pugsley, J. and Austin, Z. (2005) 'Reliability, validity, and generalizability of an Objective Structured Clinical Examination (OSCE) for assessment of entry-to-practice in pharmacy', *Pharmacy Education*, 5(1), pp. 33–43.

Murray, C., Grant, M., Howarth, M. and Leigh, J. (2008) 'The use of simulation as a teaching and learning approach to support practice learning', *Nurse Education in Practice*, 8(1), pp. 5–8.

Nazar, H., Obara, I., Paterson, A., Nazar, Z., Portlock, J. and Husband, A. (2017) 'A consensus approach to investigate undergraduate pharmacy students' experience of interprofessional education', *American Journal of Pharmaceutical Education*, 81(2).

Nestel, D., Calandra, A. and Elliott, R. (2007) 'Using volunteer simulated patients in development of pre-registration pharmacists: Learning from the experience', *Pharmacy Education*, 7(1), pp. 35–42.

New South Wales Department of Health (2006) 'Patient Safety and Clinical Quality Program: Third Report on Incident Management in the NSW Public Health System 2005-2006'. North Sydney.

NHS (2014a) 'Chickenpox'. Available at: https://beta.nhs.uk/conditions/chickenpox/?WT.mc_id=organic_split. (Accessed on: 08/08/2014).

NHS (2014b) 'Cold sore (herpes simplex virus)'. Available at: http://www.nhs.uk/conditions/Cold-sore/Pages/Introduction.aspx. (Accessed on: 08/08/2014).

NHS (2014c) 'Colic'. Available at: http://www.nhs.uk/Conditions/Colic/Pages/Introduction.aspx. (Accessed on: 09/08/2014).

NHS (2014d) 'Croup'. Available at: http://www.nhs.uk/conditions/croup/pages/introduction.aspx. (Accessed on: 08/08/2014).

NHS (2014e) 'Impetigo'. Available at: https://beta.nhs.uk/conditions/impetigo/?WT.mc_id=organic_split. (Accessed on: 10/08/2014).

NHS (2014f) 'Measles'. Available at: http://www.nhs.uk/conditions/measles/Pages/Introduction.aspx. (Accessed on: 03/06/2014).

NHS (2014g) 'Meningitis'. Available at: http://www.nhs.uk/conditions/Meningitis/Pages/Introduction.aspx. (Accessed on: 09/08/2014).

NHS (2014h) 'Mumps'. Available at: http://www.nhs.uk/conditions/Mumps/Pages/Introduction.aspx. (Accessed on: 08/08/2014).

NHS (2014i) ‘Whooping Cough’. Available at: http://www.nhs.uk/conditions/whooping cough/pages/introduction.aspx. (Accessed on: 10/08/2014).

NHS (2015) ‘NHS services explained’. Available at: http://www.nhs.uk/NHSEngland/AboutNHSservices/Pages/NHSServices.aspx. (Accessed on: 06/01/2015).

NHS (no date) ‘Stay Well This Winter’. Available at: https://www.nhs.uk/staywell#o5quIy6QsX1hgTKJ.97. (Accessed on: 14/12/2016).

NHS England (2013) ‘Transforming Urgent and Emergency Care Services In England.

NHS England (2014a) ‘Five Year Forward View’.

NHS England (2014b) ‘Patient Safety Alert. Stage One: Warning - Risks arising from breakdown and failure to act on communication during handover at the time of discharge from secondary care.’

NHS England (2016a) ‘General Practice Forward View’.

NHS England (2016b) ‘Standards For The Communication Of Patient Diagnostic Test Results On Discharge From Hospital’.

Nicol, D. and Macfarlane-Dick, D. (2005) ‘Formative assessment and self-regulated learning: A model and seven principles of good feedback practice', *Studies in Higher Education*, 31(2), pp. 199–218.

NMC (2011) ‘Supporting information for implementing NMC standards for pre-registration nursing education’. *Nursing and Midwifery Council.*

Novick, G. (2008) ‘Is there a bias against telephone interviews in qualitative research?’, *Research in Nursing & Health*, 31(4), pp. 391–398.

NPA (2016) ‘Ask Your Pharmacist Week (7-14 November)’. *National Pharmacy Association.*

NPSA (2007) ‘Safety in Doses: Improving the use of Medicines in the NHS’. *National Patient Safety Agency.*

NUS (2012) ‘Never too late to learn. Mature students in higher education’, *National Union of Students*.

Nyssen, A., Larbuisson, R., Janssens, M., Pendeville, P. and Mayne, A. (2002) ‘A comparison of the training value of two types of anesthesia simulators: Computer screen-based and mannequin-based

simulators', *Anesthesia & Analgesia*, 94, pp. 1560–1565.

O'Daniel, M. and Rosenstein, A. (2008) 'Professional Communication and Team Collaboration', in Hughes, R. (ed.) *Patient Safety and Quality: An Evidence-Based Handbook for Nurses*. Agency for Healthcare Research and Quality.

Olin, J. and Cole, S. (2015) 'Computer-based clinical simulation cases in oncology pharmacotherapy: Student perceptions from two campuses', *Currents in Pharmacy Teaching and Learning*, 7(2), pp. 157–162.

Oliven, A., Nave, R., Gilad, D. and Barch, A. (2011) 'Implementation of a web-based interactive virtual patient case simulation as a training and assessment tool for medical students', *Studies in Health Technology and Informatics*, 169, pp. 233–237.

Onwuegbuzie, A. (2000) 'Positivists, post-positivists, post-structuralists, and post-modernists: Why can't we all get along? Towards a framework for unifying research paradigms', *Annual Meeting of the Association for the Advancement of Educational Research*, p. 25.

Onwuegbuzie, A. and Leech, N. (2003) 'On becoming a pragmatic researcher: The importance of combining quantitative and qualitative research methodologies', *Annual Meeting of the Mid-South Educational Research Association*.

Onwuegbuzie, A. and Leech, N. (2007a) 'A call for qualitative power analyses*', *Quality and Quantity*, 41(1), pp. 105–121.

Onwuegbuzie, A. and Leech, N. (2007b) 'Validity and qualitative research: An oxymoron?', *Quality and Quantity*, 41(2), pp. 233–249.

Opdenakker, R. (2006) 'Advantages and disadvantages of four interview techniques in qualitative research', *Qualitative Social Research*, 7(4).

Oppenheim, A. (1998) 'Questionnaire Design, Interviewing and Attitude Measurement'. Continnuum-3PL.

Orr, K. (2007) 'Integrating virtual patients into a self-care course', *American Journal of Pharmaceutical Education*, 71(2), pp. 1–9.

Oxford Dictionaries (2017a) 'Definition of pharmacist in English'. Available at: https://en.oxforddictionaries.com/definition/pharmacist. (Acccessed on: 20/02/2014).

Oxford Dictionaries (2017b) ‘Definition of simulation in English’. Available at: https://en.oxforddictionaries.com/definition/simulation. (Accessed on: 20/02/2014).

Oxford Dictionaries (2017c) ‘Definition of fidelity in English’. https://en.oxforddictionaries.com/definition/fidelity. (Accessed on: 16/07/2014).

Paediatric Formulary Committee (2014) ‘BNF for Children’. London: BMJ Group, Pharmaceutical Press, and RCPCH Publications.

Page, R. (2000) ‘Brief history of flight simulation’, in *SimTecT 2000 Proceedings*, pp. 11–17.

Pantziaras, I., Courteille, O., Mollica, R., Fors, U. and Ekblad, S. (2012) ‘A pilot study of user acceptance and educational potentials of virtual patients in transcultural psychiatry’, *International Journal of Medical Education*, 3, pp. 132–140.

Park, M. and Summons, P. (2013a) ‘A computer-generated digital patient for oral interview training in pharmacy’, *Advanced Science and Technology Letters*, 28, pp. 126–131.

Park, M. and Summons, P. (2013b) ‘An efficient virtual patient image model interview training in pharmacy’, *International Journal of Bio-Science and Bio-Technology*, 5(6), pp. 137–145.

Parsons, T., Kenny, P., Ntuen, C., Pataki, C., Pato, M., Rizzo, A., St-George, C. and Sugar, J. (2008) ‘Objective structured clinical interview training using a virtual human patient’, *Medicine Meets Virtual Reality*, (16), pp. 357–362.

Pashler, H., Cepeda, N., Wixted, J. and Rohrer, D. (2005) ‘When does feedback facilitate learning of words?’, *Journal of Experimental Psychology: Learning, Memory and Cognition*, 31(1), pp. 3–8.

Patton, M. (1990) ‘Designing Qualitative Studies’, in *Qualitative Evaluation and Research Methods*. SAGE Publications, pp. 169–186.

Paudyal, V., Watson, M., Sach, T., Porteous, T., Bond, C., Wright, D., Cleland, J., Barton, G. and Holland, R. (2013) ‘Are pharmacy-based minor ailment schemes a substitute for other service providers? A systematic review’, *British Journal of General Practice*, 63(612), pp. 472–481.

Paudyal, V., Hansford, D., Cunningham, S. and Stewart, D. (2014) ‘Pharmacists’ adoption into practice of newly reclassified medicines from diverse therapeutic areas in Scotland: A quantitative study of factors associated with decision-making’, *Research in Social and Administrative Pharmacy*, 10(1), pp. 88–105.

Pearl, J. (2013) ‘Can you trust your local pharmacy’s advice?’, *http://www.which.co.uk/news/2013/05/can-You-Trust-Your-Local-Pharmacys-Advice-319886/*. (Accessed on: 15/08/2014).

Peck, B. and Miller, C. (2010) ‘I think I can, I think I can, I think I can...I know I can Multi-user Virtual Environments (MUVEs) as a means of developing competence and confidence in undergraduate nursing students: An Australian perspective’, *Procedia - Social and Behavioral Sciences*, 2(2), pp. 4571–4575.

Peeters, M., Zitko, K. and Schmude, K. (2016) ‘Development of critical thinking in pharmacy education’, *Innovations in Pharmacy*, 7(1), pp. 1–9.

Pereira, D. and Cavaco, A. (2014) ‘Exploring computer simulation to assess counseling skills amongst pharmacy undergraduates’, *Indian Journal of Pharmaceutical Education and Research*, 48(1), pp. 17–26.

Petrakou, A. (2010) ‘Interacting through avatars: Virtual worlds as a context for online education’, *Computers and Education*, 54(4), pp. 1020–1027.

Phelps, A., Agur, M., Nass, L. and Blake, M. (2014) ‘GPhC Registrant Survey 2013 Findings’. *General Pharmaceutical Council.*

Piemme, T. (1988) ‘Computer-assisted learning and evaluation in medicine’, *JAMA*, 260(3), pp. 367–72.

Pierce, E. (2013) ‘Designing and Conducting Quantitative Research Studies’, in Curtis, E. A. and Drennan, J. (eds) *Quantitative Health Research Issues and Methods*. First Edit. Open University Press.

Popay, J., Roberts, H., Sowden, A., Petticrew, M., Arai, L., Rodgers, M., Britten, N., Roen, K. and Duffy, S. (2006) ‘Guidance on the Conduct of Narrative Synthesis in Systematic Reviews’, *A Product from the ESRC Methods Programme*.

Pope, C. and Mays, N. (1995) ‘Qualitative research: Reaching the parts other methods cannot reach: an introduction to qualitative methods in health and health services research’, *BMJ*, 311, pp. 42–45.

Pope, C., Ziebland, S. and Mays, N. (2000) ‘Qualitative research in health care: Analysing qualitative data’, *BMJ*, 320(7227), pp. 114–116.

Porteous, T., Ryan, M., Bond, C. and Hannaford, P. (2006) ‘Preferences for self-care or professional advice for minor illness: A discrete choice experiment’, *The British Journal of General Practice*,

56(533), pp. 911–7.

Poulton, T., Conradi, E., Kavia, S., Round, J. and Hilton, S. (2009) 'The replacement of "paper" cases by interactive online virtual patients in problem-based learning', *Medical Teacher*, 31, pp. 752–758.

Poulton, T., Ellaway, R., Round, J., Jivram, T., Kavia, S. and Hilton, S. (2014) 'Exploring the efficacy of replacing linear paper-based patient cases in problem-based learning with dynamic web-based virtual patients: Randomized controlled trial', *Journal of Medical Internet Research*, 16(11).

Poulton, T. and Balasubramaniam, C. (2011) 'Virtual patients: A year of change', *Medical Teacher*, 33(11), pp. 933–937.

Prensky, M. (2001) 'Digital natives, digital immigrants part 1', *On the Horizon*, 9(5), pp. 1–6.

PSNC (2017) 'Summary Care Record (SCR) home'. Available at: http://psnc.org.uk/contract-it/pharmacy-it/electronic-health-records/summary-care-record-scr-home/. (Accessed on: 18/06/2017).

Quizon, P., Loquias, M. and Ching, C. (2011) 'Competency assessment in dispensing and incompatibilities laboratory', *International Journal of Pharmacy Teaching and Practices*, 2(2), pp. 76–80.

Ramshaw, B., Young, D., Garcha, I., Shuler, F., Wilson, R., White, J., Duncan, T. and Mason, E. (2001) 'The role of multimedia interactive programs in training for laparoscopic procedures', *Surgical Endoscopy*, 15, pp. 21–27.

Ray, S., Wylie, D., Rowe, A., Heidel, E. and Franks, A. (2012) 'Pharmacy student knowledge retention after completing either a simulated or written patient case', *American Journal of Pharmaceutical Education*, 76(5), pp. 1–6.

Reape, A., Lips-Nassif, C., Bailey, L., Ashwell, P. and Brown, D. (2011) 'The use of human patient simulators for teaching UK pharmacy students about critical care', *Pharmacy Education*, 11(1), pp. 1–7.

Rees, J., Smith, I. and Smith, B. (2010) 'Introduction to Pharmaceutical Calculations'. Pharmaceutical Press.

Reeves, S., Freeth, D., Mccrorie, P. and Perry, D. (2002) '"It teaches you what to expect in future": Interprofessional learning on a training ward for medical, nursing, occupational therapy and physiotherapy students', *Medical Education*, 36, pp. 337–344.

Richardson, A., Bracegirdle, L., McLachlan, S. and Chapman, S. (2013) 'Use of a three-dimensional virtual environment to teach drug-receptor interactions.', *American Journal of Pharmaceutical Education*, 77(1).

Ridley, S. Booth, S. and Thompson, C. (2004) 'Prescription errors in UK critical care units', *Anaesthesia*, 59(12), pp. 1193–1200.

Rolfe, G. (2013) 'Philosophical basis for research', in Curtis, E. and Drennan, J. (eds) *Quantitative Health Research Issues and Methods*. First Edit. Open University Press.

Rosen, K. (2008) 'The history of medical simulation', *Journal of Critical Care*, 23, pp. 157–66.

Rosen, K., McBride, J. and Drake, R. (2009) 'The use of simulation in medical education to enhance students' understanding of basic sciences', *Medical Teacher*, 31(9), pp. 842–846.

Rosenthal, M., Austin, Z. and Tsuyuki, R. (2010) 'Are pharmacists the ultimate barrier to pharmacy practice change?', *Canadian Pharmacists Journal*, 143(1), pp. 37–42.

Rozenblum, R. and Bates, D. (2013) 'Patient-centred healthcare, social media and the internet: The perfect storm?', *BMJ Quality & Safety*, 22(3), pp. 183–186.

RPS (2012) 'Medicines, Ethics and Practice. The Professional Guide For Pharmacists'. *Royal Pharmaceutical Society*.

RPS (2014) 'Shaping Pharmacy For The Future Pharmacists And GP Surgeries', *Royal Pharmaceutical Society*.

RPS (2015) 'Transforming the Pharmacy Workforce in Great Britain: The RPS Vision'. *Royal Pharmaceutical Society*.

RPS (2016) 'Medicines, Ethics and Practice. The Professional Guide For Pharmacists'. *Royal Pharmaceutical Society*.

RPS (2017) 'Considering Pharmacy? What You Need To Know'. *Royal Pharmaceutical Society*.

Rutter, P., Horsley, E. and Brown, D. (2004) 'Evaluation of community pharmacists' recommendations to standardized patient scenarios', *The Annals of Pharmacotherapy*, 38(6), pp. 1080–1085.

Sadler, D. (1989) 'Formative assessment and the design of instructional systems', *Instructional Science*, 18, pp. 119–144.

Sale, J. Lohfeld, L. and Brazil, K. (2002) 'Revisiting the quantitative-qualitative debate: Implications for

mixed-methods research', *Quality & Quantity*, 36, pp. 43–53.

Salinitri, F., O'Connell, B., Garwood, C., Lehr, V. and Abdallah, K. (2012) 'An Objective Structured Clinical Examination to assess problem-based learning', *American Journal of Pharmaceutical Education*, 76(3).

Salkind, N. (2011) 'Statistics for People Who (Think They) Hate Statistics'. SAGE Publications.

Salter, S., Karia, A., Sanfilippo, F. and Clifford, R. (2014) 'Effectiveness of e-learning in pharmacy education', *American Journal of Pharmaceutical Education*, 78(4), pp. 16–22.

Sansom, C. (2015) 'The virtual classroom and Ebola preparedness', *The Lancet. Infectious Diseases,* 15(5), pp. 515–516.

Sapsford, R. (1999) 'Survey Research'. SAGE Publications.

Saramunee, K., Krska, J., Mackridge, A., Richards, J., Suttajit, S. and Phillips-Howard, P. (2012) 'How to enhance public health service utilization in community pharmacy?: General public and health providers' perspectives', *Research in Social and Administrative Pharmacy,* 10(2), pp. 1–13.

