Effectiveness of the Use of Simulation Training in Healthcare Education

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Abstract

The focus of the research programme within this thesis is an investigation of scenario-based simulation training in undergraduate healthcare education. The aim of the main study was to determine the effectiveness of high-fidelity simulation training with adult branch nursing students. Their acquisition of knowledge and skills was tested using a 15-station Objective Structured Clinical Examination (OSCE) pre- and post- the simulation intervention with randomised control and experimental groups of volunteer students. The results show that simulation training is an effective learning method as students from the experimental group, who were given the opportunity to observe and take part in high-fidelity simulation training followed by debriefing, made significantly higher improvements between their two OSCE performances than students from the control group.

The second study focused on interprofessional learning with a randomised control group investigation of the students' knowledge of the roles and skills of other healthcare professions involved in the same simulation session. The results demonstrate that observing and taking part in multidisciplinary scenarios and their debriefings contributed to the students' acquisition of knowledge about the roles and skills of other health professionals. The study also showed that students' perception of multidisciplinary team working was significantly influenced by whether or not they had experienced interprofessional high-fidelity scenario-based simulation training.

The main original themes emerging from the research work presented in this thesis comprise the implementation of high-fidelity scenario-based simulation training and debriefing with undergraduate students from a range of healthcare disciplines and the objective measure of the effectiveness of such learning opportunities. This work has now started to impact on simulation practice in undergraduate education within the University and beyond.

Acknowledgements

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Chapter I
Introduction

I.1/ Theme of this thesis

This thesis focuses on the importance of the use of full-scale simulation training in healthcare education. Adequate education and training of healthcare professionals is a fundamental issue as it impacts on patient care. It is widely recognised that the teaching methods used play a very important role during training for the acquisition of skills and retention of knowledge. It is commonly accepted, yet not proven in all aspects of patient care, that simulation can help trainees better understand and practise skills that will later be used to save patients' lives and improve their care. Although the use of relatively expensive patient simulators in training healthcare professionals has increased in recent years, there is still very little valid published evidence to prove that their use as a teaching aid to help in the re-creation of critical or emergency care situations, as well as everyday patient encounters, is actually beneficial to trainees or practising healthcare professionals in terms of their subsequent clinical practice.

I.2/ Background and motivations

The use of full-scale simulation training tools, such as patient and surgical simulators, enables experiential learning in a safe environment (Cioffi 2001; Medley and Horne 2005) and has been encouraged in the Institute of Medicine's 1999 report "To Err is Human: Building a Safer Health System" (Kohn et al., 1999) to train novice as well as experienced practitioners from different disciplines allied to healthcare (Issenberg et al., 1999). More recently, one of the five key recommendations made in the annual report of the Chief Medical Officer for England was for greater use of simulation training in all its forms through full integration into training programmes and funded for clinicians at

all stages (Chief Medical Officer, 2009). The new training tools developed to facilitate simulation-based learning require the use of new teaching and training methods (Kneebone, 1999) that need to be assessed for effectiveness. If methods are demonstrated to be appropriate and beneficial, they should be considered for wider adoption, such as in nursing and medical schools, as well as in healthcare organisations, for training and continuing professional development. The general opinion is that scenario-based simulation, as a learning method, combined with the appropriate technology is beneficial, and this is demonstrated by the fact that over 1000 full-body size interactive paediatric and adult patient simulators have been sold in the United Kingdom alone in the last decade between the different manufacturers. Nevertheless most experts in the field still believe that more research is needed to prove that skills acquired in a simulated environment are transferable to real life patient care and that it is a cost-effective teaching method (Ziv, Small et al. 2000; Owen and Plummer 2002; Kneebone 2003). As raised in a study on learning needs assessments in nursing education, the impact of allocation of resources needs to be carefully considered in terms of cost-effectiveness (Mailloux, 1998). This is especially important when considering that a full-body size and interactive patient simulator can cost up to £150,000 and also often requires dedicated space and trained staff to operate it and facilitate the sessions in the most appropriate manner. A few studies have proven the effectiveness of the use of mannequin-only training for some particular psychomotor skills (Stratton et al., 1991, Roberts et al., 1997), but a patient simulator is much more than a large assembly of individual body part training models known as part-task trainers. As described by Gaba, "*simulation is a technique – not a technology*" (2004, p GlavinThe few quantitative research studies into the educational effectiveness of full-

The few quantitative research studies into the educational effectiveness of full-scale simulation training that have been carried out in this field demonstrate weaknesses from a design or sample size point of view (Abrahamson et al., 1969, Chopra et al., 1994b, Morgan and Cleave-Hogg, 2000), such as the attempt by Steadman et al (2006) to compare problem-based learning (PBL) versus simulation-based learning. The issue with that study lay in the fact that some of the students were exposed to the same simulation scenario as the one used in the final test to compare the students' performance. To be more precise, that study was composed of three stages and involved two randomised groups of medical students who were initially assessed during a simulation session and obtained similar scores. During the second stage, students either experienced PBL relating to dyspnoea and simulation about abdominal pain; or PBL focussing on abdominal pain and simulation on dyspnoea. Finally all students

were tested on a dyspnoea simulation scenario which gave a predictable advantage to one group of students as they had benefited from a similar experience in the second stage of the study.

Although anecdotal evidence and collecting feedback from learners is useful (Gordon et al., 2001, Cleave-Hogg and Morgan, 2002, Gordon, 2000, Treadwell and Grobler, 2001, Rystedt and Lindstrom, 2001, Murray et al., 2002), it has limitations and does not provide a scientific answer as to whether or not simulation is an effective training method. The usefulness of considering the feedback from students resides in finding out what they like or do not like about various simulation facilitation approaches, however students may not appreciate the educational principles of the learning experiences they are exposed to and express preference for a demonstrative approach as opposed to an approach that forces them to think.

Many other previous studies presenting similar weaknesses from a design point of view or involving too few subjects have been the motivation to carry out a more rigorous research project to evaluate the effectiveness of full-scale simulation training. The time, resources, and financial investment that can result from adopting simulation in a training curriculum call for it being properly assessed at least for its educational impact. Although the main study presented in this thesis was conducted with Diploma nursing students from the University of Hertfordshire, there is no obvious reason why the outcome with other healthcare professions should be different. This led to the development of a follow-on study around scenario-based interprofessional simulation learning to look at knowledge acquisition within multidisciplinary teams.

I.3/ Aims and objectives

Having critically reviewed the research literature pertaining to simulation in healthcare education and identified gaps, the research question of the main study was formulated at the end of 2000 while the research question pertaining to the second study was formulated in 2006. The actual data collection periods for both studies were respectively January 2002 to May 2003 and November 2007 and May 2008, and were both preceded by a year of planning and development of the various tools used and educational strategies to be implemented.

The main study sets out to provide evidence to support or dismiss the use of full-scale or realistic scenario-based simulation training in nurse education, although the findings have potential for transferability to other healthcare professions. The research question could be phrased: “What is the impact of scenario-based simulation training on undergraduate students’ acquisition of clinical skills and knowledge?”

The primary aim of the main study is to evaluate the effectiveness of this teaching approach. It was conducted in the University of Hertfordshire Intensive Care and Emergency Simulation Centre and involved Diploma of Higher Education in nursing students. As part of this study an objective form of assessment was required. The Objective Structured Clinical Examination (OSCE) was thought to be the most appropriate assessment method. A complete OSCE was designed and tested as part of this study, as well as a series of realistic clinical scenarios that could be programmed and run in a standardised manner with the patient simulator used. A programme of OSCE and simulation sessions was organised and used with three consecutive cohorts of nursing students, with a consistent curriculum, in their second and third year of the Diploma programme.

The aim of the multidisciplinary project which emerged from the main study is to develop and pilot a programme to facilitate the use of realistic scenario-based simulation training with groups of final year students from different professions and evaluate the educational impact. To achieve this, a bank of multidisciplinary scenarios with patients requiring the input from diverse health professions and a questionnaire were created. It will also provide a basic evaluation of the students’ perceived benefit of taking part in such training session.

The research question linked to this second study is: ”What is the effect of exposing multidisciplinary teams of undergraduate students to scenario-based simulation training on their knowledge of each others’ roles and skills and on their perception towards working as part of a multidisciplinary team?”

I.4/ Contribution to knowledge of the research

There is a need for a robust and objective study that critically appraises the value of full-scale simulation-based training over the acquisition of a broad range of skills. This study attempts to address the weaknesses of previous studies as highlighted earlier, for example by not using full-scale simulation as part of the assessment strategy and by recruiting a larger sample of participants.

The original aspects of this thesis are that it;

- is the first implementation of full-scale scenario-based simulation in undergraduate nursing education;
- is the first objective quantitative study in the area of full-scale scenario-based simulation training in healthcare education;
- is the first time that an OSCE was used to evaluate the effect of full-scale scenario-based simulation learning;
- is the first objective quantitative study demonstrating that observing and taking part in multidisciplinary scenarios and the debriefings contributed to the students' acquisition of knowledge about the roles and skills of other health professions;
- demonstrates that the students' exposure to simulation significantly influences their perception of interprofessional working;
- is one of the earliest evaluation of high-fidelity scenario-based interprofessional simulation training in undergraduate education.

I.5/ Structure of the thesis

This thesis has been structured in nine different chapters covering different aspects of the work undertaken as part of this PhD thesis. The introduction chapter, Chapter I, sets out the theme of the thesis with the background and motivations. It also introduces the actual aims and objectives of the studies described and their original aspects.

Chapters II and III form part of the literature review. They make use of some of the already published journal articles from the author of this thesis. To put full-body size

mannequin technology into context, Chapter II presents a brief history of the evolution of patient simulators starting with the first basic resuscitation models and moving toward the more complex and interactive full size patient simulators. This chapter includes a presentation of the patient simulator used in this study; SimMan, from Laerdal Medical. The last section of this chapter sets out what is generally accepted as best practice based on published work, but also reveals the identified limitations and specific advantages of this educational approach. Chapter III covers other areas of the literature relevant to the work presented in this thesis, such as competency assessment, debriefing, interprofessional education using simulation, and a review of the published research on the effect of simulation education in patient safety.

Chapter IV presents the research tools used for the main study, namely the scenarios for the simulation sessions and the Objective Structured Clinical Examination (OSCE) stations, and how they have been developed. The methods and research design of the main study will be explained in Chapter V as well as the rationale for the target sample, the implementation of the research tools to collect the data, and the ethical approval. The results of the study relating to the OSCE and questionnaire are presented and analysed in chapter VI.

Chapter VII presents another study which directly emerged from the main study and was implemented with multidisciplinary teams of undergraduate healthcare students exposed to scenario-based simulation training. This chapter covers all aspects of this study from design to data collection and presentation of the results.

Chapter VIII is the final chapter and includes a discussion of the results which have been presented with regards to both studies. The chapter finishes with key conclusions about the work carried out as part of this research and recommendations for other educators and researchers. The appendices included at the end of this thesis include the full set of OSCE marking sheets and instructions for students and examiners, the questionnaire, the scenarios programmed for the simulation sessions of the main study, the feedback written by students on the guest book, the description of further undergraduate simulation training activities which have been directly influenced by the main study and have been primarily conducted with uniprofessional groups of students, and some of the key publications resulting from this study.

Chapter II
History of patient simulators and initial educational developments

The historical and technical background information presented in this chapter will primarily relate to full body size mannequins used for training in healthcare rather than present the development and use of part-task trainer or models made to practise clinical skills or demonstrate clinical features of diseases while maintaining social laws and modesty. The second part of this chapter will present different concepts and ideas relating to medical or healthcare simulation training which are partially taken from papers published by the author of this thesis (Alinier et al., 2006b, Alinier, 2007b),(Alinier, 2011) and also supported by the work from other authors. It also serves the purpose of setting the scene as to the type of simulation experience students have had the opportunity to be involved in during the simulation sessions undertaken in the University's simulation centre within the two studies.

II.1/ Definition of simulation

The word simulation in itself seems well understood but causes problems when a precise definition is sought. Shannon (1975) defined the term "*simulation*" as "*the process of designing a model of a real system and conducting experiments with this model for the purpose either of understanding the behaviour of the system or of evaluating various strategies for the operation of the system*." (p.34). This explanation shows that simulation can have a broad range of applications, but leads one to believe that it is primarily for technical applications and testing. A simpler definition found in the Online Oxford English Dictionary (1989) describes it as a "*technique of imitating the*

behaviour of some situation or process (whether economic, military, mechanical…) by means of suitably analogous situation or apparatus, especially for the purpose of study or personnel training." This definition is more readily applicable to the use of simulation in healthcare education and needs to be kept in mind when considering teaching methods claiming a simulation approach. It explicitly implies the use of simulation as a training activity putting people in situations resembling reality. A definition proposed by one of the pioneers of simulation describe it as being "*a technique – not a technology – to replace or amplify real experiences with guided experiences that evoke or replicate substantial aspects of the real world in a fully interactive manner*" (Gaba 2004, p. i2). While initially concentrating on the technological aspect of simulation with the introduction of a range of simulation models or mannequins, the following sections of this chapter will set the scene with regard to what is really meant by simulation in healthcare education in the view of today's simulation user community as well as elucidate on some common misconceptions. A novel typology published in Medical Teacher (Alinier, 2007b) enabling the differentiation of simulation levels will also be presented as a guide to simulation users of different modalities in healthcare education.

II.2/ The first resuscitation model

Peter Safar of the Johns Hopkins University in Baltimore is one of the pioneers of mouth-to-mouth artificial ventilation and he also demonstrated the inefficacy of the early technique of arm lift/chest pressure ventilation (Safar, 1958). This being brought to his attention during a resuscitation congress in Norway, Lind, a Norwegian anaesthetist, had the idea to contact Åsmund Laerdal, at the time a soft plastic toy and fake wounds manufacturer, to ask him to design a partial body training mannequin for mouth-to-mouth ventilation (Grenvik and Schaefer, 2004). This proved to be a turning point for the toy business of Laerdal (Figure 1). In 1960 the initial "Anne" mannequin was put to the test in Norwegian schools with a control group only seeing a video of the new resuscitation method (Safar, 1958) and an experimental group practising that same method on the new mannequin (Tjomsland et al., 2005). It was at that time a team of doctors realised external chest compression could improve cardio-pulmonary resuscitation (CPR) as it was producing a blood flow in cardiac arrest victims (Kouwenhoven et al., 1960). Very rapidly, under recommendation of Safar, the Anne mannequin was enhanced with an internal spring in the sternum to allow for the

practice of external chest compression. It is from this point in time that the Airway-Breathing-Circulation (ABC) of CPR started to be taught on what was called “Resusci-Anne”. The face of the mannequin (Figure 1) is the death mask of a young girl who drowned in the river Seine, in France, at the turn of the 19th century (Rosen, 2008). Speculations are that she committed suicide as a result of a one-sided romance. Åsmund Laerdal was moved by the story and decided to adopt her mask for the face of Resusci-Anne because he was convinced that if such a mannequin was life-sized and life-like, students would be better motivated to learn this lifesaving procedure (Rosen, 2008).

The educational experiment involving the first Anne finished in 1961 and demonstrated the value of learning mouth-to-mouth using the mannequin to obtain better ventilation skill proficiency. As with today’s model, the airway could be obstructed, and it was necessary to do a chin lift and head tilt to open the airway before being able to blow air in the mouth (Cooper and Taqueti, 2004). With support from Norwegian savings banks buying mannequins for schools, the programme was rolled out throughout the whole country (Lind, 1961, Tjomsland et al., 2005). This made Norway the pioneer country in teaching mouth-to-mouth ventilation to an entire population (Tjomsland et al., 2005).

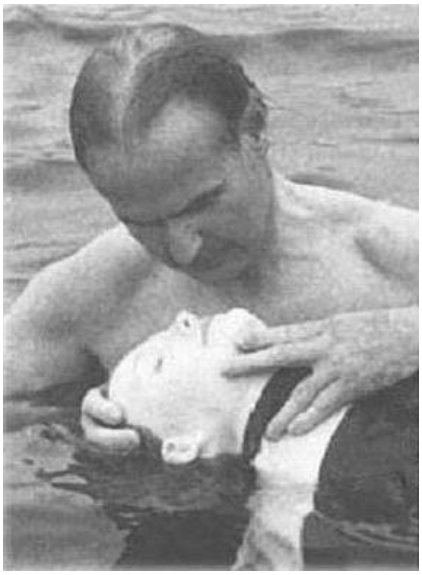

Figure 1: Åsmund Laerdal with Resusci-Anne (Cooper and Taqueti, 2004)

Over the years the family of Resusci-Anne has grown and evolved to even incorporate electronic feedback systems to record students’ performance while they carry out CPR (Nelson, 1982). To suit all budgets and training requirements the complete range of Annes, from the most basic to the most advanced, is still sold by Laerdal, which now

possesses the largest share in terms of first aid training equipment sales. It was only after the mid-1990s that Laerdal started to develop more advanced mannequins encouraged by Grenvik and colleagues (Grenvik and Schaefer, 2004, Cooper and Taqueti, 2004).

II.3/ The first “electronic” mannequins

The early developments of advanced patient simulators were highly marked by two main models developed in the United States of America and with slightly different purposes and capabilities. These were called “Sim One” and “Harvey”.

II.3.1/ Sim One

The first computer-controlled full size patient simulator was Sim One (Abrahamson et al., 1969). It was developed in 1967 by engineer Stephen Abrahamson and physician Judson Denson from the University of Southern California, in collaboration with Aerojet General Corporation and the Sierra Engineering Company (Abrahamson and Wallace, 1980, Denson and Abrahamson, 1969).

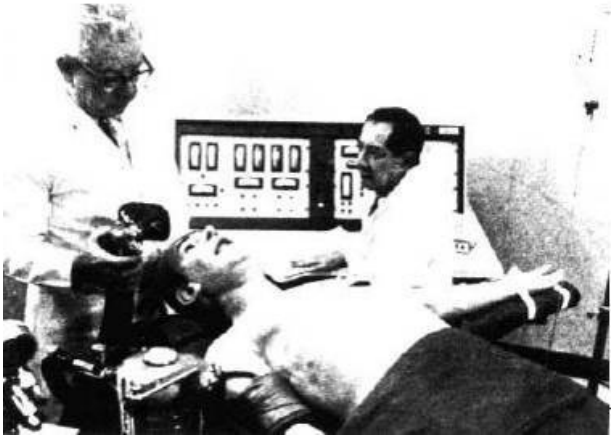

Figure 2: Dr Stephen Abrahamson and Dr Judson Denson with Sim One in the late 1960s.
(Abrahamson and Wallace, 1980)

The primary function of Sim One was to be an anaesthetic training mannequin to enable the assessment of competence in routine procedures and in anaesthetic emergencies (Collins and Harden, 1998). It was modified in 1971 to make it more useful for other health professionals (Hoffman and Abrahamson, 1975). It had many 'high-fidelity' features which made it interactive such as chest movement and correct anatomy, blinking eyes, pupil dilation, jaw movement, a measurable blood pressure and auscultable heart sounds (Abrahamson and Wallace 1980). It could even respond to four intravenously administered drugs and two medical gases as part of a computer programme (Abrahamson et al., 1969). The project cost $272,000 over three years. Although pilot studies showed that Sim One could halve the time taken to train anaesthesia residents to achieve a pre-determined level of competency, the mannequin had limited success. It was used in the Medical School curriculum of the University of Southern California, but probably because of its prohibitive cost and poor reliability, only one was ever produced (Cooper and Taqueti, 2004). This team of pioneers were evidently ahead of the demand and of the technology for such applications, but they significantly contributed to the development of healthcare simulation and were the first to try to determine the educational impact of exposure to simulator training (Abrahamson et al., 1969).

II.3.2/ Harvey

Harvey is now a very well known and still widely used cardiology patient simulator (CPS) (Ziv et al., 2000, Issenberg et al., 2001, Issenberg et al., 1999, Sajid et al., 1990). Development began in 1968 by Michael Gordon at the Medical Training and Simulation Laboratory in the University of Miami (Sajid et al., 1990, Gordon et al., 1980, Gordon et al., 1981, Gordon, 1974). The final prototype was completed in 1976, at which time Harvey became commercially available and distributed worldwide.

Over the years Harvey has been regularly upgraded to increase the number of cardiac pathologies it could simulate (30 for the latest version), and also to enhance the realism of the auscultation sounds and decrease the price of the system. The overall size of the technological part of the simulator reduced significantly to make it become more portable (42kg). In its current form, Harvey has:

- Venous and arterial pulses (Carotid, jugular, brachial, and femoral)

- Precordial movements (Pulmonary, right and left ventricular, and left displaced ventricular)
- Cardiac auscultation sounds (Aortic, pulmonary, and mitral with their corresponding radiation sounds, as well as tricuspid and carotid)
- Pulmonary auscultation sounds (Left and right lungs, upper, inferoposterior and inferoanterior, and abdominal breathing sounds)
- Voice (from the operator)
- Non-invasive blood pressure arm
- Interactive computer link to change these parameters
- Flashcard slot for software upgrades
- Complete teaching curriculum information package (UMedic)

Figure 3: The cardiology patient simulator with Dr Michael Gordon in the early 1970s.
(Cooper and Taqueti, 2004)

Harvey is primarily used for teaching bedside clinical skills to medical students (Gordon et al., 1980, Ewy et al., 1987, Woolliscroft et al., 1987, Gaskin et al., 2000, Jones et al., 1997). It has also proven to be very valuable for trainees when used as a self-learning teaching aid. A number of research studies have been carried out to test its educational efficacy and showed with various levels of credibility and validity that it benefited trainees (Ewy et al., 1987, Woolliscroft et al., 1987, Issenberg et al., 1999). These educational research efforts have enabled Harvey to become a teaching aid recommended by the American College of Cardiology Task Force as an integral part of the day-to-day teaching of clinical cardiology (Gregoratos and Miller, 1999). In 2002, the British Heart Foundation (BHF) provided every medical school in the UK with this £56,000 CPS and its multimedia computer assisted learning programme, UMedic. This

training package includes corresponding patient history and data, a summary of the pathology and epidemiology of each diseases, ECGs, X-rays, laboratory results, as well as the appropriate medical and surgical therapy (Gordon et al., 1999). The BHF initiative also established in Dundee, under the directorship of Stuart Pringle, a UK National Harvey Resource Centre to help the 22 medical schools who received Harvey (BHF, 2002). It is currently in use in over 140 medical training centres around the world.

II.4/ The evolution of modern patient simulators

As explained in the previous sections of this chapter, advanced mannequins were introduced in medical education nearly forty years ago. Until recently highly sophisticated mannequins were an important investment for any healthcare training centre. As the technology progresses in terms of ideas, computational power and software developments, it becomes easier and cheaper to develop more realistic and interactive patient simulators. The awareness of their existence and of their potential benefits as a training aid has driven their development by other pioneers. New projects will further enhance their capabilities and increase their level of fidelity or realism with human patients (Alinier et al., 2006a). Other major patient simulators that have contributed to the history of this specialist area will be presented in this section alongside contemporary ones. Patient simulators have become more and more sophisticated over the years and enable a wider range of invasive and non-invasive procedures to be performed on them. They are not now only used for individual practice of skills or procedures but more commonly used as a platform for teamwork training in crisis situations or for the management of acutely ill patients. Two major technological trends, which will be discussed later, have been developed. They are high-fidelity and intermediate or medium-fidelity patient simulators.

II.4.1/ Other patient simulators

Other important patient simulators that have now almost disappeared but occupied an important place in the area of simulation training include the MedSim Eagle, the Leiden

Anaesthesia Patient Simulator, the Sophus Anaesthesia Simulator, ACCESS, and the Gainesville Anesthesia Simulator. Although they were all more or less developed simultaneously, they were done independently, which allowed for the use of different technological approaches and ideas (Cooper and Taqueti, 2004).

The MedSim Eagle was in fact a product originally developed by Gaba and colleagues from Stanford Medical Schools and called CASE for "Comprehensive Anaesthesia Simulation Environment" (Gaba and DeAnda, 1988). The first prototype was made in 1986 with a combination of commercially available waveform generators, virtual instruments, a computer, and a basic mannequin setup in an operating theatre environment (Cooper and Taqueti, 2004). It could be connected to real monitoring medical equipment and produce meaningful data output (Doyle, 2002) which was a real advantage for training. The next version contained a cardiovascular physiological model and began to be used to investigate various aspects of human performance in anaesthesia (Gaba and DeAnda, 1989, Gaba and Lee, 1990, Gaba et al., 1998). The system was eventually acquired by MedSim Ltd and named "Eagle". The company sold approximately 30 simulators before stopping production and closing in 2001.

Other sophisticated mannequins or systems were developed but were never commercialised. The Leiden Anaesthesia Simulator (LAS) is the result of the work of Chopra and his colleagues in the Netherlands (Chopra et al., 1994a). It used the same concept as the early CASE prototype as it used existing components such as the Laerdal airway management trainer (Laerdal Medical, Stavanger, Norway), for the head and thorax, and an artificial arm from Adam Rouilly (Sittingbourne, England) for drug infusion (Chopra et al., 1994a). It had a simulated urinary output using a volumetric pump with coloured fluid. The LAS was also used for the first quantitative educational research study (Chopra et al., 1994b).

The Sophus Anaesthesia Simulator was developed in 1991 by a team from Denmark and had a computer user interface on which scenarios could be programmed (Christensen et al., 1997). ACCESS or the Anaesthesia Computer Controlled Emergency Situation Simulator was developed in the United Kingdom in the early 1990s (Byrne et al., 1994). It used an airway management part-task trainer and a computer monitor with controllable waveforms to simulate the patient monitor. It was a simple design and could be used very effectively for some anaesthesia scenarios.

At the same time as CASE was developed, a team from the University of Florida, directed by Dr Michael Good created, the Gainesville Anesthesia Simulator (GAS) (Cooper and Taqueti, 2004). The full-size mannequin was primarily developed around a sophisticated lung model simulating the response to anaesthetic gases. It was then enhanced to integrate recognition and response to injected drugs. Once the development of the fully operating patient simulator was completed all the patents constituting the GAS were purchased by a new company in Florida to commercialise the product as described in the following section.

II.4.2/ METI Human Patient Simulator

The “Human Patient Simulator” or “HPS” has been commercially available since 1996 following the purchase of the patents belonging to the University of Florida by Medical Education Technologies, Inc, commonly known as METI (Sarasota, Florida). Hence the HPS is based on the original Gainesville Anaesthesia Simulator developed by Good and colleagues from the University of Florida (Cooper and Taqueti, 2004). Like the MedSim Eagle, the HPS has many features including a realistic airway anatomy, palpable pulses, lung movements, heart and breath sounds, eyes that open and close with reacting pupils, as well as a thumb switch used to monitor neuromuscular blockade during anaesthesia. The overall system is very bulky as the mannequin is connected to two computers, one for the operator interface and one for the physiological mathematical models. The latter is also interfaced to a large rack containing a number of sub-systems for the simulation of different physiological parameters and the gas analyser for example.

The sophistication of this mannequin means that it is classified as a high-fidelity patient simulator as explained in the following section. Because of the different modules which must be connected to the HPS, it is not a very portable system and is often confined to a specifically dedicated room. The HPS has primarily been designed for the training of anaesthetists, hence it is most commonly setup in a simulated operating theatre. The mannequin can breathe real medical gases and can be realistically put to sleep using an anaesthesia machine. For the recognition of injected drugs, the system relies on a bar code reader near the injection site and a flow meter to determine the volumes injected. This constrains users to employ bar-coded syringes representing different pre-diluted drugs so it can appropriately respond to the treatment provided. Apart from this

limitation, the HPS can be connected to real clinical monitoring equipment for non-invasive procedures. The HPS has become particularly popular for medical training purposes, especially in the United States of America. Since its appearance on the market in 1996 METI had sold over 400 HPS around the world in 2006 (METI, 2006) and reached 700 by the end of 2011 (Personal communication with CAE employee, 2011). This is an unprecedented commercial success for high-fidelity patient simulators, especially at a cost of around £150,000 per HPS system.

II.4.3/ SimMan: Universal Patient Simulator

Following on from the success of Resusci-Anne and after the acquisition of Medical Plastic Corporation (MPL) in 2000, Laerdal worked with the support from the University of Pittsburgh on the development of a mannequin more sophisticated than any of the other Laerdal training models (Cooper and Taqueti, 2004). In 2001, Laerdal Medical had tested and was able to commercialise their first advanced adult patient simulator. This computer-controlled patient simulator was called SimMan and could be operated from a standard personal computer via an interface control box itself connected to an emulated patient monitor, and with the mannequin linked to a compressor. The interface box also allows for remote control of the different physiological parameters of SimMan, which makes it a very user-friendly patient simulator. Laerdal made it generally and technically a simpler mannequin because it does not rely on mathematical physiological models and is very limited in terms of compatibility with real monitoring equipment. The savings in research and development have enabled Laerdal to offer the first version of its SimMan at a much lower price (~£25,000) than higher fidelity patient simulators such as the METI HPS. The arrival of this new computer-controlled mannequin totally altered the healthcare simulation market previously under the monopoly of METI. This forced METI to also develop an intermediate or medium-fidelity patient simulator to compete with SimMan. It was called the “Emergency Care Simulator” (ECS) and was launched in 2003. To date Laerdal have sold around 6000 SimMan mannequins around the world in just over 10 years (Personal communication with Laerdal employee, 2011).