Savoldelli, G., Naik, V., Hamstra, S. and Morgan, P. (2005) 'Barriers to use of simulation-based education', *Canadian Journal of Anesthesia*, 52(9), pp. 944–950.

Scalese, R., Obeso, V. and Issenberg, S. (2007) 'Simulation technology for skills training and competency assessment in medical education', *Journal of General Internal Medicine*, 23(S1), pp. 46–49.

Schultz, K. and Marks, A. (2007) 'Community-based collaboration with high school theater students as standardized patients', *American Journal of Pharmaceutical Education*, 71(2).

Schwartzman, E., Hsu, D., Law, A. and Chung, E. (2011) 'Assessment of patient communication skills during OSCE: Examining effectiveness of a training program in minimizing inter-grader variability', *Patient Education and Counseling*, 83(3), pp. 472–7.

Schwid, H. (2000) 'Anesthesia simulators - Technology and applications', *IMAJ*, 2, pp. 949–953.

Scottish Health Council (2011) 'A Scottish Health Council report on participation and online technology. Briefing Paper'.

Seefeldt, T., Mort, J., Brockevelt, B., Giger, J., Jordre, B., Lawler, M., Nilson, W. and Svien, L. (2012) 'A pilot study of interprofessional case discussions for health professions students using the virtual

world Second Life', *Currents in Pharmacy Teaching and Learning*, 4, pp. 224–231.

Sera, L. and Wheeler, E. (2017) 'Game on: The gamification of the pharmacy classroom', *Currents in Pharmacy Teaching and Learning*, 9(1), pp. 155–159.

Seropian, M., Brown, K., Gavilanes, J. and Driggers, B. (2004) 'Simulation: Not just a manikin', *Journal of Nursing Education*, 43(4), pp. 164–170.

Seston, E. and Hassell, K. (2011) 'Workforce update - Joiners, leavers, and practising and non-practising pharmacists on the 2010 register', *The Pharmaceutical Journal*, (286), pp. 473–476.

Seston, E., Holden, K. and Cantrill, J. (2001) 'Emergency hormonal contraception: The community pharmacy perspective', *The Journal of Family Planning and Reproductive Health Care*, 27(4), pp. 203–208.

Seston, L. and Hassell, K. (2009) 'Pharmacy workforce Census 2008: Main Findings', *Royal Pharmaceutical Society of Great Britain*.

Seybert, A., Laughlin, K., Benedict, N., Barton, C. and Rea, R. (2006) 'Pharmacy student response to patient-simulation mannequins to teach performance-based pharmacotherapeutics', *American Journal of Pharmaceutical Education*, 70(3), pp. 1–5.

Seybert, A., Smithburger, P., Kobulinsky, L. and Kane-Gill, S. (2012) 'Simulation-based learning versus problem-based learning in an acute care pharmacotherapy course', *Simulation in Healthcare*, 7(3), pp. 162–5.

Seybert, A. and Kane-Gill, S. (2011) 'Elective course in acute care using online learning and patient simulation', *American Journal of Pharmaceutical Education*, 75(3), pp. 1–5.

Seybert, A. Kobulinsky, L. and McKaveney, T. (2008) 'Human patient simulation in a pharmacotherapy course', *American Journal of Pharmaceutical Education*, 72(2).

Shadish, W., Clark, M. and Steiner, P. (2008) 'Can nonrandomized experiments yield accurate answers? A randomized experiment comparing random and nonrandom assignments', *Journal of the American Statistical Association*, 103(484), pp. 1334–1344.

Sheaffer, E. and Addo, R. (2013) 'Pharmacy student performance on constructed-response versus selected-response calculations questions', *American Journal of Pharmaceutical Education*, 77(1).

Short, D., Frischer, M. and Bashford, J. (2004) 'Barriers to the adoption of computerised decision

support systems in general practice consultations: A qualitative study of GPs' perspectives', *International Journal of Medical Informatics*, 73(4), pp. 357–362.

Sijstermans, R., Jaspers, M., Bloemendaal, P. and Schoonderwaldt, E. (2007) 'Training inter-physician communication using the Dynamic Patient Simulator®', *International Journal of Medical Informatics*, 76(5–6), pp. 336–343.

Simmons, B. (2010) 'Clinical reasoning: Concept analysis', *Journal of Advanced Nursing*, 66(5), pp. 1151–1158.

Smith, A. and Darracott, R. (2011) 'Modernising Pharmacy Careers Programme Review of Pharmacist Undergraduate Education and Pre-Registration Training and Proposals for Reform Discussion Paper'.

Smith, J., Picton, C. and Dayan, M. (2013) 'Now or never: Shaping pharmacy for the future', (November), p. 54.

Smith, M. and Benedict, N. (2015) 'Effectiveness of educational technology to improve patient care in pharmacy curricula', *American Journal of Pharmaceutical Education*, 79(1).

Smith, M., Mohammad, R. and Benedict, N. (2014) 'Use of virtual patients in an advanced therapeutics pharmacy course to promote active, patient-centered learning', *American Journal of Pharmaceutical Education*, 78(6).

Smith, M., Siemianowski, L. and Benedict, N. (2016) 'Virtual patient case sharing across two schools of pharmacy', *American Journal of Pharmaceutical Education*, 80(9).

Smithburger, P., Kane-Gill, S., Kloet, M., Lohr, B. and Seybert, A. (2013) 'Advancing interprofessional education through the use of high fidelity human patient simulators', *Pharmacy Practice*, 11(2), pp. 61–65.

Sonnenberg, F. and Beck, J. (1993) 'Markov Models in medical decision making: A practical guide', *Medical Decision Making*, 13(4), pp. 322–338.

Stephenson, T. (2005) 'How children's responses to drugs differ from adults', *British Journal of Clinical Pharmacology*, 59(6), pp. 670–673.

Stevens, A., Hernandez, J., Johnsen, K., Dickerson, R., Raij, A., Harrison, C., DiPietro, M., Allen, B., Ferdig, R., Foti, S., Jackson, J., Shin, M., Cendan, J., Watson, R., Duerson, M., Lok, B., Cohen, M., Wagner, P. and Lind, D. (2006) 'The use of virtual patients to teach medical students history taking and communication skills', *The American Journal Of Surgery*, 191(6), pp. 806–11.

Sturges, J. and Hanrahan, K. (2004) 'Comparing telephone and face to-face qualitative interviewing: A research note', *Qualitative Research*, 4(1), pp. 107–118.

Sullivan, G. and Artino Jr, A. (2013) 'Analyzing and interpreting data from likert-type scales', *Journal of Graduate Medical Education*, 5(4), pp. 541–542.

Sultana, F. (2007) 'Reflexivity, positionality and participatory ethics: Negotiating fieldwork dilemmas in international research', *ACME*, 6(3), pp. 374–385.

Sun, P., Tsai, R., Finger, G., Chen, Y. and Yeh, D. (2008) 'What drives a successful e-Learning? An empirical investigation of the critical factors influencing learner satisfaction', *Computers and Education*, 50(4), pp. 1183–1202.

Sweet, L. (2002) 'Telephone interviewing: Is it compatible with interpretive phenomenological research?', *Contemporary Nurse*, 12(1), pp. 58–63.

Taglieri, C., Crosby, S., Zimmerman, K., Schneider, T. and Patel, D. (2017) 'Evaluation of the use of a virtual patient on student competence and confidence in performing simulated clinic visits', *American Journal of Pharmaceutical Education*, 81(5).

Tansey, P. and Unwin, D. (1969) 'Simulation and Gaming in Education'. London, England: Methuen Educational Ltd.

Taran, S. (2010) 'An examination of the factors contributing to poor communication outside the physician-patient sphere', *McGill Journal of Medicine*, 13(1), pp. 86–91.

Tashakkori, A. and Teddlie, C. (1998) 'Mixed Methodology. Combining Qualitative and Quantitative Approaches'. SAGE Publications.

Taylor, J. and Walford, R. (1972) 'Simulation in the Classroom'. England: Penguin Books Ltd.

Teddlie, C. and Tashakkori, A. (2003) 'Major Issues and Controversies in the Use of Mixed Methods in the Social and Behavioural Sciences', in Tashakkori, A. and Teddlie, C. (eds) *Handbook of Mixed Methods in Social & Behavioural Research*. First Edit. SAGE Publications.

Tilley, J. and Kaihoi, B. (2011) 'Virtual Worlds : A New Universe for Education, Patient Care, and More', *PT in Motion*, pp. 16–23.

Tobin, G. and Begley, C. (2004) 'Methodological rigour within a qualittaive framework', *Journal of Advanced Nursing*, 48(4), pp. 388–396.

Tofil, N., Benner, K., Worthington, M., Zinkan, L. and White, M. (2010) 'Use of simulation to enhance learning in a pediatric elective', *American Journal of Pharmaceutical Education*, 74(2).

Triola, M., Feldman, H., Kalet, A., Zabar, S., Kachur, E., Gillespie, C., Anderson, M., Griesser, C. and Lipkin, M. (2006) 'A randomized trial of teaching clinical skills using virtual and live standardized patients', *Journal of General Internal Medicine*, 21(5), pp. 424–429.

Tunney, M. and Bell, H. (2011) 'Self-directed learning: Preparing students for lifelong learning', *Pharmacy Education*, 11(1), pp. 12–15.

Tynjälä, P. and Häkkinen, P. (2005) 'E-learning at work: Theoretical underpinnings and pedagogical challenges', *Journal of Workplace Learning*, 17(5/6), pp. 318–336.

Uman, L. (2011) 'Systematic reviews and meta-analyses', *Journal of the American Academy of Child and Adolescent Psychiatry*, 20(1), pp. 57–59.

Villaume, W., Berger, B. and Barker, B. (2006) 'Learning motivational interviewing: Scripting a virtual patient', *American Journal of Pharmaceutical Education*, 70(2).

Vrasidas, C. (2004) 'Issues of pedagogy and design in e-learning systems', *Proceedings of the 2004 ACM Symposium on Applied Computing*.

Vyas, D., McCulloh, R., Dyer, C., Gregory, G. and Higbee, D. (2012) 'An interprofessional course using human patient simulation to teach patient safety and teamwork skills', *American Journal of Pharmaceutical Education*, 76(4).

Vyas, D., Feng, X., Bhutada, N. and Ofstad, W. (2014) 'A comparison between a simulation-based and traditional direct patient care introductory pharmacy practice experiences', *Pharmacy Education*, 14(1), pp. 9–15.

Vyas, D., Bhutada, N. and Feng, X. (2012) 'Patient simulation to demonstrate students' competency in core domain abilities prior to beginning advanced pharmacy practice experiences', *American Journal of Pharmaceutical Education*, 76(9).

Vyas, D., Ottis, E. and Caligiuri, F. (2011) 'Teaching clinical reasoning and problem-solving skills using human patient simulation.', *American Journal of Pharmaceutical Education*, 75(9).

Wagner, E. (2000) 'The role of patient care teams in chronic disease management', *BMJ,* 320(7234), pp. 569–572.

Wallace, J., Rao, R. and Haslam, R. (2002) 'Simulated patients and Objective Structured Clinical Examinations: Review of their use in medical education', *Advances in Psychiatric Treatment*, 8, pp. 342–350.

Watkins, C. and Mortimore, P. (1999) 'Pedagogy: What do we know?', in Mortimore, P. (ed.) *Understanding Pedagogy and Its Impact on Learning*. First. Sage Publications Ltd.

Watson, M., Bond, C., Grimshaw, J. and Johnston, M. (2006) 'Factors predicting the guideline compliant supply (or non-supply) of non-prescription medicines in the community pharmacy setting.', *Quality & Safety in Health Care*, 15(1), pp. 53–7.

Watson, M., Ferguson, J., Barton, G., Maskrey, V., Blyth, A., Paudyal, V., Bond, C., Holland, R., Porteous, T., Sach, T., Wright, D. and Fielding, S. (2015) 'A cohort study of influences, health outcomes and costs of patients' health-seeking behaviour for minor ailments from primary and emergency care settings', *BMJ Open*, 5.

Watson, M. and Bond, C. (2004) 'The evidence-based supply of non-prescription medicines: barriers and beliefs', *International Journal of Pharmacy Practice*, 12(2), pp. 65–72.

Watson, M., Cleland, J. and Bond, C. (2009) 'Simulated patient visits with immediate feedback to improve the supply of over-the-counter medicines: A feasibility study', *Family Practice*, 26(6), pp. 532–542.

Watson, M., Norris, P. and Granas, A. (2006) 'A systematic review of the use of simulated patients and pharmacy practice research', *International Journal of Pharmacy Practice*, 14(2), pp. 83–93.

Weller, J. (2004) 'Simulation in undergraduate medical education: Bridging the gap between theory and practice', *Medical Education*, 38, pp. 32–38.

Wendling, A., Halan, S., Tighe, P., Le, L., Euliano, T. and Lok, B. (2011) 'Virtual humans versus standardized patients: Which lead residents to more correct diagnoses?', *Academic Medicine*, 86(3), pp. 384–388.

Whelan, A., Mansour, S., Farmer, P. and Yung, D. (2007) 'Moving from a lecture-based to a problem-based learning curriculum-perceptions of preparedness for practice', *Pharmacy Education*, 7(3), pp. 239–247.

Which? (2008) 'Pharmacies get test of own medicine'. Available at: http://www.which.co.uk/news/2008/09/pharmacies-get-test-of-own-medicine-157330/. (Accessed

on: 10/09/2016).

WHO (1997) ‘The Role Of The Pharmacist In The Healthcare System. Preparing The Future Pharmacist: Curricular Development’. Vancouver, Canada.

WHO (2015) ‘Measles’. Available at: http://www.who.int/mediacentre/factsheets/fs286/en/. (Accessed on: 06/07/2014).

Wiedenmayer, K., Summers, R., Mackie, C., Gous, A., Everard, M. and Tromp, D. (2006) ‘Developing pharmacy practice: A focus on patient care.’

Wild, R., Griggs, K. and Downing, T. (2002) ‘A framework for e-learning as a tool for knowledge management’, *Industrial Management & Data Systems*, 102(7), pp. 371–380.

Wilkinson, S. (2000) ‘Women with breast cancer talking causes: Comparing content, biographical and discursive analyses’, *Feminism & Psychology*, 10(4), pp. 431–460.

Williams, B., Brown, T. and Etherington, J. (2013) ‘Learning style preferences of undergraduate pharmacy students’, *Currents in Pharmacy Teaching and Learning*, 5(2), pp. 110–119.

Willis, S., Hassell, K., Seston, E. and Hann, M. (2009) ‘Using learning outcomes for undergraduate pharmacy education to assess final-year students’ perceptions of their preparedness for pharmacy practice’, *International Journal of Pharmacy Practice*, 17(6), pp. 351–358.

Willis, S., Shann, P. and Hassell, K. (2006) ‘Who will be tomorrow’s pharmacists and why did they study pharmacy?’, *The Pharmaceutical Journal*, (277), pp. 107–108.

Wind, L., Dalen, J., Muijtjens, A. and Rethans, J. (2004) ‘Assessing simulated patients in an educational setting: the MaSP (Maastricht Assessment of Simulated Patients)’, *Medical Education*, 38, pp. 39–44.

de Winter, J. and Dodou, D. (2010) ‘Five-Point Likert Items: t-test versus Mann-Whitney-Wilcoxon’, *Practical Assessment, Research & Evaluation*, 15(11), pp. 1–16.

Wong, T., Ip, E., Lopes, I. and Rajagopalan, V. (2014) ‘Pharmacy students’ performance and perceptions in a flipped teaching pilot on cardiac arrhythmias’, *American Journal of Pharmaceutical Education*, 78(10), pp. 185.

Woodham, L., Ellaway, R., Round, J., Vaughan, S., Poulton, T. and Zary, N. (2015) ‘Medical student and tutor perceptions of video versus text in an interactive online virtual patient for problem-based learning: A pilot study’, *Journal of Medical Internet Research*, 17(6).

Wrzesien, M. and Alcañiz Raya, M. (2010) 'Learning in serious virtual worlds: Evaluation of learning effectiveness and appeal to students in the E-Junior project', *Computers & Education*, 55(1), pp. 178–187.

Yang, R., Hashimoto, D., Predina, J., Bowens, N., Sonnenberg, E., Cleveland, E., Lawson, C., Morris, J. and Kelz, R. (2013) 'The virtual-patient pilot: Testing a new tool for undergraduate surgical education and assessment', *Journal of Surgical Education*, 70(3), pp. 394–401.

Yilmaz, K. (2013) 'Comparison of quantitative and qualitative research traditions: epistemological , theoretical', *European Journal of Education*, 48(2), pp. 311–325.

Yorke, M. (2003) 'Formative assessment in higher education: Moves towards theory and the enhancement of pedagogic practice', *Higher Education*, 45(2), pp. 477–501.

Yu, A., Flott, K., Chainani, N., Fontana, G. and Darzi, A. (2016) 'Patient Safety 2030', *NIHR Imperial Patient Safety Translational Research Centre. London, UK.*

Zary, N., Johnson, G., Boberg, J. and Fors, U. (2006) 'Development, implementation and pilot evaluation of a Web-based Virtual Patient Case Simulation environment – Web-SP', *BMC Medical Education*, 6(10).

Ziebland, S., Lavie-Ajayi, M. and Lucius-Hoene, G. (2015) 'The role of the Internet for people with chronic pain: Examples from the DIPEx International Project', *British Journal of Pain*, 9(1), pp. 62–64.

Ziv, A., Ben-David, S. and Ziv, M. (2005) 'Simulation based medical education: An opportunity to learn from errors', *Medical Teacher*, 27(3), pp. 193–199.

Zlotos, L., Power, A., Hill, D. and Chapman, P. (2016) 'A scenario-based virtual patient program to support substance misuse education', *American Journal of Pharmaceutical Education*, 80(3).

# Appendix 1 – Summary of the quality assessment conducted on the studies included in the systematic review

| Paper in Literature Review | Clear question? | Clear learning need? | Clear description of educational context? | Clear description of inter-vention? | Appro-priate study design? | Appro-priate methods? | Appro-praite outcome measures? | Other explan-ation of results? | Explan-ation of un-anticipated outcomes? |
|---|---|---|---|---|---|---|---|---|---|
| Al-Dahir *et al.* (2014) | Yes | Yes | Yes | Partly – No description of VP | Yes | Yes | Yes – Cronbach alpha | Yes | Yes |
| Barnett *et al.* (2016) | Yes | Yes | Yes | Yes | Yes | Yes | No | Yes | Yes |
| Battaglia *et al.* (2012) | Yes | Yes | Yes | Yes | Yes | Yes | No | Yes | Yes |
| Benedict (2010) | Yes | Yes | Yes | Partly – No description of VP | Yes | Yes | No | Yes | Yes |
| Benedict and Schonder (2011) | Yes | Yes | Yes | Partly – No description of VP | Yes | Yes | No | Yes | Yes |
| Benedict *et al.* (2013) | Yes | Yes | Yes | Partly – No description of VP | Yes | Yes | Yes - Pre-post- test face validity | Yes | Yes |
| Bindoff *et al.* (2014) | Yes | Yes | Yes | Yes | Yes | Yes | No | Yes | Yes |
| Bracegirdle and Chapman (2010) | Yes | Yes | Yes | Yes | Yes | Yes | No | Yes | No |

| Paper in Literature Review | Clear question? | Clear learning need? | Clear description of educational context? | Clear description of inter-vention? | Appro-priate study design? | Appro-priate methods? | Appro-praite outcome measures? | Other explan-ation of results? | Explan-ation of un-anticipated outcomes? |
|---|---|---|---|---|---|---|---|---|---|
| Cavaco and Madeira (2012) | Yes | Yes | Yes | N/A - Review of ppts use of VPs | Yes | Yes | No | Yes | No |
| Caylor *et al.* (2015) | Yes | Yes | Yes | Yes | Yes | Yes | Yes – Validity and reliability | Yes | Yes |
| Chaikoolvatana and Goodyer (2003) | Yes | Yes | Yes | Yes | Yes | Yes | No | Yes | Yes |
| Claudio *et al.* (2015) | Yes | Yes | Yes | Yes | Yes | Yes | No | No | No |
| Douglass *et al.* (2013) | Yes | Yes | Yes | Yes | Yes | Yes | Yes – Face validity of exam Q's | Yes | Yes |
| Ferrone *et al.* (2017) | Yes | Yes | Yes | Yes | Yes | Yes | No | Yes | Yes |
| Fleming *et al.* (2009) | Yes | Yes | Yes | Yes | Yes | Yes | Yes – SP's validated | Yes | No |
| Fuhrman Jr. *et al.* (2001) | Yes | Yes | Yes | Yes | Yes | Yes | No | No | No |
| Hussein and Kawahara (2006) | Yes | Yes | Yes | Yes | Yes | Yes | No | Yes | Yes |

| Paper in Literature Review | Clear question? | Clear learning need? | Clear description of educational context? | Clear description of inter-vention? | Appro-priate study design? | Appro-priate methods? | Appro-praite outcome measures? | Other explan-ation of results? | Explan-ation of un-anticipated outcomes? |
|---|---|---|---|---|---|---|---|---|---|
| Jabbur-lopes *et al.* (2012) | Yes | Yes | N/A – Lit review | Yes – Clear description of search strategy | Yes | Yes | No | Yes | No |
| Lambertsen *et al.* (2017) | Yes | Yes | Yes | Yes | Yes | Yes | No | Yes | Yes |
| Lichvar *et al.* (2016) | Yes | Yes | Yes | Yes | Yes | Yes | Yes – Validity and reliability | Yes | Yes |
| Loke *et al.* (2011) | Yes | Yes | Yes | Yes | Yes | Yes | Yes – Re-test | No | No |
| Marriott (2007) | Yes | Yes | Yes | Yes | Yes | Yes | No | Yes | No |
| McDowell *et al.* (2016) | Yes | Yes | Yes | Yes | Yes | Yes | No | No | No |
| McFalls (2013) | Yes | Yes | Yes | Partly – No description of VP | Yes | Yes | No | No | No |
| Menendez *et al.* (2015) | Yes | Yes | Partly – Ppts poorly explained | Yes | Yes | Yes | Partly - Used same tools same as Hussein and Zary – lack of previous validation of these | No | No |

| Paper in Literature Review | Clear question? | Clear learning need? | Clear description of educational context? | Clear description of inter-vention? | Appro-priate study design? | Appro-priate methods? | Appro-praite outcome measures? | Other explan-ation of results? | Explan-ation of un-anticipated outcomes? |
|---|---|---|---|---|---|---|---|---|---|
| Olin and Cole (2015) | Yes | Yes | Yes | Partly – No description of VP | Yes | Yes | No | Yes | Yes |
| Orr (2007) | Yes | Yes | Partly – Ppts poorly explained | Yes | Yes | Yes | No | Yes | Yes |
| Park and Summons (2013) | No | No | Partly – Ppts poorly explained | Yes | Yes | Yes | No | No | No |
| Pereira and Cavaco (2014) | Yes | Yes | Yes | Yes | Yes | Yes | No | Yes | Yes |
| Seefeldt *et al.* (2012) | Yes | Yes | Yes | Yes | Yes | Yes | No | Yes | No |
| Smith and Benedict (2015) | Yes | Yes | N/A – Lit Review | Yes – Clear description of search strategy | Yes | Yes | No | No | No |
| Smith *et al.* (2014) | Yes | Yes | Yes | Partly – No description of VP | Yes | Yes | Partly – Pre- post-test face validity | Yes | Yes |
| Smith *et al.* (2016) | Yes | Yes | Yes | Partly – No description of VP | Yes | Yes | Partly – Pre- post-test face validity | Yes | No |
| Taglieri *et al.* (2017) | Yes | Yes | Yes | Yes | Yes | Yes | No | Yes | Yes |

| Paper in Literature Review | Clear question? | Clear learning need? | Clear description of educational context? | Clear description of inter-vention? | Appro-priate study design? | Appro-priate methods? | Appro-praite outcome measures? | Other explan-ation of results? | Explan-ation of un-anticipated outcomes? |
|---|---|---|---|---|---|---|---|---|---|
| Villaume *et al.* (2006) | Yes | Yes | Partly – Ppts poorly explained | Yes | Yes | Yes | No | No | Yes |
| Zary *et al.* (2006) | Yes | Yes | Yes | Yes | Yes | Yes | No | No | No |
| Zlotos *et al.* (2016) | Yes | Yes | Yes | Yes | Yes | Yes | No | Yes | No |

# Appendix 2 – Ethical approval letter for the main study

Keele University

RESEARCH AND ENTERPRISE SERVICES

REF: ERP2221

18th September 2014

Jessica Thompson
Room 0.56
Hornbeam Building

Dear Jessica,

**Re: To establish how bespoke interactive information technology can best support pre-registration pharmacy training: A mixed methods approach**

Thank you for submitting your revised application for review. I am pleased to inform you that your application has been approved by the Ethics Review Panel. The following documents have been reviewed and approved by the panel as follows:

| Document | Version | Date |
|---|---|---|
| Summary Document | 1 | 04/08/2014 |
| Letter of Invitation | 2 | 04/09/2014 |
| Information Sheets | 2 | 04/09/2014 |
| Consent Form | 1 | 06/08/2014 |
| Consent Form Screenshots | 1 | 06/08/2014 |
| Questionnaire | 1 | 06/08/2014 |
| Interview Topic Guides | 1 | 06/08/2014 |
| Virtual Patient Case Study Quiz | 1 | 01/07/2014 |
| Virtual Patient Case Study Link | 1 | 01/07/2014 |
| Paper-based case study quiz | 1 | 02/07/2014 |
| Paper-based case study | 1 | 02/07/2014 |

If the fieldwork goes beyond the date stated in your application, you must notify the Ethical Review Panel via the ERP administrator at uso.erps@keele.ac.uk stating ERP2 in the subject line of the e-mail. If there are any other amendments to your study you must submit an 'application to amend study' form to the ERP administrator stating ERP2 in the subject line of the e-mail. This form is available via http://www.keele.ac.uk/researchsupport/researchethics/

If you have any queries, please do not hesitate to contact me via the ERP administrator on uso.erps@keele.ac.uk stating ERP2 in the subject line of the e-mail.

Yours sincerely

**Dr Bernadette Bartlam**
**Chair – Ethical Review Panel**

CC RI Manager
Supervisor

Research and Enterprise Services, Keele University, Staffordshire, ST5 5BG, UK
Telephone: + 44 (0)1782 734466 Fax: + 44 (0)1782 733740

# Appendix 3 – Letter of invitation for main study

*Do you spend your time playing computer games or downloading new apps for your phone?*

*Have you ever found yourself bored by pharmacy revision?*

*Do you wonder how you're going to show your competence at all performance standards?*

*Do you wonder how you're going to learn everything you need to know to pass the pre-registration exam?*

A piece of research taking place into the use of technology in pre-registration training may be something for you to think about taking part in.

Dear pre-registration trainee,

My name is Jessica Thompson and I am currently completing my PhD at Keele University.

I'd like to take this opportunity to introduce you to my research and ask for your help in participating.

My research is entitled 'To establish how bespoke interactive information technology can best support pre-registration pharmacy training: a mixed methods approach.'

The purpose of this study is to evaluate the effectiveness of interactive virtual patients in supporting pre-registration pharmacist training. The primary reason for this research is the increasing technological developments in healthcare and the need for education to align with this. There is a significant lack of research into the use of virtual patients in pharmacy and none at all into the benefits it may offer pre-registration training. It is not yet clear how essential this is likely to become for the course.

**Benefits of taking part:**

- ✓ Extra support during the pre-registration year
- ✓ Encounter a wider variety of experiences and patient groups than may occur in pre-registration training
- ✓ Develop essential clinical and practice knowledge, and communication and clinical reasoning skills
- ✓ Improve confidence for the pre-registration exam and practice
- ✓ Help prepare you for any OSCEs you may encounter in the pre-registration year OR if no OSCEs then simulations offer an alternative to simply role-playing with tutor
- ✓ Can use the case studies as evidence to show your progress and development against performance standards
- ✓ Can form part of your CPD

✓ Each case study will take ~15 minutes to complete

I am not aware of any disadvantages or risks to you in taking part in the study.

**If you decide to take part in the research you will be asked to:**

- Complete 3 interactive virtual patient case studies and 3 paper based case studies
- Each case study will have a short pre- and post- multiple-choice quiz to complete, which will allow me to assess any knowledge improvement and allow you to see areas which may need more work
- When all case studies have been completed, you will be asked to complete a questionnaire and may be invited for a telephone interview
- At the end of the research you will be provided with access to all case studies and research components in preparation for the pre-registration exam

All case studies aim to help you develop essential knowledge and skills required during the pre-registration year and in practice, and will provide a safe environment to do so.

The study will hopefully start in October and will run for 6 months. All you need to be able to take part is an internet connection as everything is done via the internet.

This will not form part of your formal pre-registration evaluation and results will remain confidential to the research team.

**Interactive computer case studies:**

1. Emergency hormonal contraception consultation
2. Renal function effects
3. Childhood illness

**Paper based case studies:**

1. Infusion rate calculation
2. Warfarin counselling
3. Drug interactions

Please see the Participant Information Sheet for further details about the study.

Participation in this research is completely voluntary and you may choose not to participate without consequence. You may decline to answer any of the questions if you so wish and you may decide to withdraw from this study at any time without any negative consequences.

If you would like to take part or have any questions about the project, please email me at j.f.thompson@keele.ac.uk.

Thank you for taking the time to read this.

Yours sincerely

Jessica Thompson
School of Pharmacy
Hornbeam Building Room 0.56
j.f.thompson@keele.ac.uk
01782 733985
Keele University, Staffordshire, ST5 5BG, UK

# Appendix 4 – Participant Information Sheet for the main study

**Study Title - To establish how bespoke interactive information technology can best support pre-registration pharmacy training: A mixed methods approach**

### Invitation

You are being invited to take part in a research study. This project is being undertaken by Jessica Thompson, Dr Simon White and Professor Stephen Chapman from the School of Pharmacy at Keele University. You do not have to take part but before you decide, it is important for you to understand why the research study is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask me (j.f.thompson@keele.ac.uk) if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.

### What is the purpose of the study?

The purpose of the study is to evaluate the effectiveness of interactive virtual patients at supporting pre-registration pharmacist training.

### Why have I been chosen?

You are being invited to take part in this research study because you will be completing your pre-registration training in a UK based community or hospital pharmacy from 2014-2015. I am aiming to recruit 40-50 (or more) pre-registration pharmacists to participate in the research.

### Do I have to take part?

It is up to you to decide whether or not to take part. You are free to withdraw from this study at any time without giving reasons.

### What will happen to me if I take part and what do I have to do?

If you decide to take part in the study you will be asked to complete 3 online interactive virtual patient case studies and 3 paper-based case studies. These case studies are designed to help you develop essential knowledge and skills required during the pre-registration year and in practice, and will provide a safe environment to do so. Surrounding each case study will be a short pre- and post-quiz for you to complete, which will consist of multiple choice questions specific to that case study topic. You will have access to each case study for one month – during which time you may work through the scenario on as many occasions as you wish. You must complete the post-quiz to be able

to access the next case study. When all virtual patient case studies have been completed you will be asked to complete an online evaluative survey. This will also occur when all the paper-based cases have been completed. At the end of the study, you will be provided with access to all case studies and quizzes to help prepare for the pre-registration exam. Towards the end of your training you may also be invited to participate in a telephone interview.

### What are the possible disadvantages and risks of taking part?

I am not aware of any disadvantages or risks to you in taking part in the study.

### What are the possible benefits of taking part?

There are a number of benefits to you personally in taking part in this study. You are being given the opportunity to use novel technology and the case studies aim to enhance your pre-registration year. They may help you develop essential clinical and practice knowledge, and communication and clinical reasoning skills required for the pre-registration exam and when you're fully qualified. They will also help prepare you for any OSCE's you have in the pre-registration year. If you want, you can use the case studies as evidence to show your progress and development against performance standards and they can also form part of your continuing professional development (CPD). Each case study will take around 15 minutes to complete and the surveys and interview will take around 30 minutes depending how thorough you wish to be. Overall, the research being carried out may result in great benefits for future pre-registration training. If interactive information technology is found to be beneficial to the pre-registration training year, then it may be possible to make it available for all students to use in the future.

### What if there is a problem or something goes wrong?

If you have a concern about any aspect of this study, you may wish to speak to me. I will do my best to answer your questions. You should contact me (Jessica Thompson) at j.f.thompson@keele.ac.uk. Alternatively, if you do not wish to contact me you may contact Professor Stephen Chapman on s.r.chapman@keele.ac.uk. If you remain unhappy about the research and/or wish to raise a complaint about any aspect of the way that you have been approached or treated during the course of the study please write to Nicola Leighton, who is the University's contact for complaints regarding research at the following address: Research & Enterprise Services, Dorothy Hodgkin Building, Keele University, ST5 5BG, email address n.leighton@keele.ac.uk, telephone number 01782 733306.

### Who will have access to information about me?

All personal information that I collect about you during the course of the research will be protected according to the Data Protection Act 1998. This means that personally identifiable information about you will be kept strictly confidential. Information will be analysed, stored and published via numbers and not names. Electronic data will be stored on password-protected media that only I have access to. Hardcopies of documentation will be kept secure in a locked cupboard that only I have access to.

At the end of the study all data and documents containing personally identifiable information about you will be destroyed. You will not be able to be identified in any reports or publications. Data will be kept for at least five years but will not be used in any other research without obtaining further informed consent. When the data no longer needs to be retained it will be disposed of securely; paper information will be shredded and electronic information will be deleted and made irretrievable.

### How will information about me be used?

Information collected from completion of the quizzes will be used to determine whether an improvement of knowledge can be successfully measured. Information obtained from the questionnaire and interview will be used to determine your thoughts on the technology and case studies. The results (including anonymised direct quotes) will be included in a research report and may subsequently be published as research papers in academic journals and presented at conferences. No individual person will be identifiable in quotes, reports, presentations or summaries.

### Who is organising and funding the research?

The research will be funded by the School of Pharmacy at Keele.

### Who has reviewed the study?

The research study has been reviewed and given approval by Keele University Ethical Review Panel.

### Further Information and Contact Details

If you have any questions or require any further information, either now or at any time during the study, please contact me (Jessica Thompson) at j.f.thompson@keele.ac.uk. Alternatively, you can contact me in writing at the School of Pharmacy, Keele University, Staffordshire ST5 5BG.