Although SimMan does not generate the patient data from physiological mathematical models, all expected parameters can be displayed and controlled by the operator on the emulated patient monitor. Emulated instruments can be used by trainees to perform

actual measurements such as non-invasive blood pressure by palpation or auscultation using the special Laerdal sphygmanometer and a real stethoscope. The Software allows for the programming of scenarios in the form of flowchart, or pre-programmed reactions, with trigger events such as customised functions, time, or activations of sensors on the mannequin (Assisted ventilation, cardiopulmonary resuscitation, defibrillation, or palpation of the pulse). Like all advanced patient simulators, SimMan has a realistic airway that can recreate several complications (Laryngospasm, tongue oedema, trismus, airway swelling…), spontaneous breathing, voice, auscultation sounds, ECG output, palpable pulses, and allows for drug injections (See Appendix VI).

Although SimMan has had two upgrades since its release, the patient simulator used for the studies presented in this thesis was the original SimMan patient simulator from 2001. The upgrades made to SimMan in 2005, commonly referred to as SimMan 2, included a larger patient monitor with more functionality, palpable pedal pulses, and an improved software interface. Then in 2008 was the launch of SimMan 3G using a totally new platform and software enabling wireless and tubeless operation, hence making the patient simulator much more mobile.

II.5/ High and intermediate fidelity patient simulators

Medical training equipment manufacturers offer a wide range of products in order to satisfy their customers, from very basic models such as part-task trainers to fully interactive patient simulators. In order to qualify the level of realism and interactivity of these products a terminology has emerged. This terminology applies to models and mannequins and ranges from low-fidelity to high-fidelity (Seropian et al., 2004). Low-fidelity relates to non-interactive models or mannequins and is only of peripheral interest to this thesis. They require direct external input from a trainer to inform the students about the condition of the “patient”, such as whether they should consider that a pulse can be felt or not or if the patient is still conscious or not. A Resusci-Anne used in a First Aid at Work certificate examination context is an example of a low-fidelity patient simulator often used in a low-fidelity simulation context (See section II.6.2).

High-fidelity patient simulators relate to very realistic computer-controlled mannequins which use mathematical models to derive physiological data (Alinier, 2007b). The respiratory and cardiovascular physiological models are linked with pharmacological models so that the effects and interactions of the drugs injected to the patient simulator by the trainees can be realistically calculated and relayed back to the monitoring equipment (Maran and Glavin, 2003). A gas analyser linked to the patient simulator's airway and flow meter with a barcode reader enables it to autonomously respond and mimic all the parameters of the human physiology in real time without input from an operator and using real monitoring equipment (Van Meurs et al., 1997). The operator simply needs to set the initial patient parameters and basic trends of the chosen scenario or incident, and the system will then autonomously change the patient simulator's physiological parameters over time according to the treatment provided by the scenario participants. They are primarily used for anaesthetic training due to their ability to recognise gases and drugs and allow sedation in a real or mock-up operating room. The METI HPS, for example, is the only high-fidelity patient simulator.

Intermediate or medium fidelity patient simulators are also computer driven but they are slightly less technologically advanced than high-fidelity patient simulators. They require the operator to continuously adjust the physiological parameters according to the scenario participants' actions or to pre-programme physiological trends and scenarios in anticipation of the participants' actions using predefined triggers, some of which may be detected by the mannequin to generate an autonomous response. The fact that this type of patient simulator does not operate from mathematical physiological models, but relies on an operator, may produce unrealistic responses to the treatment it receives on one hand, but it is a lot more flexible as a learning tool. The patient can be kept alive even if trainees are not providing appropriate treatment or are simply too slow. These partly interactive computer-controlled mannequins offer a range of features comparable to the high-fidelity mannequins which are suitable for most healthcare professionals' training needs (Airway features, breathing, voice, auscultation sounds, ECG output, pulses, blood pressure…). The fact that they are not model driven present the disadvantage that they require the operator to always keep an eye on what the scenario participants are doing to the patient and listen to the names, concentration, and volume of the drugs injected. The operator must also know the effect of the drugs and their combined interaction on the physiology of the patient, while at the same time keeping in mind the underlying patient condition to realistically change the physiological parameters.

There is a very significant price difference between these two types of patient simulators which can be as much as a factor of ten. The level of fidelity of the patient simulator or equipment is not to be confused with the level of fidelity of the overall simulation experience which also includes for example environment and psychological fidelity (Borodzicz, 2004) that contribute to immersing the students into the simulation experience. Hence, a given patient simulator may be used in both low and high fidelity capacities depending on how it is being used and for what purpose (Seropian et al., 2004). It is recognised that with experience and knowledge, and if used appropriately, educators can achieve a similar level of realism in the scenarios they run using either type of technological platform. The use of either level of fidelity of patient simulator (intermediate or high) does not necessarily lead to increased students' performance or learning outcome as demonstrated in a study by Kardong-Edgren et al. (2007). Patient simulators' success as training aids is partly proven by their popularity with educators and trainees. The arrival of these intermediate fidelity simulators has driven the growth of the number of simulation centres internationally. The first study presented in this thesis made use of an early model of the intermediate fidelity patient simulator: the Laerdal SimMan Universal Patient Simulator and tries to provide a real evaluation of its effectiveness when used for scenario-based simulation training in undergraduate nursing education.

II.6/ Simulation in healthcare education

Although only very sporadically, realistic and fairly advanced simulation training tools have been used for several decades to train doctors (Abrahamson et al., 1969). Since the late 1960s, the more advanced and high cost technology was only accessible to a few privileged candidates doing their medical training in the institutions of the first patient simulator pioneers. Simulation, in its different aspects and levels, is now increasingly gaining in popularity and the literature supports its use in undergraduate healthcare education (Issenberg et al., 1999, Alinier et al., 2006a, Nursing and Midwifery Council, 2007) and for continuing professional development (CPD) or continuing medical education (CME) (Kohn et al., 1999, Chief Medical Officer, 2009). The potential for the use of realistic simulation training tools in undergraduate healthcare education, CPD or CME is vast. Due to the general increase of the theoretical components of healthcare educational programmes, such as the

introduction of the Project 2000 curricula for nursing students (Nicol and Freeth, 1998), new graduates are usually less skilled and confident than used to be the case on starting their first clinical job (McCallum, 2007, Hamill, 1995, Bradshaw and Merriman, 2008). In addition, the European working time directive has reduced the training hours of doctors, hence limiting their exposure and acquisition of patient care experience (Johannsson et al., 2005). It is suggested that this could be addressed by increasing their exposure to simulation (Bradley, 2006). The current lack of simulation training opportunities to students and healthcare practitioners has been reported and recognised by both educators and students (Fernandez et al., 2007, Robertson, 2006, Chief Medical Officer, 2009, Department of Health, 2008a). There are a number of reasons that can explain the fact that nurses and other healthcare trainees are still too rarely exposed to lifelike situations in a training context such as lack of resources, expertise, time, and funding. However the use of patient simulators also presents a number of advantages over more traditional methods of teaching and learning that are as important for medical staff as they are to nursing and other healthcare professionals and may indirectly reduce the current limitation to its wider implementation. This will be discussed in the penultimate section of this chapter.

Simulation has grown to the point that several national and international multidisciplinary societies with a focus on healthcare education through simulation have emerged in the last two decades. These include the Society for Simulation in Healthcare (SSH, http://www.ssih.org) in the United States of America, the Society in Europe for Simulation Applied to Medicine (SESAM, http://www.sesam-web.org), the UK National Association of Medical Simulators (NAMS, http://www.namsuk.co.uk) which merged in 2010 with the Clinical Skills Network (CSN) to form the Association for Simulated Practice in Healthcare (ASPiH, http://www.aspih.org.uk), to only cite the major English speaking societies. This is not an exhaustive list but only a sample of the most established simulation societies in healthcare education. On the same front, since 2006, new peer reviewed journals have been inaugurated such as Clinical Simulation in Nursing (http://nursingsimulation.com) and Simulation in Healthcare (http://sih.edmgr.com). Over time the attendance at these meetings has grown considerably. For example, considering a conference held in the same location (San Diego, California, USA), the number of participants has increased from 240 at the joint 2003 Meeting of the Society for Technology in Anaesthesia (STA) and the International Meeting on Medical Simulation (IMMS) to nearly 700 in 2006, 1600 in 2008, and over 3100 in 2012. With the creation of SSH in 2006, IMMS became independent from STA and was renamed the International Meeting for Simulation in Healthcare (IMSH).

Full-scale simulation training is very distinct from clinical skills training in its educational philosophy as it relies on the autonomy of the scenario participants and offers a greater opportunity for the practice of non-technical skills such as communication, decision making, and team working. It is not a substitute for experience acquired by caring for real patients, but an extension to clinical skills training that should be used to bridge theoretical and practical training and work in the clinical environment with real patients. It should be used as a medium to allow trainees to use their skills in context to demonstrate their level of understanding, skills, and knowledge. In other words, it is about providing an environment for students to apply theory to practice in an experiential manner and in a safe and realistic environment (Morgan et al., 2006), rather than being directed how to do things. Students have to be appropriately introduced to simulation: the concept, the environment, and the technology. The complexity of the scenarios to which they are exposed should be tailored according to their current level of skills, knowledge, and experience to meet their learning requirements and encompass an appropriate range of learning objectives (Alinier, 2011). Scenario design has been mentioned by Rudolph et al. (2007a) as an “art and science” (p.162) as the scenarios need to engage its participants in various modes (Physical, conceptual or semantic, and emotional and experiential) (Dieckmann et al., 2007a). With the appropriate patient simulator, actors and environment, simulation can be made so realistic that many characteristics of real life situations are reproduced or even triggered in terms of emotion and stress. However such tools have to be used appropriately and progressively in order not to discourage or de-motivate young or inexperienced trainees. Exposing trainees to over-complicated cases without the appropriate support could prove overwhelming and put them off such learning experiences in the future.

II.6.1/ Common misconceptions about simulation

It has been suggested that the term simulation may be used in too broad a context or inappropriately (Beaubien and Baker, 2004). For example, to consider that the use of an interactive full-size patient simulator to teach trainees passively at its bedside to demonstrate some practical skills or observe its electrocardiogram (ECG) on a monitor forms a simulation session for the simple reason that it uses simulation technology or takes place in a simulation centre is inaccurate. A common characteristic of many

widely accepted educational definitions of healthcare simulation is that trainees are required to be actively involved in trying to solve the problem presented to them by interacting and communicating with their peers, the patient, the equipment, and the environment (Miller, 1984, Spannaus, 1978) as could happen in a real life situation. It consists of placing students in a realistic clinical situation where they are the key persons in charge of the situation and the patient, while at the same time operating in a safe and controlled environment, under observation for post-experience debriefing and remediation.

The expression “written simulation” is also used in the literature (Abrahamson and Wallace, 1980, Feinstein et al., 1983, Miller, 1987) and typically refers to essay-type clinical problems or written patient management problems. Whilst this method may be useful to reinforce skills, it does not provide the interactive aspect of a true simulation. This teaching method requires trainees to rely as much on their imagination as on their knowledge and hence is not as realistic as would be expected of a simulation exercise. It requires them to think and recreate mentally the environment in which the action would take place as described in the written script. Observing facts concerning patients and taking the history directly is different from reading the information about these patients. In real-life, trainees will not only be concentrating on written information but will also be assessing, questioning, and listening to their patients. When answering written problems, trainees frequently forget to describe or address things they would have done in a real setting where non-verbal cues may prompt their actions. Similarly, written indications or cues that may have remained unnoticed by trainees in real life are made completely explicit in the written setting of the scenario script.

Because of their nature, written simulations may force the educators to provide too much or too little information to trainees. The patient history may be given rather than taken which may affect the cues which in the real case trainees would have to learn to pick out. The use of such cues in the clinical case is therefore not learnt which means that important aspects of learning about the clinical situation are ignored. Simulation should allow trainees to concentrate on the clinical problem as it would be presented in real life, without relying on their imaginative sense. An approach that would enhance written simulations would include an interactive component where trainees would be required to interact with a standardised patient (Collins and Harden, 1998) from whom they could take the chief complaint and obtain additional information only if requested. This could be video recorded for marking or debriefing of the trainee. An alternative method, less human resource intensive, would be to use a software that allows

trainees to find for themselves the information about a given patient, perform a diagnosis, and administer appropriate treatment (Schwid et al., 2001). These pieces of software are now available and can be used as assessment as well as learning tools. Most of them provide feedback to trainees at the end of a scenario. They are often referred to as screen-based simulations or micro-simulation (Alinier, 2007b, Ziv et al., 2000, Lane et al., 2001, Rosen, 2008, Grenvik et al., 2004).

II.6.2/ Proposed simulation typology

As technology evolves, more advanced and sophisticated training tools become available for trainees to acquire and practise their skills. At the highest levels, simulation tools can be used to address cognitive, psychomotor as well as interpersonal skills. It is important for its application principles to be well defined and rigorously applied to get the best benefits from this educational method. Proposing an up-to-date typology of the current simulation technologies, as presented later in this chapter, is a starting point toward standardising their use and prescribing their educational requirements for training centres. The typology presented in this chapter is for simulation developers and users, and rationally defines the tools and methodologies available, their applicability for the specific skills or knowledge to be imparted to trainees and their appropriate assessment. Alongside developing standards for the use of simulation training tools such typology could encourage better practice on the part of the educators for the trainees' benefit, and ultimately, for better patient care.

One of the earliest typologies of medical simulation identified five types of simulation learning methods with simple but clear definitions (Miller, 1987). Ranging from the lowest to the highest level of fidelity, these were: Written simulation, 3-D models, Computer-simulation, Multimedia and Simulated patients. The computing technology having considerably changed over the last 20 years, the typology proposed by Miller has become outdated. More recently an analytic framework was suggested to identify and characterise critical elements of simulators (Meller, 1997). It had four dimensions which were: the patient, the procedure, the healthcare trainee, and the instructor or facilitator, and there were three possible modes of operation for each of them; passive, active, or interactive. This typology added an important aspect to the educational concept which related to the way the simulation technology or tool was being used in its context. Although it did not extend to all possible types of simulation learning

methods and was not explicitly used by other medical simulation educationalists, it conveyed an important message that could be expanded. Other proposed simulation tools can, more or less controversially, include organs, animals, cadavers, sophisticated screen-based simulators, videotapes, and virtual reality simulators (Ziv et al., 2000, Issenberg et al., 2001, Lane et al., 2001).

One of the latest typologies proposed three levels; case studies and role play, part-task trainers, and full mission simulation (Beaubien and Baker, 2004). This typology regroups many types of simulation tools in the same category, such as models of limbs and screen-based simulation, both as part-task trainers. However simulation tools also need to be ranked or described according to their functions, as proposed by Meller (1997), or to the lifelike experience they can potentially provide to users.

The typology proposed should not only consider the simulation tools such as a dummy or software, but should examine them from a broader perspective. It should take into account whether or not and to what degree the environment in which they are used and their interactivity has been reproduced, and also the mode in which trainees are interacting with them. This would give trainees a better idea of the type of simulation technique they have been trained with, a measure of how realistic it was, and also enable them to describe it more easily to a third party. This way a standardised definition incorporating the degree of fidelity to reality of each type of simulation approach could be used. Table 1 presents the hierarchical list of the different recognised simulation techniques identified in a recent paper (Alinier, 2007b) with a summary of their specific requirements, their typical use, their advantages and disadvantages, and their type. Ideally a set of agreed and recognised standards should be developed for the use of educational simulation techniques at different levels to enable educators and trainees to compare learning experiences.

	Simulation levels					
	Level 0	Level 1	Level 2	Level 3	Level 4	Level 5
Simulation technique	Written/pen and paper simulations or "Patient Management Problems" and latent images	3-D models which can be a basic mannequin, low fidelity simulation models, or part-task simulators	Screen-based simulation Computer simulation, Simulation software, videos, DVDs, or Virtual Reality (VR)	Standardised patients Real or simulated patients (trained actors), Role play	Intermediate fidelity patient simulators. Advanced full body 3-D models not fully interactive	Interactive patient simulators or human patient simulators, also known as high-fidelity simulation platforms
Mode	Usually student led	Student or trainer led	Student or trainer led	Student or trainer led	Student or trainer led	Preferably student led
Type	Passive		Interactive		Partly interactive	Interactive
Skills addressed	Cognitive	Psychomotor	Cognitive	Psychomotor, cognitive, and interpersonal	Psychomotor, cognitive, and interpersonal	Psychomotor, cognitive, and interpersonal
Facility required	Classroom	Clinical skills room or classroom	Multimedia/Computer laboratory or classroom	Depends on the scenario requirements	Clinical skills room or simulation centre realistic setting (simulated theatre, ICU, A&E)	Simulation centre (simulated theatre, ICU, A&E or ward) with audio and video recording equipment
Typical use	Patient management Diagnostic Mainly for assessment	Demonstration and practice of skills	Cognitive skills Clinical management	Patient assessment, diagnostic, or management problems Interpersonal skills	Interpersonal and procedural skills Full-scale simulation training	Interpersonal and procedural skills Full-scale simulation training
Disadvantages	Very unrealistic Feedback cannot be given instantaneously after the exercise	Limited range of training functions No interactivity	Unrealistic setting. Students and trainers have to be familiar with the software/equipment Software has to be kept up to date with the latest guidelines VR sometimes requires very high computational power	For small groups of students. Patients have to be trained. Inconvenient if the exercise has to be repeated many times or for invasive practice unless used in conjunction with a part-task trainer	May require programming of scenarios. Several trainers required for a relatively small group of students Trainers have to be familiar with the equipment	Cost (mannequin and facility) Several trainers required for a relatively small group of students. Trainers have to be familiar with the equipment Not very portable
Advantages	Low cost (no special equipment required) One lecturer may be sufficient for a large number of students	Equipment relatively mobile One lecturer may be sufficient for a class of students working on the same skill Spares patient discomfort	Relatively low cost, except for VR. One lecturer may be sufficient for a large number of students. Students can use it on their own (self learning) Software often provides feedback	Can be very realistic A must for communication skills and patient history taking	Provides a fairly realistic experience. involving a broad range of skills. Students' performance sometimes recorded. Usually portable	Provides a realistic experience. involving a broad range of skills. Students' performance recorded for debriefing

Table 1: Proposed typology of simulation methodologies split in six levels, that can each be either student or trainer-led (Alinier, 2007b).

The six types of educational simulation tools or levels that have been identified and presented in Table 1 cover a wide range of degrees of authenticity. In order not to create too many categories, Virtual Reality and screen-based simulation (Schwid et al., 2001, Ziv et al., 2000), were grouped together, as was done with standardised and real patients (Collins and Harden, 1998). According to the degree of complexity of the skill being practised or tested and to the trainees' competence, a certain level of fidelity might be more or less suitable. Usually, the higher the degree of fidelity, the more prepared or qualified trainees need to be (Figure 6). To that effect the different types of simulation described can be used in two different modes: skill or protocol practice, or simulated event, and each can take place with a range of approaches, maybe starting by being fully trainer-led during basic skills acquisition, and moving towards being student-led for a more holistic patient care educational experience (Figure 4).

The term "fidelity" generally relates to the degree of realism of the learning experience participants are exposed to and is multidimensional. The degree of fidelity of the simulation experience may be affected by different elements which can be referred to as:

- Psychological fidelity
- Environmental fidelity / Physical fidelity
- Technological fidelity / Equipment fidelity

The psychological fidelity is about the actual involvement of the learners in the scenario as if it was a real event and is probably more important than any of the other elements. It is primarily dictated by the preparation of the learners and the role the educator will play so they can immerse themselves in the scenario. To achieve a high degree or level of fidelity during scenario-based simulation education, it must be student-led, as illustrated on Figure 4. The environmental or physical fidelity relates to the setting within which the simulated experience takes place, and how close it resembles the real environment in which the scenario is meant to be taking place. The technological or equipment fidelity is about the simulation technology and how closely it is from the real entity it is simulating, usually a patient (i.e. patient simulator or standardised patient) or an invasive procedure carried out on a patient (i.e. surgical or virtual reality simulator). This aspect is sometimes encompassed with the physical fidelity element and depends on the degree of sophistication of the simulation tool used, for example whether its operation relies on an operator changing parameters or whether it operates in a more autonomous fashion, based on a mathematical physiological model. In all cases, the degree of fidelity is not necessarily proportional to the educational effectiveness of the

learning experience (Dieckmann et al., 2007a, Borodzicz, 2004, Kardong-Edgren et al., 2007).

Skill or protocol practice (Figure 4) can be referred to as the pedagogy making use of simulation tools but not necessarily in a realistic setting. The trainer may interact and give guidance to trainees during the exercises, and he could be qualified as an "interactive element" according to Meller's typology (1997). It is probably the most appropriate way of introducing a new piece of teaching aid to trainees such as explaining the functionality of an interactive patient simulator or to guide them through their first attempt at performing a challenging clinical procedure. This approach reduces the degree of realism or fidelity of any of the defined simulation levels. The environment is not significantly important because trainees may require expert guidance while primarily learning or practising a psychomotor skill. When students have gained a deeper understanding of the practice of the skill, they can become more autonomous and then practise by themselves in a "student-led" approach. This example corresponds to students learning through an approach that starts from the bottom left hand corner and progressing to the top left hand corner of Figure 4.

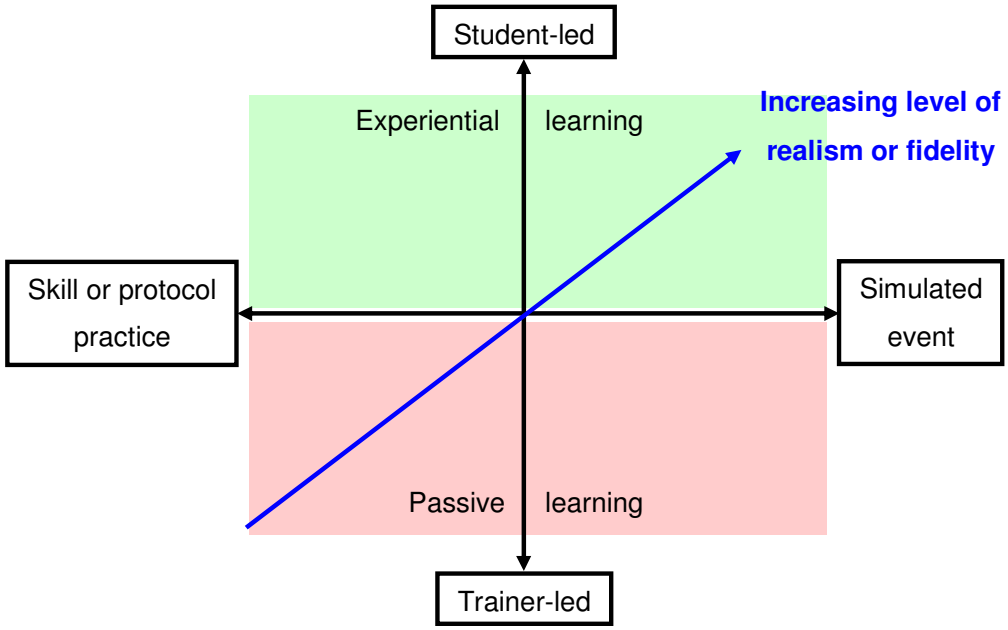

Figure 4: Diagrammatical representation of the possible learning approaches using simulation technology (Alinier, 2011).

On the other hand, the simulated event mode of teaching is really meant to give realistic experience to trainees. After the initial familiarisation period, they should ideally not get any guidance during the scenarios and would be expected to make appropriate decisions by themselves or as a team. In that mode, it is only after a scenario that trainees should be sensibly debriefed and may receive feedback on their performance (See section III.3). This shows that similar provision should be made to distinguish between those two delivery approaches and that they can be combined as illustrated in Figure 4. They can also be seen as “trainer-led”, because trainees receive guidance and instructions at the start of a simulation session, during the familiarisation period with the patient simulator, and during the scenarios. In the “student-led” case, they are the one making the decisions and facing the consequences of their actions during the scenarios. The facilitation aspect is the key difference between the educational approaches of low versus high-fidelity simulation.

Whether it is “trainer-led” or “student-led”, and at any degree of fidelity, simulation requires close supervision or observation to ensure trainees are performing correctly and to ensure that their errors are noticed and can be discussed and corrected at an early stage. This supervision should be provided in terms of facilitated debriefing in post scenario-based training in the “student-led” approach to allow trainees to learn from their mistakes (Ziv et al., 2005, Beaubien and Baker, 2004), whereas it should be provided during training, often in the form of feedback when they are practising individual psychomotor skills in “trainer-led” sessions. Figure 4 shows that the more we move towards the top right hand corner of the diagram, the more realistic the scenario is. It is important to point out that for all student-led scenarios, the trainees will actually be acquiring knowledge and skills through experiential learning (Cleave-Hogg and Morgan, 2002, Kolb, 1984), which is further reinforced during the debriefing (See section III.3).

Most of those simulation methods are or can be used for both teaching and examination purposes. Although simulation technology from levels 0 to 4 presented in Table 1 are commonly used for assessment, often as part of an OSCE, it is not the case yet for the full-scale simulation (Level 5). Because it often involves teams working around a high-fidelity patient simulator, it adds non-negligible dimensions to the examination process. This type of learning approach is only starting to become more widely used, and thinking about using it for examination purposes with a team of learners is still very controversial and also very costly if done on an individual basis. Reliable and tested performance rating scales need to be developed for each individual

scenario and learner role, not only to capture candidates' clinical knowledge and their clinical skills, but also their attitude, their teamwork abilities and professionalism to cite only a few attributes.

Depending on the skills level of teaching that needs to be delivered, the use of certain types of simulation tools is more or less appropriate. Lower levels of learning or understanding of skills, or basic academic knowledge are better taught in classrooms. Some skills however should be taught in clinical skills centres as they require the use of part-task trainers or other pieces of clinical equipment. It is once a relevant range of skills has been mastered by trainees that the use of simulated patients (Collins and Harden, 1998) or of patient simulators may be the most effective and practical way to observe how those skills are being applied in context. Some educators fail to identify what type of tool is better suited to what learning stage and for what purpose. Such failure can adversely affect trainees' acquisition of skills and the selection of the best methods of assessment. Similarly, the word simulation should be used more concisely and in context to prevent confusion and this will be further discussed in section II.7.2 of this chapter. To be most beneficial, it is important that facilitators or trainers recognise that the appropriate type of simulation tool needs to be used correctly and at the right stage in the trainees' educational curriculum (Beaubien and Baker, 2004) to achieve their learning objectives. To that effect several simulation facilitator courses have been developed by universities and simulation centres worldwide to help educators develop the new skills which are particular to high-fidelity simulation education (Issenberg, 2006, Vollmer et al., 2008, Fanning and Gaba, 2007, Dieckmann and Rall, 2008a, Alinier, 2007a). The expertise required to facilitate such training has also been supported in a recent report from Sir Liam Donaldson as part of one of his recommendations regarding simulation and safer medical practice whereby "*A skilled faculty of expert clinical facilitators should be developed to deliver high-quality simulation training*." (Chief Medical Officer, 2009), p.55). The importance of preparation and skills mix among the team facilitating a simulation session is emphasised in a paper by Lambton and Prion (2009) where it is mentioned that the "faculty" need to possess: educational, clinical and technical expertise. The latter point can be illustrated by the fact that for the studies presented in this thesis, the environment and patient simulators were subjected to technical alterations in order to enhance their functionality for particular scenarios such as enabling unilateral chest movement of the patient simulator during spontaneous breathing or the remote control of an electronic patient record monitor.

II.7/ The key aspects to simulation training

As presented earlier, the development of full-scale patient simulators started in the 1960's (Abrahamson and Wallace, 1980) in the United States and was primarily developed for training in anaesthesiology and cardiology. Since then a number of studies have been carried out in order to determine if the use of such technology as a teaching tool was really beneficial and cost effective (Holcomb et al., 2002, Hoffman and Abrahamson, 1975, Gordon et al., 1980, Stewart et al., 1984, Nackman et al., 2003, Allen et al., 1998). A major factor in the effectiveness of the use of such training technology is the actual way in which it is used, in other words, the teaching approach and method (Issenberg and Scalese, 2007, Issenberg et al., 2005, Salas and Burke, 2002). It is increasingly recognised that to maximise the students' learning and make the best use of the resources (Leigh and Hurst, 2008) one "needs a champion for simulated technology use, a faculty member who believes in the technology, is informed and excited about its use, and has a "contagious" effect on other faculty members." (Medley and Horne 2005, p.34).