**Thank you for taking time to read this information!**

# Appendix 5 – Consent form for main study

**Title of Project: To establish how bespoke interactive information technology can best support pre-registration pharmacy training: A mixed methods approach**

Name and contact details of Principal Investigator: Jessica Thompson, Room 0.56, School of Pharmacy, The Hornbeam Building, Keele University, Keele, Staffordshire, ST5 5BG, 01782 733327, j.f.thompson@keele.ac.uk

Please tick box if you agree with the statement

| | | |
|---|---|---|
| 1 | I confirm that I have read and understand the information sheet for the above study and have had the opportunity to ask questions. | ☐ |
| 2 | I understand that my participation is voluntary and that I am free to withdraw at any time. | ☐ |
| 3 | I agree to take part in this study. | ☐ |
| 4 | I understand that data collected about me during this study will be anonymised before it is submitted for publication. | ☐ |
| 6 | I agree to allow the dataset collected to be used for future research projects | ☐ |
| 7 | I agree to be contacted about possible participation in future research projects. | ☐ |
| 8 | I agree for any quotes to be used | ☐ |

| _____ | _____ | _____ |
|---|---|---|
| Name of participant | Date | Signature |
| _____ | _____ | _____ |
| Researcher | Date | Signature |

# Appendix 6 – Questionnaire for main study

Name: _____

Gender: Female ☐ Male ☐

Age: _____

Ethnicity: _____

Main sector of pre-registration training: Hospital ☐ Community ☐

Region of pre-registration training: _____

School of Pharmacy: _____

Degree Classification: _____

Average number of times you accessed the virtual patient cases: _____

Have you had any previous virtual patient experience? Yes ☐ No ☐

Please tick the box that relates to your agreement with the following statements for the case studies:

| | **Strongly Disagree** | **Disagree** | **Undecided** | **Agree** | **Strongly Agree** |
|---|---|---|---|---|---|
| The simulation provided a realistic patient simulation | | | | | |
| When completing the simulations I felt as if I were the pharmacist caring for this patient | | | | | |
| When completing the simulations I felt I had to make the same decisions as a pharmacist would in real life | | | | | |
| The simulations were interesting | | | | | |
| The simulations were enjoyable | | | | | |
| The difficulty of the simulations were appropriate for my level of training | | | | | |
| The feedback I received was adequate for my needs | | | | | |
| The objectives for the simulations were clear and easy to understand | | | | | |
| I was able to access the simulations at my convenience | | | | | |
| The simulations helped develop my clinical reasoning skills | | | | | |
| The simulations helped develop my problem-solving and decision making skills | | | | | |
| The simulations have helped me to put theory into practice | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| I am confident I am developing skills from the simulations that will be required in practice | | | | | |
| I am confident I am gaining knowledge from the simulations that will be required in practice | | | | | |
| It is my responsibility to learn what I need to know from the simulations | | | | | |
| Completing the simulations has improved my confidence for the pre-registration exam | | | | | |
| I feel better prepared to care for real life patients | | | | | |
| I feel more confident about collaborating with patients and other healthcare professionals | | | | | |
| The simulations have increased my confidence about practicing as a pharmacist | | | | | |
| Overall the experience has enhanced my learning | | | | | |

1. What did you like about the case-studies?

2. What did you dislike about the case studies?

3. Which case studies did you find most useful?

4. Which case studies did you find least useful?

5. How do you think the case studies would best fit into the pre-registration training year?

6. Are there any improvements which could be made to the case studies?

7. Are there any other case study topics you would have found useful?

8. Any additional thoughts or comments:

# Appendix 7 – Semi-Structured Interview Guide

Usefulness as a training tool

1. What do you think about VP technology?
2. Was the VP useful to your training?
3. Did the VP help you learn/develop knowledge/skills?
4. Do you think pre-reg would benefit from the introduction of VP technology?
5. Would you use anything like this in the future for training modules or prescribing courses if they were available?

Support during pre-registration training

6. Do you feel the VP helped support your training?
7. Could the VP have supported you in any other way?
8. Did you use any cases as evidence for competencies?
9. Did using the VP help you feel more confident for the pre-registration exam or future practice?
10. Do you feel you gained anything extra from using the VP than if you hadn't used it?

Case study topics

11. Do you think the case studies were able to impact your learning?
12. Which case studies do you feel were most useful?
13. Now that you have finished pre-reg, are there are other topics you would have found useful to be turned into case studies?

Enjoyment

14. Did you enjoy using the virtual patient technology?
15. Did you feel more inclined to study when using the VP?

OSCE preparation/alternative

16. Did you have any OSCEs during pre-reg?
17. Did the cases help prepare you?
18. Were the cases a good alternative?
19. Did you have any other patient cases or problems to work through during pre-reg given to you by your training place? – How were these in relation to the VP?

Barriers

20. Were there any barriers to using the VP?

Improvements

21. Are there any improvements that would make the VP a better training tool?

# Appendix 8 – MCQ quiz for case one

1. How long is Levonelle licensed to be taken after unprotected intercourse?
    a) 24 hours
    b) 48 hours
    c) 72 hours
    d) 96 hours
    e) 120 hours

2. How long is EllaOne licensed to be taken after unprotected intercourse?
    a) 24 hours
    b) 48 hours
    c) 72 hours
    d) 96 hours
    e) 120 hours

3. Which of these medicines may affect absorption of Levonelle?
    a) Carbamazepine
    b) Ciclosporin
    c) Ciprofloxacin
    d) Phenobarbital
    e) Erythromycin

4. How old must a patient be for a sale of Levonelle?
    a) 14
    b) 15
    c) 16
    d) 17
    e) 18

5. Which of the following may prevent a patient having EllaOne?
    a) Lactose intolerance
    b) Crohn's disease
    c) Asthma not controlled by glucocorticoids
    d) Coeliac disease
    e) Rifampacin for tuberculosis

6. Which of the following may prevent a patient having Levonelle?
    a) Lactose intolerance
    b) Crohn's disease
    c) Asthma not controlled by glucocorticoids
    d) Coeliac disease

e) Rifampacin for tuberculosis

7. What is the effectiveness of EllaOne at preventing pregnancy if taken 120 hours after unprotected intercourse?
    a) 98%
    b) 84%
    c) 75%
    d) 68%
    e) 56%

8. What is the effectiveness of Levonelle at preventing pregnancy if taken 24 hours after unprotected intercourse?
    a) 100%
    b) 98%
    c) 95%
    d) 90%
    e) 85%

9. What type of intrauterine device is available as emergency contraception?
    a) Copper
    b) Titanium
    c) Hormonal
    d) Silicone
    e) Aluminium

10. How long can the emergency contraceptive intrauterine device be inserted after sexual intercourse?
    a) 24 hours
    b) 48 hours
    c) 72 hours
    d) 96 hours
    e) 120 hours

11. Which of these are key points which need to be covered when counselling a patient requesting emergency contraception?
    a) Risk of sexually transmitted infections
    b) Concomitant antibiotic use
    c) Side effects of treatment
    d) Effectiveness of treatment
    e) Regular contraceptive methods

12. What are the most common side effects associated with Levonelle use?
    a) Nausea

b) Lower abdominal pain
c) Heartburn
d) Dsymennorheoa
e) Constipation

13. When taking Levonelle for EHC a patient will require a second dose if they vomit within what period of time?
    a) 1 hour
    b) 2 hours
    c) 3 hours
    d) 4 hours
    e) 5 hours

14. When taking EllaOne for EHC a patient will require a second dose if they vomit within what period of time?
    a) 1 hour
    b) 2 hours
    c) 3 hours
    d) 4 hours
    e) 5 hours

15. You can take Levonelle more than once in the same cycle
    a) True
    b) False

16. You can take EllaOne more than once in the same cycle
    a) True
    b) False

17. A patient can take both Levonelle and EllaOne in the same cycle?
    a) True
    b) False

18. Patients can get emergency contraception before unprotected sex has taken place
    a) True
    b) False

19. Patients on cerazette should take emergency contraception if they have taken a tablet more than 3 hours late and have had unprotected sex
    a) True
    b) False

20. Patients allergic to levonorgestrel cannot take EllaOne

a) True
b) False

# Appendix 9 – Link to all VP Cases

http://www.keelesop.co.uk/vp_levonelle/

http://www.keelesop.co.uk/vp_hospitalpatient/

http://www.keelesop.co.uk/vp_childillness

# Appendix 10 – NI case study one with answers

Learning objectives:

- Communicate with a patient requesting EHC in an appropriate, professional manner
- Demonstrate effective understanding of the information that needs to be obtained from a patient to ensure safe provision of EHC
- Demonstrate effective understanding of the main counselling points associated with EHC
- Describe the different options available for EHC
- Identify the reference sources available for more information regarding EHC

A young woman comes into the community pharmacy where you are working as a pharmacist and requests to speak to you about a personal issue.

1. What are the first things you should do when greeting the patient?

2. The patient requests the morning after pill. What questions do you need to ask a woman requesting emergency hormonal contraception to determine if there is an option suitable for them?

3. The only emergency contraception you have in the store is Levonelle. What advice points do you need to cover to ensure the patient has enough information to make a decision about wanting treatment?

4. From questioning you find out the emergency contraception is for the woman who came into the pharmacy. She is 31 years old and had unprotected sex the night before. No contraceptive measures were taken but the woman is on Yasmin but she admits to finishing her pack a fortnight ago and not having started a new pack yet due to stress. Her last period was about a week ago and it was normal. There is no chance she is already pregnant and she has not used emergency contraception in her current cycle. She takes painkillers and indigestion tablets if she needs them but is on no other medication. She has no liver or malabsorption problems. She has no allergies. Would you supply Levonelle to this patient?

   Yes / No Option

**Answers**

1. What are the first things you should do when greeting the patient?

- Introducing yourself
- Asking if they want to go into a private room
- Asking how you can help

2. The patient requests the morning after pill. What questions do you need to ask a woman requesting emergency hormonal contraception to determine if there is an option suitable for them?

- Who is it for?
- What is their age?
- When did the unprotected intercourse take place?
- Was any contraception used during intercourse?
- Is the patient on any contraception?
- When was their last period and was it normal?
- Is there any chance they are already pregnant?
- Has the patient already used any EHC in the current cycle?
- Is the patient on any other medication?
- Does the patient have any problems that may affect absorption of the tablet?
- Does the patient have any liver problems?
- Does the patient have any allergies?

3. The only emergency contraception you have in the store is Levonelle. What advice points do you need to cover to ensure the patient has enough information to make a decision about wanting treatment?

- Mode of action
- Failure rate
- Vomiting within 2 hours
- Side effects
- Symptoms of pregnancy
- Effect on the foetus
- Other options of emergency contraception
- Information on contraception methods
- Need for condom use
- Risk of STIs

4. From questioning you find out the emergency contraception is for the woman who came into the pharmacy. She is 31 years old and had unprotected sex the night before. No contraceptive measures were taken but the woman is on Yasmin but she admits to finishing her pack a fortnight ago and not having started a new pack yet due to stress. Her last period was about a week ago and it was normal. There is no chance she is already pregnant and she has not used emergency contraception in her current cycle. She takes painkillers and indigestion tablets if she needs them but is on no other medication. She has no liver or malabsorption problems. She has no allergies. Would you supply Levonelle to this patient?

- Yes

Resources: BNF, SPCs, MEP, RPS Guidance on EHC, CPPE EHC e-learning and e-assessment, The Faculty of Sexual and Reproductive Healthcare website (Emergency contraception guidance).

# Appendix 11 – Consent form telephone interviews

**Title of Project: To establish how bespoke interactive information technology can best support pre-registration pharmacy training: A mixed methods approach**

Name and contact details of Principal Investigator: Jessica Thompson, Room 0.56, School of Pharmacy, The Hornbeam Building, Keele University, Keele, Staffordshire, ST5 5BG, 01782 733327, j.f.thompson@keele.ac.uk

Please tick box if you agree with the statement

| | | |
|---|---|---|
| 1 | I confirm that I have read and understand the information sheet for the above study and have had the opportunity to ask questions. | ☐ |
| 2 | I understand that my participation is voluntary and that I am free to withdraw at any time. | ☐ |
| 3 | I agree to take part in this study. | ☐ |
| 4 | I understand that data collected about me during this study will be anonymised before it is submitted for publication. | ☐ |
| 5 | I agree to the interview being audio recorded | ☐ |
| 6 | I agree to allow the dataset collected to be used for future research projects | ☐ |
| 7 | I agree to be contacted about possible participation in future research projects. | ☐ |
| 8 | I agree for any quotes to be used | ☐ |

| _____ | _____ | _____ |
|---|---|---|
| Name of participant | Date | Signature |
| _____ | _____ | _____ |
| Researcher | Date | Signature |

# Appendix 12 - Participant Information Sheet for Telephone Interviews

**Study Title - To establish how bespoke interactive information technology can best support pre-registration pharmacy training: A mixed methods approach**

### Invitation

You are being invited to take part in a research study. This project is being undertaken by Jessica Thompson, Dr Simon White and Professor Stephen Chapman from the School of Pharmacy at Keele University. You do not have to take part but before you decide, it is important for you to understand why the research study is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask me (j.f.thompson@keele.ac.uk) if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.

### What is the purpose of the study?

The purpose of the study is to explore pre-registration trainee's thoughts and experiences of the virtual patient technology. The study aims to identify the usefulness of the technology at supporting pre-registration training and how trainees believe it may be integrated into the pre-registration training year. We are also hoping to explore thoughts on the use of the technology as an alternative or adjunct to any Objective Structured Clinical Examinations (OSCEs), as well as barriers to use and improvements.

### Why have I been chosen?

You are being invited to take part in this research study because you will be completing your pre-registration training in a UK based community or hospital pharmacy from 2014-2015. I am aiming to conduct telephone interviews with 20 (or more) pre-registration trainees. Individuals will be invited to participate in the interview based on their responses to the questionnaire to ensure a wide range of thoughts and experiences are explored in greater depth than the questionnaire allows.

### Do I have to take part?

It is up to you to decide whether or not to take part. You are free to withdraw from this study at any time without giving reasons.

### What will happen to me if I take part and what do I have to do?

If you decide to take part you will be asked to complete a short 30 minute telephone interview at a time that is convenient for you. I would like to digitally record the conversation.

### Will I be recorded, and how will the recorded media be used?

The digital recording made during this research project will be used for analysis only. No other use will be made of it without your written permission, and no one outside of the project will be allowed access to the original recordings.

### What are the possible disadvantages and risks of taking part?

I am not aware of any disadvantages or risks to you in taking part in the study.

### What are the possible benefits of taking part?

I am not aware of any obvious benefits to you personally in taking part in this study. However, if the virtual patient technology is found to be useful at supporting pre-registration training it may be something that is further utilised in the future as a training tool. Your thoughts are important to determine the value of the technology. Taking part in this study will help contribute to research on this topic, which may lead to benefits for future pre-registration trainees.

### What if there is a problem or something goes wrong?

If you have a concern about any aspect of this study, you may wish to speak to me. I will do my best to answer your questions. You should contact me (Jessica Thompson) at j.f.thompson@keele.ac.uk. Alternatively, if you do not wish to contact me you may contact Professor Stephen Chapman on s.r.chapman@keele.ac.uk. If you remain unhappy about the research and/or wish to raise a complaint about any aspect of the way that you have been approached or treated during the course of the study please write to Nicola Leighton, who is the University's contact for complaints regarding research at the following address: Research & Enterprise Services, Dorothy Hodgkin Building, Keele University, ST5 5BG, email address n.leighton@keele.ac.uk, telephone number 01782 733306.

### Who will have access to information about me?

All personal information that I collect about you during the course of the research will be protected according to the Data Protection Act 1998. This means that personally identifiable information about you will be kept strictly confidential. Information will be analysed, stored and published via numbers and not names. Electronic data will be stored on password-protected media that only I have access to. Hardcopies of documentation will be kept secure in a locked cupboard that only I have access to. At the end of the study all data and documents containing personally identifiable information about you will be destroyed. You will not be able to be identified in any reports or publications. Data will be kept for at least five years but will not be used in any other research without obtaining further informed consent. When the data no longer needs to be retained it will be disposed of securely; paper information will be shredded and electronic information will be deleted and made irretrievable.

### How will information about me be used?

The results (including anonymised direct quotes) will be included in a research report and may subsequently be published as research papers in academic journals and presented at conferences. No individual person will be identifiable in quotes, reports, presentations or summaries.

### Who is organising and funding the research?

The research will be funded by the School of Pharmacy at Keele.

### Who has reviewed the study?

The research study has been reviewed and given approval by Keele University Ethical Review Panel.

### Further Information and Contact Details

If you have any questions or require any further information, either now or at any time during the

study, please contact me (Jessica Thompson) at j.f.thompson@keele.ac.uk. Alternatively, you can contact me in writing at the School of Pharmacy, Keele University, Staffordshire ST5 5BG.

**Thank you for taking time to read this information!**

# Appendix 13 – Recruitment email to pre-registration trainees

Dear All,

My name is Jessica Thompson and I have been given your details so I could contact you regarding my research.

The purpose of this study is to evaluate the effectiveness of interactive virtual patients in supporting pre-registration pharmacist training. The primary reason for this research is the increasing technological developments in healthcare and the need for education to align with this. There is a significant lack of research into the use of virtual patients in pharmacy and none at all into the benefits it may offer pre-registration training. It is not yet clear how essential this is likely to become for the course.

The study will hopefully start in October (this is when you will have access to the first case) and will run for 6 months.