The use of simulation tools is starting to play an increasingly important role in the education of healthcare trainees and providers. Whether it is acquired under simulated condition or in real-life, accumulated and repeated experience often improves performance and confidence (Morgan and Cleave-Hogg, 2002). This applies to all activities in life and is particularly important for healthcare professionals to whom the primary concern is to save lives and ensure patients' well-being. The variety of simulation tools now available means that this teaching approach is appropriate for any learning objective whether it involves cognitive, psychomotor, or non-technical skills. However until recently there has been little strong evidence supporting the value of simulation based training and any positive impact in real practice.

II.7.1/ Providing a realistic learning experience

It is a pre-requisite that anyone taking part in full-scale or high-fidelity simulation training already possesses the underpinning knowledge and skills that will be required during the scenarios (Abrahamson and Wallace, 1980, Kardong-Edgren et al., 2008, Hegarty and Bloch, 2002, Alinier, 2011). Due to the preparation, equipment, and

human resources required, the cost of running simulation sessions is not negligible, which implies that it should be used effectively and at a proper time in the training curriculum to be profitable as a teaching and learning experience for the people who are exposed to it (Murray and Schneider, 1997). Depending on the degree of fidelity (Beaubien and Baker, 2004, Miller, 1984, Alinier, 2007b), or on the technology used, an important amount of preparation time can be required to develop and run challenging and realistic scenarios enabling effective learning.

As stated earlier, a simulation is a practical experience that produces a convincing re-creation of a real-life event or set of conditions. Trainees should become focused on the exercise whether it is screen-based or in a full-scale, high-fidelity simulated environment. For full-scale simulation, the environment in which it takes place plays an important part in how effective the simulation learning exercise will be. The parameters involved include the atmosphere created in the room (equipment/decoration/noise), the task being undertaken, the distractions, the number of participants or trainees, and the timescale over which the scenario is occurring. All these parameters have to be as realistic as possible in the eyes of the learners to offer the best experience possible towards providing better learning outcomes (Seropian, 2003). Even if trainees are aware that they are taking part in a simulated exercise, it is essential that it reflects reality to totally engage them and help them suspend disbelief (Gaba, 2004). It is important to help participants experience the same pressure and stress they would have in real-life. This refers to the psychological fidelity (Borodzicz, 2004). In such a situation, not having their tutor hovering near them or giving prompts helps trainees forget more rapidly that they are taking part in a simulated exercise and encourages them to make decisions by themselves. Similarly trainees should be asked to dress as they would in their professional role. It is very useful to help them to get into their role in a scenario, especially when it involves participants from different disciplines who may not know each other as their uniform may help them to identify each other's role and profession.

The briefing of the trainees and their orientation to the environment and simulation specific equipment is one of the key components of any simulation session. No assumptions can or should be made about the participants' knowledge and they should all be fully briefed about how the session is run, what is expected from them, how the patient simulator operates, and the overarching learning objectives of the session (Kneebone, 1999, Alinier et al., 2006b). From personal experience, simulation sessions bringing together trainees from different specialties who are not used to working

together should include an ice breaking activity. It helps trainees to learn about each other and facilitates communication and teamwork during the actual scenarios. For the "student-led" type of sessions (Figure 4), trainees should be informed that they should not expect significant input from the facilitators, other than in an acting capacity and that they are themselves in charge of their "patient". In order to drive the scenarios in a particular direction, a facilitator or a trainee might be used as an actor to create a disruption, deliberately commit an error, or simply help by performing a particular procedure for which the trainee is not qualified (Seropian, 2003, Alinier, 2011). This approach helps to offer a "high-fidelity" simulation experience to the participants, irrespective of the type of simulator used.

When familiarising the trainees with the environment and the patient simulator, and irrespective of its degree of sophistication and interactive capabilities in terms of gases and drugs' recognition, they should be told that they need to clearly specify what treatment they are administering (drug/dose/concentration/route) to the patient so the operator can adjust appropriately and in real time its physiological parameters. Such a point is also valid for high-fidelity patient simulators with the capacity to sense drug therapy as it encourages good communication and teamwork practice among trainees. It sometimes allows them to pick up each other's mistakes and prevent medical errors from occurring during a scenario which can then be discussed during the debriefing to emphasise the importance of good communication. It also enables trainees observing the scenario remotely to stay informed, think, and discuss the treatment their peers are providing to the patient simulator.

The adoption of high or intermediate-fidelity simulation technology is often accompanied by the installation of Audio/Video systems which enable other trainees to observe the performance of their peers in a non-disruptive manner from another room (Alinier et al., 2006b, Alinier, 2008b, Alinier, 2007a). In a similar way as not having their tutor directly observing trainees, keeping their peers away from the simulation scene helps them to concentrate on the scenario and to take it more seriously. While in the observation room the other trainees can freely discuss the actions taken by the scenario participants. It helps them to realise how differently they act and think under stress depending on whether they are part of a crisis or if they are simply observing it remotely. Such a facility usually allows for recording and playback of the scenarios which can sometimes provide very good support for debriefing purposes of particular aspects of patient care and teamwork such as communication and situation awareness.

II.7.2/ Consequences of misuse

Misuse of simulation terminology can give false impressions to trainees, making them believe that they are fully prepared to confront reality. They could become overconfident when faced with reality where they may perform badly. This frequently results in loss of motivation, ambition, and self-confidence, and a consequent lack of trust in their own expertise and their tutors. Similarly, when using two-dimensional media or other methods like screen-based simulation, trainees should be warned that their behaviour in "providing" or "suggesting" care to an actor on a video would often be very different to the one they would have in a real context due to the lack of physical and psychological fidelity. For example, trainees' response to interactive training videotapes showing trauma wounds would probably be very different to them treating real wounds. Providing care involves more than just intellectual processes. Emotional effects of acute real-life encounters can affect our thinking abilities and skills. Things can be much more bearable out of context or in a non-realistic environment than they are in real circumstances, and trainees may not appreciate that fact (Alinier, 2007b).

Another possible issue relates to knowing when to introduce in the students' curriculum which form of simulation modality. For example one should not involve students in a "student-led" simulation session until they have the underpinning skills or pre-requisite knowledge required in the scenarios they are being exposed too. This could make trainees feel powerless and very vulnerable. They might develop a dislike of high-fidelity simulation-based learning. This very point shows the importance and value of clinical skills training, a low-fidelity simulation approach that helps students acquire various basic skills as distinctive components. It is a learning stage that cannot be by-passed to accelerate learning as it is an integral component of the knowledge and skills escalator or continuum (Maran and Glavin, 2003) which will later be presented as a framework for acquisition of experience and skills through practical and simulation-based learning activities (Figure 6) (Alinier, 2007b). It is recognised that trainees already feel apprehensive about their first simulation exposure as they often view it as an assessment exercise where their skills and knowledge can be judged by the facilitators and their peers. They however often report that simulation will help them to better remember what they are learning as it bridges the gap between theory and practice.

It could be argued that trainees should not be taught using simulation training tools as such, except alongside a wide range of delivery methods aimed at teaching a particular skill. Even if transferability of skills from part-task trainers to real patients was demonstrated for a number of skills such as airway management (Roberts et al., 1997) and cardiovascular assessment (Woolliscroft et al., 1987), there is a danger that trainees become skilful at dealing with the simulation technology itself rather than with actual patients. Trainers have to make sure that the skills assimilated by trainees are not becoming automatic procedures that can only be performed using a given model and under certain circumstances. Primarily those media are employed to get trainees used to practising clinical procedures which will then be performed on real patients. Exercises or scenarios should be varied in difficulty and in the succession of events occurring thus allowing trainees to experience the range of situations and patient behaviour or responses, recognising that no one is the "*average patient*" (Alinier, 2007b).

II.8/ The advantages of medical simulation

Simulation has a number of advantages over any other training method previously used to practise high levels of cognitive and practical skills. It is a very ethical and safe way of learning without causing harm, inconvenience, or putting patients at risk (Miller, 1987, Ziv et al., 2000, Ziv et al., 2003). The elements, such as the patient and the environment are totally controllable in terms of the experience one chooses to expose the students to such as patients with particular medical conditions and the presence of distractive events. It allows trainees to experience and learn contextually, which promotes understanding and retention of knowledge (Hegarty and Bloch, 2002, Dieckmann et al., 2007a, Cleave-Hogg and Morgan, 2002, Maran and Glavin, 2003, Borodzicz, 2004). Simulation is also a very convenient method of formatively assessing specific skills. The assessment component can take place during scenario through observation or during debriefing by questioning trainees. Because it is a controllable environment, identical scenarios can be repeated with different groups of trainees (Miller, 1984, Morgan et al., 2003, Seropian, 2003) or they can be customised to incrementally augment the difficulty of a patient case. By varying parameters of scenarios it is possible to expose trainees to a wider range of possible behaviours and outcomes than they could encounter in clinical practice in a given length of time. As a

result of observations drawn from scenarios, weaknesses can be identified and trainees can be encouraged to practise particular skills until they master them at a satisfactory level.

High-fidelity simulation involves more than trainees practising complex protocols, patient management or clinical skills. Simulation can easily integrate the human factor dimension where non-technical skills such as teamwork, communication, leadership or decision making skills can be contextually applied (For example: Operating theatre, Accident and Emergency, pre-hospital settings). This is an area that is now becoming well established and contextually developed and is often referred to as Crisis Resource Management (CRM) training (Beaubien and Baker, 2004, Leonard et al., 2004, Holzman et al., 1995, Aggarwal et al., 2004, Gaba et al., 2001) and draws its principles from the aviation training industry (Helmreich, 2000). It often forms part of CPD activities involving postgraduate trainees and experienced healthcare practitioners but is now extending to undergraduate trainees with whom there is now a greater emphasis on interprofessional education (Alinier et al., 2009, Ker et al., 2003, Hallikainen et al., 2007, Mikkelsen Kyrkjebø et al., 2006). Due to their lack of clinical practice experience, this often implies looking at much more than the actual clinical scenario, communication, and team working skills, as facilitators may need to address a much broader variety of aspects ranging from health and safety, differences in manual handling practices, to pharmacology.

A review from Miller (1990) on the assessment of clinical skills, competence and performance, raises an interesting point concerning the performance and action components of future graduates (Figure 5). According to Miller, examinations should be designed so as to test students in conditions closely related to their future professional function. The pyramid or triangle Miller used for illustrative purposes shows the different skills stages that trainees should be able to demonstrate (Figure 5). "*Faculties* [Educators] *should seek both instructional methods and evaluation procedures that fall in the upper reaches of this triangle*" (Miller 1990, p. 65). This represents the stage where students have to demonstrate that they are able to apply their skills and knowledge appropriately. It would have for an outcome that students are better prepared for their future professional role.

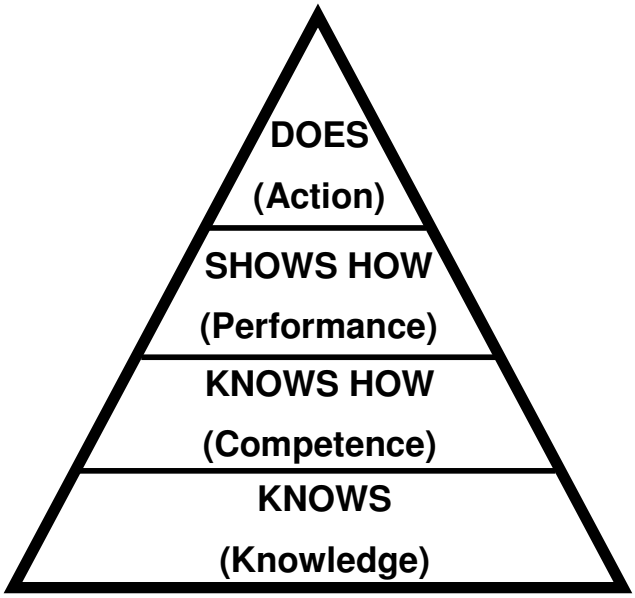

Figure 5: Framework for assessment proposed by Miller, 1990.

Provided it is rigorously organised, simulation can be used for summative assessment as it can recreate realistic situations that place trainees close to the top of Miller's pyramid (Miller, 1990) (Figure 5) where trainees would independently decide on a course of *action* and demonstrate their knowledge and skills. Alternatively, at a lower degree of fidelity, a range of skills using several simulation modalities can be examined much more easily by breaking down the activities into smaller simulation tasks using Objective Structured Clinical Examinations (OSCE) (Alinier, 2003, Harden and Gleeson, 1979). For example trainees can be asked to *perform* a particular procedure, hence showing how they would do it. At even lower stages of this pyramid, trainees can be requested to demonstrate their *competence* by explaining how they would perform a procedure during a viva, or simply demonstrate their *knowledge* of a procedure in the form of a written exercise.

Figure 6 illustrates the proposed framework for acquisition of experience, knowledge, and skills through practical and simulation-based learning activities adapted from Miller's pyramid (1990) and according to the simulation levels defined in the proposed typology (Table 1) (Alinier, 2007b).

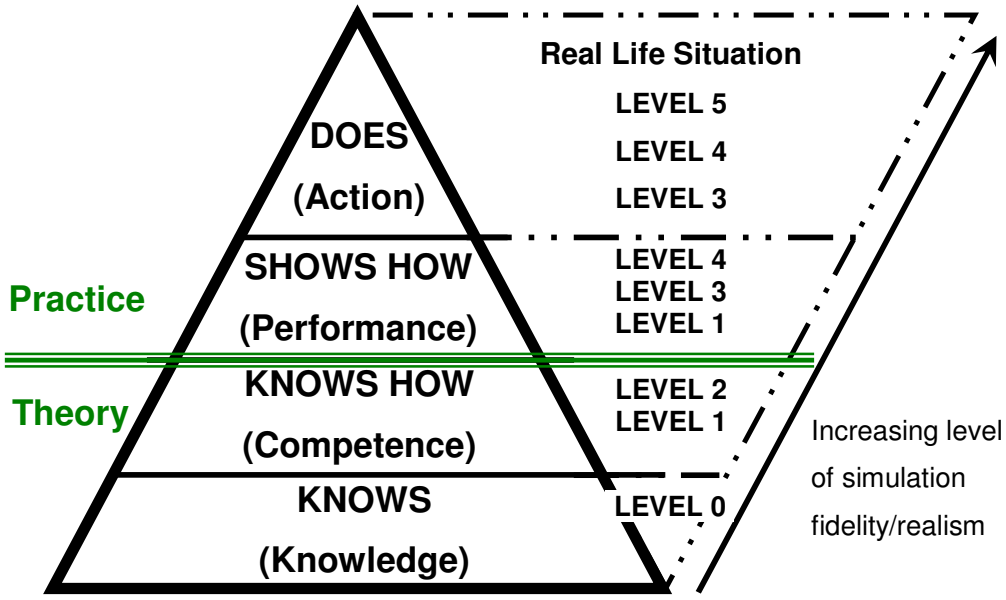

Figure 6: Framework for acquisition of experience through practical and simulation-based learning activities (Alinier, 2007b).

II.9/ The drawbacks of simulation in healthcare

One might think that simulation-based training allows for a high throughput of trainees, however it is not the case as the learning experience is more individualised and appropriate human and physical resources need to be available. When dealing with the action component of the framework for acquisition of experience (Figure 6), we are aiming to expose students to a high-fidelity simulation experience, which means that, as in real life a very limited number of trainees can be involved in any scenario. Simulation relies heavily on space, time, equipment, and skilled human resources, which makes this type of educational approach very expensive to provide and facilitate. It presents inevitable shortcomings for many institutions which creates a barrier. Setting up and running even the smallest simulation centre can be very expensive as it requires clinical and technical staffing, a patient simulator or simulated patient (generally paid) in a simulated operational clinical area, a control room, a debriefing room, and an integrated Audio/Visual system to enable remote observation and recording for review and debriefing purposes. High students' numbers, staff availability,

and other technological or resource limitations might restrict trainees' simulation exposures.

The trainees' first encounter with the patient simulator through a scenario is often only an adaptation period, even after an introductory and familiarisation period at the beginning of a session. It is mainly during a second scenario that a student will really start to be able to adapt and treat the patient simulator more realistically. This implies that each trainee should be involved in a minimum of two scenarios to benefit from a first simulation encounter. This remark is supported by findings from Dieckmann et al. (2007b) who interviewed participants after each scenario they took part in and reported they felt increasingly secure having become more used to the patient simulator and simulation environment. Taking into consideration that scenarios are run in almost real time and are followed by a debriefing period which will cover several learning points, each scenario and debriefing period might take up to one hour. Depending on the scenarios and on the healthcare professional groups represented, three to five trainees might be involved in each scenario. These facts show that it is difficult to offer adequate and beneficial simulation exposure to more than six to eight trainees over a half-day of simulation learning, especially if it is uniprofessional. This educational approach is and should be about providing a quality learning and hands-on experience to a few trainees at a time.

Some major limitations of simulation training relate to the actual features of the patient simulators rather than the environment. The environment is in fact made up of functional pieces of technological equipment which can be real or rebuilt or adapted to fit the simulation purposes. The patient simulator is however a substitute for the real patient and designing such a system to allow the replication of a wide range of clinical cases is a difficult challenge. Despite the progress in terms of the technology used in the design of the most advanced patient simulators to make them more interactive and human-like, they still have a number of shortcomings that make them unrealistic, especially for students with very little clinical experience. Important features such as the lack of skin tone, feel, temperature, facial expressions, capillary refill, and mobility, and which yet are technically achievable but would make patient simulators totally cost prohibitive, represent important limitations. The lack of these features means that a small minority of students still have difficulties considering and treating patient simulators like real patients. These aspects can be critical for the initial patient assessment or the recognition of symptoms as they provide visual and physical cues. In the present time, make-up needs to be applied, students may ask about the physical

appearance of the patient, or students may be prompted through the patient voice with the patient saying for example “I am cold” or “I am hot”.

Several studies have qualitatively explored the potential of simulation training and obtained encouraging responses with primarily cost as the main disadvantage (Gordon et al., 2001). Investment in US$250,000.00 patient simulators has been made by many institutions worldwide, yet it is recognised that very few robust studies have demonstrated their real effectiveness in healthcare education (Beaubien and Baker, 2004, Ziv et al., 2000, Gordon et al., 2001, Forrest and Taylor, 1998). Until strong evidence is found to support the use of simulation in healthcare education, the cost will remain a major obstacle to the widespread development of such learning methods. The role of teaching institutions is to prepare students for their future professional activity. Teaching is about providing students with opportunities to learn so they can gain knowledge and skills (Brown and Atkins, 1988). To achieve this, educators should endeavour to use a range of the most appropriate teaching methods, and this should include some simulated exercises for the acquisition of experience and forms of OSCE for formative and summative assessment. One of the aims of the research presented in this thesis is to determine if exposure of nursing students to scenario-based simulation significantly improves their skills in comparison to students who do not benefit from the same opportunity. To measure the effectiveness of scenario-based simulation training, the tool used was the OSCE which is introduced in chapter IV.

II.10/ Chapter summary

The history of patient simulators presented in this chapter pans out over the past 50 years rather than since the first appearance of training models such as the birthing machine from Madame Du Coudray in 1756 (Gelbart, 1998). Since 1960, the Laerdal Resusci-Anne has been and still is a key training mannequin for the acquisition of CPR skills in the history of modern resuscitation techniques. Although there have been a number of more complete and complex mannequins developed following that such as the Sim One anaesthetic training mannequin and the Harvey cardiology patient simulator, they have not had the same educational impact. Their higher degree of sophistication and development cost has respectively prohibited the commercial production of the Sim One, and slowed down the adoption of Harvey in medical

schools across the world. The second “birth” of patient simulators was linked to the realisation that their use could be extended well beyond the practice and acquisition of clinical skills. Teamwork and human factors were central to the development of the “Comprehensive Anesthesia Simulation Environment” by Gaba and colleagues and was commercialised for a decade under the name “MedSim Eagle”. Other teams around the world also made attempts at developing their own patient simulator such as the Leiden Anaesthesia Simulator (LAS) in the Netherlands, the Sophus Anaesthesia Simulator in Denmark, the Anaesthesia Computer Controlled Emergency Situation Simulator (ACCESS) in the UK, and the Gainesville Anesthesia Simulator (GAS) in the USA, which was the most sophisticated of all. The patents of the latter one were sold to Medical Education Technology, Inc (METI) who renamed and commercialised it as the “Human Patient Simulator” (HPS) in 1996. More recently, a large number of adult and paediatric patient simulators have appeared on the market such as the Laerdal SimMan used in this study. Their price generally matches their level of sophistication, interactivity, and autonomous level of operation. They are commonly referred to as low, medium or intermediate, and high-fidelity patient simulators, but it is commonly accepted that the same learning can often be achieved with both intermediate and high-fidelity patient simulators provided the same facilitation style is adopted.

This chapter has clearly demonstrated the point that that simulation is an educational approach rather than a tool, but that it very often means a different thing to different people. Simulation being increasingly popular, associations who organise regular scientific meetings have been created as well as specialised peer reviewed journals dedicated to simulated practice in healthcare. Both are fundamental to the sharing of good practice and development of the educators involved in simulation-based training. A typology derived by the author of this thesis and focusing on the technology or simulation medium has been presented in relation to its educational application with students and in contrast to earlier typologies. Clear explanations regarding the different simulation training modalities, as trainer-led (low or intermediate-fidelity) or student-led (high-fidelity) have been provided in relation to the level of experience of the learners. For students to benefit from the best possible experience acquired through simulation, it needs to be facilitated by educators who appreciate all the intricacies of this educational approach and its variances. As a concluding note, the currently perceived advantages and drawbacks of simulation-based education have been presented.

Chapter III
Review of the relevant simulation literature

This chapter will explore the current simulation literature relevant to various aspects of the programme of research of this thesis. The main domains are namely exploring the adoption of a modern training approach such as simulation to better prepare the future healthcare workforce, the assessment of competence and how it can be achieved in a simulation context, debriefing and how it differentiates from feedback and recommendations on how it should be facilitated, the use of simulation in undergraduate interprofessional education, and an overview of the research on the effect of simulation education in patient safety and on patient outcome.

III.1/ Adapting teaching practices to a changing work environment

Contemporary clinical environments with their increasing patient numbers with high acuity illness and or injury require nurses to be able to rapidly and competently respond to changes in patients' conditions. Newly qualified nurses must also have advanced skills in order to work in today's technologically complex clinical settings (Chase and Pruitt, 2006). However it has been found in an American national survey conducted in 2003 that nearly one fifth of the 496 nursing students who responded were concerned about the quality of the nursing education they received as they thought they were not developing real nursing experience (Norman et al., 2005). In addition, it has become apparent that newly graduated nurses are often lacking the skills required to survive in a modern and technology advanced clinical environment (McDowell and Ma, 2007).

Nurse educators need to use innovative teaching strategies to appropriately prepare students for the reality of clinical practice where technology is increasingly used, especially due to the limited availability of quality clinical placements and mentors (Dugan and Amorim, 2007, Magnusson et al., 2007). Experience in the clinical settings cannot be pre-planned, so while on placement students are often not exposed to experiences that correspond to the content taught in the classroom setting (Comer, 2005). One approach that has been suggested to help prepare nursing students practise safely in the clinical setting is through the use of the latest educational technologies (Bellack, 2004, Henneman et al., 2007, Jeffries, 2005). However it is important to consider that our teaching approach needs to evolve alongside the educational technology used (Alinier, 2007b). Scenario-based simulation training making use of simulated patients or computer-controlled mannequins has gained increasing popularity in healthcare education (Ziv et al., 2006, McGaghie et al., 2006, Bradley, 2006, Issenberg et al., 2005). It affords the opportunity to provide learners with an environment to develop important cognitive and psychomotor skills away from the real clinical setting (Spunt et al., 2004). It also enables educators to tailor the scenario-based simulation experience offered to the students with the curriculum taught in the classroom, hence significantly enhancing their learning experience.

III.2/ Assessment of competence using simulation

In nurse education, the assessment of clinical competence forms part of approximately half of the overall volume of assessment of individual students while the other half is dedicated to theoretical assessment (Watson et al., 2002). Watson et al. (2002) also discuss the fact that the assessment of competence always involves some form of assessment by someone. The assessment of competence through direct observation in the practice setting used to be the preferred and recommended modality (McKinley et al., 2001) however changes in the teaching methodologies and technology have started to make simulation a more attractive modality for the assessment of clinical competencies. An alternative to clinical placement observations which was introduced in medical education in the 1970's and is still in use in various healthcare disciplines and in various forms nowadays is the Objective Structured Clinical Examination

(OSCE) (Harden McG et al., 1975). The concept of the OSCE will be discussed in section IV.1, but it is worth mentioning that it provides an assessment modality that enables students to demonstrate their clinical competence under a variety of simulated conditions while being observed by assessors who preferably do not know the students to increase the objectivity of the process (Watson et al., 2002). Simulated conditions are sometimes perceived as 'second best' (Eraut, 1994) because it can be perceived as artificial however well a station has been designed. Watson et al. (2002) in their paper focusing on the research evidence for the use of clinical competence assessment in nursing discuss the fact that the assessment of clinical competence is a difficult issue due to the selection decisions to be made with regards to the wide array of competencies that could potentially be assessed. The other dilemmas are whether competence should be assessed globally or through multiple competencies, and the lack of objectivity of assessment methods due to the tool used or the potential familiarity of the examiners with the students. Watson et al. (2002) argues that simulation overcomes some of these problems but raises others, such as the lack of validity because it is simulation rather than a real patient encounter. The realism of any simulation experience is always contestable, from the perspective of the scenario which has been developed and the technology used. The realism is also contestable with respect to the behaviour of the learners who are reacting to the scenario whilst being totally aware it is not a real situation and that they are being observed, hence being subjected to a different kind of stress. Simulation offers both a unique method and opportunity for the assessment of knowledge, clinical competence, and clinical judgement as it provides a safe, controlled, and potentially realistic context that can be reproduced as many times as necessary to ensure fairness in the examination process of learners as long as the potential variability of the other parameters, such as the assessment tool and/or the assessors, are also appropriately managed. Very few studies report the use of scenario-based simulation to assess the competence of nursing students.

Very short scenarios involving a simulated patient (actor) have been used very successfully by a team of nurse educators in the UK as part of an OSCE designed to minimise examination anxiety and closely simulate clinical practice. It was organised in a way so that the students did not have to move around different stations but remained throughout the process with the same trained assessor who took the role of a clinical tutor supervising the students performing various tasks as if they were in the clinical area (Nicol and Freeth, 1998). That example made use of a modified form of global rating that comprised four dimensions (safety, accuracy, effectiveness, and

affectiveness) for each of the 10 stations as well as a 'prompt-list' of expected behaviours for each station to help the assessors evaluate the students' performance (Nicol and Freeth, 1998). Global rating scales are meant to allow the grading of the overall performance of a student and reduce the danger of rewarding exhaustive reasoning whereby students try to have "all boxes ticked" rather than exercise clinical judgement. Global rating scales have been reported to be as reliable as traditional checklists (Cunnington et al., 1996, Regehr et al., 1998) in the sense that they provide consistent results in given circumstances. There is however still a reported relative lack of valid evaluation instruments measuring learning outcomes which may be inhibiting the adoption of simulation in nursing education (Kardong-Edgren et al., 2010).

Key areas regarding the use of scenario-based simulation for assessment in anaesthesiology have been identified and described by Boulet and Murray (2010). Their article provides a broad overview of the use of simulation for measuring healthcare provider skills and competencies in a simulated situation. They highlight the following four important areas with regards to the assessment of competence under simulated circumstances in anaesthesia: defining the pertinent skills and choosing relevant tasks, establishing appropriate metrics, determining the sources of measurement error in test scores, and providing evidence to support the validity of test score inferences. While the context is within the field of anaesthesia, the principles and framework discussed have applicability to other healthcare areas and to other assessment environments. Irrespective of whether assessment of competence is done in the clinical environment during a real patient care encounter, in a simulation scenario, or in the more controlled context of an OSCE station, one has to determine what exactly is being assessed and how the performance can be measured in a valid and reliable way.

The development of valid and reliable instruments is often not systematic (Watson et al., 2002) and is a time consuming and complex process that requires various skills and domains of expertise (Stewart and Archbold, 1997). From a validity and reliability point of view, specific elements such as the *content, construct,* and *criterion* of assessment tools need to be carefully developed (Kardong-Edgren et al., 2010). For each item of an assessment tool, these elements respectively relate to;

- their appropriateness and comprehensiveness of the measurement.
- the process of establishing that a particular action adequately represents the concept being evaluated.