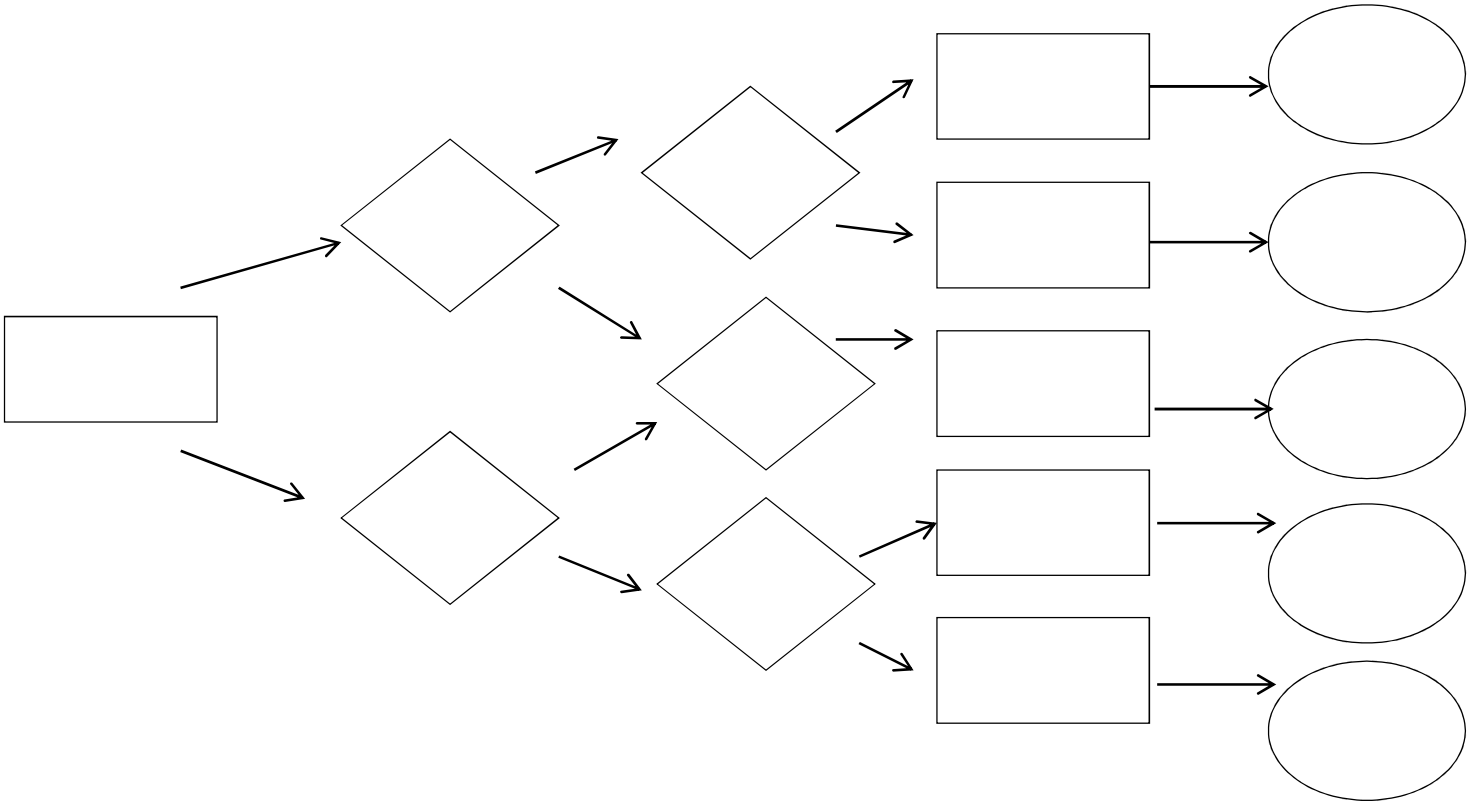
I have attached a letter of invitation and information sheet for you to read over which will hopefully help you decide if you want to participate.

If you have any questions about the research or pre-registration training in general feel free to ask!

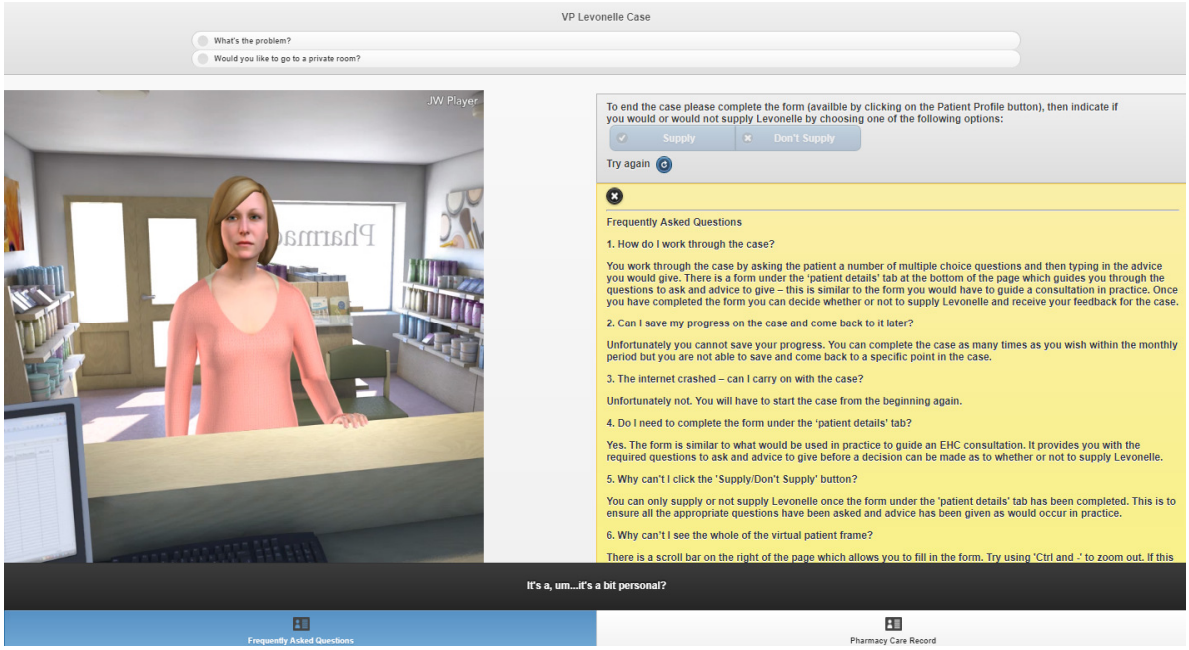
Best wishes,

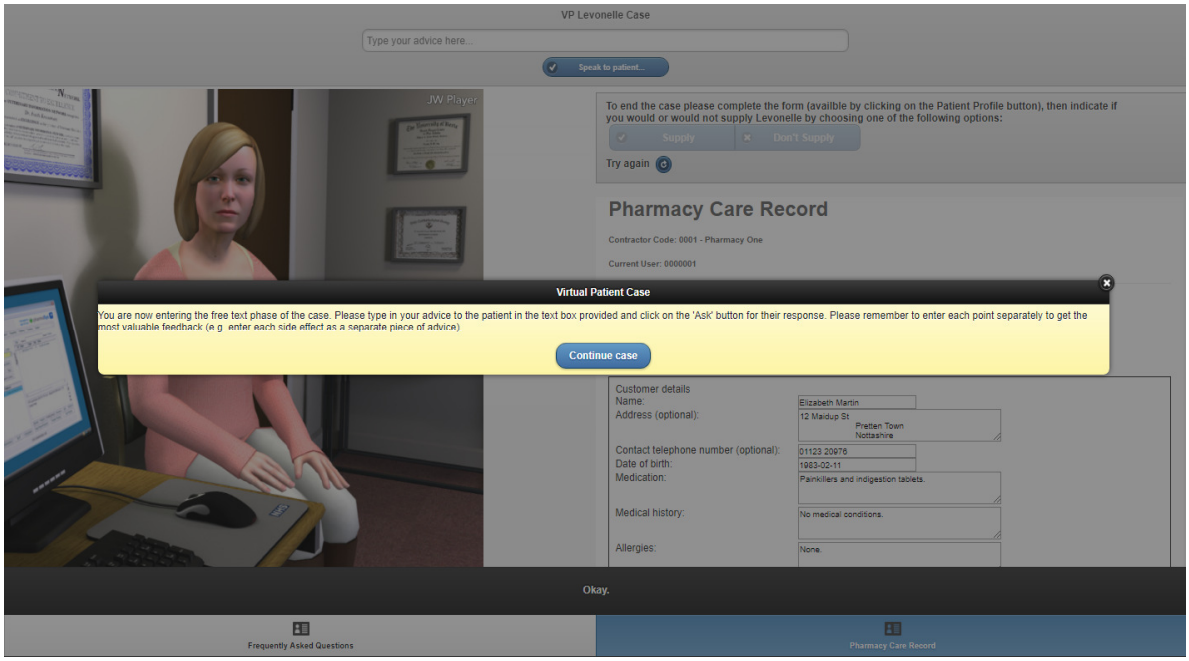
Jess Thompson

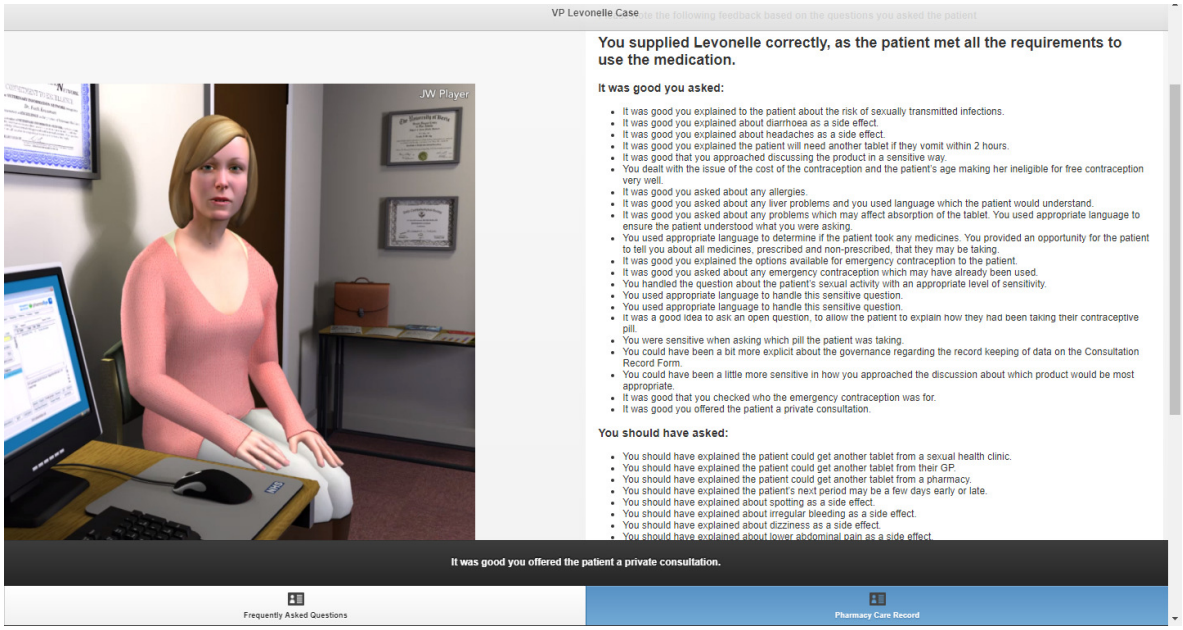
# Appendix 14 – Decision Tree Image



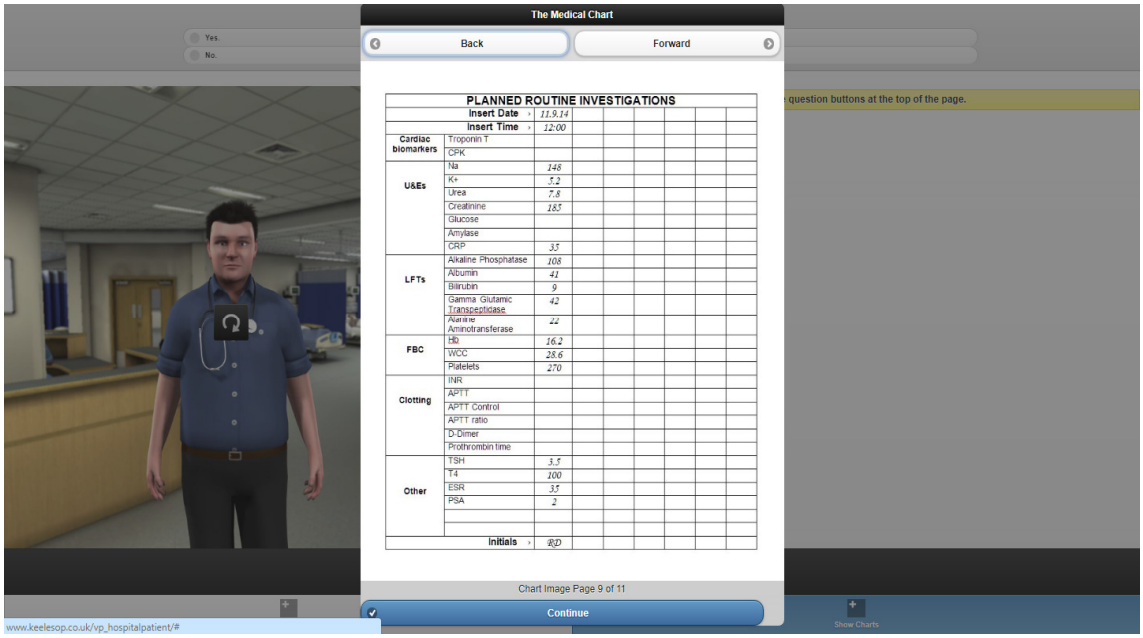
# Appendix 15 – EHC VP Pictures

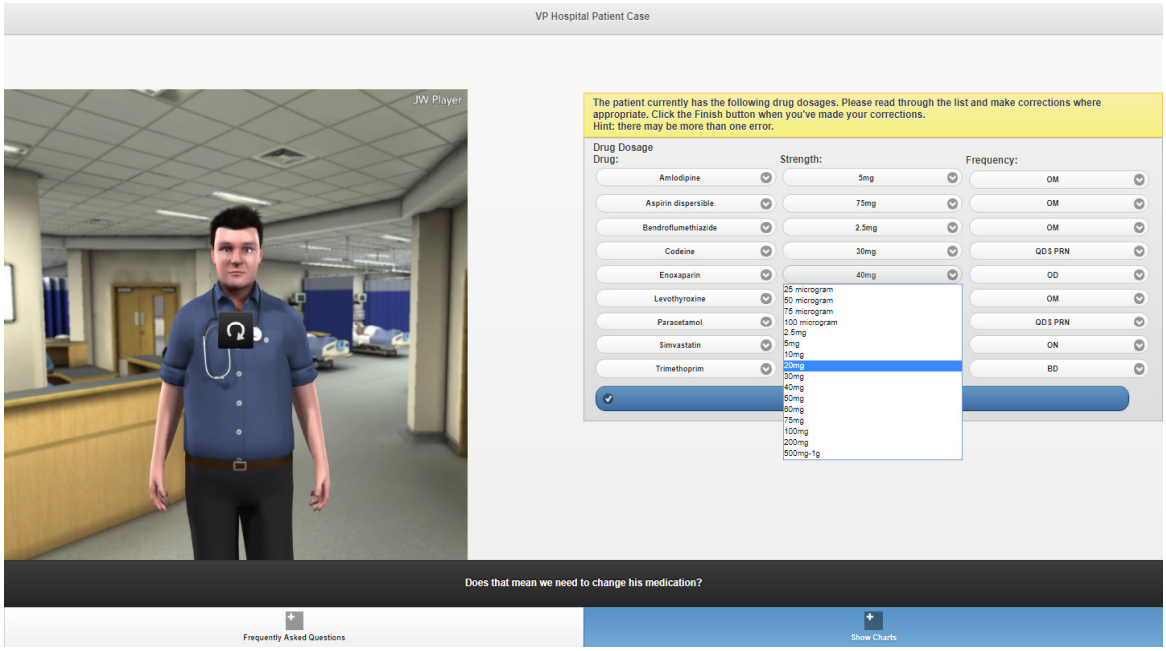


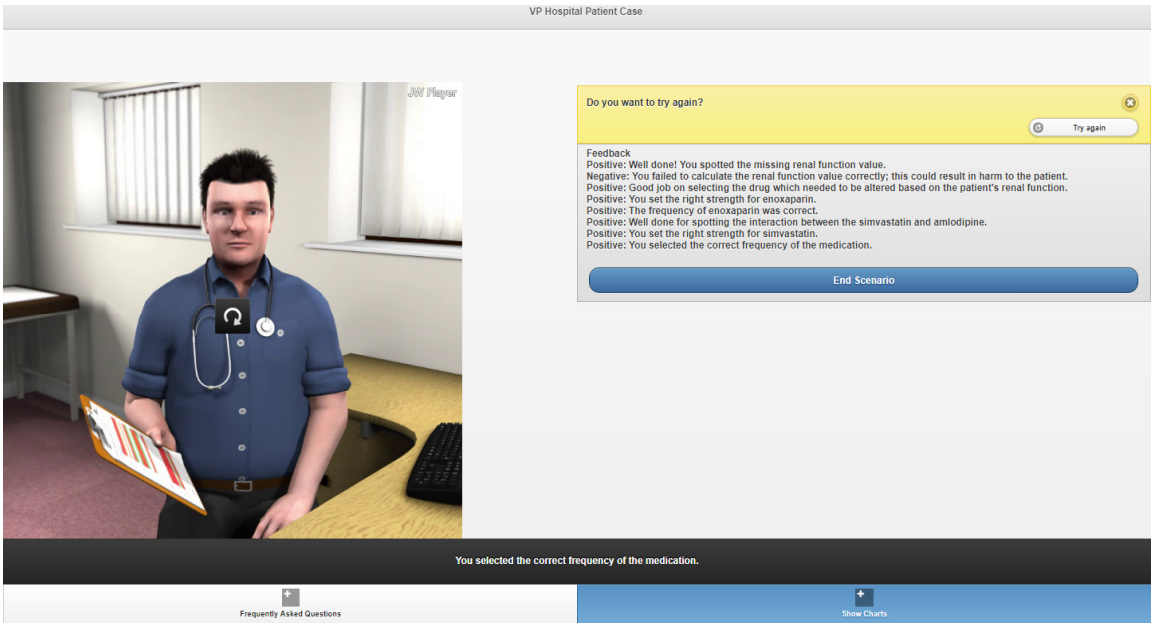




VP Levonelle Case
You supplied Levonelle correctly, as the patient met all the requirements to use the medication.
It was good you asked:
It was good you explained to the patient about the risk of sexually transmitted infections.
It was good you explained about diarrhoea as a side effect.
It was good you explained about headaches as a side effect.
It was good you explained the patient will need another tablet if they vomit within 2 hours.
It was good that you approached discussing the product in a sensitive way.
You dealt with the issue of the cost of the contraception and the patient's age making her ineligible for free contraception very well.
It was good you asked about any allergies.
It was good you asked about any liver problems and you used language which the patient would understand.
It was good you asked about any problems which may affect absorption of the tablet. You used appropriate language to ensure the patient understood what you were asking.
You used appropriate language to determine if the patient took any medicines. You provided an opportunity for the patient to tell you about all medicines, prescribed and non-prescribed, that they may be taking.
It was good you explained the options available for emergency contraception to the patient.
It was good you asked about any emergency contraception which may have already been used.
You handled the question about the patient's sexual activity with an appropriate level of sensitivity.
You used appropriate language to handle this sensitive question.
You used appropriate language to handle this sensitive question.
It was a good idea to ask an open question, to allow the patient to explain how they had been taking their contraceptive pill.
You were sensitive when asking which pill the patient was taking.
You could have been a bit more explicit about the governance regarding the record keeping of data on the Consultation Record Form.
You could have been a little more sensitive in how you approached the discussion about which product would be most appropriate.
It was good that you checked who the emergency contraception was for.
It was good you offered the patient a private consultation.
You should have asked:
You should have explained the patient could get another tablet from a sexual health clinic.
You should have explained the patient could get another tablet from their GP.
You should have explained the patient could get another tablet from a pharmacy.
You should have explained the patient's next period may be a few days early or late.
You should have explained about spotting as a side effect.
You should have explained about irregular bleeding as a side effect.
You should have explained about dizziness as a side effect.
You should have explained about lower abdominal pain as a side effect.
JW Player
It was good you offered the patient a private consultation.
Frequently Asked Questions
Pharmacy Care Record

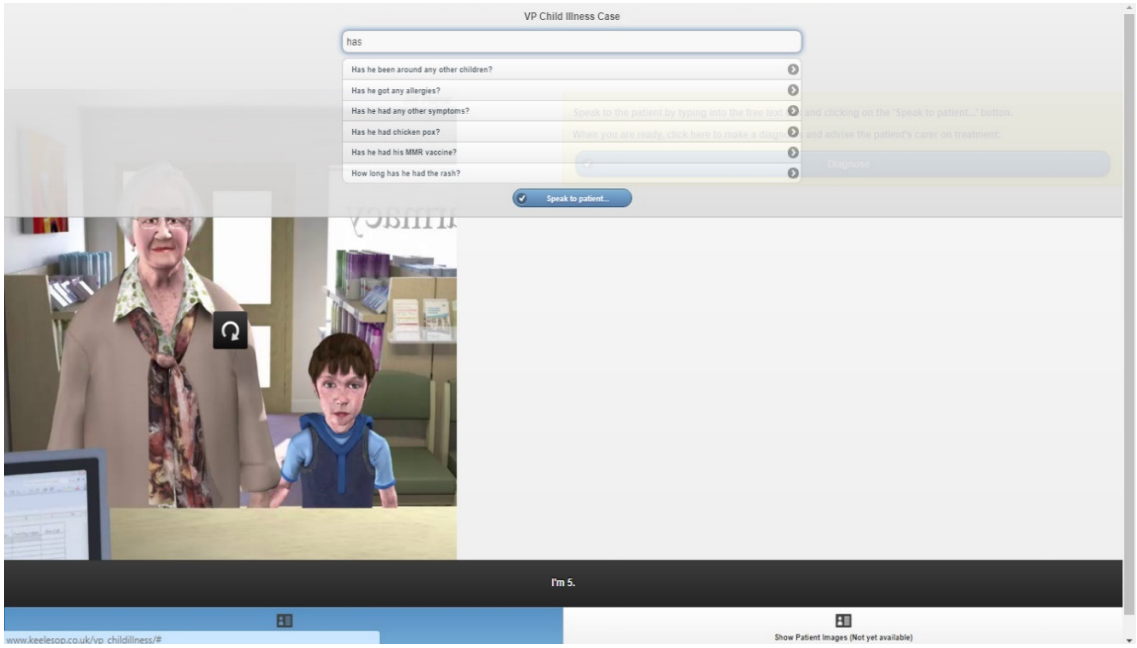
# Appendix 16 – Renal Function VP Pictures

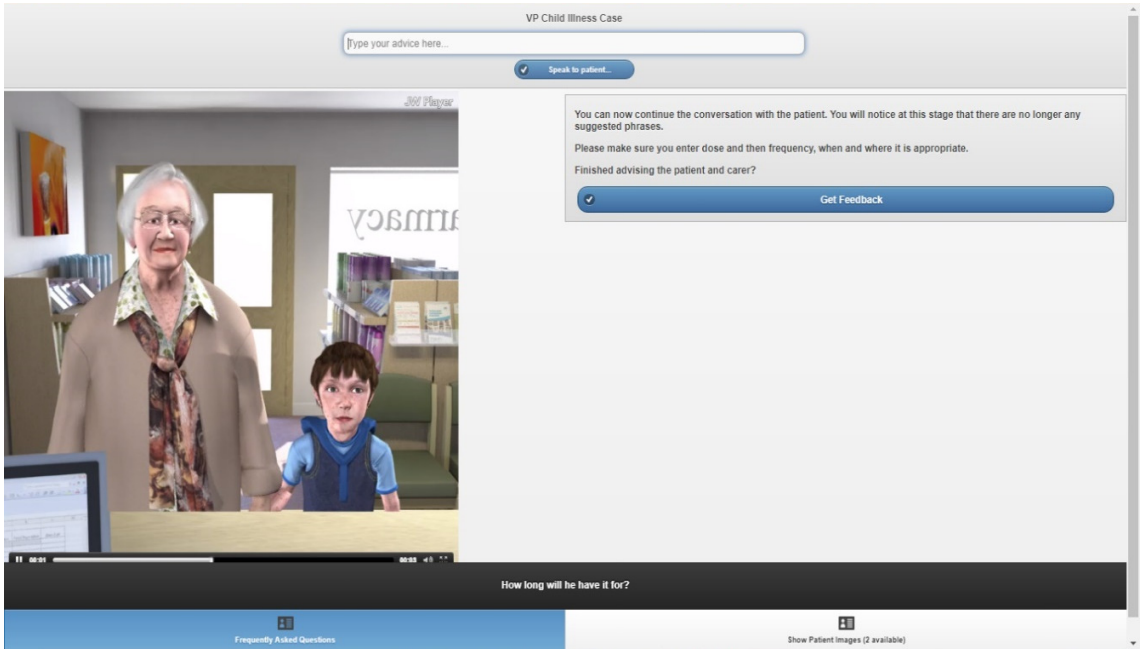


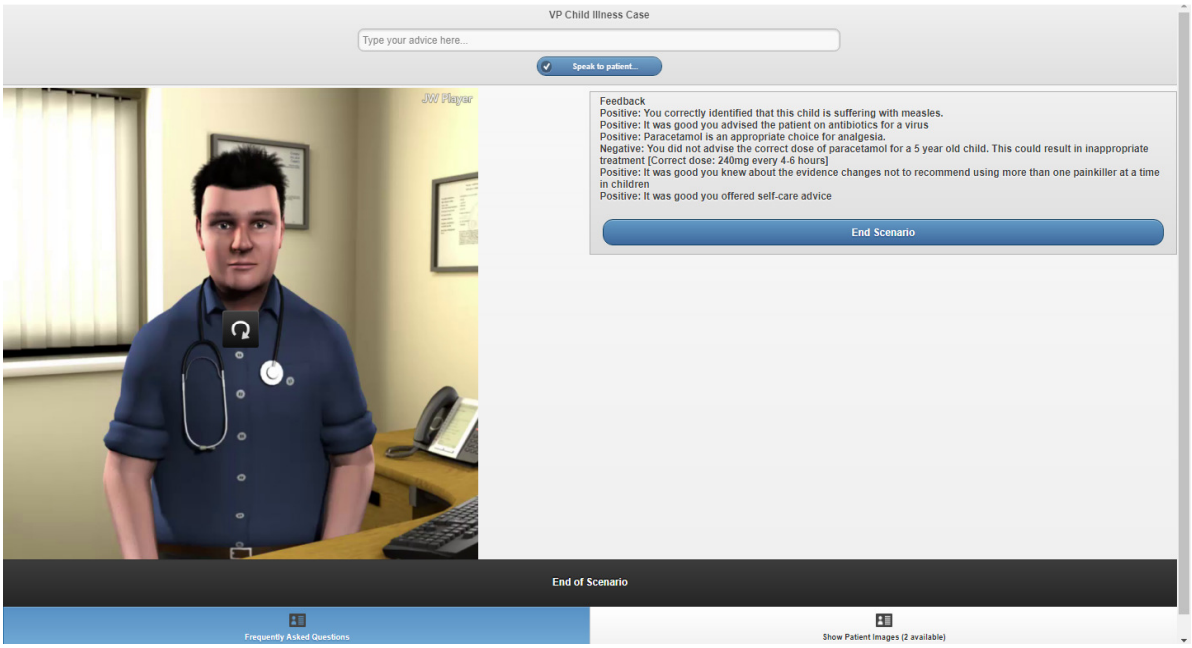




VP Hospital Patient Case
JW Player
Do you want to try again?
Try again
Feedback
Positive: Well done! You spotted the missing renal function value.
Negative: You failed to calculate the renal function value correctly; this could result in harm to the patient.
Positive: Good job on selecting the drug which needed to be altered based on the patient's renal function.
Positive: You set the right strength for enoxaparin.
Positive: The frequency of enoxaparin was correct.
Positive: Well done for spotting the interaction between the simvastatin and amlodipine.
Positive: You set the right strength for simvastatin.
Positive: You selected the correct frequency of the medication.
End Scenario
You selected the correct frequency of the medication.
Frequently Asked Questions
Show Charts

# Appendix 17 – Child Illness VP Pictures




VP Child Illness Case
Type your advice here...
Speak to patient...
JW Player
Feedback
Positive: You correctly identified that this child is suffering with measles.
Positive: It was good you advised the patient on antibiotics for a virus
Positive: Paracetamol is an appropriate choice for analgesia.
Negative: You did not advise the correct dose of paracetamol for a 5 year old child. This could result in inappropriate treatment [Correct dose: 240mg every 4-6 hours]
Positive: It was good you knew about the evidence changes not to recommend using more than one painkiller at a time in children
Positive: It was good you offered self-care advice
End Scenario
End of Scenario
Frequently Asked Questions
Show Patient Images (2 available)

# Appendix 18 - NI case study two with answers

Learning objectives:

- Practice calculating renal function
- Demonstrate an improvement in calculation skills
- Explain the various ways in which renal function can affect drug doses
- Practice modifying drug dosages accurately
- Identify the reference sources available for more information regarding renal function

Mr Foiles, a 69 year old male has been admitted to hospital following a fall in the night.

His hospital notes and medication chart can be accessed using the link below:

https://docs.google.com/a/keele.ac.uk/file/d/0B51vLJipmVOIR2trQjlxLXN4NTA/preview

Have a read over his notes and then answer the questions below.

1. What is the patient's CrCl?

2. Do any drugs need to be adjusted based on the patient's renal function?

3. Are there any other issues with the patient's medication?

**Answers**

1. 27.38ml/min
   CrCl = (140-age) x weight x 1.23 / Serum creatinine
   So for Mr Foiles CrCl = (140-69) x 58kg x 1.23 / 185 = 27.38

2. Yes. The enoxaparin dose should be reduced to 20mg OD due to the patient's renal function being <30ml/min.
   (BNF, Enoxaparin SPC)

3. The dose of simvastatin should be reduced to 20mg. Patient's who are on amlodipine and simvastatin should be on a dose no higher than 20mg ON due to increased risk of myopathy. This is also the maximum dose of simvastatin for patients on diltiazem due to an increased risk of myopathy.
   (MHRA Drug Safety Update)
   Resources: BNF, SPC, Martindale, Renal Drug Handbook, Drug Induced Renal Failure, MHRA Guidance

# Appendix 19 – NI case study three with answers

Learning objectives:

- Demonstrate an improvement in knowledge of common childhood conditions
- Describe the differences between several childhood conditions
- Explain the options available for OTC treatment in children
- Identify the reference sources available for more information regarding childhood conditions

A mother and a child come into the pharmacy. The boy has developed a rash and the mother is wanting information about what it is and what treatment can be provided.

1. What questions do you need to ask to establish what may be wrong with the child?

You find out the child is 5 years old. He has had the rash for ~2 days and it started behind his ears and face as a red and blotchy rash and has now moved down his neck and onto his arms and legs. Before the rash appeared the child had a cold; a bad temperature and a cough which keeps him awake at night. After looking, you notice some white spots in the child's mouth. Upon further questioning you find out the child hasn't been around anybody else with a rash, has had his MMR vaccine and has already had chicken pox. He hasn't been abroad anywhere recently and hasn't got any allergies. The patient is on no other medication and no previous treatment has been tried.

2. What do you think may be wrong with the child?

3. What treatment advice would you give to the mother?

**Answers**

1. What questions do you need to ask to establish what may be wrong with the child?

- Age of the child
- What symptoms have they got?
- How long have they had the rash?
- Is the patient on any other medication?
- Has any treatment been tried already?
- Does the child have any allergies?
- Has he been around any other children with a rash recently?
- Has he had chicken pox?
- Has he had his MMR vaccine?
- Have they been abroad recently?

2. What do you think may be wrong with the child?

- Measles – even though he has had his MMR vaccine it is still possible to have it again

3. What treatment advice would you give to the mother?

- Antibiotics are not required – measles is a virus and it will not respond to antibiotics
- It should clear up within 1-2 weeks
- You can give paracetamol 240mg every 4-6 hours
- You can give ibuprofen 150mg three times a day
- New evidence recommends giving only one painkiller at a time and if the child does not respond then to try another – so do not give both paracetamol and ibuprofen
- Cough mixtures that you can give for under 6 include glycerol, honey and lemon and simple linctus
- Self-help – close curtains and dim lights, use damp cotton wool to clean eyes, lemon or honey in water, place a bowl of water in the room to make it more humid and relieve cough
- Keep him off school and away from other children for 4 days after the rash first appeared

Resources: BNFC, CPPE Responding to minor ailments, FASTtrack Managing symptoms in the pharmacy, Martindale, RPS Guidance, MEP, MHRA guidance,

# Appendix 20 – Extra NI case study one with answers

Mr Sander's has been admitted to hospital following a myocardial infarction. He has gone into cardiogenic shock and the consultant has prescribed a dobutamine infusion 2.5-10mcg/kg/min. He also insists on the smallest volume possible to be administered to prevent fluid overload.

The nurse is unsure how to set the syringe pump and asks for your advice.

**Patient info:**

Patient weight: 76kg

NKDA

Medication history: Aspirin 75mg AM
Simvastatin 20mg ON
Bisoprolol 5mg AM
Ramipril 5mg AM
Omeprazole 20mg AM

1. What amount of dobutamine should the patient receive per hour? (mg/hr)

2. What rate should the syringe pump be set at? (ml/hr)

3. Does the medication need to be diluted?
   - Yes ☐
   - No ☐

4. Is there anything specific that the nursing staff need to monitor?

**Answers**

1. Amount of dobutamine per hour?
- 11.4mg/hr

2. Rate of syringe pump per hour?
- 2.28ml/hr

3. Does the medication need to be diluted?
- It can be but not in this scenario as do not want fluid overload

4. Is there anything specific that needs to be monitored?
- Heart rate and rhythm, blood pressure, diuresis, cardiac output, central venous pressure, pulmonary capillary pressure, potassium levels
  Resources: BNF, Dobutamine SPC, CKS (no longer updated), Introduction to Pharmaceutical Calculations by Rees, Smith and Smith (other calculation books are available)

# Appendix 21 – Extra NI case study two with answers

A patient comes into the community pharmacy where you are working wanting to speak to the pharmacist.

Upon greeting the patient, she explains she wants to buy something to help with back-pain. She's seen Nurofen Express tablets being advertised on the television and would like to try them.

1. What questions do you need to ask the patient before offering treatment?
2. Upon questioning you find out that the back pain has come on since she has been gardening at the weekend. It is painful to twist and bend but they are the only symptoms. The only medication she is on is Priadel.

   What is your response?