- and a measure of how well each item or cluster of items in an instrument predicts success on all other measures.

Instruments need to capture information about attributes important in nursing practice, such as the affective (or behavioural), cognitive, and psychomotor (technical) learning domains (Jefferies and Norton, 2005). To that effect a number of instruments evaluating these very domains have been developed and tested, sometimes with reported reliability and validity.

Radhakrishnan, Roche, and Cunningham (2007) conducted a quasi-experimental pilot study with nursing students to look at various performance categories assessed using simulation. They were namely: safety, basic assessment, prioritization, problem-focused assessment, ensuing interventions, delegation, and communication, and made use of a researcher developed evaluation tool with tick boxes used by the assessors to capture the observed behaviours. No reliability or validity was reported for the evaluation tool used although the authors mention that objectivity was achieved by using a binary scoring of the expected behaviour (present or absent) performed by an examiner unfamiliar with the students (Radhakrishnan et al., 2007).

A study by Wayne et al. (2006) made use of an observational checklist based on the American Heart Association (AHA) guidelines to assess Advanced Cardiac Life Support (ACLS) competency skills of internal medicine residents. They calculated the inter-rater reliability and internal consistency reliability, and obtained very satisfactory results. Through reliable assessment of the residents' ACLS competence, their study demonstrated the ability of deliberate practice using a patient simulator to produce mastery performance in ACLS scenarios.

Although confined to a limited and predefined range of competencies for which a reliable assessment tool has been developed, these studies demonstrate that simulation can successfully be used as an assessment medium.

III.3/ Debriefing literature

The process of debriefing has been described by Petranek et al. (1992) as "*an oral discussion session in which students and teachers engage in a question and answer*

session designed to guide students through a reflective process about their learning" (p.176). Although it normally takes place after a completed experiential learning episode (Raemer et al., 2011), it is sometimes used during a training exercise ("in-simulation") (Van Heukelom et al., 2010), for example when scenarios are run in a 'stop-and-go' manner. It can be viewed as an educational activity that helps the students to reflect on any feelings about their experience or thoughts about their own competency (Jeffries and Rizzolo, 2006). Fanning and Gaba (2007) have defined debriefing as a "*facilitated or guided reflection in the cycle of experiential learning*" (p.116). It is during the time of that activity that students are given the opportunity to summarise and integrate what was learned from the experience and develop a sense of accomplishment (Dunlap, 2005). It can also be self-empowering to students as it allows them to learn to monitor their own performance (Teekman, 2000). However we may not necessarily be learning from all our experiences as we need to take time to reflect on them, derive meaning, and recognise circumstances when what we have learnt can be applied (Thiagarajan (1998). In a healthcare education context, according to Jeffries (2006) among other experts, this activity is perceived as being so important that the time allocated for it should be at least as long as the duration of the simulation experience itself. Brackenreg (2004) argues that a period of debriefing is a necessity following any experiential learning activity such as a simulation experience to ensure students achieve the desired learning objectives but also to give them the chance to resolve any emotional issues created by the experience. Without time for debriefing and reflection students would be left to develop their own meaning from the experience, which may not be the meaning intended by the facilitator.

Reflection does not just happen as students often need guidance to initiate reflective processes (Moon, 2000). The role of the facilitator can be adjusted to the level of the students for the debriefing to achieve its goals (Dieckmann et al., 2009). This can be achieved by guiding the reflection of the students step by step so they can derive a meaning from the context, actions, and events that occurred. A key role of the facilitator is to identify and close gaps in the knowledge and skills of the learners (Raemer et al., 2011). A study using a 2-group, repeated measures, experimental design conducted by Shinnick et al. (2011) with nursing students demonstrated that debriefing is the most significant contributor to knowledge acquisition following high-fidelity simulation training. A good debriefing helps learners understand every aspects of the events of a scenario and the effect of their actions on the direction it took. Should they be placed in a similar situation in a real clinical environment, it is expected that the

learners will benefit from having previously reflected about that type of situation and make the right decision or action.

Feedback and debriefing are not interchangeable words and the distinction should be made clear. Feedback relies on information being passed from an instructor to a learner following an event whereby the trainee is 'corrected' while being fairly passive, simply receiving guidelines for adjustment and development, often in relation to a psychomotor or technical skill. Debriefing however takes into account the fact that individuals learn far better as active participants responsible for their own learning process (Dismukes and Smith, 2000) and takes the form of a dialogue to gather information. To highlight the difference an emphasis is often made on the fact that a debriefing should be '*facilitated*' (Dismukes et al., 2006, Fanning and Gaba, 2007).

Dewey (1933) provided an early perspective on reflective thinking which implied that it is a form of thinking that involves turning a subject over multiple times in the mind to consider it from various aspects. He described this type of thinking as orderly and leading to some conclusion based on the ideas or situation considered. In his own words, the function of reflective thinking is "*to transform a situation in which there is experienced obscurity, doubt, conflict, disturbance of some sort, into a situation that is clear, coherent, settled, harmonious*" (p.100). A distinction was made by Schön (1987) between 'reflection on action' and 'reflection in action', the first one being self reflection that occurs while an individual is involved in some experience, while the other one is about thinking back on what we have done in order to realize how our insight in action may have contributed to an unexpected outcome. According to Schön (1987) learning occurs in low risk environments when students are guided through their reflection to understand what is the most important from the learning experience. The success of reflection on action depends on a fine tuned dialogue between the facilitator and the students where emotions and thinking processes are carefully considered and discussed. The debriefing facilitator is also responsible for providing advice, evaluation, or explanations to assist the students learn what is required. According to Schön (1987), the result of this reflection on action is knowledge and skills that can be applied in future performances and in reflection in action during these future performances.

According to the Experiential Learning Model described by Kolb (1984) learning occurs by providing students with a realistic experience which is followed by a period of reflective observation in which the experience is examined from multiple perspectives. He describes learning as being a "*process whereby knowledge is created through the*

transformation of experience" (p.38). It can be said that a period of reflection leads to the development of abstract conceptualisations or patterns and meanings about the experience. These conceptualisations are used to develop hypotheses that are tested through active experimentation in future performances and actions. Simulation provides a unique medium for such experience as it can be used to guide future actions for situations that may not commonly be experienced in clinical practice due to their rare nature for example.

Despite this theoretical information which provides a general overview of guided reflection and the type of thinking required during debriefing, there are limited best practice approaches directly related to simulation in healthcare education published in the literature (Fanning and Gaba, 2007, Raemer et al., 2011). Recommendations made by Thiagarajan (1998) regarding debriefing can be applied to the healthcare education setting as he suggests that it should be structured and consist of several standard steps. These steps include the exploration of the feelings and emotions, discussion of intentions or objectives of the experience, sharing of insights to explore perceptions, discussions of the authenticity of the experience and its applicability to real life situations, and what could have been done differently. Also in line with the work from Petranek et al. (1992), similar debriefing steps have been proposed by Hertel and Millis (2002). They include discussions of emotions and what happened during the simulation focusing on personalisation and reasons of actions taken, application of the experience to both past and future learning, and how the simulation can be applied in real life situations. These steps are essential to debriefing and are what makes it so different from feedback which is so unidirectional.

Simon et al. (2010) have developed the 'Debriefing Assessment for Simulation in Healthcare' (DASH) tools which uses a behaviourally anchored rating scale to identify the extent to which students or peer-facilitators perceive that the facilitator demonstrated six elements crucial to an effective debriefing session following a simulation experience. The elements relate to:

1 – Establishing an engaging learning environment.
2 – Maintaining an engaging learning environment.
3 – Structuring the debriefing in an organised way.
4 – Provoking engaging discussions.
5 – Identifying and exploring performance gaps.
6 – Helping simulation participants achieve or sustain good practice (p.3).

Although this contains subjective elements, it provides a useful guide for facilitators to ensure they adhere to agreed principles regarding a good debriefing. In use, the attention facilitators will have to pay to its different elements will vary greatly depending on the type of learners. A varying degree of emphasis may be required on the different elements depending on the outcome of a scenario or the level of the learners. For example some learners may require the facilitators to constantly ensure the debriefing remains structured, whilst with other learners the facilitators will need to put more effort on provoking an engaging discussion.

Mort and Donahue (2004) propose that debriefing should cover the 'four E's': events, emotions, empathy, and explanations in the form of a discussion addressing each of these pointers. These are key elements of any scenario-based learning episode as addressing them helps both the learners and facilitators derive a better understanding of what happened. Facilitators should demonstrate empathy to the students by acknowledging that their thoughts and emotions are all valid, but in general it encompasses the contents of the steps presented earlier in terms of establishing and maintaining an engaging learning environment. Although not detailing how to conduct a debriefing, Owen and Follows (2006) have proposed the mnemonic 'GREAT' as a pointer for the debriefing of simulation sessions by encouraging facilitators to:

- Refer to the most recent '**Guidelines**' related to the scenario.
- Use '**Recommendations**' from published reviews in the absence of guidelines.
- Give time to learners to reflect on the simulation to identify the key '**Events**'.
- Help learners go through a detailed '**Analysis**' of the simulation experience.
- And help learners identify what learning they will be able to '**Transfer**' to clinical practice.

With the exception of the last letter which can be used during the summary of a debriefing, 'GREAT' is not presented in a chronological order for direct implementation. On the contrary the facilitator will often be required to jump back and forth between the different elements as different parts of the scenarios are analysed. The first two elements of the mnemonic require advance preparation on the part of the facilitators and on well developed and up-to-date scenarios, that information should be readily available to them. The last three letters require learners to think about the learning experience and its implication on their future clinical practice.

With respect to the way a debriefing is facilitated it has been identified that learners may not fully benefit and even complain from a debriefing which focuses primarily on

their positive actions rather than areas where they could improve or made mistakes (Lasater, 2007). Rather than being totally non-judgemental Rudolph et al. (2006, , 2007b, Rudolph et al., 2008) advocate for 'debriefing with good judgement' whereby the student's frame of reference that informed an action is taken into consideration, thus helping them to understand what needs to be learned from the experience. This needs to be done in a way that does not put students on the defensive by using an approach that pairs advocacy with enquiry in order to understand the students' perspective of their performance during the scenario (Rudolph et al., 2006). For example a facilitator could objectively describe an observed behaviour and result, which is the advocacy component, and then ask the students to clarify this observation and ascertain the students' perspective and reason for the behaviour, which is the inquiry component. Asking students about their perspective demonstrates respect on the part of the facilitator which should promote a good learning environment. Gaining the students' confidence and creating a safe learning environment are important ingredients of a debriefing session as well as clarifying the format of such event and ensuring mutual confidentiality from the start of a simulation session (Fanning and Gaba, 2007). Keeping motivation active and providing psychological safety also needs to be considered (Kuiper et al., 2008) and are key to ensuring an engaging learning environment. As summarised by Rudolph et al. (2008) "*Effective debriefers are neither harshly judgmental nor falsely "non-judgemental"; they neither berate students nor sugar-coat or camouflage criticisms. Rather, they provide clear, honest critiques in a way that is respectful and curious about the student's perspectives"* (p.1010-1011). Rall et al. (2000) in the conclusion of their paper emphasise the critical importance of well facilitated debriefing and the potentially devastating consequence of a poorly facilitated debriefing. The debriefing phase is such a crucial component of the simulation experience that it can literally negate any learning that may have taken place during the scenario and irreversibly demoralise learners.

III.4/ Research in interprofessional education using simulation

It has been argued by Freeth and Nicol (1998) that "*Successful interprofessional learning can provide a model for effective, collaborative working*" (p.455). Research

conducted with patients in a primary care setting over a 15-month period indicates that multidisciplinary healthcare teams should be the main strategy for effective care of chronically ill patients (Rodriguez et al., 2007). Grumbach and Bodemheimer (2004) advocate that enhanced patient outcomes and greater patient satisfaction can be achieved when an interdisciplinary team approach is adopted. To that effect, it is easily arguable that efforts should be made for healthcare professionals to be better prepared to learn to work together for the benefit of their patients. In the last decade Interprofessional Education (IPE) has become a focal point in the UK (General Medical Council, 2009, Department of Health, 2000, Chief Medical Officer, 2009, Department of Health, 2008b) and more widely in the international healthcare training agendas through national reforms and recommendations (World Health Organization, 1988, Goble, 2004, Rosen, 2008, Mikkelsen Kyrkjebø and Brattebø, 2006), as well as local initiatives (Johnson et al., 2011).

Multiprofessional, multidisciplinary and interprofessional, interdisciplinary are often used interchangeably (Finch, 2000, Pirrie et al., 1999) yet the terms do not have exactly the same meaning. The first two refer to a number of professions or disciplines being represented, while the other two imply a level of interaction between these professions or disciplines. For example, multiprofessional education has been defined by Thistlethwaite and Nisbet (2007) as "*occasions when two or more professions learn side by side*" (P.68). In contrast, Interprofessional Education (IPE) is defined as an educational episode when members of two or more healthcare professions engage in learning with, from, and about each other (Barr et al., 2005). Throughout this thesis reference is regularly made to "multidisciplinary project", "multidisciplinary scenario" and "multidisciplinary teams" in the sense that it involves several disciplines and professions but only becomes interdisciplinary or interprofessional when an exchange has occurred between the parties represented through an activity when it can then be referred to as interprofessional simulation education for example.

It is suggested that the introduction of IPE has the potential to prevent barriers from arising between different professional groups (Ker et al., 2003) or to highlight those and help develop mutual respect among team members from different disciplines (Mikkelsen Kyrkjebø and Brattebø, 2006). There is also evidence that IPE can help breaking down stereotypical views professionals hold about one another and can result in an increased understanding of the roles, responsibilities, strengths, and limitations of other professions (Barr et al., 2005, Parsell and Bligh, 1999). As highlighted by Bradley (2006), scenario-based simulation can promote the importance of team-based and

interprofessional approaches to learning and health care. The protected time provided by simulation sessions and the debriefing following each scenario are ideal opportunities to explore interprofessional team work.

Work on clinical IPE using simulation is not that novel and the value of such learning experience has been appraised by medical students and newly qualified nurses taking part in an interprofessional clinical skills course away from the real ward environment (Freeth and Nicol, 1998). The course participants were involved in the "simulated" management and follow through of a complete patient care pathway from admission to discharge, with intermittent and contextualised psychomotor or technical and cognitive skills learning. The general feedback on the course was that it was a valuable experience for all participants as it provided them insight that was going to impact on their own clinical practice and emphasised the fact that patient care is a team approach. It helped them to clarify their own role and to also better understand the role of the other care providers. Although it was reported that the feedback received from the participants was overwhelmingly positive, the medical students expressed their dislike for the communication element of the course despite the generally recognised need for a novice practitioner to develop their interpersonal skills (Freeth and Nicol, 1998). The most likely reason may be that it was too didactic or that they did not value non-medical elements of clinical practice, like communication, as much as nursing students. The feedback acquired through this type of empirical studies is highly valuable to inform further work conducted in this area so it can be modified to better engage the learners.

Simulation provides a unique opportunity however it is often not as straightforward to organize as one might hope it could be. Many organizational barriers and practical obstacles have already been identified with regards to the implementation of IPE (Cooper et al., 2001, Reeves et al., 2006, Pecukonis et al., 2008, Barnett et al., 2011). These can range from timetable clashes and the important volume of students enrolled on the various programmes to the reluctance from academic staff to adopt a different teaching approach. Issues of professional cultures and diverging opinions do not only exist between healthcare staff from different professions, but also between healthcare educators from different professions, which may be a greater issue as these are the people who should act as the role models for their trainees and from whom they may acquire biases or preconceived ideas about the other healthcare professionals. An important concept which is being promoted by Hamilton (2011) is that of *Interprofessional Cultural Competence* to support the view of Pecukonis et al. (2008)

regarding the avoidance of the creation of *profession-centric practitioners* that we risk if we carry on training healthcare professionals in isolation. Their recommendation to achieve effective and fully integrated IPE in educational programmes is to create curricula that promote interprofessional cultural competence by decreasing profession-centrism.

In 2006, when the Nursing and Midwifery Council invited Higher Education Institutions to undertake a pilot study around the use of simulation in undergraduate nursing education (Nursing and Midwifery Council, 2006), a number of selected institutions organised interprofessional sessions using a variety of simulation modalities and addressing various learning objectives. In one of the related published pilot studies Moule et al. (Moule et al., 2008) describe that the discussions among students from various nursing disciplines that followed the simulations were highlighting different aspects of their professional practice. Students had the opportunity to critically explore the care delivery from different perspectives, based on the disciplines represented in the learning experience. Their study also included an interview process with a limited sample of clinical practice mentors regarding the students' involvement in the simulation sessions. They also reported that students developed knowledge and practical skills, as well as an understanding of team working and appreciation of differing interdisciplinary practices. Although not robustly demonstrated, their study highlighted the fact that simulation was potentially a valuable approach to help students acquire not only knowledge and experience, but also to develop an appreciation for different practices in care delivery approaches.

It is acknowledged that further research is required to prove or disprove the merits of simulation-based education in improving team-based collaboration among undergraduate healthcare students (Hoffman and Harnish, 2007), and how this transfers into the real world post-qualification and impacts on patient outcome. It is already argued that an educational emphasis on health care teamwork may lead to increased job satisfaction, improved mental health, and workforce retention (Xyrichis and Ream, 2008). This is a sign that there is scope for this concept to be better integrated within healthcare educational programmes so the effect can be more rigorously tested.

III.5/ Research on the effect of simulation education in patient safety

Simulation has been reported on several occasions as being used to teach patient safety to healthcare professionals (Henneman et al., 2007, DeVita et al., 2005, Ziv et al., 2000, Kyrkjebø et al., 2006, Mikkelsen Kyrkjebø and Brattebø, 2006, Pian-Smith et al., 2009, Rall and Dieckmann, 2005), it is however argued that not just any simulation-based training experience is beneficial in terms of error reduction and improved patient safety. The educational interventions need to be designed and delivered appropriately. Salas et al. (2005) propose the following guidelines:

1- Understand the training needs and requirements.
2- Instructional features, such as performance measurement and feedback, must be embedded within the simulation.
3- Craft scenarios based on guidance from the identified learning objectives.
4- Create opportunities for assessing and diagnosing individual and/or team performance within the simulation.
5- Guide the learning.
6- Focus on cognitive/psychological simulation fidelity.
7- Form a mutual partnership between subject matter experts and learning experts.
8- Ensure that the training program worked based on multilevel evaluation.

Reliance on perceived benefits or self evaluation of a training intervention with regards to a learner's degree of confidence in performing a procedure or in providing safe patient care is not sufficient. Several studies have demonstrated that it is not a very reliable measure as learners may misjudge their abilities (Davis et al., 2006, Moorthy et al., 2006, Gordon, 1991). A succinct review of simulation publications conducted by Nishisaki et al. (2007) linking patient safety with self-efficacy, competence, and operational performance in the clinical setting showed that further research was sorely needed, especially in the area of team performance. Encouraging results were shared in relation to high-fidelity procedural simulation for endoscopic and surgical procedures with marked benefits in the actual clinical setting. For example, in a randomised control trial involving surgical residents, gallbladder resection was performed 29% faster and with five times less chances of burning non-target tissue in the virtual reality laparoscopy trained group versus residents who had the standard training only

(Seymour et al., 2002). A similar study by Grantcharov et al. (2004) showed that simulation trained residents performed laparoscopic cholecystectomy significantly faster than residents from the control group. Another randomised control group study with residents without previous endovascular experience showed that residents who received the catheter simulation-based training were significantly more successful in completing angioplasty cases and showed higher scores on a procedural checklist and on a global rating scale than residents who received the didactic training for the technique of catheter intervention for angioplasty (Chaer et al., 2006). These examples demonstrate that some training methods are superior to others, and in these cases support the use of simulation.

One of the key advantages of simulation-based education is the opportunity for participants to be exposed to clinical cases using various types of simulation modalities in a safe and controllable environment. Whilst this ensures that patients are not exposed to unnecessary risks, it is also an ideal environment to observe patient safety issues and remedy to them by introducing participants to safer ways of practising. This can be achieved, for example, by introducing them to ways of improving their communication skills through the use a standardised tool like SBAR (Leonard et al., 2004) or ensuring they comply with best standards of practice with regards to clinical skills and infection control. Some evidence linking the benefits of simulation education to patient safety or improved patient outcome is starting to emerge with regards to behavioural, technical and cognitive skills addressed through a simulation-based educational intervention.

One of the first team simulation-based educational interventions that was linked with sustained improved patient outcome, and hence related to patient safety, was in a study published by Draycott et al. (2006) which demonstrated a significant reduction in low 5-minute Apgar scores and hypoxic-ischaemic encephalopathy (HIE), in a tertiary referral maternity unit of a teaching hospital, after the introduction of Obstetrics Emergency Training. It was reported that infants born with 5-minute Apgar scores inferior or equal to 6 decreased from 86.6 to 44.6 per 10,000 births ($P<0.001$) and those with HIE decreased from 27.3 to 13.6 per 10,000 births ($P=0.032$) following the introduction of the training courses (Draycott et al., 2006). From a similar type of educational intervention, the same team also reported a significantly improved neonatal outcome with regards to the management of shoulder dystocia as appropriate delivery manoeuvres were used more systematically and there was a significant reduction in neonatal injury at birth (Draycott et al., 2008). The training interventions mentioned

above also highlighted the importance of team working skills although this was not measured but was a core component of the way the learning occurred.

Another key study demonstrating the benefit of a simulation-based training intervention with regards to patient safety relates to the sustained and significant reduction of catheter related bloodstream infections which, following training intervention, had its medium rate per 1,000 catheter days reduced from 2.7 infections at baseline to 0 at 3 months ($P \leq 0.002$), and from 7.7 at baseline to 1.4 at 16 to 18 months of follow-up ($P < 0.002$) (Barsuk et al., 2009a) . Additional research by the same team regarding the medical residents taking part in the study showed that the simulation-based educational programme increased their skills in simulated central venous catheter insertion with a direct beneficial impact on patient care thanks to decreased related complications (Barsuk et al., 2009b).

III.6/ Chapter summary

Based on the review of the literature presented in this chapter, it is becoming extremely apparent that in the last decade the use of simulation as an educational modality has substantially evolved and increased in order to address particular needs. Whilst still debated with regards to potential lack of validity, it is also more commonly used in the area of assessment to explore psychomotor/technical, affective/behavioural, and cognitive skills because it provides a safe, controlled, and realistic context that can be reproduced as many times as necessary.

An area of simulation that has particularly evolved from a pedagogical point of view is the post-scenario phase, commonly referred to as the “debriefing” which is a facilitated discussion that encourages students to summarise and reflect on their experience as opposed to “feedback” where students receive guidelines for adjustment and development. Debriefing is a key component of simulation-based education that currently has limited published guidelines in the literature for simulation educators. Irrespective of the approach adopted, gaining the students’ confidence and creating a safe learning environment are important ingredients of a good debriefing session as it helps to create a positive learning atmosphere and encourages participants to engage in the discussion.

Relatively little research has been conducted in the area of simulation in interprofessional education, especially at the undergraduate level. Whilst it remains to be proven, it is suggested that introducing IPE has the potential to prevent barriers from arising between different professional groups, and it can certainly promote the importance of team-based approaches in the delivery of health care. Simulation-based IPE opportunities are favourably perceived by students as opposed to more didactic approaches, however the organisation of such experiential learning opportunities is hindered by many organisational barriers and practical obstacles such as timetable issues, potentially important number of programmes with large class sizes, reluctance from educators to change their practice, professional culture issues, and resource limitations.

With regards to the effect of simulation in relation to patient safety, there is good evidence that procedural simulation in areas such as catheter care, angioplasty, endoscopic, and laparoscopic procedures improves performance in the actual clinical setting. It is yet to be tested properly in many other areas of patient care, although similar positive outcomes can be expected. On the behavioural aspect, effect of simulation-based education on teamwork and crisis resource management on patient care in the clinical setting is starting to emerge through a number of studies as simulation is becoming a more widely and rigorously adopted training modality by healthcare institutions.

The review of the literature has shown that aspects of simulation-based education in healthcare still need to be further investigated. In order to contribute to the knowledge-based in this domain the work conducted as part of this research programme looked at the use of full-scale or realistic scenario-based simulation training in nurse education addressing the question What is the impact of scenario-based simulation training on undergraduate students' acquisition of clinical skills and knowledge?". Another aspect which was then thought to be highly relevant and of growing importance was concerning the facilitation of realistic scenario-based simulation training sessions with groups of final year students from different professions and evaluate the educational impact. The research question linked to this second study is:"What is the effect of exposing multidisciplinary teams of undergraduate students to scenario-based simulation training on their knowledge of each others' roles and skills and on their perception towards working as part of a multidisciplinary team?"

Chapter IV
Development of the Research Tools

The first study seeks to improve on methodological weaknesses found in much of the research around scenario-based simulation that had been published before 2001 by using a rigorous experimental design with purposefully developed research tools. When this programme of research started, the available research was weighted heavily towards descriptive and survey research, yielding little data regarding the efficacy of simulation in enhancing cognitive learning (Lammers, 2007, Issenberg et al., 2005). In addition, research in other healthcare fields such as medicine can provide evidence in support of learning methods, but the results must necessarily be treated with caution as the differences in populations and educational programs may limit generalisation from medicine to nursing.

The content of this chapter relates to the development of the research tools, namely the OSCE stations, the simulation scenarios, and the questionnaire. The OSCE was chosen as the assessment strategy as well designed stations can allow for the objective assessment of a very broad range of individual skills. It was also felt that it was different enough from the research intervention not to advantage any particular group of students when comparing their performance. Some of the information presented in this chapter has partially been published in the journals of Nurse Education Today (Alinier, 2003) and Nurse Education in Practice (Alinier et al., 2004).

IV.1/ The OSCE

The Objective Structured Clinical Examination (OSCE) was originally developed in Dundee in the mid-seventies. Harden and Gleeson had the idea of creating this test in order to assess clinical competences of trainee doctors by making them individually

rotate through a number of exercises called “stations” where they could be individually assessed using precise sets of criteria in the form of checklists (Harden and Gleeson, 1979). Throughout the series of stations, trainees could be assessed for example on skills such as patient assessment, interpretation of results, diagnostic, clinical procedures, and communication. Since then, the use of OSCE has been widely and increasingly recognised as an effective evaluation tool and many publications have greeted its use as a means of objectively assessing students’ practical skills across other healthcare disciplines such as nursing, physiotherapy, radiography, pharmacy and dentistry (Marshall and Harris, 2000, Mossey, 2001, Hulett and Gilder, 1986, Alinier, 2003, Austin et al., 2003, Evans et al., 2011).

An OSCE is normally composed of fifteen to twenty short exercises or stations through which students rotate individually as illustrated in Figure 7. Stations can take the form of small scenarios, case studies, multiple choice questionnaires, short theoretical questions, or even rest stations to help the students relax from time to time. Depending on the aims and objectives of the session, the stations can either be linked or independent. In the first instance it could replicate the journey of a patient at different stages of care, in which case students would need to enter the OSCE via a specific station and refer to the information they collect as they go along to solve the following stations (Harden, 1990). In the other case, because stations are not related, students do not need to start at a specific station. This mode is less time consuming for the examiners as it allows for the assessment of batches of students as opposed to a series where the OSCE room progressively fills up with students at the start, then gradually empties. When using independent stations, the number of candidates taking part in the OSCE session is determined by the number of stations forming the examination. This often implies that the session needs to be repeated several times to examine large groups of students, or that all stations are duplicated to run several OSCE circuits in parallel. Each OSCE station is normally allocated the same amount of time which may last between 3 and 10 minutes followed by a short rotation interval so students have time to move to the following station (Alinier, 2003). Each station can relate to one or more particular skills associated with the subject area. Stations can either be practical and invigilated by an examiner, or theoretical, in the form of an unsupervised pen and paper exercise, or simply a rest station where students can re-gather their thoughts. The co-ordination of the session is a key element for the smooth running of the OSCE, and for this reason the principal investigator and author of this thesis acted as the session co-ordinator. The co-ordinator’s role was to control the electronic timing system (Alinier and Dodd, 2007) and redirect students when they

were unsure of the station they should next go to. By the end of the OSCE all the students will have gone through each station and been marked according to precise checklists by the examiners of practical stations, which makes the overall examination based on objective judgements. Theoretical stations are marked in a similar way after the session. The standardisation and structure provided by such a tool ensure its reliability (van der Vleuten, 1996b). Reliability is to be understood as the strength of the tool being used in providing the same result or score for a given performance repeated identically by a candidate, irrespective of the assessor. This will be discussed further in section V.5.

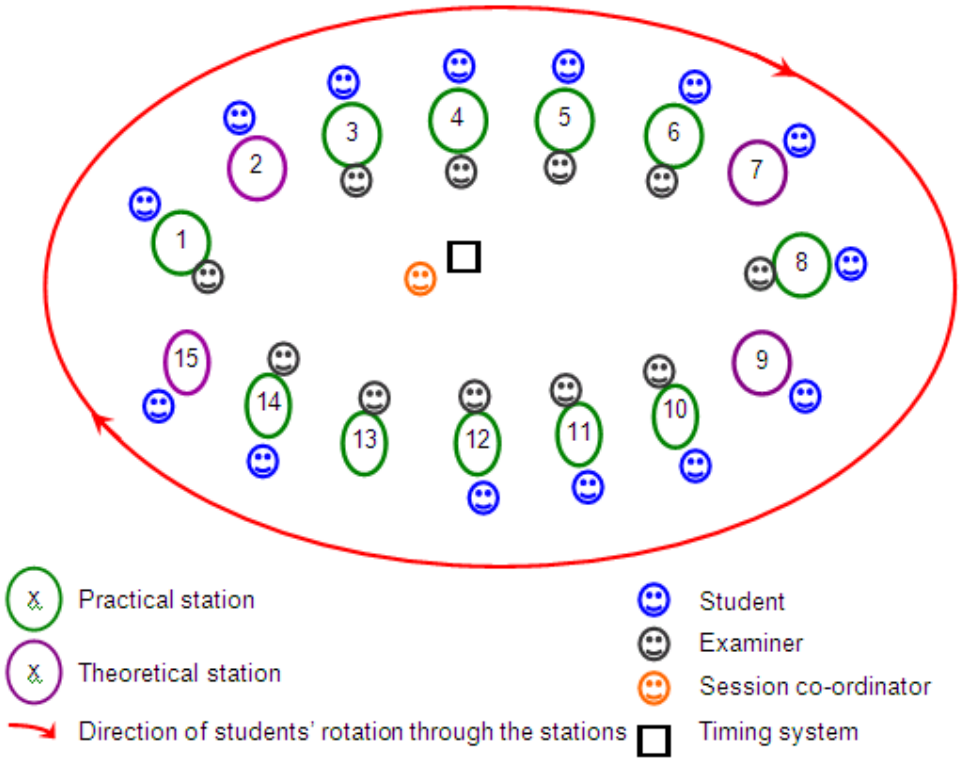

Figure 7: Diagrammatical representation of the 15-station OSCE used during the study.

In order to construct a valid and reliable assessment tool a range of core skills that were judged to be important for nursing practice and relevant to the students' curriculum was compiled using a Delphi method. This was done trough repetitive consultation process with a panel of experienced nursing lecturers from the University of Hertfordshire until they reached an agreement on the skills to include. The list of potential skills to be included was reviewed and ranked in priority order. For the purpose of this study this list of core skills focused on important nursing clinical skills,

communication, and the use of technology in nursing practice was then used to develop relevant and challenging exercises that could be administered in the form of OSCE stations to test the students' level of competence. Using again a Delphi method a total of 15 stations were developed for the OSCE. This joint methodological development process involving the same panel of experienced nursing lecturers helped determine that the identified skills should be tested using eleven practical and four theoretical independent stations. The panel members also reached a satisfactory consensus regarding the contents and tasks or questions of the various stations to assess the identified nursing skills through the development of a series of draft station themes and assessment criteria. This iterative process whereby the panel of experienced nursing lecturers reviewed and suggested alterations to the various drafts of the stations' marking strategies was used to ensure the marking scheme of each station was judged in terms of objectivity. This process was used to ensure the appropriateness of the tasks and questions with respect to the students' curriculum and whether they were actually assessing what we wanted to assess accurately and with consistency for validity and reliability (van der Vleuten, 1996b). To that effect and as recommended by Kardong-Edgren et al. (2010) the content, construct, and criterion of the assessment tool were carefully developed. As advised by Jeffries and Norton (2005) the final instrument covered the affective (or behavioural), cognitive, and psychomotor (technical) learning domains. These will later be referred to as the "elements" of each station and they are presented in table 3. The marking scheme was further slightly amended as a result of conducting the pilot phase of the study (See section V.4).

The above Delphi process and piloting of the instruments resulted in a clear set of instructions and a precise marking sheet being developed for each station (Table 2, See also Appendix II). The instructions to the students included: the station number, the task to be performed, and whenever possible, the points for which they were being observed and assessed. For the examiners, the instructions were more detailed and also included, on the first occasion, a short training session prior to the actual OSCE session provided by the principal investigator. The examiners' instructions included the list of equipment required for the station, the information provided to students, and how the station should be reset for each student. In addition they received a pack of marking sheets to record each student's performance (See Appendix II) and the list of students' anonymity numbers in the order in which they were expected to be tested on each station. Most of these components can be seen on Figure 8 with station 6 where

students had to assemble a resuscitator, then size and insert an oropharyngeal airway in the airway management trainer. For the assessment to be as objective as possible, the marking sheets included tick boxes with specific expected achievements to record students' actions corresponding to the exercise undertaken. All the ticks could then be counted and marked at the bottom of the station assessment sheet by the examiner (Appendix II).

Stations	**Type**	
ECG Electrodes positioning (3-Lead)	1	Practical
Outcomes of incorrect ECG electrodes' positioning	2	Theoretical
Dysrhythmia recognition (5 Rhythms)	3	Practical
Kontron Monitor: Determining state of alarm settings	4	Practical
HP Monitor: Modifying heart rate and temperature alarm settings	5	Practical
Airway management (Oropharyngeal airway, bag ventilation)	6	Practical
Safety aspects of the use of a defibrillator	7	Theoretical
Pulse oximetry measurement (Finger & ear probes)	8	Practical
Electrical equipment set up problem	9	Theoretical
Set up volumetric infusion pump	10	Practical
Determining the cause for syringe driver alarm	11	Practical
Ventilator tubing installation	12	Practical
Blood pressure measurement	13	Practical
Electric bed positioning with entangled giving set	14	Practical
Cardiac arrest signs	15	Theoretical

Table 2: List of OSCE stations designed for the study.

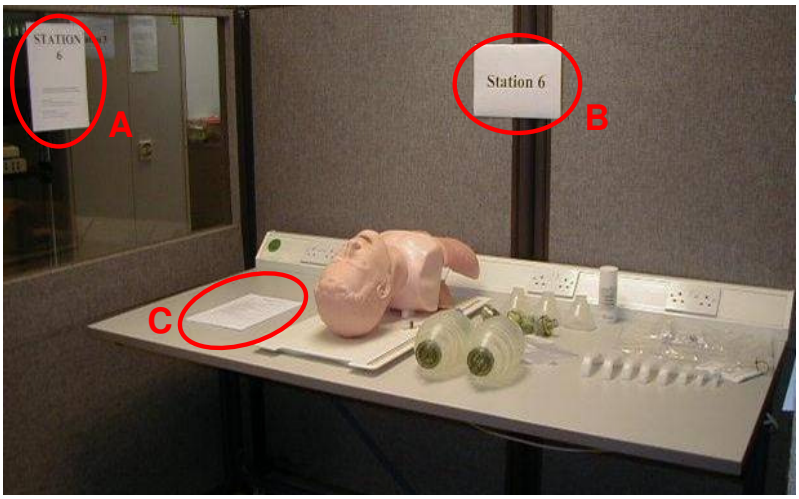

Figure 8: Setup of station 6 with student's instructions (A), station number (B) and marking sheets for the examiner (C).

	Elements Assessed:	Marked over:	Percentage weighting
Station 1	A, A, E, F	20	8.89%
Station 2	A, B, B, D	20	8.89%
Station 3	B, B	10	4.44%
Station 4	C, E, G	15	6.67%
Station 5	C, E, G	15	6.67%
Station 6	A, C, E, E	20	8.89%
Station 7	B, D	10	4.44%
Station 8	A, B, F	15	6.67%
Station 9	D, G	10	4.44%
Station 10	C, E, G	15	6.67%
Station 11	E, G	10	4.44%
Station 12	C, E, G	15	6.67%
Station 13	A, B, E, F	20	8.89%
Station 14	C, D, F	20	8.89%
Station 15	B, D	10	4.44%
Total		225	100.00%

A: Clinical Skills, B: Knowledge and comprehension, C: Technical ability, D: Critical thinking, E: Confidence, F: Communication, G: Troubleshooting

Table 3: Elements assessed and weighting of the different OSCE stations.

Not all stations carried the same weight in terms of scoring as shown in Table 3 because stations were marked out of 10, 15 or 20 points depending on the number of elements that were being assessed. The overall OSCE was marked out of 225 points, which corresponded to a 100% mark over the fifteen stations (Table 3).The maximum number of points attributed for any given station depended on the elements that could be assessed during the exercise as well as their importance. Every station comprised 2 to 4 types of elements each marked out of 5 points, hence covering a range of competencies highly relevant to modern nursing practice (Little, 2000, Zhang et al., 2001, Jeffries and Norton, 2005). The elements chosen to be assessed in each station are listed in Table 3 and can be categorises as follows:

A. Clinical Skills
B. Knowledge and comprehension
C. Technical ability
D. Critical thinking
E. Confidence
F. Communication
G. Troubleshooting

Irrespective of the number of elements a station included or its complexity, the duration of every station was the same to comply with the OSCE process. The feasibility of successfully completing the required task on each station within the imparted time was tested during the pilot phase of the stations, involving students from the same programme of study. The detailed marking sheets of all the stations and the examiners and students' instructions can be seen in Appendix II.

Although OSCEs are recognized as a highly reliable and valid assessment method (Sloan et al., 1995), the design of the instructions to the exercises and their marking sheets are extremely important. In this project, very detailed attention was paid to the design of the OSCE instructions and to the marking and answer sheets. Although having been demonstrated in a number of studies (Cunnington et al., 1996, Regehr et al., 1998) to be equally valid, checklists were used over global rating scales. This choice was made so the assessment could be as objective as possible while requiring minimum training on the part of the assessors to ensure a high inter-rater reliability which has been on occasions demonstrated to be higher when checklists are used (Morgan et al., 2001). It was also perceived to be a more objective way of assessing students' performance by the panel of educators who was involved in the content design, validation, and piloting of the 15 OSCE stations.

IV.2/ The simulation scenarios

The scenarios used for this study were developed by lecturers with nursing and paramedical experience and who were not part of the panel involved in the design of the OSCE. This prevented potential bias in the development of the scenarios which would have clearly advantaged the students from the experimental group. The scenario developers' brief was to create scenarios in the form of patients with an evolving condition over the course of the students' interaction that would require them to call upon a range of important nursing skills. A total of four realistic scenarios were developed, derived from two commonly encountered health conditions in the acute care setting. The cases chosen were hypovolemia and myocardial infarction as they were requiring students to use various skills such as communication, applying monitoring equipment for patient clinical assessment, manipulating the patient's bed, and potentially resuscitation of the patient. The scenarios were pre-piloted at an early stage of the study over 4 sessions with volunteer paramedic and nursing students to ensure the realistic and progressive change of the patients' physiological parameters and response to intervention, prior to the piloting of the overall study design. These pilot simulation sessions were also organised to see how students were responding to the mannequin and how the sessions should be facilitated so the scenarios could be run realistically despite the simulated context and actively engage the students in considering the mannequin as a real patient. It is also during this phase that adjustments were made to the layout of the simulation environment to separate the observation and patient simulator control areas from the scenario area. The scenarios made use of the Laerdal SimMan patient simulator in an adapted all-in-one room simulation environment (Alinier, 2007a, Alinier, 2008a) (See Figure 11).

The selection or design of the scenarios were in no way dictated by the OSCE stations or were meant to prepare the students for it. During the briefing, scenarios, and debriefing students were not prompted or demonstrated how the equipment worked, but they were instead working in their capacity as if they were newly qualified nurses. When help was required by the students to progress the scenario such as for the prescription of medication, oxygen, or fluids, the facilitators were acting the appropriate roles, performing a clinical examination, or receiving a handover of the patient care.

Scenario 1:

The information provided to the nursing students at the start of that scenario was: "*It is 3 am, and you have just been called by Mr Peter Garden. This patient is 63 years old and was hospitalised a week ago following a cardiac arrest. He is expecting cardiac surgery tomorrow. He is catheterised, under Opiates and Glucose IV infusion, but not being monitored*." On arrival, the nursing students notice that the patient complains of a crushing chest pain. The actions expected from the students are to measure the blood pressure, saturation, temperature, respiratory rate, setup cardiac monitoring, and call for help. The doctor comes and requests for some blood tests and goes away. When the patient goes into cardiac arrest, the nursing students should: call the crash team, lower the bed so the patient is laying flat, remove the bed end, initiate Basic Life Support (BLS), insert an oropharyngeal airway, use a resuscitator to ventilate the patient. Once the patient comes back to a sinus rhythm and starts to vomit, the nursing students should help turn the patient on his side, use suction to clear his airway.

Scenario 2:

The information provided to the nursing students at the start of that scenario was: "*You have just started your shift. Mr John Sim, 51 years old has just returned to your ward following a lumbar laminectomy. It is time for you to see him and take his vital signs*." The students should notice the patient's bed is tilted head up and Mr Sim is drowsy and confused. The actions expected from the students are to check the wound drain, measure the blood pressure, saturation, temperature, respiratory rate, call for help, ask for permission to stop the Morphine infusion, give oxygen, tilt the bed head down, increase fluid administration to the patient, call the Doctor and the operating theatre to inform of possible internal haemorrhage.

Scenario 3:

The information provided to the nursing students at the start of that scenario was: "*You have just started your shift. Mr Dan Greenman, 38 years old has just arrived in recovery ward following the operation of a leaking aneurism. His relatives are concerned as he is feeling very weak and called for you to see him*." The student nurses should notice that the patient is currently sitting up in bed and starts to become confused. His heart rate and breathing rate have increased and blood pressure decreased since the last set of observations was taken. The patient eventually looses consciousness. The nurses should call for help, flatten the bed, reduce the infusion rate of opiate, and administer oxygen.

Scenario 4:

The information provided to the nursing students at the start of that scenario was: “It is 14:00 and you are in the ward. One of the patients, Mr Mike Pot, 57y/o, who has had a quadruple bypass complains of chest pain and difficulty in breathing.” The students are expected to take all the patient observations, including a 12-lead ECG, give oxygen, and call for help. The patient will arrest before helps arrives so the students are expected to initiate BLS, put the crash call out, get the crash trolley, and prepare the area for the resuscitation team. They should insert an oropharyngeal airway and remove the bed end. After defibrillation and after return of cardiac output, the students should help turning the patient to its side and use suction to clear the airway as the patient is vomiting.

Simulation sessions / Student groups	**Session 1**	**Session 2**	**Session 3**	**..**	**Session X**
Group A	All Observers	- Scenario 3 for team A1 while A2 observes. - Scenario 4 for team A2 while A1 observes.		..	
Group B		All Observers	- Scenario 1 for team B1 while B2 observes. - Scenario 2 for team B2 while B1 observes.	..	
Group C			All Observers	..	
…				..	
Group X	- Scenario 1 for team X1 while X2 observes. - Scenario 2 for team X2 while X1 observes.			..	All observers during a session with another group

Table 4: Allocation of scenarios per simulation session and student groups of four students split in teams of two.

The sessions organised were exposing, in turn, the students to scenarios 1 and 2 or 3 and 4 as shown in Table 4. Students were invited to attend the simulation sessions as two groups of four students. Each group was split in teams of two students, but the teams from only one group were ever taking part in the scenarios in any given session, and this was after their attendance as observers to a previous simulation session.

Although the scenarios were very similar, each provided the students with a different patient history. The planning of the consecutive sessions presented in Table 4 (and in Table 6 in a different format) also ensured all students had the opportunity to observe at least once, during their first session, their peers managing both types of clinical cases; a patient with a myocardial infarction and an hypotensive patient. During their second session, students were either active participant in a cardiac arrest (Scenario 1 or 4) or management of a patient in hypovolemic shock (Scenario 2 or 3), and then observers of the other scenario with the students from the other group attending that session. All scenarios were pre-programmed on the SimMan software interface with deterioration and recovery trends to reduce the time spent at the controls by the facilitator and to ensure consistency and standardisation in the running of the scenarios and evolution of the patient's physiological parameters. These programmes were not shared with the students during the debriefing as it was not necessary for them to see the exact scripts to understand what was happening to the patient. A sample of the programmed scenarios on the early version of the SimMan software is shown in Appendix IV. The process of the simulation sessions making use of these scenarios followed by a debriefing period is explained in section V.3.2.

IV.3/ The questionnaire

Questionnaires were used for different aspects of the work presented in this thesis, namely to collect demographic information, to find out what the study participants anticipated or thought about specific aspects of the sessions they were involved in, but also as an assessment strategy in the case of the second study.

Only one questionnaire was used for the first study (See Appendix III). Following recommendations from the literature, and as per its intended purpose, the questionnaire included a very limited number of items with short and simple questions

to make it as easy as possible for participants to understand and fill in without skipping questions (Lietz, 2010). The questionnaire included only elements that contributed to the collection of data intended to be used for comparative analysis purposes between the control and experimental groups of students and to determine if any of them were determinant factors of their OSCE performance or in their predisposition in working in a technological environment. As such the questionnaire was used to collect demographic information about the participants using open fields (for age and type of previous healthcare experience) and tick boxes (for gender, previous healthcare experience, prior simulation experience at the University, and two Likert scales). Two items of this questionnaire made use of a 5-point Likert scale ranging respectively from “Very confident” to “Not confident at all”, and from “Very stressful” to “Not stressful at all”. The corresponding items aimed at collecting information about their perceived level of stress and confidence about working in a highly technological environment. If required, a 5-point scale can be easily rescaled to facilitate comparison during statistical analysis (Dawes, 2008). It is also argued that the middle point option increases slightly the overall validity and reliability of a response scale (Saris and Gallhofer, 2007).

From the start of the first study, students had been allocated a randomly assigned anonymity number which students used at every stage of the study so their data and OSCE results could be kept together. To that effect, one of the items included in the questionnaire was dedicated to collecting the students’ anonymity number. Having the questionnaire distributed to all students just before their participation in their second OSCE session and requesting them to return it at a specific location on campus once fully completed, before the OSCE, facilitated “physical” anonymity and obtaining honest and accurate answers rather than socially desirable responses. If students had been handed out the questionnaire during a session and required to hand it in person once completed, they may have had a tendency to respond in a manner that makes them look good rather than respond in an accurate and truthful manner (Holtgraves, 2004). This questionnaire was satisfactorily tested during the pilot phase of the study to make sure all elements would be clearly understood by students (See section V.4).

IV.4/ Chapter summary

This chapter described the development of the overall 15-station OSCE using a Delphi method involving a panel of experienced nursing lecturers. The logistics of running such OSCE sessions as part of the main study has been described. The details of the skills or elements tested by the various stations has been presented for each station and can be seen in Appendix II alongside the student's instructions and objective marking scheme derived for each station. The second important element of the main study is the content of the intervention for the experimental group of students. Students from the experimental group were required to attend two simulation sessions, during one of which they were involved as observers and on a second occasion as scenario participants. A total of four clinical scenarios presenting patients suffering with either hypovolemia (Two post-operative haemorrhage cases) or myocardial infarction (Pre and post-cardiac surgery) were developed with input from nursing staff with the relevant expertise. Only two of the four scenarios were ever used during each simulation session as each student was taking part in two simulation sessions. For consistency between the different simulation sessions organised and to help run the scenarios in a more autonomous manner, the scenarios were totally pre-programmed on the Laerdal SimMan software. A third key component of the work presented in this chapter relates to the use of a short and simple questionnaire and how it has been developed to collect demographic data as well as information about the students' perceived level of stress and confidence about working in a highly technological environment. The information gathered using the questionnaire was intended to be used for an analysis of the factors affecting performance within each group. It also enables the investigation of whether there is any relation between the information collected and other aspects of the research programme such as their performance on the OSCE.

Chapter V
Methods

The content of this chapter was partially published in the journal Nurse Education in Practice (Alinier et al., 2004) and presents in detail how the study was designed and carried out. This chapter is divided into seven sections to justify and describe the study design, the choice of the participant sample, the data collection tools, the pilot study, the validity and reliability of the assessment tool, the ethical considerations, and how the data analysis was going to be carried out.

V.1/ Study design

Although action research could have been considered as a research methodology, it was ruled out due to the very nature of the approach that would have had to be adopted. As mentioned in the editorial of the journal *Action Research* by Brydon-Miller et al. (2003), it is “work in progress” (P.11), an evolving process which would not have been appropriate to address the research question tackled by this study; “What is the impact of scenario-based simulation training on undergraduate students’ acquisition of clinical skills and knowledge?”. An action research approach would have had a detrimental effect on the number of participants recruited to the various phases of such a project to observe the effect of simulation interventions, reducing the reliability of the data collected. In contrast, empirical research whereby data may have been collected from subjects through observations and surveys may be viewed as having less validity although this has been challenged by a paper comparing the results of studies about similar subjects using either research methods (Concato et al., 2000). A comprehensive review of psychological, educational, and behavioural research studies that included studies with randomised and observational designs demonstrated that rigorously prepared observational designs do not consistently overestimate or underestimate the effect of treatment or intervention (Lipsey and Wilson, 1993). The appropriateness of observational investigations and surveys varies in different situations (Concato et al., 2000) .

This study was designed as a randomised controlled trial (RCT) based on a pre-test/post-test design to enable comparison between a control and an experimental group of students. RCTs are generally considered the gold-standard for the evaluation of the effectiveness of an intervention because they protect against selection bias (Kunz et al., 2007). They are said to provide evidence of the highest grade (Concato et al., 2000) and their use has been strongly recommended in educational research (Torgerson and Torgerson, 2001). An RCT allows the effect of an intervention on a random sample of subjects to be studied in comparison to another random sample from the same population. An observational study approach would not have allowed the objective detection of a difference following exposure to simulation training between the two study groups. The use of a pre-test/post-test design is frequently used in educational research as it is particularly well suited to investigate the effect of an educational innovation (Dugard and Todman, 1995). For such experimental design, it is recommended to have at least two groups formed randomly with only one receiving a treatment (Fraenkel and Wallen, 2003) as was the case in this study.

Before any data was collected, this study was approved by the Ethics Committee for Nursing, Midwifery, Paramedic Sciences, Social Work and Counselling as further developed in section V.6. Throughout this study students followed their normal University programme curriculum, and in addition took part in a few specific sessions. Students from the experimental group took part in scenario-based hands-on simulation sessions in a simulated clinical intensive care setting over a period of two afternoons (Figure 9) and all students were invited to take part in an Objective Structured Clinical Examination (OSCE) session at the start and at the end of the study (Alinier et al., 2004).

Allocation of the students to either the experimental or control group was performed randomly at the beginning of the initial assessment session, which was an OSCE as presented in section IV.1. Control and experimental group students were re-assessed after a 6-month curriculum period was completed to enable comparison between the two groups and to determine whether or not the simulation experience had had any effect on the level of competence and confidence of the students from the experimental group (Alinier et al., 2006b). Although other variables or external factors may have influenced the students' performance during the second assessment phase, they could have equally affected both study groups hence limiting the effect of any potential contamination or bias. These variables included the students' rotations through their

placement areas which provided them with different clinical experiences, but also for some of them, part-time healthcare work experience.

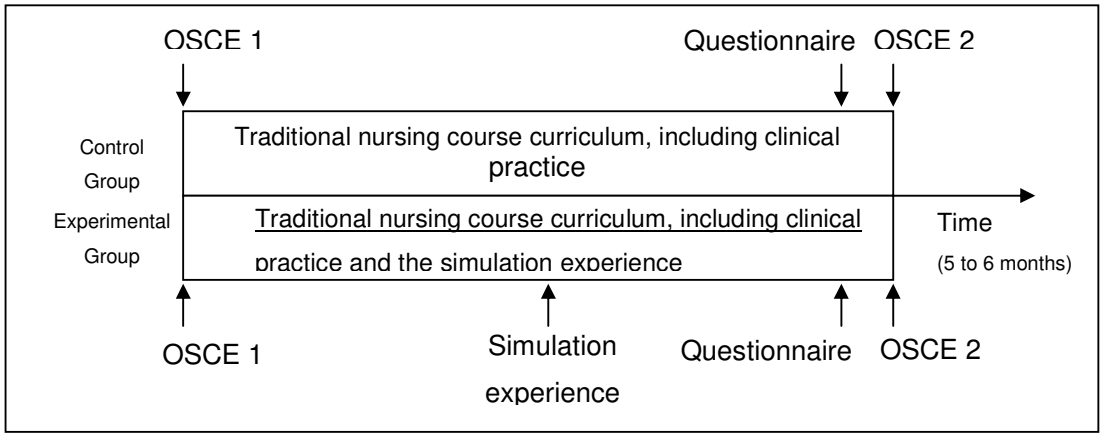

Figure 9: Study design to determine the effect of simulation training. (Alinier et al., 2006b)

V.2/ Study sample

Participation in this project was open to three consecutive cohorts of students (N=344) in their second year of a Diploma in higher education in adult nursing. The participating cohorts were: February 2000, September 2000, and February 2001, and experienced a consistent curriculum. Diploma students were chosen over any other groups for the study because they had two intakes per year (February and September) and larger cohort sizes than any other healthcare programme of study. This significantly increased the chances of recruiting a large enough sample of students to obtain robust results. Students were invited to attend the sessions of the research programme in addition to their timetabled classes or as an alternative to some of the specific teaching sessions. Access to the students was granted through their programme tutor and they were contacted when they were as one group in a lecture theatre. At the time of inviting them to take part in the study, they were briefed about the concept of the OSCE and the overall aim of the project. Among the 344 adult branch students from the three cohorts, 133 volunteered to take part in the study by attending the initial OSCE (38.7% response rate), and 99 completed their participation by also attending the second OSCE and the simulation sessions if they were recruited to the experimental group

(28.8% participation rate out of 344 students and 25.6% drop out rate out of 133 students). All participants were given a randomly generated anonymity number to be used on the OSCE marking sheets. The average age of the overall population was 29.9 years, against 31.2 (SD±8.2) for the actual sample, and the average age of the students who dropped out was 28.7. The proportion of female students was 88.7% within the student population, 83.8% within the participants' sample, and 91.2% in the loss to follow up. Although a relatively large number of students dropped out of the study, the average age and gender distribution of the sample is still representative of the overall nursing students' population studying on the programme at the time (Table 5).

		Experimental Group	**Control Group**	**Student Population**
Number of students (n)		49 (49.5%)	50 (50.5%)	344
Gender:	Male	7 (14.3%)	9 (18.0%)	39 (11.3%)
	Female	42 (85.7%)	41 (82.0%)	305 (88.7%)
Average age (Years)		29.3 (SD±7.5) Range [20-46]	33.0 (SD±8.4) Range [21-55]	29.9 (SD±8.7) Range [19-66]
Candidates with previous experience		20 (40.8%)	16 (32.0%)	N/A
Average years of previous care experience for experienced students		2.2 (SD±2.1) Range [0.3-8]	3.4 (SD±2.6) Range [0.3-11]	N/A

Table 5: Demographic characteristics of the experimental and control groups and the overall population of the student cohorts concerned.

Because the study had to be carried out over a restricted period of time, and the fact that the researcher had no control over students' participation in this study because they could not be forced to take part in the study, no power calculation was performed at the start of the study to determine the minimum number of participants required. Instead, as many volunteers as possible were recruited to the research study over its duration. Performing a power calculation after data collection has been completed has little value other than to reassess the published data to plan another study (Neely et al., 2003) and is in fact not recommended unless it is to update an initial power calculation to adjust the estimates made (Walters, 2009). What is however recommended in such

a situation is to calculate the confidence interval (Walters, 2009). Given the population and sample size, we can now determine that the Confidence Interval is 8.3% when assuming a 95% Confidence level.

V.3/ Data collection

As presented in Chapter IV, an OSCE was designed and used as the main assessment tool for this study. All the OSCE sessions took place in HICESC while setup specifically for this type of assessment session (Figure 10) between January 2002 and May 2003. The configuration of the centre differed for these sessions as partitions were added to physically separate the stations so students would be less distracted by what was happening in the other stations. HICESC was also used for all the simulation sessions but in a different configuration so the space would more closely represent a clinical environment while allowing part of the centre to be used for remote observation. Live remote video transmission of the scenario was achieved using a large TV monitor and a camera on a tripod positioned on opposite sides of a partition separating the simulation area from the seating area (Figure 11).

As discussed in Chapter IV, a well prepared OSCE is recognised as a valid, reliable and practical assessment method to assess the practical and cognitive skills of healthcare trainees (Harden and Gleeson, 1979, Sloan et al., 1995). An OSCE is composed of several stations relating to potentially any aspect of patient care, either in a practical way, invigilated by an examiner (Figure 12), or in a theoretical way, in the form of a pen and paper exercises (Figure 13) (Alinier, 2003).