**Answers**

1. What questions do you need to ask the patient before offering treatment?

- Has she had any other symptoms
- How long have the symptoms been present
- Has she tried anything already
- Is she on any other medication
- Is she pregnant or breastfeeding
- Has she got any medical conditions
- Has she got any allergies

2. What is your response?

- Priadel is lithium
- Do not recommend the patient has Nurofen Express (ibuprofen) as interaction between lithium and NSAIDs may lead to lithium toxicity –
  - Stockleys – NSAIDs may increase lithium levels leading to toxicity. NSAIDs should be avoided unless lithium levels can be very well monitored
  - BNF – excretion of lithium reduced by NSAIDs (black dot interaction)
- Patient suffering acute back pain, advise on an alternative option for pain relief which doesn't affect lithium levels –
  - Paracetamol or co-codamol
  - Rubefacients are an option but evidence does not support their use in acute or chronic musculoskeletal pain
  - Topical NSAIDs may provide some relief – topical application of large amounts can result in systemic effects.

Resources: BNF, Stockley's Drug Interactions, Drug SPCs, Stockley's Herbal Medicines Interactions, Drug Interactions Analysis and Management (by Hansten and Horn), Martindale, MHRA guidance

# Appendix 22 – Extra NI case study three with answers

You are a pharmacist working in an anticoagulant clinic.

Mr Jones, a 45 year old male, is attending the clinic for the first time.

The patient is being started on warfarin for atrial fibrillation and this is your opportunity to counsel the patient on his new medicine.

Please answer the following questions and provide all required counselling on the topics below as if you were speaking to a patient.

1. How does warfarin work?
2. Why are you on warfarin?
3. How should the patient take warfarin?
4. What should the patient do if they take an incorrect dose?
5. What monitoring is required with warfarin?
6. What happens with the patient's repeat prescriptions?
7. What side effects should you provide counselling on?
8. What advice should you give the patient regarding dental treatment?
9. What should you tell the patient regarding interactions with other medicines?
10. What should you tell the patient regarding dietary interactions?
11. What do you need to tell the patient regarding their alcohol intake?
12. Any other points
13.

**Answers**

1. How does warfarin work?

- Warfarin is an anticoagulant
- It prevents harmful blood clots forming in your blood vessels by increasing the amount of time it takes for your blood to clot

2. Why are you on warfarin?

- You are on warfarin for atrial fibrillation and this will be for long term use
- In atrial fibrillation the irregular beating of the heart can cause clots to form, so we want to prolong the time the blood takes the clot to reduce your risk of a heart attack or stroke

3. How should the patient take warfarin?

- Warfarin should be taken at the same time each day
- You will have to make up your dose of warfarin each day from different strength tablets. You may be on a different dose each day and it is important you understand how to make up the correct dose
- You will be given different coloured tablets: 1mg tablets are brown, 3mg tablets are blue and 5mg tablets are blue

- If your dose is 4mg you should take 1x1mg (brown) and 1x1mg (blue)

4. What should the patient do if they take an incorrect dose?
- If you miss a dose or take an incorrect dose, take the next dose as usual and make a note in your yellow booklet
- If the dose you took was a lot more than your prescribed dose you should contact your anticoagulant clinic

5. What monitoring is required with warfarin?
- You will require regular monitoring if you are on warfarin to see if the dose you are on is correct
- The test is called an INR test which stands for international normalised ratio
- It tests how long your blood takes to clot
- A person not on warfarin would expect to have an INR or 1. As we want to increase the length of time it takes your blood to clot, your target INR is 2.5, but between 2 and 3 is ok. This means we want your blood to take 2.5 times longer to clot than somebody not on warfarin
- The dose of your warfarin will be adjusted based on what your INR is
- At the start of treatment you will need to go for INR tests every few days to determine the correct dose of warfarin, when this is stable the interval will increase and eventually every 3 months

6. What happens with the patient's repeat prescriptions?
- You order warfarin just the same as other medicines on a repeat prescription – it is important to order them in advance so you don't run out
- You will need to bring your yellow book with you to the pharmacy when you come to pick up warfarin

7. What side effects should you provide counselling on?
- Bleeding and bruising more easily
- If you cut yourself, apply firm pressure to the site for at least 5 minutes
- When to seek medical attention –
    - Nosebleed >10 minutes
    - Blood in vomit, sputum, urine or stools
    - Black faeces
    - Severe or spontaneous bruising
    - Unusual headaches
    - Significant blows to the head
    - Involved in major trauma
    - Unable to stop bleeding

8. What advice should you give the patient regarding dental treatment?
- Can still go to the dentist as usual

- In most cases, dental treatment can go ahead as normal without needing to stop warfarin
- Need to tell dentist that are on warfarin and show them recent INR result

9. What should you tell the patient regarding interactions with other medicines?

- Many medicines can interact with warfarin
- It is important to let any healthcare professional know that you are on warfarin
- You should not buy aspirin or anything like ibuprofen as that will increase your risk of bleeding
- Paracetamol is the preferred painkillers
- Always check with a pharmacist before buying any medication, including any herbal or alternative medicines

10. What should you tell the patient regarding dietary interactions?

- It is important to eat a well balanced diet
- Any major changes in diet can affect warfarin
- Foods rich in vitamin K can affect INR –
    - Vitamin K is used by the body to make blood clots, and warfarin reduces this
    - Green leafy vegetables, chick peas, liver, egg yolk, cereals containing wheat bran and oats, mature cheese, blue cheese, avocado, olive oil
    - Eat a regular amount of these foods
- Avoid drinking cranberry juice as can increase the effects of warfarin and increase the risk of bleeding

11. What do you need to tell the patient regarding their alcohol intake?

- Avoid binge drinking
- Do not exceed national guidelines – 3 units/day for man
- Anticoagulant control is affected when there are major changes in alcohol consumption

12. Any other points

- Changes in your condition, illness, other medication, diet etc can all have an effect on anticoagulant control and you may require more frequent INR testing – important to tell a healthcare professional or your anticoagulant clinic

Resources

BNF, Warfarin SPC, CKS (no longer updated), Stockley's Drug Interactions, Warfarin Yellow Book (available at: http://www.nrls.npsa.nhs.uk/resources/?EntryId45=61777)

# Appendix 23 – MCQ quiz for case two

1. What resources are available for information on drug doses and renal function?
    a) BNF
    b) Martindale
    c) Summary of Product Characteristics
    d) NEWT
    e) The Renal Drug Handbook

2. Which of these eGFR values indicates a person with severe (stage 4) renal function?
    a) >90
    b) 60-89
    c) 30-59
    d) 15-29
    e) <15

3. Which of these drugs can cause acute kidney injury?
    a) Metformin
    b) NSAIDs
    c) ACEI
    d) Penicillins
    e) Allopurinol

4. Which of these drugs requires dose adjustment if renal function <30ml/min?
    a) Gentamycin
    b) Tazocin
    c) Phenytoin
    d) Teicoplanin
    e) Paracetamol

5. Which of these may require a LMWH dose to be adjusted?
    a) Hepatic impairment
    b) Renal impairment
    c) Cardiac disease
    d) Body weight
    e) Age

6. Bleeding is the most common side effect from treatment with a LMWH
    a) True
    b) False

7. Heparin treatment may result in hypokalaemia
    a) True
    b) False
    May result in hyperkalaemia - Heparin can suppress adrenal secretion of aldosterone leading to hyperkalaemia

8. Heparin induced thrombocytopenia occurs when platelet count is reduced by 20%
    a) True
    b) False
    Occurs when reduced by 30% and usually develops after 5-10 days treatment with a heparin

9. For patients at both extremes of weight eGFR is a more accurate measure of renal function
    a) True
    b) False
    Creatinine clearance should be used in those BMI <18.5 or >30

10. Dosages should not be adjusted based on eGFR renal function calculation in those under 18
    a) True
    b) False
    Should use Cockroft and Gault CrCl

11. A patient has been put on rivaroxaban for VTE prophylaxis after hip replacement surgery at a dose of 10mg OD for 5/52. The patient has already had 2 doses, how many 10mg tablets do they need to be sent home with for a complete course to be taken
    a) 23
    b) 25
    c) 33
    d) 35
    e) 42

12. 200mg of potassium permanganate is dissolved in 2.5L of water, what is the % strength?
    a) 0.004%
    b) 0.008%
    c) 0.016%
    d) 0.08%
    e) 0.16%

13. A patient with atrial fibrillation is started on the usual stabilising regime followed by the usual maintenance dose of amiodarone. How many 200mg amiodarone tablets are required for 2 months treatment?
    a) 38
    b) 49
    c) 52

d) 77
e) 98

14. A patient has been on 30mg MST Continus BD and Oramorph 20mg over 24 hours for pain relief. What is the equivalent dose of diamorphine SC over 24 hours?
    a) 4mg
    b) 9mg
    c) 15mg
    d) 18mg
    e) 24mg

15. A patient has been taking 40mg citalopram OD. They are in hospital and are unable to swallow tablets so are being converted to citalopram oral drops. What is the equivalent number of drops per day that the patient should take?
    a) 10
    b) 16
    c) 20
    d) 24
    e) 30

16. A 25 year old female patient requires treatment with Argatroban due to heparin induced thrombocytopenia. This should be given by continuous IV infusion at a dose of 2mcg/kg/min. The patient weighs 56kg. What amount of drug will the patient receive over 1 hour?
    a) 0.112mg
    b) 3.36mg
    c) 6.72mg
    d) 67.2mg
    e) 112mg

17. Fucidin cream contains 2% sodium fusidate. What weight of sodium fusidate is present in 35g Fucidin cream?
    a) 60mg
    b) 70mg
    c) 300mg
    d) 600mg
    e) 700mg

18. How many Rifater tablets are required for the initial phase of unsupervised treatment of TB for a patient weighing 65kg?
    a) 140
    b) 168
    c) 280
    d) 336

e) 672

19. An adult weighing 48kg requires gentamicin treatment of 3mg/kg/day in 3 divided doses. What volume of 40mg/ml injection should be given every 8 hours?
    a) 0.61ml
    b) 1.2ml
    c) 1.6ml
    d) 3.3ml
    e) 3.6ml

20. What weight of NaCl is required to produce 1.5L of a solution, such that 20ml of this solution diluted to 500ml gives a 0.2% w/v solution?
    a) 5g
    b) 25g
    c) 50g
    d) 75g
    e) 100g

# Appendix 24 – MCQ quiz for case three

1. What is the correct paracetamol dose for a 3 year old child in pain?
    a) 30mg every 4-6 hours
    b) 60mg every 4-6 hours
    c) 120mg every 4-6 hours
    d) 180mg every 4-6 hours
    e) 240mg every 4-6 hours

2. What is the correct dose of ibuprofen for an 11 year old child in pain?
    a) 100mg TDS
    b) 150mg TDS
    c) 200mg TDS
    d) 250mg TDS
    e) 300mg TDS

3. Which of these is a symptom associated with a measles infection?
    a) Red-brown rash
    b) Cold symptoms
    c) Temperature
    d) Productive cough
    e) Swelling of salivary glands

4. What is the name of the white spots that appear in the mouth associated with measles?
    a) Koplik spots
    b) Urticaria
    c) Comedones
    d) Cold sores
    e) Strep throat

5. Which of these symptoms are associated with meningitis?
    a) Dark red-purple rash
    b) Rash which does not blanch
    c) Sensitivity to light
    d) Stiff neck
    e) Vomiting

6. Which of these medicines should not be given to children under 16 years of age?
    a) Aspirin
    b) Codeine
    c) Diclofenac
    d) Tetracyclines

e) Senna

7. Which childhood disease has symptoms similar to the common cold with difficulty breathing and a barking cough?
    a) Pertussis
    b) Croup
    c) Colic
    d) Strep throat
    e) Influenza

8. Which childhood disease is characterised with an itchy red rash that develops into fluid filled blisters which eventually crust over?
    a) Measles
    b) German measles
    c) Chicken pox
    d) Impetigo
    e) Hand, foot and mouth

9. Which childhood disease is characterised by fever, headache and painful swelling of the salivary glands causing the cheeks to puff out?
    a) Roseola
    b) Rubella
    c) Mumps
    d) Croup
    e) Sinusitis

10. What childhood skin infection is associated with a rash of red bumps or blisters that may ooze or be covered with a honey-coloured crust?
    a) Hand, foot and mouth syndrome
    b) Impetigo
    c) Cold sores
    d) Canker sores
    e) Boils

11. Chicken pox is caused by the herpes zoster virus
    a) True
    b) False

12. Cold sores are caused by the human papilloma virus (HPV)
    a) True
    b) False

13. Colic usually starts after 4 weeks of age

a) True
b) False
(most common under 2 weeks)

14. Children with tonsillitis who are allergic to penicillin should be treated with co-amoxiclav?
    a) True
    b) False
    Co-amoxiclav contains amoxicillin and clavulanic acid therefore a patient with severe penicillin allergy should not receive this. Penicillin allergic patients should not be treated with any penicillins, cephalosporins or other beta-lactam antibiotics (carbapenems and aztreonam) due to structural cross-reactivity.

15. Whooping cough is also known as pertussis
    a) True
    b) False

16. Use of aspirin in under 16's can result in Reye's syndrome?
    a) True
    b) False

17. Chloramphenicol for conjunctivitis can be used over the counter in children over 2 years
    a) True
    b) False

18. Loperamide can be used as an over the counter antidiarrhoeal in children from the age of 6
    a) True
    b) False
    Over the age of 12

19. Fifth disease is characterised by a prominent red rash on the face?
    a) True
    b) False

20. Mebendazole is licensed for the treatment of threadworms in children older than 2 years
    a) True
    b) False

# Appendix 25 – Validated evaluation instruments

Taken from Abdo and Ravert (2006):

Table 2

| Item | Student Responses Number (%) | | | |
|---|---|---|---|---|
| | Strongly Disagree | Disagree | Agree | Strongly Agree |
| 1. Scenario used with the patient simulator recreates real-life situations (R) | 0 (0%) | 0 (0%) | 8 (47.1%) | 9 (52.9%) |
| 2. Scenario adequately tests technical skills (V) | 0 (0%) | 1 (5.9%) | 10 (58.8%) | 6 (35.3%) |
| 3. Scenario adequately tests clinical decision-making (V) | 0 (0%) | 0 (0%) | 8 (47.1%) | 9 (52.9%) |
| 4. I was adequately prepared for the testing experience with the patient simulator (I) | 0 (0%) | 1 (5.9%) | 12 (70.6%) | 4 (23.5%) |
| 5. Needed an orientation to working with the patient simulator before the diagnostic test (I) | 0 (0%) | 5 (29.4%) | 9 (52.9%) | 2 (11.8%) |
| 6. The patient simulator space resembled a real critical care setting (R) | 0 (0%) | 2 (11.8%) | 13 (76.5%) | 2 (11.8%) |
| 7. Temperature in room was comfortable (I) | 0 (0%) | 0 (0%) | 12 (70.6%) | 5 (29.4%) |
| 8. Lighting in room was adequate (I) | 0 (0%) | 1 (5.9%) | 11 (64.7%) | 5 (29.4%) |
| 9. Patient simulator model provides a realistic patient simulation (R) | 0 (0%) | 1 (5.9%) | 12 (70.6%) | 4 (23.5%) |
| 10. Technical skills taught in the course are valuable (I) | 0 (0%) | 0 (0%) | 7 (41.2%) | 10 (58.8%) |
| 11. Clinical decision making skills taught in this course are valuable (I) | 0 (0%) | 0 (0%) | 4 (23.5%) | 13 (76.5%) |
| 12. Increased my confidence about going into the real clinical setting (T) | 0 (0%) | 0 (0%) | 8 (47.1%) | 9 (52.9%) |
| 13. Working with the patient simulator was a valuable learning experience for me (V) | 0 (0%) | 0 (0%) | 6 (35.3%) | 11 (64.7%) |
| 14. My interaction with the patient simulator improved my clinical competence (T) | 0 (0%) | 0 (0%) | 8 (47.1%) | 9 (52.9%) |
| 15. Working with the patient simulator reinforced objectives of this course (V) | 0 (0%) | 0 (0%) | 9 (52.9%) | 8 (47.1%) |
| 16. Pace reflected flow of actual clinical setting (I) | 0 (0%) | 4 (23.5%) | 10 (58.8%) | 3 (17.6%) |
| 17. Prepared me to perform in the "real-life" clinical setting (T) | 0 (0%) | 0 (0%) | 10 (58.8%) | 7 (41.2%) |
| 18. Received adequate feedback regarding my performance (V) | 0 (0%) | 4 (23.5%) | 10 (58.8%) | 3 (17.6%) |
| 19. Overall the experience enhanced my learning (V) | 0 (0%) | 0 (0%) | 6 (35.3%) | 11 (64.7%) |

Subscale items: (T) = transferability, (R) = realism, and (V) = value; Individual items = (I)

Taken from Lambton *et al.* (2008):

**Table 2** Survey Results

| Measures | No. | Responses % | $\chi^2$ | *df* | *p* |
|---|---|---|---|---|---|
| I do not feel confident about ability to collect data (% disagree) | | | | | |
| T1 | 31 | 97 | 6.253 | 9 | .71 |
| T2 | 47 | 85 | | | |
| T3 | 40 | 90 | | | |
| T4 | 31 | 97 | | | |
| Cum | 149 | 91 | | | |
| I feel more confident about collaborating with physicians and nurses (% agree) | | | | | |
| T1 | 31 | 97 | 7.081 | 9 | .62 |
| T2 | 47 | 96 | | | |
| T3 | 40 | 90 | | | |
| T4 | 31 | 100 | | | |
| Cum | 149 | 95 | | | |
| I do not think I can communicate better with children or their families (% disagree) | | | | | |
| T1 | 30 | 93 | 9.444 | 9 | .39 |
| T2 | 47 | 77 | | | |
| T3 | 40 | 75 | | | |
| T4 | 31 | 94 | | | |

Table 2 *(Continued)*

| Measures | No. | Responses % | $\chi^2$ | *df* | *p* |
|---|---|---|---|---|---|
| I do not communicate better with other nurses (% disagree) | | | | | |
| T1 | 30 | 97 | 5.714 | 9 | .77 |
| T2 | 47 | 83 | | | |
| T3 | 39 | 90 | | | |
| T4 | 31 | 94 | | | |
| Cum | 147 | 90 | | | |

$^{**}$ $p < .01$

**Table 3** Open-ended Questions

| What areas have improved through participation in Sim Lab? | How has Sim Lab made a difference in caring for patients in clinical? | Will you be able to transfer information from simulation to real patients? |
|---|---|---|
| Themes at T1 (%): | Themes at T1 (%): | Response at T1 (%): |
| Communication skills (55) | Confidence (35) | Yes: 94 |
| More aware of how to handle problems (26) | | No: 0<br>No answer: 6 |
| Themes at T2 (%): | Themes at T2 (%): | Response at T2 (%): |
| Communication skills (30) | Confidence (26) | Yes: 68 |
| CPR, iv skills (21) | | No: 2<br>Hopefully: 6<br>No answer: 24 |
| Themes at T3 (%): | Themes at T3 (%): | Response at T3 (%): |
| Communication skills (35) | Being more prepared (20) | Yes: 53 |
| | Confidence (18) | No: 0<br>No answer: 47 |
| Themes at T4 (%): | Themes at T4 (%): | Response at T4 (%): |
| Communication with parents, other nurses (48) | Confidence (32) | Yes: 71 |
| Priority setting (32) | Skill acquisition (16) | No: 0<br>No answer: 39 |
| Confidence (32) | | |

*(Continued)*

Taken from Leng *et al.* (2009):

***Form 1: Student questionnaire concerning their learning and clinical reasoning experiences with virtual patients:***

Please respond using the following 5-point scale: 1) strongly disagree, 2) disagree, 3) neutral, 4) agree and 5) strongly agree, 6) not applicable). Please indicate briefly the reason(s) for your response for each question (optional).