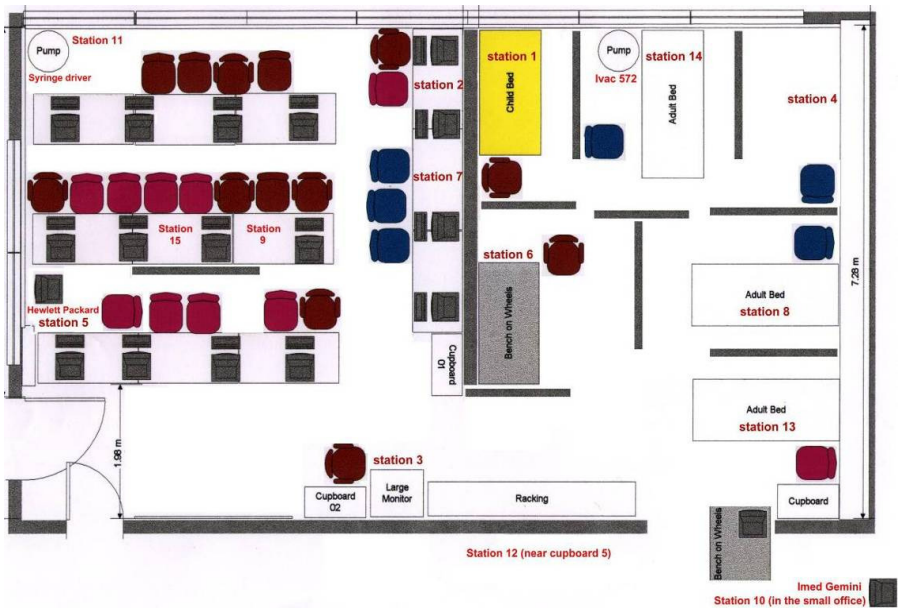

Figure 10: HICESC set-up for an OSCE session.

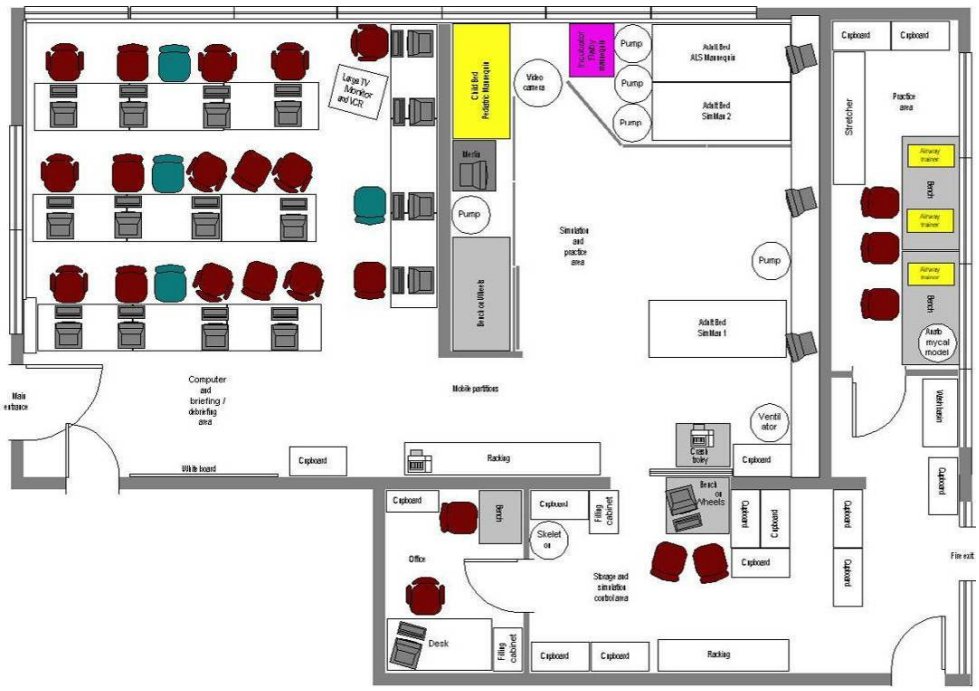

Figure 11: HICESC set-up for a simulation training session.

Figure 12: Student positioning a blood pressure cuff on a patient simulator while being observed by an examiner (Station 13).

Figure 13: Layout of theoretical stations where no examiner was required.

For the purpose of this study, a fifteen-station OSCE was developed as described in Chapter IV (Alinier et al., 2004). This meant that only fifteen students could be examined per session (see Figure 7). Students had five minutes per station plus a one-minute gap to rotate to the next one, which made the examination last 90 minutes. Each OSCE session ran over two hours for each group of fifteen students as they needed to sign in, be given an anonymity number, and be reminded about the

organisation of the OSCE. The OSCE included four theoretical stations with questions related to safety and nursing practice (Alinier et al., 2004). Each of the other eleven stations was supervised by an examiner and required students to use their clinical knowledge, technical ability, and communication skills (Alinier et al., 2004). Those stations were marked at the time of the examination whereas the theoretical stations were marked later. A concise set of instructions and marking scales was prepared for the fifteen stations in order to make the marking as objective as possible (Appendix II). All OSCE examiners were trained by the principal investigator to ensure consistency in the running of the stations, limited communication with the students, and annotation of the assessment sheets.

V.3.1/ First OSCE

During the briefing, the students were informed that their first OSCE participation was going to be run under summative assessment conditions (Alinier, 2003), as a formal evaluation of their level of performance with the determination of an actual score and without the provision of immediate feedback. This is the original mode of operation of an OSCE as defined by Harden and Gleeson (1979), with the exception that it was not contributing toward their course assessment. The role of the examiner was to observe and record the performance of the students on a particular station without helping them even at the end of the session. Students were warned in advance that they were not expected to be familiar with all the exercises they were going to undertake during the OSCE as it could have had an adverse effect on their confidence. Such a negative feeling could form a major barrier toward learning (Boud et al., 1985) and their future participation in a subsequent session of the project. No feedback was given to the students about their performance at that stage and they were made aware that it was going to be the case until they had done the second series of OSCE, marking the end of their participation in the study.

It was the first exposure of an examination of this kind for the students. This made it a fairly stressful experience because they were being observed by examiners on the practical stations and assessed on different skills (Table 2). However, it was perceived as a useful and valuable experience according to the feedback given by students (Alinier, 2003), and as found previously by Bramble (1994) and others (Nicol and

Freeth, 1998, Bradley and Humphris, 1999, Khattab and Rawlings, 2001). It was taken by all of the volunteer students to determine the baseline of their current skills.

V.3.2/ Simulation session

The aim of the simulation session was to provide students from the experimental group with a realistic clinical experience in a safe environment while avoiding any specific preparation or coaching for the OSCE. During the scenarios, students had the opportunity to interact in an autonomous capacity with the equipment relating to the care of their patient.

Students randomly selected to the experimental group were separated into groups of four students and each attended two simulation sessions of three hours focusing on patient care and clinical skills. Two groups were invited to each session with one group acting as observers, while the students from the other group took part in the scenarios as illustrated in Table 6 (Alinier et al., 2004) and previously explained concerning the scenario allocation to each consecutive session (Table 4). For these sessions HICESC was used in its simulation session configuration as shown on Figure 11.

Simulation sessions / Role of students	Session 1	Session 2	Session 3	Session 4	…	Session X
Observing	Group A	Group B	Group C	Group D	…	Group X
Participating in scenario	Group X	Group A	Group B	Group C	…	Group X-1

Table 6: Role of students during the simulation sessions. A, B, C… X being different groups of 4 students.

Programme	Duration
Registration and Introduction	10 min
Teamwork & communication discussion	20 min
Introduction to SimMan and familiarisation/demonstration	20 min
Break	5 min
Scenario with 1st pair of students and debriefing with participation of observers	25 min
Scenario with 2nd pair of students and debriefing with participation of observers	25 min
Debriefing	10 min
Break	5 min
Scenario with 1st pair of students and debriefing with participation of observers	25 min
Scenario with 2nd pair of students and debriefing with participation of observers	25 min
Discussion and session conclusion	10 min

Table 7: Programme of the simulation session over three hours.

The first part of the session comprised an introduction and discussion about teamwork and communication in the context of the clinical environment (Table 7). Students were then introduced to the concept of “simulation” and familiarised with the patient simulator (Appendix VI). Before the beginning of the scenarios students were clearly briefed about the remainder of the session. This was run in an informal way to gain students’ confidence and to help them relax before the scenarios started. Students were explained what was expected from them and what help they could get from the facilitators if and when needed. It was important that the right amount of time was allocated to the introduction for the students to understand how a simulation session was conducted, to become more familiar with the simulated environment, and to be able to work without constant guidance from the facilitators during the scenarios. This was a key element of all simulation sessions, which were a core component of this study.

Scenario participants were provided with a set of patient notes and background information that they had to take into consideration to treat the patient. During the scenarios students worked in teams of two and had the opportunity to be in charge of

two distinct simulated situations and to care for the patient simulator as they would do in a real ward setting as newly qualified nurses. Working in small teams gave students the opportunity to have as much hands-on experience as possible. Four different scenarios involving pre- and post-operative patients were programmed for use during the simulation sessions (See Appendix IV). This was done in order to standardise the way the patient deteriorated and responded to treatment during each scenario. Although the scenarios were different they required students to interact with similar pieces of equipment such as bed controls and monitoring devices. The remainder of the group observed the scene remotely. Both aspects, observing and taking part in a scenario, were seen to be important as part of the overall learning experience as they could benefit from seeing their peers dealing with clinical scenarios, and taking part in the debriefings. The simulated clinical environment was arranged so that students involved in the scenario were not disturbed by the students observing the scenarios. This was achieved using an audio/video link which simultaneously recorded and displayed the scene on a monitor in an adjacent room (Figure 11). The points the observers were asked to concentrate on were: communication, teamwork, situation awareness, decision-making, and clinical skills. These points were then discussed during the scenario debriefings.

Students reacted well to the use of simulation as a teaching tool in the way the environment was setup and the session was facilitated. After a few minutes they usually started considering the mannequin as a real patient, and communicated with "him" as shown on Figure 14. When appropriate or when help was requested, one of the academics running the session took the role of a resuscitation officer or a doctor. After each scenario the students' performance was debriefed with the participation of the observers. The debriefing was facilitated in a supportive and non-threatening way and participants were guided in their reflection to cover issues that they might have overlooked during the scenarios. Students who observed the scenarios were also asked to take part in the debriefing by commenting on what they had seen and recorded in their notes based on the points on which they had to concentrate. Observers benefited from analysing the actions made by their peers during the scenarios, from taking part in the debriefing, and from hearing any advice given.

Figure 14: Nursing students talking with the patient simulator during a scenario.

It is important to note that in this simulated intensive care setting, students may have needed to use some of the equipment that was also present in the OSCE but they were not specifically asked to use the instruments in the way that they were used in the examination. They were given advice and asked questions related to the scenarios during the debriefing, however they were at no time briefed or reminded about how to use the equipment as required in the OSCE process.

V.3.3/ Second OSCE

All students were invited to take part in a second OSCE approximately six months after their first participation to determine their skills and competence level at that time. According to Niehaus et al. (1996) the same OSCE can be repeated up to four times a year with different groups of students without affecting the results. A six-month separation between the two OSCEs together with the number of stations ensured that students were not simply learning how to do the test and also limited the possibility of contamination whereby students could have shared the questions of the various stations with their peers. Each OSCE session comprised students from the control and experimental group which provided an equal opportunity for contamination hence this was not considered to be of major concern in the overall result of the study. Although all OSCE sessions included students from both study groups, students from the experimental group took part in their second OSCE at least five weeks after they had

taken part in their second simulation session, further avoiding any tendency for those sessions to 'prepare' the students for the OSCE. The examiners had no way of knowing to which study group students belonged to. The OSCE stations and marking schemes remained identical throughout the duration of the project to enable comparison of the results. In addition, for the second OSCE students were given feedback after the assessment period of each practical station. This type of OSCE was called "mixed mode" (Alinier, 2003) because its principle lies between the traditional formative and summative OSCE. A formative activity is generally developmental and stress free with no implication on students' progression towards obtaining a qualification whereas the outcome of a summative activity contributes to a final assessment and has potentially highly significant implications. A summative activity often proves to be a very stressful event for students. The mixed mode OSCE enables both the collection of data and provision of individual feedback to students at each station. Many students preferred the second OSCE to the first one as they could receive immediate feedback on their performance and they were less stressed because they already had the experience of the first OSCE session. This OSCE mode is very useful to monitor the abilities of individual students as well as to help them determine their weaknesses and improve their skills thanks to the feedback provided by the examiners.

Figure 15: Student trying to determine the alarm settings of a patient monitor.

The second OSCE session marked the end of the involvement in the study for any student. The feedback received from the students seem to verify a comment made by Nicol & Freeth (1998, p. 608): "*OSCE has the advantage of being viewed as a very worthwhile and highly relevant experience for the students*". In the clinical setting, for safety reasons, students do not have the opportunity to interact with equipment such as patient monitors as illustrated on Figure 15, which emphasises the value of such experiences for the students.

After participation in the study students were given a certificate of attendance. The research co-ordinator adopted an open-door policy to give students the opportunity to receive further feedback, discuss their performance, and see how they progressed between the two OSCEs. Students used their certificate of attendance for their nursing practice portfolio. At this stage many students gave further positive feedback (Appendix V) which emphasised the fact that they valued the different sessions of the study, whether they were from the control or from the experimental group.

V.3.4/ Questionnaire

Before the start of the second OSCE all students completed a questionnaire about the use of technology in nursing practice and concerning their level of confidence and stress about working in a "high-tech" (highly technological) environment (Appendix III). Technology plays an increasingly important role in health care in general as it ranges from patient monitoring devices to input and retrieval of information in electronic patient record systems. In that sense, clinical settings can be considered to be high-tech environments. If the technology is not designed for users with a range of abilities in mind its use can be the source of errors and provoke stress (Weckman and Janzen, 2009). It is recognised that various definitions of stress exist but the type of stress implied in this questionnaire relates to the negative response to an environment resulting in physical and psychological maladaptation of the subjects concerned (Clegg, 2001), in this case, the nursing students. On the other hand, confidence is meant to refer to the perceived level of comfort or trust in their ability to operate in highly technological environment, implying that they would need to interact with the technology surrounding them in the clinical setting.

The questionnaire was also used to obtain demographic information and details about students' previous healthcare experience and current placement area. The information collected enabled to determine whether or not the two randomly selected study groups were comparable. The main results of this questionnaire are reported in Table 5 and will be presented in Chapter VI.

It is important to note that during the study, students from both groups were gaining experience from their various clinical practice placements which are part of their nursing programme. Some questions related to their past experience and to the place where they last did a placement. Despite these questions it was particularly difficult to analyse this particular issue as students have anecdotally reported different levels of supervision input from their placement tutors and students regularly changed their area of practice (Accident and & Emergency, Community, Coronary Care Unit, Intensive Treatment Unit, Elderly care…) while they were only asked to report their current or latest practice area. However, overall it can be assumed that the size of the groups and the randomisation of the students between them will balance the effect of the rotation through the different specialist units during placements and their previous clinical experience between the two groups. The results from the questionnaire will enable an analysis of the factors affecting performance within each group and to correlate these details with their performance in the OSCE.

V.4/ Pilot study

The objective of running through a pilot phase was to test the overall design and different components of this study such as the OSCE stations, the questionnaire, and the scenarios of the simulation training session. The results obtained through this phase were not expected to be used toward the main study but only to test the methods and help the researcher build his experience in organising and running the various sessions. The development and pilot phase of the scenarios and OSCE sessions involving students occurred between January 2001 and January 2002.

All the sessions and tools of this research study were piloted during their development with groups of nursing and paramedic students. The data collected from the pilot OSCEs did not allow for any preliminary data analysis to be performed. This was due

to an almost total loss to follow up of the participants and alterations made to some of the stations between the first and second series of OSCE sessions. The results by individual station and the feedback received from both students and examiners were used to improve the validity and objectivity of the different OSCE stations. From the first pilot OSCE sessions, it appeared that some of the stations were too easy (Stations 4, 8, 12, and 13) while others proved too challenging for the students (Stations 1, 2, 3, and 5). To resolve this potential issue, the students' instructions to some of the stations were revised to provide clearer information. The marking scheme was revised for some of the stations by adding marking components, or by changing the mark distribution. The most difficult aspect to assess objectively was how confident students were in using a particular piece of equipment or demonstrating a particular skill. The best solution found was to monitor the time taken to perform a task and mark it against a pre-determined scale, a method which has used almost at the same time in another study by Owen and Plummer for the assessment of students' endotracheal intubation skills (2002). The pilot sessions were also used to train many of the OSCE examiners involved in the subsequent sessions during the study.

For the pilot of the study, only four students were invited for each simulation session with a team of two facilitators. It was felt that the simulation experience needed to be maximised as it was a key element of the study. Based on the feedback from the pilot simulation sessions, it was felt that students could learn a lot from the observational period of each simulation session. As a result, the duration of exposure to the simulated environment and scenario-based experience was increased by allowing an additional group of four students to observe the session before having the opportunity to be actively involved in the scenario-based simulation training during the next session (See Table 4 and Table 6). Thanks to the layout of the simulation centre used at the time (2000-2003) and having gained sufficient experience in running the simulation sessions and the scenarios, the number of facilitators was reduced to one for most sessions.

V.5/ Validity and reliability

As discussed earlier, OSCEs are widely recognised as a highly reliable and valid assessment method (Sloan et al., 1995). Provided they are designed to a high

standard they will assist evaluating the identified skills that are to be evaluated (validity) with consistency by providing the same result as the exercise is repeated identically or assessed by different examiners (reliability). In this study very detailed attention was paid to the design of the OSCE instruction notices and to the different marking criteria and answer sheets. Checklists were used on the marking sheets to make sure that the assessment was objective. A panel of nursing lecturers was involved in the validation of the 15 stations for content relevance and accuracy. This was done at the time of the creation of the OSCE stations and once again taking into account the scores of the students during the pilot sessions as well as the comments from the examiners. This process helped refine the assessment tool.

The design and content of the marking sheets was such that even someone with very little knowledge of the skill being tested could reliably mark the performance of students. Harden and Gleeson (1979), pioneers of OSCE, determined that there could be three variables: the students, the examiner, and the patient. In our case, the variability of the use of a standardised patient as is commonly used in an OSCE (Collins & Harden 1998) was removed by only assessing students' interaction with equipment and/or mannequins which were used in a passive way (Alinier et al., 2006b). To overcome any inter-rater reliability issues on each station, all OSCE examiners were trained to examine particular stations, not to prompt students, and remained allocated to a particular station as much as possible (Alinier et al., 2006b). The marking of stations during different sessions was analysed for inter-rater reliability during the pilot phase and at the beginning of the study as all stations were not always marked by the same examiners. The analysis showed very little variation of mean score and standard deviation between examiners for each station over the sample of students assessed during the first series of OSCE. Over the sample analysed, the highest variation in standard deviation was 13.17 percentage points over 6 different examiners on Station 11, and as low as 6.47 percentage points over 4 examiners on station 12. It was felt that overall results demonstrated reliability of the assessment tool developed for each station.

The primary aim of the pilot sessions was to test the OSCE stations and train the examiners whilst using a similar sample of students as the ones used for the study. The outcome of the pilot sessions was that some of the stations' marking criteria, and instructions were revised for clarification to lower or increase the difficulty of the stations. For each OSCE station, the marks given by the different examiners were analysed and compared to its overall mean and standard deviation. No significant

difference was found in the assessment of any given station marked by different examiners. This process ensured that the marking scheme developed for the different stations was reliable.

V.6/ Ethical considerations

According to the University's Policies and Regulations (UPR), any research project conducted by students or staff involving human beings requires Ethical Approval before it can start (UPR AS/A/2). Following a full submission and presentation to the Research Ethics Committee for Nursing, Midwifery, Paramedic Sciences, Social Work and Counselling, ethical approval was granted for this study in January 2001 and was renewed in January 2002 to extend its validity until the end of the data collection period (Approval number NM2000/09 I).

Access to the students was gained through cohort and programme tutors. All students of the cohorts involved were informed of the purpose, requirements, duration and anticipated benefits of the study through oral presentations given by the main researcher to the different cohorts. In addition all volunteer participants were given an information letter alongside their anonymity number and consent form to brief them about the study just before attending the first OSCE session. All students were given the possibility to be involved in this study and they were also given the option not to participate. They were also informed that they could freely withdraw from the study at any time without having to provide any justification. Students who had been randomly selected to the control group were invited to attend the simulation training sessions after they attended their second OSCE session so they were not disadvantaged and it would not bias the results of the study. Students were informed that they would be awarded a certificate of attendance to enhance their professional portfolio when completing the study.

A potential concern from an ethical point of view was the students' emotional response to the simulation of cardiac arrest incidents. When clinical difficulties were arising during a scenario, students could receive help and the deterioration of the patient was slowed down in order to enable students to regain control of the situation. Whenever the outcome of a scenario was irreversible (i.e. "death" of the patient simulator),

students were debriefed in order to reassure them and the scenario was repeated so they could correct themselves and achieve a positive outcome with their patient. As stipulated in the ethics application form, in case of distress, students would have been advised to access the student counselling services through the University's Occupational Health Nurse.

No ethical issues were reported to the researcher by the end of the study or by the time all students from the different cohorts involved graduated from their Diploma in higher education in adult nursing in February 2004.

V.7/ Data analysis

All data analysis was performed using SPSS version 11.0 (Statistical Program for Social Scientists, Chicago, IL, USA) which provides an extensive library of analysis techniques. The data collected as part of this study included the first and second OSCE results from each student over the 15 stations as percentage marks and their demographic information from the questionnaire they individually filled in at the beginning of the second OSCE session (Appendix III).

The data from both the control and experimental groups were separately regrouped to allow for comparative analysis and determine if any differences noticed between the students' performance for the first and second OSCE reached statistical significance. Data from a total of 99 students was usable as they fulfilled their assigned engagement as either part of the control group, with participation to two OSCE sessions and return of their questionnaire, or as part of the experimental group with participation to two OSCE and simulation sessions, and return of their questionnaire.

Statistical significance of the difference in mean OSCE results was evaluated using independent-samples t-tests between students from the control and experimental groups. This test is appropriate for the data analysed as the students belonged to the same population and there was not any particular criteria to allocate the students to either the control of experimental group. This was done on a random basis with the allocation of an anonymity number for each student. With regards to the questionnaire data, which made use of a 5-point Likert scale, a Mann–Whitney U-test was used to

analyse the difference between students' perceptions of stress and confidence according to the study group they belonged to. This non-parametric test was chosen due to the use of ordinal data (Likert scale) for the questions compared.

Further statistical tests were performed using the information collected with the questionnaire which required a different approach and the use of other statistical tests. For example cross-tabulation tables can be generated to reduce the data being analysed by merging responses into larger categories. This was done in order to meet the minimum requirements of certain tests. The Chi-Square test, for example, can be used as a test of significance for association between nominal variables (Blaikie, 2003) such as students' perception of stress versus their perception of confidence (See Table 34 and Table 35). Other tests conducted using this approach included the comparison of the students' perception of confidence or of stress about working in a technological environment in relation to their previous healthcare related experience or of their gender. In addition, the students' age was analysed with respects to their previous healthcare related experience, their perceived level of confidence and of stress about working in a technological environment. Another aspect that was judged interesting to test was to explore the students' improvement in OSCE performance in relation to their gender, age, previous healthcare related experience, and their perceived level of confidence and of stress about working in a technological environment.

V.8/ Chapter summary

This chapter covered all aspects of the research methods of the main study, starting with the design of the RCT involving a convenience sample of students from three consecutive cohorts of second year Diploma in higher education in adult nursing students, with an identical curriculum. The second section presented the study sample, and explored the demographics between the volunteer students from both study groups to ensure they were comparable. The third section related primarily to the OSCE which was used as the key instrument to collect data about the students' performance on a range of skills pre and post-intervention for all students. Explanations are given as to how the first and second OSCE were run in a slightly different manner for the benefit of the students. The same section also included a description as to how the simulation sessions were organised and run without preparing the students for the

second OSCE, but also a presentation of the questionnaire that was used to collect the demographic information as well as the students' perceived level of confidence and stress about the use of technology in nursing practice. The fourth and fifth sections explain how the various components of the study were piloted and amended as judged necessary to ensure their suitability for the study, but more importantly to ensure their validity and reliability. Lastly, ethical considerations regarding this study as well as the approach to data analysis were presented and discussed at the end of this chapter.

Chapter VI
Results from the Main Study

The results of the study presented in this chapter have been partly published in the Journal of Advanced Nursing (Alinier et al 2006). The chapter has been divided into sections which correspond to the different batches of data collected through the different stages of the study. In addition a section has been dedicated to the comparative analysis of the performance of the two study groups between the first and second OSCE. The final section reports the results collected from the questionnaire for the experimental and control groups. The results presented are based on the 99 students who completed the study by attending all the required sessions. Fifty were in the control group and 49 in the experimental group. The hypotheses tested in this chapter are:

- Students from the experimental group are more likely to make a more significant improvement between their two OSCE performances than students from the Control group.
- Students with previous healthcare experience are less likely to make higher improvement in their OSCE performance.
- Students from the Experimental group should be more confident about working in a technological environment than Control group students.
- Students from the Experimental group should find it less stressful about working in a technological environment than Control group students.
- Students who report being confident about working in a technological environment should feel less stressed about having to work in such environment than the other students.
- Students with previous healthcare experience should report being more confident and feeling less stressed about working in a technological environment than students without previous experience.
- Gender affects the students' perceived levels of stress and confidence about working in a technological environment.

- More mature students should be more likely to have had some form of previous healthcare experience than younger students.
- Younger students should report being more confident and less stressed about working in a technological environment than more mature students.
- Improvement in OSCE performance should be affected by students' age.

VI.1/ Results from the first OSCE

Students were only randomly allocated to either the control or experimental group during their participation in the first OSCE as it was the session used to register them into the study. Although the comparability of the two study groups was explored using gender and age, the initial OSCE performance could be an important factor and will be considered in the following section.

OSCE 1 results (%)	**Participants** (n=99)	**Loss to follow up** (n=34)	**Sample** (n=133)
Mean (%)	48.18	47.38	47.98
95% Confidence Interval for Mean			
Lower Bound	46.31	44.10	46.37
Upper Bound	50.06	50.67	49.59
Standard Deviation	9.38	9.41	9.36
Minimum (%)	26.67	23.11	23.11
Maximum (%)	79.11	68.44	79.11

Table 8: Overall results for the first OSCE for all participating students and for the students who dropped out from the study at a later stage.

VI.1.1/ Sample and participants' first OSCE results

From the 133 students who took part in the first OSCE session, 34 did not attend all the sessions they were asked to attend to fulfil their commitment to either the control or the

experimental group. The average performance for the first OSCE, taking into account the different station weighting presented in Table 3, was 48.18% (95% C.I. 46.31-50.06) for the participants, who are the students who completed the whole study (Table 8). Analysis of the first OSCE performance of the 34 students lost to follow up indicated that their average performance was 47.38% (95% C.I. 44.10-50.67) for the first OSCE (Table 8). Although this is slightly lower than that of the students who completed the whole study, it remains very comparable and hence indicates that their withdrawal from the study should not bias the final results.

Although it is the overall improvement in OSCE performance that is of foremost importance in this study, the results obtained by stations by all students having taken part in the first OSCE are reported in Table 9. As expected students did not score equally on all stations as it identified some weaknesses in their knowledge and performance. This had also been noticed during the pilot sessions which led to the revision of some of the instructions and marking criteria of particular OSCE stations.

As clarified earlier, when comparing the overall OSCE score means between the participating students and the sample, the effect of the exclusion of the students in the loss to follow up is minimal. When looking at individual stations, the removal of their data from Table 10 had a maximum negative effect for station 13 (mean score reduced by 1.02 percentage points) and a maximum positive effect for station 6 (mean score increased by 1.44 percentage points).

OSCE 1 percentage results	N	Minimum (%)	Maximum (%)	Mean (%)	Standard Deviation (%)
Station 1	133	20.00	100.00	**62.89**	21.00
Station 2	133	0.00	80.00	**32.37**	15.39
Station 3	133	0.00	60.00	**26.17**	18.29
Station 4	133	26.67	100.00	**63.98**	18.51
Station 5	133	6.67	100.00	**54.86**	28.35
Station 6	133	0.00	85.00	**43.31**	19.67
Station 7	133	0.00	80.00	**35.41**	19.33
Station 8	133	13.33	100.00	**67.22**	20.52
Station 9	133	20.00	100.00	**58.65**	18.04
Station 10	133	6.67	93.33	**59.43**	19.22
Station 11	133	0.00	100.00	**43.61**	16.62
Station 12	133	0.00	73.33	**13.58**	13.01
Station 13	133	15.00	85.00	**48.80**	16.89
Station 14	133	15.00	95.00	**55.73**	15.25
Station 15	133	0.00	100.00	**42.03**	21.10
Valid N (listwise)	133				

Table 9: OSCE 1 results per station for all students from the sample.

OSCE 1 percentage results	N	Minimum (%)	Maximum (%)	Mean (%)	Standard Deviation (%)
Station 1	99	20.00	100.00	**63.33**	20.45
Station 2	99	0.00	80.00	**32.27**	15.93
Station 3	99	0.00	60.00	**25.76**	18.24
Station 4	99	26.67	100.00	**63.54**	18.30
Station 5	99	6.67	100.00	**55.15**	29.34
Station 6	99	10.00	85.00	**44.75**	18.66
Station 7	99	0.00	80.00	**35.66**	19.70
Station 8	99	13.33	100.00	**68.75**	20.97
Station 9	99	20.00	100.00	**58.48**	18.43
Station 10	99	6.67	93.33	**59.43**	19.26
Station 11	99	0.00	100.00	**43.13**	16.64
Station 12	99	0.00	73.33	**12.96**	11.73
Station 13	99	15.00	85.00	**47.78**	15.91
Station 14	99	25.00	95.00	**56.54**	15.98
Station 15	99	0.00	100.00	**42.02**	21.57
Valid N (listwise)	99				

Table 10: OSCE 1 results per station for all participating students.

VI.1.2/ First OSCE results per station

Table 11 and Table 12 respectively report the OSCE marks per station for the control and experimental groups, which respectively corresponds to whether the students had been randomly selected to only follow their normal curriculum or if they were going to take part in the scenario-based simulation sessions. In both groups, students scored particularly low (under 27%) on stations 3 and 12 which were testing their recognition of ECG rhythms and their ability to reconstruct the tubing of a patient ventilator circuit. Students from both groups scored reasonably well (over 60%) on stations 1, 4 and 8 which were testing their ability to take an ECG, determine the alarm settings on a patient monitor, and the function and use of pulse oximeters.

The minimum and maximum scores reported in Table 11 and Table 12 for the first OSCE demonstrate that there is a very similar spread of cognitive and practical abilities among the students within the two study groups. Similarly the standard deviations for each station are similar across the two tables. A careful comparison of Table 11 and Table 12 shows that there are mean maximum differences between the two groups of 7.33% for station 2, 6.18% for station 14, and 4.40% for station 8 as can be seen in Table 13.

OSCE 1 percentage results	N	Minimum (%)	Maximum (%)	Mean (%)	Standard Deviation (%)
Station 1	50	20.00	95.00	**62.20**	20.83
Station 2	50	0.00	70.00	**35.90**	14.45
Station 3	50	0.00	60.00	**25.00**	17.76
Station 4	50	26.67	93.33	**64.20**	19.64
Station 5	50	13.33	100.00	**54.13**	27.29
Station 6	50	10.00	85.00	**43.60**	19.80
Station 7	50	10.00	80.00	**37.00**	19.09
Station 8	50	26.67	100.00	**70.93**	20.64
Station 9	50	20.00	100.00	**58.80**	20.17
Station 10	50	6.67	93.33	**60.00**	20.82
Station 11	50	0.00	100.00	**43.40**	18.36
Station 12	50	0.00	73.33	**13.80**	13.98
Station 13	50	15.00	85.00	**48.10**	15.74
Station 14	50	25.00	95.00	**59.60**	17.52
Station 15	50	0.00	100.00	**40.80**	19.47
Valid N (listwise)	50				

Table 11: OSCE 1 results per station for control group students.

OSCE 1 percentage results	N	Minimum (%)	Maximum (%)	Mean (%)	Standard Deviation (%)
Station 1	49	20.00	100.00	**64.49**	20.21
Station 2	49	0.00	80.00	**28.57**	16.65
Station 3	49	0.00	60.00	**26.53**	18.88
Station 4	49	26.67	100.00	**62.86**	17.00
Station 5	49	6.67	100.00	**56.19**	31.53
Station 6	49	15.00	80.00	**45.92**	17.55
Station 7	49	0.00	80.00	**34.29**	20.41
Station 8	49	13.33	100.00	**66.53**	21.28
Station 9	49	30.00	100.00	**58.16**	16.67
Station 10	49	13.33	86.67	**58.84**	17.71
Station 11	49	10.00	80.00	**42.86**	14.86
Station 12	49	0.00	40.00	**12.11**	8.94
Station 13	49	20.00	85.00	**47.45**	16.24
Station 14	49	25.00	90.00	**53.42**	13.72
Station 15	49	0.00	100.00	**43.27**	23.66
Valid N (listwise)	49				

Table 12: OSCE 1 results per station for experimental group students.

OSCE 1	Study group?	N	Mean	Standard Deviation	Std. Error Mean
Station 2	Control	50	35.90	14.45	2.04
	Experimental	49	28.57	16.65	2.38
Station 8	Control	50	70.93	20.64	2.92
	Experimental	49	66.53	21.28	3.04
Station 14	Control	50	59.60	17.52	2.48
	Experimental	49	53.42	13.72	1.96

Table 13: Summary of the stations with distinct result differences during the first OSCE between the two study groups.

To determine if the differences noticed are simply due to the fact that the data is now being analysed over two medium size samples, independent samples t-test were carried out. Considering a level of statistical significance of 0.05, the results of the analysis carried out and reported in Table 14 show that for stations 8 and 14 the

difference in performance between the two study groups is not statistically significant, although very close to statistical significance for station 14 (p=0.0.054) for which the control group students outscored the experimental group students by about 6 percentage points. However the t-test for equality of means for station 2 shows that there is a significant statistical difference between the two groups (independent sample t-test df=97, p=0.021). The control group performed significantly better on station 2 with a mean score of 35.90% (SD±14.45) whereas the students from the experimental group obtained a mean score of 28.57% (SD±16.65).

Although this 7.33 percentage points difference between the two study groups could be an issue at this stage, it only relates to one station out of fifteen, hence should not affect the overall results of the study when taking into account the second OSCE. It is also important to notice that the poorer performance of the experimental group students at some of the stations is counter balanced by other stations at which they have performed marginally better than the students from the control group. For example, for stations 6 and 15, they have respectively scored an additional 2.32 and 2.47 percentage points than students from the other group.

OSCE 1		Levene's Test for Equality of Variances		**t-test for Equality of Means**						
		F	Sig.	t	df	Sig. (2-tailed) P value	Mean Diff.	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Station 2	Equal variances assumed	1.863	0.175	2.34	97	0.021	7.33	3.13	1.11	13.54
Station 8		0.432	0.513	1.05	97	0.299	4.40	4.21	-3.96	12.76
Station 14		3.438	0.067	1.95	97	0.054	6.18	3.17	-0.10	12.47

Table 14: Independent samples t-test for the stations of the first OSCE with distinct result differences between the two study groups.

VI.1.3/ First OSCE results per study group

The overall mean OSCE results obtained by the control and experimental groups are presented in Table 15. This takes into account the fact that all stations did not carry the same weight (Table 3). Omitting OSCE results of those who dropped out at that stage, the average OSCE score was 48.82% (95% CI 45.90–51.73) for the control group and 47.54% (95% CI 45.11–49.97) for the experimental group. The highest (79.11%) and lowest (26.67%) scores obtained during the first OSCE were obtained by students from the control group (Table 15).

			OSCE 1 results (%)
Control Group (n=50)	Mean (%)		48.82
	95% Confidence Interval for Mean	Lower Bound	45.90
		Upper Bound	51.73
	Standard Deviation (%)		10.26
	Minimum (%)		26.67
	Maximum (%)		79.11
Experimental Group (n=49)	Mean		47.54
	95% Confidence Interval for Mean	Lower Bound	45.11
		Upper Bound	49.97
	Standard Deviation (%)		8.46
	Minimum (%)		30.67
	Maximum (%)		68.00

Table 15: Results obtained by the two study groups for the first OSCE.

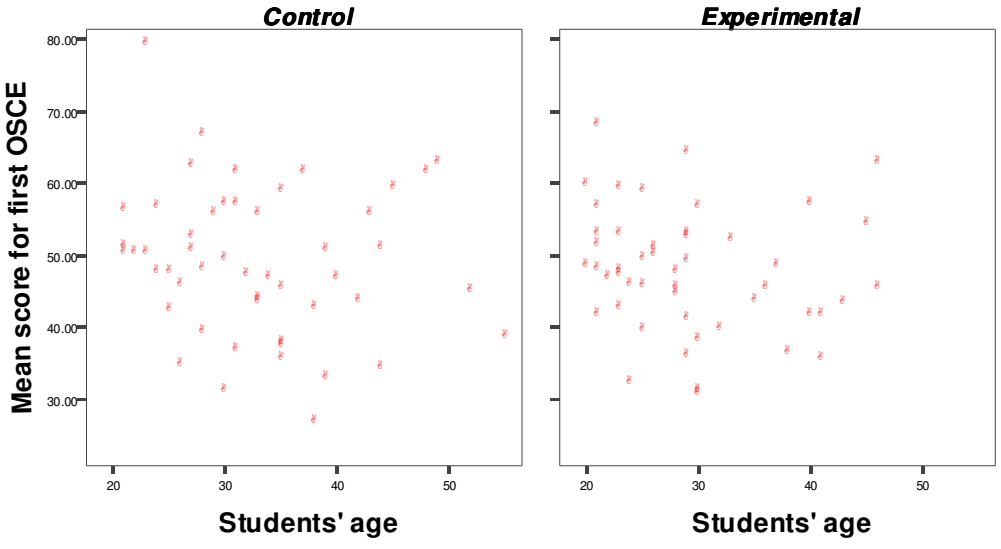

Figure 16: Scatterplot of the students' age versus their first OSCE result.

Two statistical representations of the first OSCE result by the two study groups are presented in Figure 16 and Figure 17. The results of the first OSCE illustrated by the scatterplot (Figure 16) and the box plots (Figure 17) show the broad comparability of the two distributions, perhaps with the slight exception of a single, although modest, outlier in the control group with a high mark of 79.11%.

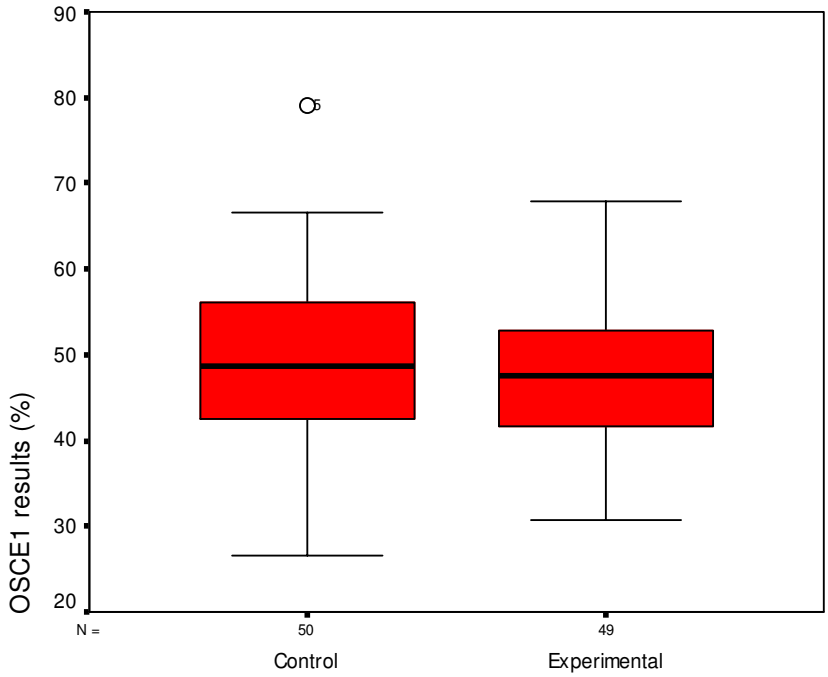

Figure 17: Boxplot of the first OSCE results for the control and experimental groups.

VI.2/ Results from the second OSCE

VI.2.1/ Second OSCE results per station

Table 16 shows the results obtained by the participating students during the second OSCE for each station. Students scored very high marks (over 75%) on several stations (1, 4, 5 and 8), but also still scored poorly (under 38%) for two stations (2 and 12).

A comparison of Table 10 and Table 16 shows that overall students have improved their performance between the first and second series of OSCEs. Considering that the two series of OSCEs were identical and approximately 6 months apart, this improvement for each station was expected as students benefited from additional clinical placement experience and knowledge acquired during lectures or clinical skills laboratory sessions. Both study groups, although composed of students from a mixture of three different cohorts, followed an identical curriculum and hence were exposed to similar learning experiences. The main difference was the intervention with the students from the experimental who were exposed to scenario-based simulation training at least five weeks before taking part in their second OSCE session.

OSCE 2 percentage results	N	Minimum (%)	Maximum (%)	Mean (%)	Standard Deviation (%)
Station 1	99	30.00	100.00	**76.26**	17.28
Station 2	99	5.00	75.00	**37.17**	15.12
Station 3	99	0.00	100.00	**47.47**	24.34
Station 4	99	26.67	100.00	**75.42**	18.56
Station 5	99	0.00	100.00	**77.44**	23.75
Station 6	99	0.00	95.00	**52.22**	25.62
Station 7	99	0.00	100.00	**43.54**	20.17
Station 8	99	46.67	100.00	**78.99**	12.50
Station 9	99	20.00	90.00	**59.90**	16.32
Station 10	99	13.33	100.00	**68.89**	18.27
Station 11	99	10.00	100.00	**46.57**	18.47
Station 12	99	0.00	80.00	**23.10**	17.05
Station 13	99	20.00	95.00	**64.24**	15.02
Station 14	99	25.00	100.00	**68.79**	15.75
Station 15	99	0.00	90.00	**43.13**	23.24
Valid N (listwise)	99				

Table 16: OSCE 2 results per station for all participating students.

A comparison of Table 17, which presents the second OSCE results per station for the control group, with Table 18, which presents the results for the experimental group, shows that students from the experimental group almost consistently scored higher than students from the other group. The only exception is for station 13 on which students from the control group outscored the other group by 1.33 percentage points.

OSCE 2 percentage results	N	Minimum (%)	Maximum (%)	Mean (%)	Standard Deviation (%)
Station 1	50	30.00	95.00	**70.40**	17.67
Station 2	50	10.00	75.00	**36.90**	14.74
Station 3	50	0.00	100.00	**46.00**	23.39
Station 4	50	26.67	100.00	**70.67**	20.91
Station 5	50	0.00	100.00	**72.80**	27.40
Station 6	50	0.00	95.00	**46.50**	28.22
Station 7	50	0.00	80.00	**39.60**	19.06
Station 8	50	46.67	100.00	**78.27**	13.59
Station 9	50	20.00	90.00	**55.40**	16.19
Station 10	50	13.33	100.00	**64.13**	19.33
Station 11	50	20.00	90.00	**46.40**	18.93
Station 12	50	0.00	60.00	**21.40**	14.45
Station 13	50	20.00	95.00	**64.90**	15.86
Station 14	50	25.00	100.00	**67.10**	17.85
Station 15	50	0.00	80.00	**40.20**	24.12
Valid N (listwise)	50				

Table 17: OSCE 1 results per station for control group students.

OSCE 2 percentage results	N	Minimum (%)	Maximum (%)	Mean (%)	Standard Deviation (%)
Station 1	49	40.00	100.00	**82.25**	14.79
Station 2	49	5.00	75.00	**37.45**	15.65
Station 3	49	0.00	100.00	**48.98**	25.43
Station 4	49	40.00	100.00	**80.27**	14.46
Station 5	49	20.00	100.00	**82.18**	18.43
Station 6	49	15.00	95.00	**58.06**	21.40
Station 7	49	10.00	100.00	**47.55**	20.67
Station 8	49	46.67	100.00	**79.73**	11.38
Station 9	49	40.00	90.00	**64.49**	15.28
Station 10	49	20.00	93.33	**73.74**	15.89
Station 11	49	10.00	100.00	**46.74**	18.19
Station 12	49	0.00	80.00	**24.83**	19.35
Station 13	49	25.00	90.00	**63.57**	14.25
Station 14	49	45.00	95.00	**70.51**	13.24
Station 15	49	10.00	90.00	**46.12**	22.16
Valid N (listwise)	49				

Table 18: OSCE 1 results per station for experimental group students.

Students from the control group scored over 75% only on station 8 (Table 17), whereas it was the case with four stations (1, 4, 5 and 8) for the students from the experimental group (Table 18). A comparison of both groups by station, shows similar standard deviations which are consistently in the bracket of 11% to 28%.

VI.2.2/ Second OSCE results per study group

A comparison of the overall results of the two study groups for the second OSCE indicates that students in the experimental group generally obtained higher marks than those in the control group (Table 19). On average, the control group obtained 56.00% (95% CI 53.32–58.69) at the second OSCE, whereas the experimental group scored 61.71% (95% CI 59.56–63.88). The highest and lowest marks were obtained by the same students from the control group for the second OSCE. When comparing with Table 15, the standard deviation was reduced by about 1% for both groups between the first and second OSCE.

			OSCE 2 results (%)
Control Group (n=50)		Mean (%)	56.00
	95% Confidence Interval for Mean	Lower Bound	53.32
		Upper Bound	58.69
		Standard Deviation (%)	9.46
		Minimum (%)	36.89
		Maximum (%)	79.11
Experimental Group (n=49)		Mean (%)	61.71
	95% Confidence Interval for Mean	Lower Bound	59.56
		Upper Bound	63.88
		Standard Deviation (%)	7.53
		Minimum (%)	43.11
		Maximum (%)	78.22

Table 19: Results obtained by the two study groups for the second OSCE.

The box plots (Figure 18) suggest only a very minor skew, while there is clear evidence that most experimental group students were scoring higher than the control group students. Figure 19 shows a different representation of the data using a scatterplot of the second OSCE results versus the students' age. The scatterplot also shows that students from the experimental group generally scored higher marks than students

from the control group. The scatterplot from the control group seems to show a fairly homogenous distribution of the results across all ages. The slightly younger average age of the experimental group students (29.3 against 33.0, Table 5) is quite apparent in Figure 19 and occurred despite the random allocation of the students in the two study groups at the time of the first OSCE session.

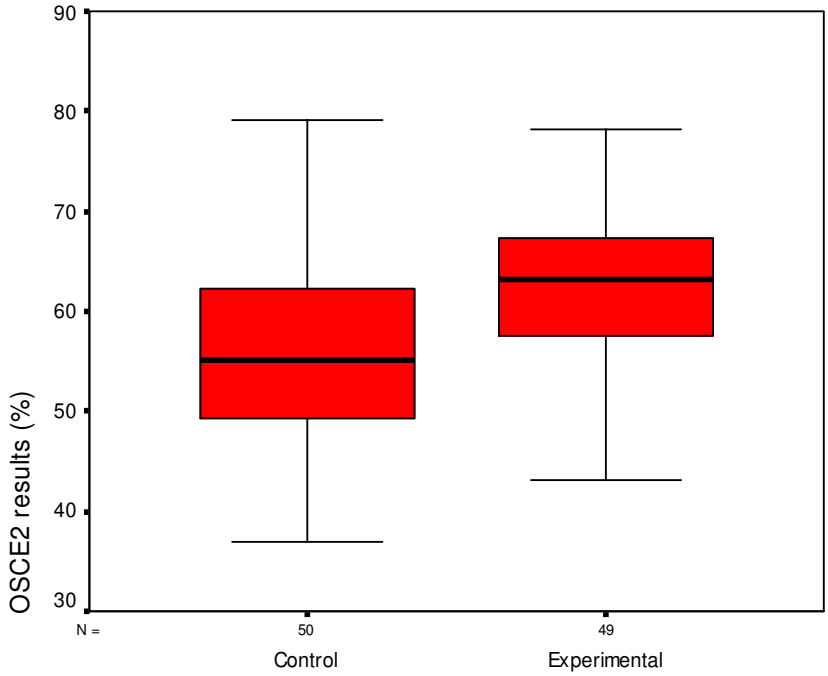

Figure 18: Boxplot of the second OSCE results for the control and experimental groups.

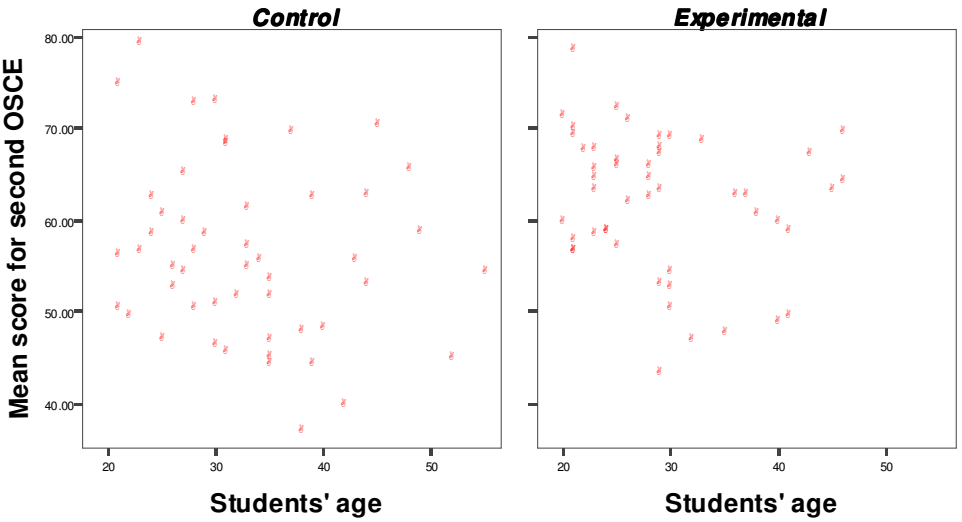

Figure 19: Scatterplot of the students' age versus their second OSCE result.

VI.3/ Determination of the effect of the intervention

An analysis of which particular skills improved for the control and experimental group students, as determined by their mean performance at each OSCE station is presented in Table 20. A colour code has been adopted to facilitate the interpretation of the results:

Red for a regression between the first and second OSCE,
Black for no significant changes, and
Green for statistically significant difference ($p<0.05$).

The average difference in improvement between the two groups was calculated for each station and is reported in Table 20. Each of those average differences between the control and experimental groups were analysed for statistical significance using an Independent Samples t-test and the p value is reported in the same cell. Students from the experimental group improved their performance on all stations. However their improvement was inferior to the one made by the control group students on station 13 (measurement of blood pressure) (Table 20). The lack of difference on this station might have been expected because this is one of the clinical skills that is extensively taught and practised in the nursing programme. The difference is minor and an Independent Samples t-test reveals that this difference is not statistically significant ($p=0.868$) (Table 20).

Although the difference is very small, it is interesting to note that students from the control group did not perform as well on stations 9 and 15 for the second OSCE as they did in the first one (Table 20).On the same theoretical stations the improvement made by the experimental group students was very small in comparison to the other stations. It was respectively 6.33% and 2.86% in comparison to an average overall improvement of 14.18% across all stations for the experimental group (Table 21).

	Control group					Experimental group					
	Mean Improvement (%)	Std. Deviation	Std. Error Mean	Minimum (%)	Maximum (%)	Mean Improvement (%)	Std. Deviation	Std. Error Mean	Minimum (%)	Maximum (%)	Experimental Mean improvement – Control Mean improvement (%) Significance (t-test)
Station 1	**8.20**	23.56	3.33	-45.00	65.00	**17.76**	23.41	3.34	-35.00	60.00	**9.56 p=0.046**
Station 2	**1.00**	16.84	2.38	-40.00	40.00	**8.88**	13.7	1.96	-20.00	35.00	**7.88 p=0.012**
Station 3	**21.00**	24.26	3.43	-20.00	90.00	**22.45**	24.2	3.46	-20.00	90.00	**1.45 p=0.767**
Station 4	**6.47**	25.20	3.56	-46.67	46.67	**17.41**	21.81	3.12	-40.00	73.33	**10.94 p=0.023**
Station 5	**18.67**	35.30	4.99	-100.0	73.33	**25.99**	32.67	4.67	-40.00	80.00	**7.32 p=0.287**
Station 6	**2.90**	27.70	3.92	-55.00	55.00	**12.14**	27.61	3.94	-40.00	80.00	**9.24 p=0.100**
Station 7	**2.60**	18.16	2.57	-40.00	40.00	**13.27**	20.55	2.94	-30.00	60.00	**10.67 p=0.007**
Station 8	**7.33**	20.08	2.84	-46.67	53.33	**13.20**	20.07	2.87	-33.33	66.67	**5.87 p=0.149**
Station 9	**-3.40**	16.73	2.37	-50.00	30.00	**6.33**	18.90	2.70	-30.00	50.00	**9.73 p=0.008**
Station 10	**4.13**	23.05	3.26	-40.00	53.33	**14.90**	20.47	2.92	-20.00	73.33	**10.77 p=0.016**
Station 11	**3.00**	24.26	3.43	-80.00	50.00	**3.88**	19.35	2.76	-40.00	40.00	**0.88 p=0.843**
Station 12	**7.60**	16.90	2.39	-40.00	46.67	**12.72**	20.51	2.93	-20.00	80.00	**5.12 p=0.178**
Station 13	**16.80**	21.85	3.09	-45.00	60.00	**16.12**	18.32	2.62	-25.00	55.00	**-0.68 p=0.868**
Station 14	**7.50**	19.49	2.76	-30.00	40.00	**17.09**	15.37	2.20	-20.00	50.00	**9.59 p=0.008**
Station 15	**-0.60**	21.52	3.04	-60.00	60.00	**2.86**	23.80	3.40	-40.00	60.00	**3.46 p=0.450**

Table 20: Independent sample t-test of the percentage OSCE score differences between the two study groups.

A summary of the overall OSCE scores obtained by the two study groups is presented in Table 21. Some of that data is also presented as a bar chart in Figure 20 and clearly shows how both study groups have scored higher marks during the second OSCE. More importantly, it shows that students from the experimental group improved even more than those from the control group. The difference in performance between the two OSCEs for the two study groups is in fact the main results of this study. The improvement in performance was 7.18 percentage points (95% CI 5.33–9.05) for the control group and 14.18 percentage points (95% CI 12.52–15.85) for the experimental group (Table 21). This data is very appropriately represented in the boxplot in Figure 21, which shows a fairly normal distribution of the improvement in performance for the two study groups. The noticeable difference of 7.00 percentage points between the means of the two study groups (95% CI 4.5–9.5) was highly statistically significant (Table 22, independent sample t-test df=97, p<0.001; test for equality of variance F=0.623, p=0.432).

		OSCE 1 results (%)	**OSCE 2 results** (%)	**% improvement** (OSCE2 - OSCE1)
Control Group (n=50)	Mean (%)	48.82	56.00	7.18
	95% Confidence Interval for Mean			
	Lower Bound	45.90	53.32	5.33
	Upper Bound	51.73	58.69	9.05
	Standard Deviation	10.26	9.46	6.54
	Std. Error Mean	1.45	1.34	0.92
	Minimum (%)	26.67	36.89	-5.33
	Maximum (%)	79.11	79.11	23.56
Experimental Group (n=49)	Mean (%)	47.54	61.71	14.18
	95% Confidence Interval for Mean			
	Lower Bound	45.11	59.56	12.52
	Upper Bound	49.97	63.88	15.85
	Standard Deviation	8.46	7.53	5.80
	Std. Error Mean	1.21	1.08	0.83
	Minimum (%)	30.67	43.11	2.67
	Maximum (%)	68.00	78.22	26.44

Table 21: Improvement in performance obtained by the control and experimental groups between the two OSCEs.

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	p value Sig. (2-tailed)	Mean Diff.	Std. Error Diff.	95% Confidence Interval of the Difference	
								Lower	Upper
Equal variances assumed	0.623	0.432	-5.64	97	1.709e-7	-7.000	1.2420	-9.4647	-4.5346

Table 22: Independent sample t-tests of the mean OSCE improvement between the two study groups

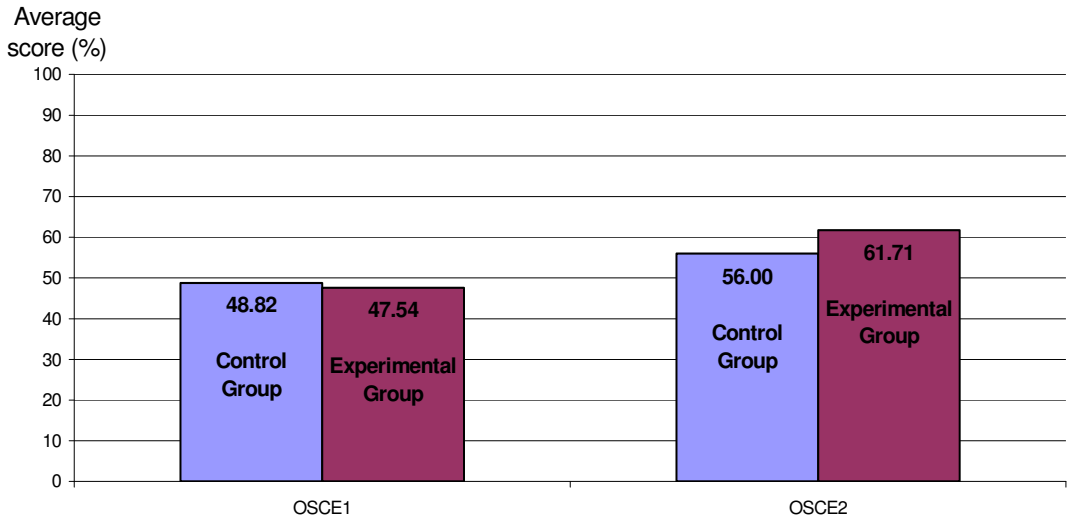

Figure 20: Bar chart representation of the study groups' performance for the two OSCEs.