**Example:**

While working on this case, I felt as if I were the doctor caring for this patient.

Strongly disagree ---------- strongly agree, not applicable

1 2 3 4 5 6

Why (if you agree):

Why not (if you disagree):

**Authenticity of patient encounter and the consultation**

1. While working on this case, I felt I had to make the same decisions a doctor would make in real life.
2. While working on this case, I felt I were the doctor caring for this patient.

**Professional approach in the consultation**

3. While working through this case, I was actively engaged in gathering the information (e.g. history questions, physical exams, lab tests) I needed, to characterize the patient's problem.
4. While working through this case, I was actively engaged in revising my initial image of the patient's problem as new information became available.
5. While working through this case, I was actively engaged in creating a short summary of the patient's problem using medical terms.
6. While working through this case, I was actively engaged in thinking about which findings supported or refuted each diagnosis in my differential diagnosis.

**Coaching during consultation**

7. I felt that the case was at the appropriate level of difficulty for my level of training.

8. The questions I was asked while working through this case were helpful in enhancing my diagnostic reasoning in this case.

9. The feedback I received was helpful in enhancing my diagnostic reasoning in this case.

**Learning effect of consultation**

10. After completing this case, I feel better prepared to confirm a diagnosis and exclude differential diagnoses in a real life patient with this complaint.

11. After completing this case I feel better prepared to care for a real life patient with this complaint.

**Overall judgment of case workup**

12. Overall, working through this case was a worthwhile learning experience.

**Open-ended questions**

13. Special strengths of the case:

14. Special weaknesses of the case:

15. Any additional comments:

# Appendix 26 – MCQ quiz for pilot NI case

1. What effect does dobutamine have on the body?
    a) Vasoconstriction
    b) Peripheral vasodilation
    c) Increased heart contractility
    d) Decreased heart contractility
    e) Increased dopamine transmission

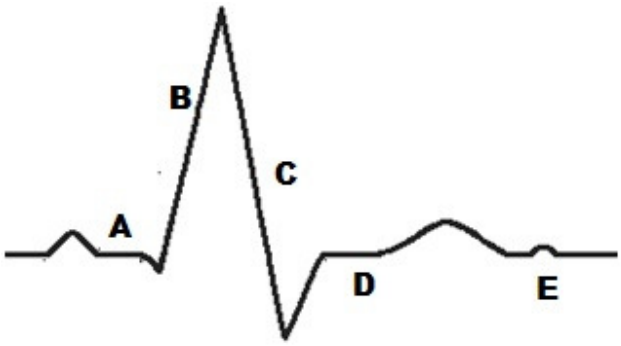
2. Which of these is **not** first line secondary treatment for a myocardial infarction?
    a) ACE Inhibitor
    b) Beta Blocker
    c) Aspirin
    d) Loop diuretic
    e) Nitrates

3. Which of these forms part of immediate treatment of someone who has suffered an ACS?
    a) Warfarin
    b) Morphine
    c) Tramadol
    d) Aspirin
    e) Amlodipine

4. Which of these is a symptom of a myocardial infarction?
    a) Shortness of breath
    b) Chest pain
    c) Pain radiating to jaw and arm
    d) Left sided weakness
    e) Pink, frothy sputum

5. What initial tests should be done to determine whether a patient has suffered a myocardial infarction?
    a) Electrocardiogram
    b) Creatinine kinase levels
    c) Troponin levels
    d) Potassium levels
    e) Echocardiogram

6. Which part of an ECG shows the ST interval?
    a) A
    b) B
    c) C
    d) D
    e) E




7. Dual antiplatelet therapy of aspirin and clopidogrel should be used for 12 months after a STEMI?
    a) True
    b) False

8. If dobutamine is administered continuously for >72 hours a patient may become tolerant to it and the dose may need to be increased
    a) True
    b) False

9. If a patients immediate troponin levels come back normal then they have not suffered a STEMI?
    a) True
    b) False

10. Digoxin should be offered to patients who have had a STEMI?
    a) True
    b) False

21. A patient has been put on rivaroxaban for VTE prophylaxis after hip replacement surgery at a dose of 10mg OD for 5/52. The patient has already had 2 doses, how many 10mg tablets do they need to be sent home with for a complete course to be taken
    f) 23
    g) 25
    h) 33
    i) 35
    j) 42

22. A patient with atrial fibrillation is started on the usual stabilising regime followed by the usual maintenance dose of amiodarone. How many 200mg amiodarone tablets are required for 2 months treatment?
    f) 38
    g) 49
    h) 52
    i) 77

j) 98

23. How many Rifater tablets are required for the initial phase of unsupervised treatment of TB for a patient weighing 65kg?
    f) 140
    g) 168
    h) 280
    i) 336
    j) 672

24. What is the concentration of a 100ml solution containing 450mg active substance?
    a) 0.045%
    b) 0.45%
    c) 4.5%
    d) 45%
    e) 450%

25. Which of these is equivalent to 6mg?
    a) 60mcg
    b) 0.6g
    c) 600mcg
    d) 0.06g
    e) 6000mcg

26. Which of these is equivalent to 15g?
    a) 1500mcg
    b) 0.15kg
    c) 1500mg
    d) 15000mcg
    e) 0.015kg

27. 200ml of an aqueous solution contains 700mg NaCl, what is the strength?
    a) 70%
    b) 35%
    c) 0.7%
    d) 0.35%
    e) 7%

28. How many mg of NaCl are required to prepare 500ml of 0.05% w/v solution?
    a) 5mg
    b) 50mg
    c) 150mg
    d) 250mg

e) 500mg

29. What weight of NaCl is required to produce a 300ml solution, such that 5ml of this solution diluted to 250ml gives a 0.1% w/v solution?
    a) 30g
    b) 15g
    c) 50g
    d) 25g
    e) 5g

30. A patient is prescribed a course of doxycycline 200mg STAT then 100mg OD for 5/7. How many 50mg capsules are required?
    a) 7
    b) 10
    c) 12
    d) 14

# Appendix 27 – Evaluative survey for pilot study

Name:

Were the quizzes of suitable difficulty for your level of training?

Yes ☐

No ☐

Please expand:

Do you think the questions are able to assess knowledge improvements for the specific topics?

Yes ☐

No ☐

Please expand:

Are there any improvements you think should be made to the quizzes?

Yes ☐

No ☐

Please expand:

Any additional thoughts or comments:

# Appendix 28 – Ethical approval pilot study

Keele University

RESEARCH AND ENTERPRISE SERVICES

11th February 2014

Jessica Thompson
Room 0.56
Hornbeam Building

Dear Jessica,

**Re: A pilot study to investigate the design, implementation and effectiveness of two clinical case studies and the associated evaluative research instruments**

Thank you for submitting your application for review. I am pleased to inform you that your application has been approved by the Ethics Review Panel. The following documents have been reviewed and approved by the panel as follows:

| Document | Version | Date |
|---|---|---|
| Summary of Proposal | 1 | 05/12/13 |
| Letters of Invitation | 1 | 05/12/13 |
| Information Sheets | 1 | 05/12/13 |
| Consent Forms | 1 | 06/12/13 |
| Consent Forms for the use of quotes | 1 | 06/12/13 |
| Questionnaire | 1 | 09/12/13 |
| Screenshot of online consent form | 1 | 16/12/13 |
| Wording of invitation to participate over social media | 1 | 16/12/13 |

The following information is not required for ethical approval but the researcher may want to be consider before undertaking the research:

- The researcher could introduce herself in the social media recruitment invitation

If the fieldwork goes beyond the date stated in your application, you must notify the Ethical Review Panel via the ERP administrator at uso.erps@keele.ac.uk stating ERP1 in the subject line of the e-mail.

If there are any other amendments to your study you must submit an 'application to amend study' form to the ERP administrator stating ERP1 in the subject line of the e-mail. This form is available via http://www.keele.ac.uk/researchsupport/researchethics/

If you have any queries, please do not hesitate to contact me via the ERP administrator on uso.erps@keele.ac.uk stating ERP1 in the subject line of the e-mail.

Yours sincerely

pp

**Dr Jackie Waterfield**
**Chair – Ethical Review Panel**

CC RI Manager
Supervisor

# Appendix 29 – Letter of Invitation for pilot study

Dear Participant,

My name is Jessica Thompson and I am completing a PhD at Keele University under the supervision of Professor Stephen Chapman and Dr Simon White. I would like to invite you to consider taking part in the research study entitled 'A pilot study to investigate the design, implementation and effectiveness of two clinical case studies and the associated, evaluative research instruments.'

The purpose of the research is to inform the methodology and test the research instruments for use in a main study which will investigate how technology can best support pre-registration pharmacist training.

If you choose to participate, you will be asked to complete and give feedback on an interactive virtual patient case study, an online survey-based case study, two multiple choice quizzes and an evaluative survey. This shouldn't take you more than an hour in total.

Participation in this research is completely voluntary and you may choose not to participate without consequence. You may decline to answer any of the questions if you so wish and you may decide to withdraw from this study at any time without any negative consequences.

If you have any questions regarding the study, or would like additional information, please contact me at j.f.thompson@keele.ac.uk. Alternatively, you can contact my supervisor Professor Stephen Chapman on s.r.chapman@keele.ac.uk.

I would like to assure you that this study has been approved by an Ethical Review Panel at Keele University.

Thank you for your reading this letter, your help is greatly appreciated.

**Please email Jessica Thompson on j.f.thompson@keele.ac.uk if you wish to participate in the research.**

# Appendix 30 – Participant Information Sheet for the pilot study

**Study title – A pilot study to investigate the design, implementation and effectiveness of two clinical case studies and the associated, evaluative research instruments**

### Invitation

You are being invited to take part in a research study. This project is being undertaken by Jessica Thompson, Dr Simon White and Professor Stephen Chapman of Keele University. You do not have to take part but before you decide, it is important for you to understand why the research study is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask me (j.f.thompson@keele.ac.uk) if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.

### What is the purpose of the study?

The purpose of the pilot study is to evaluate an interactive virtual patient case, an online survey case study, two multiple choice quizzes and a questionnaire for use in the main study. This pilot study is being conducted to inform the methodology and test the research instruments to be used in a main study that will be investigating how technology can best support pre-registration pharmacist training.

### Why have I been chosen?

You are being invited to take part in this research study because you are a current pre-registration trainee or recently qualified pharmacist. I am hoping that 10 or more pre-registration and recently qualified pharmacists will take part in this study.

### Do I have to take part?

It is up to you to decide whether or not to take part. If you choose to take part will be asked to complete an online consent form and will be provided with a copy of this at the end of the study. You are free to withdraw from this study at any time without giving reasons.

### What will happen to me if I take part and what do I have to do?

If you decide to take part in the study you will be asked to complete an interactive virtual patient case study on the topic of emergency hormonal contraception. You will also be asked to work through an online survey case study to calculate a dobutamine infusion rate. Each case study will have a short pre- and post- multiple choice quiz associated with it which you will be asked to complete. You will also be provided with a survey which you will be asked to complete and review. A questionnaire will be provided to you to give feedback on the case studies, quizzes and survey. This information will be used to inform any changes which should be made to these instruments for use in later research.

### What are the possible disadvantages and risks of taking part?

I am not aware of any disadvantages or risks to you in taking part in the study.

### What are the possible benefits of taking part?

There are few benefits to you personally in taking part in this study. You are being given the opportunity to use novel technology and the case studies and associated quizzes may have a positive effect on your knowledge of the topics covered. Taking part in this study will help inform the methodology and test the research instruments for use in the main study which will look at the

benefits the technology can offer pre-registration pharmacists, and therefore your peers and colleagues will benefit.

### What if there is a problem or something goes wrong?

If you have a concern about any aspect of this study, you may wish to speak to me. I will do my best to answer your questions. You should contact me (Jessica Thompson) at j.f.thompson@keele.ac.uk. Alternatively, if you do not wish to contact me you may contact Professor Stephen Chapman on s.r.chapman@keele.ac.uk. If you remain unhappy about the research and/or wish to raise a complaint about any aspect of the way that you have been approached or treated during the course of the study please write to Nicola Leighton, who is the University's contact for complaints regarding research at the following address: Research & Enterprise Services, Dorothy Hodgkin Building, Keele University, ST5 5BG, email address n.leighton@keele.ac.uk, telephone number 01782 733306.

### Who will have access to information about me?

All personal information that I collect about you during the course of the research will be protected according to the Data Protection Act 1998. This means that personally identifiable information about you will be kept strictly confidential. Information will be analysed, stored and published via numbers and not names. Electronic data will be stored on password-protected media that only I have access to. Hardcopies of documentation will be kept secure in a locked cupboard that only I have access to. At the end of the study all data and documents containing personally identifiable information about you will be destroyed. You will not be able to be identified in any reports or publications.

### How will information about me be used?

Information collected from completion of the quizzes will be used to determine whether an improvement of knowledge can be successfully measured. Information obtained from the questionnaire will be used to inform the methodology and test the research instruments for use in the main study. The results (including anonymised direct quotes) will be included in a research report and may subsequently be published as research papers in academic journals and presented at conferences. No individual person will be identifiable in quotes, reports, presentations or summaries.

### Who is organising and funding the research?

The research will be funded by the School of Pharmacy at Keele.

### Who has reviewed the study?

The research study has been reviewed and given approval by Keele University Ethical Review Panel.

### Further Information and Contact Details

If you have any questions or require any further information, either now or at any time during the study, please contact me (Jessica Thompson) at j.f.thompson@keele.ac.uk. Alternatively, you can contact me in writing at the School of Pharmacy, Keele University, Staffordshire ST5 5BG.

**Thank you for taking time to read this information!**

# Appendix 31 – Consent form for pilot study

Title of Project: A pilot study to investigate the design, implementation and effectiveness of two clinical case studies and the associated, evaluative research instruments

**Name and contact details of Principal Investigator:** Jessica Thompson, Room 0.56, School of Pharmacy, The Hornbeam Building, Keele University, Keele, Staffordshire, ST5 5BG, 01782 733327, j.f.thompson@keele.ac.uk

Please tick box if you agree with the statement

| | | |
|---|---|---|
| 1 | I confirm that I have read and understand the information sheet for the above study and have had the opportunity to ask questions. | ☐ |
| 2 | I understand that my participation is voluntary and that I am free to withdraw at any time. | ☐ |
| 3 | I agree to take part in this study. | ☐ |
| 4 | I understand that data collected about me during this study will be anonymised before it is submitted for publication. | ☐ |
| 5 | I agree to allow the dataset collected to be used for future research projects | ☐ |
| 6 | I agree to be contacted about possible participation in future research projects. | ☐ |
| 7 | I agree for any quotes to be used | ☐ |
| 8 | I do not agree for any quotes to be used | ☐ |

| _____ | _____ | _____ |
|---|---|---|
| Name of participant | Date | Signature |
| _____ | _____ | _____ |
| Researcher | Date | Signature |

# Appendix 32 - Social media invitation for pilot study

I am doing a PhD investigating how technology can best support the pre-registration training year. I am inviting you to participate in the pilot study to test the research instruments which will be used in the main study. You are being invited to participate because you are either a current pre-registration trainee or a recently qualified pharmacist.

If you decide to take part in the pilot study you will be asked to test two clinical case studies, two multiple choice quizzes and a survey for their completeness and usability. You will be provided with a questionnaire to obtain your thoughts. Completion of the study will take around an hour of your time, but it does not need to be done all at once.

If you are interested in participating in this pilot study or would like more information, please contact me on Facebook or email on j.f.thompson@keele.ac.uk. I look forward to hearing from you soon!