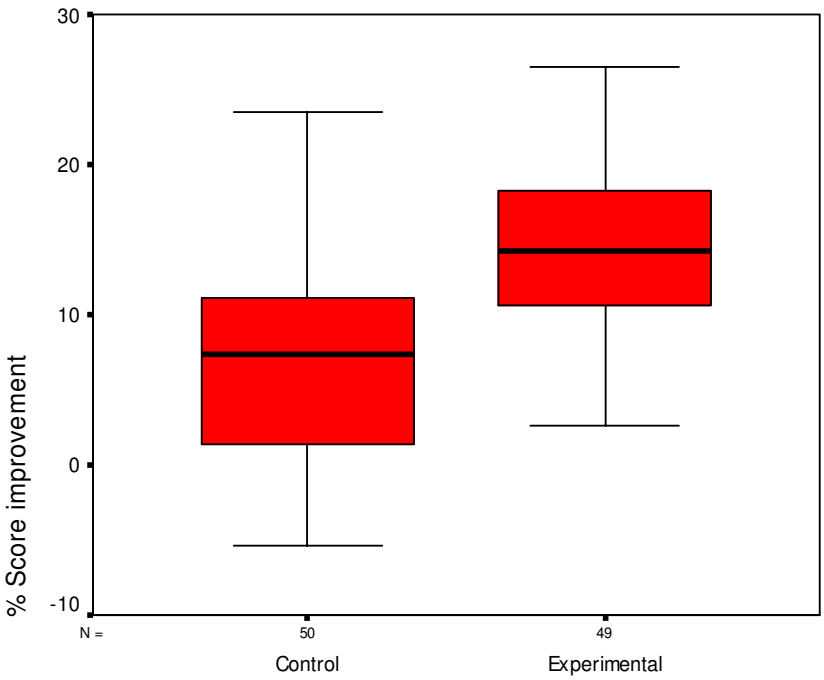

Figure 21: Boxplot of the control and experimental overall improvement in OSCE performance.

	Control group		Experimental group		Total	
	Freq.	Percent	Freq.	Percent	Freq.	Percent
Less than 7% improvement	24	48.0%	6	12.2%	30	30.3%
7% to 14% improvement	18	36.0%	17	34.7%	35	35.4%
Over 14% improvement	8	16.0%	26	53.1%	34	34.3%
Total	50	100.0%	49	100.0%	99	100.0%

Table 23: Cross-tabulation table of the mean score improvement between the two OSCEs for the two study groups.

The mean improvement between the two OSCEs for the control and experimental group was separated into three categories to allow for a Chi-Square test to be carried out. The corresponding cross-tabulation table is shown in Table 23 and the Chi-Square test results in Table 24.

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	16.734	4	**0.002**
Likelihood ratio	15.857	4	0.003
Linear-by-linear association	.286	1	0.593
N of valid cases	99		

Table 24: Chi-Square test of the study group versus the mean OSCE score improvement.

VI.4/ Questionnaire results

A questionnaire was distributed to students for them to complete just before their participation in their second OSCE session. It was used to collect information about students' perception of confidence and stress about working in a highly technological environment. The questionnaire was also used to collect the demographic information presented in section V.2/ Study sample. Although students were asked about their present placement area, this information was deemed unusable as students rotated too regularly across clinical areas.

This section is divided into six subheadings which will respectively present information from the questionnaire about the control group, the experimental group, a comparison of the data from both groups, together and independently with respect to their perceived level of stress and confidence, in relation to their previous healthcare experience and age.

VI.4.1/ Control group questionnaire results

On average, students from the control group were "unsure" to "not very confident" (3.50 SD±0.14 with 1=very confident, 5=not confident at all) about working in a "high-tech" environment, and, on average, were "not sure" (2.94 SD±1.08 with 1=not stressful at all, 5=very stressful) whether they find it stressful working in a technological environment or not (Table 25). 48.0% of the students from the control group were 'not very confident' to 'not confident at all' about working in a "high-tech" environment

(Table 26). Similarly 26% of students from the same group would find it “fairly stressful” to “very stressful” working in a technological environment (Table 27).

		How confident do you feel working in a "high-tech" environment? (1=very confident, 5=not confident at all)	How stressful do you find it working in a technological environment? (1=not stressful at all, 5=very stressful)
N Valid		50	50
N Missing		0	0
Mean		**3.50**	**2.94**
Std. Error of Mean		0.14	0.15
Std. Deviation		0.95	1.08
Minimum		1	1
Maximum		5	5
Percentiles	25	3.00	2.00
	50	3.00	3.00
	75	4.00	4.00

Table 25: Control group students’ perception of their confidence and stress level about working in a technological environment.

	Frequency	Percent	Cumulative Percent
Very confident	1	2.0	2.0
Fairly confident	5	10.0	12.0
Not sure	20	40.0	52.0
Not very confident	16	32.0	84.0
Not confident at all	8	16.0	100.0
Total	50	100.0	

Table 26: Frequency table of the control group students’ perception of their level of confidence about working in a “high-tech” environment.

	Frequency	Percent	Cumulative Percent
Not stressful at all	4	8.0	8.0
Not really stressful	13	26.0	34.0
Not sure	20	40.0	74.0
Fairly stressful	8	16.0	90.0
Very stressful	5	10.0	100.0
Total	50	100.0	

Table 27: Frequency table of the control group students' perception of how stressful they find it working in a technological environment.

		How confident do you feel working in a "high-tech" environment? (1=very confident, 5=not confident at all)	How stressful do you find it working in a technological environment? (1=not stressful at all, 5=very stressful)
N Valid		49	49
N Missing		0	0
Mean		**3.41**	**2.96**
Std. Error of Mean		0.12	0.11
Std. Deviation		0.84	0.79
Minimum		2	1
Maximum		5	5
Percentiles	3.00	2.50	2.50
	3.00	3.00	3.00
	4.00	3.00	3.00

Table 28: Experimental group students' perception of their confidence and stress level about working in a technological environment.

VI.4.2/ Experimental group questionnaire results

On average, students from the experimental group were 'not very confident' (3.41 SD±0.84 with 1=very confident, 5=not confident at all) about working in a "high-tech" environment, and were 'not sure' (2.96 SD±0.79 with 1=not stressful at all, 5=very stressful) whether they would find it stressful working in a technological environment (Table 28). 42.9% of students were 'not very confident' to 'not confident at all' about working in a "high-tech" environment (Table 29). 18.4% of the experimental group

students would find it 'fairly' to 'very stressful' working in a technological environment (Table 30).

	Frequency	Percent	Cumulative Percent
Very confident	0	0.0%	0.0%
Fairly confident	6	12.2%	12.2%
Not sure	22	44.9%	57.1%
Not very confident	16	32.7%	89.8%
Not confident at all	5	10.2%	100.0%
Total	49	100.0%	

Table 29: Frequency table of the experimental group students' perception of their level of confidence about working in a "high-tech" environment.

	Frequency	Percent	Cumulative Percent
Not stressful at all	1	2.0%	2.0%
Not really stressful	11	22.4%	24.4%
Not sure	28	57.1%	81.6%
Fairly stressful	7	14.3%	95.9%
Very stressful	2	4.1%	100.0%
Total	49	100.0%	

Table 30: Frequency table of the experimental group students' perception of how stressful they find it working in a technological environment.

VI.4.3/ Comparison of the questionnaire results by study group

The questionnaire results showed that the two groups differed only slightly with respect to their reported perceptions of stress and confidence when measured using a 5-point Likert scale: 2.94 (1, not stressful; 5, very stressful) and 3.50 (1, very confident; 5, not confident) for the control group, and 2.96 and 3.41 for the experimental group (Table 31). The main findings were that the two groups were unsure about whether it was stressful for them to work in a highly technological environment, and they were not really confident about working in such an environment. The small differences did not

approach statistical significance (Mann–Whitney U-test: perception of stress p=0.562; confidence p=0.819). In addition, our results show that, irrespective of their group, students who are not confident also admit to being stressed when exposed to working in a technological environment, and this was statistically significant (p= 0.002, chi-square, df=2, n= 99).

The similarities or very small differences in perception of confidence or stress related to working in a technological environment expressed by the students from both study groups can also be tested by performing a Chi-Square analysis. The number of categories for the students' perception of confidence and stress was reduced in order to meet the Chi-Square requirements. This was done as follows for the two relevant questions:

- Very confident; Fairly confident = Confident
- Not sure = Not sure
- Not very confident; Not confident at all = Not confident

and

- Very stressful; Fairly stressful = Stressed
- Not sure; Not really stressful; Not stressful at all = Not Stressed

	Control Group	**Experimental Group**
Confidence in working in a technological environment (1=very confident, 5=not confident at all)	3.50 (SD±0.95)	3.41 (SD±0.84)
Stressfulness of working in a technological environment (1=not stressful at all, 5=very stressful)	2.94 (SD±1.08)	2.96 (SD±0.79)

Table 31: Students' perceptions of stress and confidence in working in a technological environment.

N=99	Perception of confidence			Perception of stress		
	Confident	Not sure	Not confident	Stressed	Not Stressed	Total
Control	6 (12.0%)	20 (40.0%)	24 (48.0%)	13 (26.0%)	37 (74.0%)	50 (100.0%)
Experimental	6 (12.2%)	22 (44.9%)	21 (42.9%)	9 (18.4%)	40 (81.6%)	49 (100.0%)
Total	12 (12.1%)	42 (42.4%)	45 (45.5%)	22 (22.2%)	77 (77.8%)	99 (100.0%)

Table 32: Cross-tabulation of the students' perception of confidence and stress about working in a technological environment for the two study groups.

The reduced data concerning the perceptions of confidence and stress by study group are presented in Table 32. To meet the minimum Chi-Square test requirements there needs to be large enough numbers in the different cells of the cross-tabulation table. None must have an expected count inferior to 5, and at least 80% of the cells must have an observed count over 5. The results of the Chi-Square tests are reported in Table 33 and reveal that there is no statistically significant relationship between the perception of confidence or stress depending on the study group to which students belonged (p=0.867 and p=0.361). This validates the conclusion of the Mann–Whitney U-test presented earlier with respective p values of 0.819 and 0.562.

		Value	df	Asymp. Sig. (2-sided)
Perception of confidence depending to study group	Pearson Chi-Square	0.285	2	**0.867**
	Likelihood ratio	0.285	2	0.867
	Linear-by-linear association	0.153	1	0.696
	N of valid cases	99		
Perception of stress depending to study group	Pearson Chi-Square	0.834	1	**0.361**
	Continuity correction	0.451	1	0.502
	Likelihood ratio	0.838	1	0.360
	Linear-by-linear association	0.826	1	0.364
	N of valid cases	99		

Table 33: Chi-Square tests between the two study groups' mean differences in perception of confidence and stress about working in a technological environment.

VI.4.4/ Comparison of the questionnaire results in relation to perceived stress and confidence

The relationship between all the participating students' perception of stress when exposed to working in a "high-tech" environment and their level of confidence was also investigated and the results are presented in Table 34. A succinct analysis of the cross-tabulation table showed that students who are stressed are very unlikely to be confident. It also showed that 37.8% (17 out of 45) of the students who declared being not confident were stressed when working in a technological environment whereas only 2 out of 12 (16.7%) were both confident and stressed. This result could be expected and its statistical significance was confirmed by the Chi-Square test (Table 35, $p<0.05$).

N=99		Perception of stress				Total
		Stressed		Not stressed		
		Freq.	Percent	Freq.	Percent	
Perception of confidence	Confident	2 (9.1%)	2.0%	10 (13.0%)	10.1%	12 (100.0%)
	Not sure	3 (13.6%)	3.0%	39 (50.6%)	39.4%	42 (100.0%)
	Not confident	17 (77.3%)	17.2%	28 (36.4%)	28.3%	45 (100.0%)
	Total	22 (100.0%)	22.2%	77 (100.0%)	77.8%	99 (100.0%)

Table 34: Cross-tabulation between students' perception of confidence and stress level when working in a technological environment.

Previous healthcare experience was one of the other factors which could have influenced the students' perception of stress and confidence about working in a technological environment. Table 36 shows the students' level of confidence according to whether they had previous working experience in healthcare or not. It is important to note that only 36.4% of the participating students (n=99) had some previous healthcare experience. The results obtained show, for example, that 50.8% of the students without experience claimed not to be confident about working in a technological environment,

against 36.1% for the students with previous healthcare experience. Hence we might conclude that students with previous experience appear to be slightly more confident than the less experienced students. The statistical significance of this hypothesis is not confirmed by the Chi-Square test (Table 37, p=0.162) but there is some evidence for that assertion. Further tests looking at the same factors by individual study groups would have been interesting however the sample of data is too small for the tests to be valid.

		Value	df	Asymp. Sig. (2-sided)
Relation between perception of confidence and stress	Pearson Chi-Square	12.040	2	**0.002**
	Likelihood ratio	12.787	2	0.002
	Linear-by-linear association	7.318	1	0.007
	N of valid cases	99		

Table 35: Chi-Square tests between students' perception of confidence and stress level when working in a technological environment.

N=99		With previous experience		Without previous experience		Total	
		Freq.	Percent	Freq.	Percent	Freq.	Percent
Perception of confidence	Confident	7 (19.4%)	7.1%	5 (7.9%)	5.1%	12 (12.1%)	100.0%
	Not sure	16 (44.4%)	16.2%	26 (41.3%)	26.3%	42 (42.4%)	100.0%
	Not confident	13 (36.1%)	13.1%	32 (50.8%)	32.3%	45 (45.5%)	100.0%
	Total	36 (100.0%)	36.4%	63 (100.0%)	63.6%	99 (100.0%)	100.0%

Table 36: Cross-tabulation table of students' experience versus their reported level of confidence.

Overall	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.644	2	**0.162**
Likelihood ratio	3.561	2	0.169
Linear-by-linear association	3.348	1	0.167
N of valid cases	99		

Table 37: Chi-Square tests between students' experience and their reported level of confidence.

Similarly it is possible that the students' perception of stress could be influenced by whether or not they have had previous healthcare experience. Table 38 summarises the information about the students' perception of stress against their previous experience. Previous experience does not appear to be a determining factor in the students' perception of stress as very similar percentages can be observed whether students had previous experience or not. The Chi-Square tests (Table 39, p=0.965) shows that there was no statistical significance in the results obtained and it illustrates that it is highly likely that previous experience does not affect the perceived level of stress.

N=99		With previous experience		Without previous experience		Total	
		Freq.	Percent	Freq.	Percent	Freq.	Percent
Perception of stress	Stressed	8 (22.2%)	8.1%	14 (22.2%)	14.1%	22 (22.2%)	100.0%
	Not sure	18 (50.0%)	18.2%	30 (47.6%)	30.3%	48 (48.5%)	100.0%
	Not stressed	10 (27.8%)	10.1%	19 (30.2%)	19.2%	29 (29.3%)	100.0%
	Total	36 (100.0%)	36.4%	63 (100.0%)	63.6%	99 (100.0%)	100.0%

Table 38: Cross-tabulation table of students' experience versus their reported level of stress.

Overall	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	0.071	2	**0.965**
Likelihood ratio	0.071	2	0.965
Linear-by-linear association	0.025	1	0.874
N of valid cases	99		

Table 39: Chi-Square tests between students' experience and their reported level of stress.

The cross-tabulation between students' gender and the level of confidence is reported in Table 40. It shows that 49.4% of the female students claimed they would not be confident about working in a technological environment against 25.0% for the male students. Female students appeared to be less confident than male students according to the sample studied. The Chi-Square analysis indicates that this result does not reach statistical significance (Table 41, p=0.191) but this could be due to the limited sample size especially in relation to the few male students among the participating students. When the same test is performed using only two categories of confidence (i.e. Not confident and Other), the p value of the Fisher Exact test becomes p=0.101, which suggests that there could be a relationship between gender and perception of confidence.

	Gender	Male		Female		Total	
N=99		Freq.	Percent	Freq.	Percent	Freq.	Percent
Perception of confidence	Confident	3 (18.8%)	3.0%	9 (10.8%)	9.1%	12 (12.1%)	100.0%
	Not sure	9 (56.3%)	9.1%	33 (39.8%)	33.3%	42 (42.4%)	100.0%
	Not confident	4 (25.0%)	4.0%	41 (49.4%)	41.4%	45 (45.5%)	100.0%
	Total	16 (100.0%)	16.2%	83 (100.0%)	83.8%	99 (100.0%)	100.0%

Table 40: Cross-tabulation table of students' gender versus their level of confidence.

Overall	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.308	2	**0.191**
Likelihood ratio	3.446	2	0.179
Linear-by-linear association	2.982	1	0.084
N of valid cases	99		

Table 41: Chi-Square tests between students' gender and their level of confidence.

Gender N=99		Male		Female		Total	
		Freq.	Percent	Freq.	Percent	Freq.	Percent
Perception of stress	Stressed	1 (6.3%)	1.0%	21 (25.3%)	21.2%	22 (22.2%)	100.0%
	Not sure	8 (50.0%)	8.1%	40 (48.2%)	40.4%	48 (48.5%)	100.0%
	Not stressed	7 (43.8%)	7.1%	22 (26.5%)	22.2%	29 (29.3%)	100.0%
	Total	16 (100.0%)	16.2%	83 (100.0%)	83.8%	99 (100.0%)	100.0%
Perception of stress	Stressed	1 (6.3%)	1.0%	21 (25.3%)	21.2%	22 (22.2%)	100.0%
	Not Stressed	15 (93.8%)	15.2%	62 (74.7%)	62.6%	77 (77.8%)	100.0%
	Total	16 (100.0%)	16.2%	83 (100.0%)	83.8%	99 (100.0%)	100.0%

Table 42: Cross-tabulation table of students' gender versus their reported level of stress.

Stress in 2 categories	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	2.817	1	0.093	
Continuity correction	1.822	1	0.177	
Likelihood ratio	3.508	1	0.061	
Fisher's Exact Test				**0.112**
Linear-by-linear association	2.788	1	0.095	
N of valid cases	99			

Table 43: Chi-Square tests between students' gender and their reported level of stress.

Similarly the data presenting students' perception of stress against their gender is presented in Table 42. The table presents information using the two sets of stress categorisation in order to make the results more meaningful. The results with the stress level divided in three categories showed that 43.8% of the male students think they would not feel stressed about working in a "high-tech" environment in comparison to only 26.5% of the female students. It also showed that 21.2% of the female students would find it stressful working in a "high-tech" environment against only 6.3% of the male students. To meet the minimum Chi-Square requirements, the level of stress was divided into two categories. The result of the test in Table 43 showed that this trend was not statistically significant (Fisher's Exact Test: p=0.112) but it should however be taken into consideration. This trend was quite similar to the gender distribution of the students' perception of confidence (Table 40) which tends to confirm that there was a relationship between students' perception of stress about working in a technological environment and their level of confidence (Table 34).

VI.4.5/ Comparison of the questionnaire results in relation to previous healthcare experience

A cross-tabulation table of students' gender against their previous experience is reported in Table 44. It is important to remember that the number of male students taking part in the study was very limited (n= 16). According to this sample of students a larger proportion of female students (38.6%, and only 25% for male students) had some previous healthcare experience. This difference was not significant according to the Fisher's Exact Test (Table 45, p=0.400).

The students' previous experience in healthcare was also compared against their age. As it is likely that older students may have worked as carers or healthcare assistants prior to joining the University nursing programme. For the validity of the tests, the students were separated in two age groups at the median point of 29 years of age and the results are presented in Figure 22 and Table 46. Contrary to what may have been expected, more mature students were not more likely to have worked in the healthcare professions in the past than younger students. According to Figure 22 it appears that a greater proportion of under 29 years old students have had previous healthcare experience than older students. 46% of the younger students had previous healthcare experience whereas it was only the case for 26.5% of older students (Table 46). This

finding was tested using a Chi-Square test as shown in Table 49 and confirmed the statistical significance of this finding. Although this cannot be verified, it is likely that older students may have had work experience in a different area and opted for a radical career change.

Gender	Male		Female		Total	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Experience	4 (25.0%)	4.0%	32 (38.6%)	32.3%	36 (36.4%)	100.0%
No experience	12 (75.0%)	12.1%	51 (61.4%)	51.5%	63 (63.6%)	100.0%
Total	16 (100.0%)	16.2%	83 (100.0%)	83.8%	99 (100.0%)	100.0%

Table 44: Cross-tabulation table of students' gender versus their reported level of confidence.

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	1.065	1	0.302	
Continuity correction	0.560	1	0.454	
Likelihood ratio	1.116	1	0.291	
Fisher's Exact Test				**0.400**
Linear-by-linear association	1.054	1	0.305	
N of valid cases	99			

Table 45: Chi-Square tests between students' gender and their reported level of confidence.

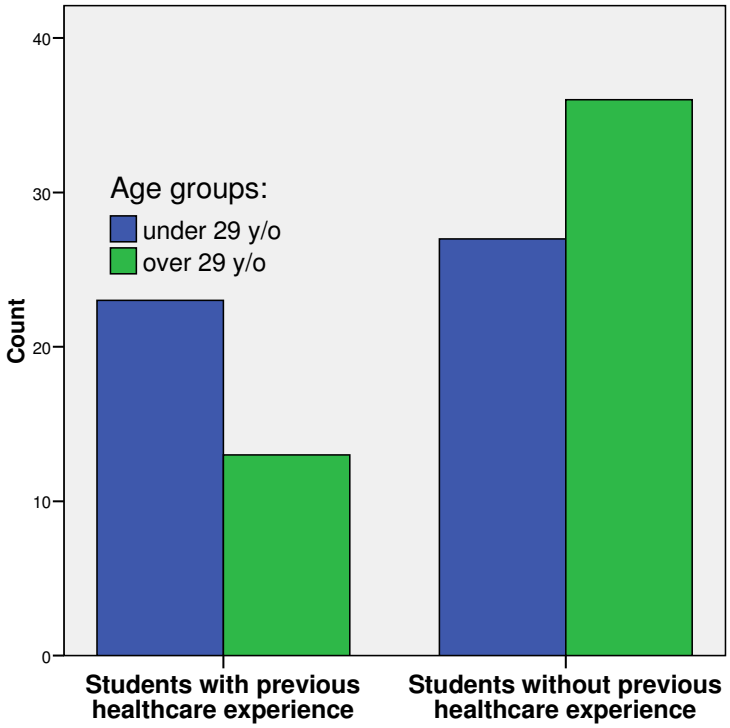

Figure 22: Bar chart distribution of students' previous healthcare experience by age group.

Over all participating students			Age groups <29.00	Age groups >29.00	Total
Previous health care experience?	Yes	Count	23 (63.9%)	13 (36.1%)	36 (100%)
		% within Age groups	46.0%	26.5%	36.4%
		% of Total	23.2%	13.1%	36.4%
	No	Count	27 (42.9%)	36 (57.1%)	63 (100%)
		% within Age groups	54.0%	73.5%	63.6%
		% of Total	27.3%	36.4%	63.6%
	Total	Count	50 (50.5%)	49 (49.5%)	99 (100%)
		% within Age groups	100.0%	100.0%	100.0%
		% of Total	50.5%	49.5%	100.0%

Table 46: Cross-tabulation table of the students' age in relation to their previous healthcare experience

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	4.054	1	**0.044**		
Continuity Correction(a)	3.256	1	0.071		
Likelihood Ratio	4.095	1	0.043		
Fisher's Exact Test				0.060	0.035
Linear-by-Linear Association	4.013	1	0.045		
N of Valid Cases	99				

Table 47: Chi-Square tests of the students' age in relation to their previous healthcare experience

The above finding will later be referred to in supporting the argument that it cannot be assumed that older students are less likely to achieve a greater score improvement between the two OSCEs than younger students.

VI.4.6/ Comparison of the questionnaire results in relation to age of the participating students

It was also thought that age of the students could influence their perception of confidence or stress level about working in a technological environment. The cross-tabulation tables presenting those results are Table 48 and Table 50. The information concerning the students' confidence has been presented in two different ways: by age groups separated in three categories (Age ≤26, between 26 and 34, and ≥34) and by age groups separated in two categories (under 29, and over 29). Both tables indicate that there is a small difference in the students' level of confidence and that older students are more likely to feel less confident than younger students. However, according to the Chi-Square tests (Table 49), this difference is not statistically significant (p=0.533).

	N=99	Age≤26		26<Age<34		Age≥34		Total	
		Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent
Perception of confidence	Confident	4 (11.8%)	4.0%	5 (15.6%)	5.1%	3 (9.1%)	3.0%	12 (12.1%)	100.0%
	Not sure	17 (50.0%)	17.2%	12 (37.5%)	12.1%	13 (39.4%)	13.1%	42 (42.4%)	100.0%
	Not confident	13 (38.2%)	13.1%	15 (46.9%)	15.2%	17 (51.5%)	17.28%	45 (45.5%)	100.0%
	Total	34 (100 %)	34.3%	32 (100%)	32.3%	33 (100%)	33.3%	99 (100%)	100.0%
		Under 29		Over 29		Total			
		Freq.	Percent	Freq.	Percent	Freq.	Percent		
	Confident	7 (14.0%)	7.1%	5 (10.2%)	5.1%	12 (12.1%)	100.0%		
	Not sure	23 (46.0%)	23.3%	19 (38.8%)	19.2%	42 (42.4%)	100.0%		
	Not confident	20 (40.0%)	20.2%	25 (51.0%)	25.3%	45 (45.5%)	100.0%		
	Total	50 (100.0%)	50.5%	49 (100.0%)	49.5%	99 (100%)	100.0%		

Table 48: Cross-tabulation table of students' age group versus their reported level of confidence.

2 age groups	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.260	2	**0.533**
Likelihood ratio	1.263	2	0.532
Linear-by-linear association	1.157	1	0.282
N of valid cases	99		

Table 49: Chi-Square tests between students' age group versus their reported level of confidence.

The effect of age on students' reported level of stress when exposed to working in a technological environment is presented in Table 50. As for the effect of age on confidence, the analysis was carried out using the age separated in two and three categories. The cross-tabulation tables do not show any particular relationship between the students' age and their level of stress. The frequency results obtained with the age divided into three categories give very low values that cannot be used to draw reliable conclusions. The section of Table 50 presenting the data with the age divided into two

groups seems to indicate that younger students are more likely to feel stressed about working in a technological environment than older students. The Chi-Square tests show that there is no strong statistical significance between the students' age and their perception of stress in both instances, however the p value has reduced from p=0.783 to p=0.162 when analysing the data with only two age categories instead of three (Table 51).

N=99		Age≤26		26<Age<34		Age≥34		Total	
		Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent
Perception of stress	Stressed	8 (23.5%)	8.1%	8 (25.0%)	8.1%	6 (18.2%)	6.1%	22 (22.2%)	100.0%
	Not Stressed	26 (76.5%)	26.3%	24 (75.0%)	24.2%	27 (81.8%)	27.3%	77 (77.8%)	100.0%
	Total	34 (100%)	34.3%	32 (100%)	32.3%	33 (100%)	33.3%	99 (100%)	100.0%
		Under 29		Over 29		Total			
		Freq.	Percent	Freq.	Percent	Freq.	Percent		
	Stressed	14 (28.0%)	14.1%	8 (16.3%)	8.1%	22 (22.2%)	100.0%		
	Not Stressed	36 (72.0%)	36.4%	41 (83.7%)	41.4%	77 (77.8%)	100.0%		
	Total	50 (100.0%)	50.5%	49 (100.0%)	49.5%	99 (100%)	100.0%		

Table 50: Cross-tabulation table of students' age group versus their reported level of stress.

3 age groups	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	0.488	2	**0.783**
Likelihood ratio	0.499	2	0.779
Linear-by-linear association	0.270	1	0.603

2 age groups	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.951	1	**0.162**
Continuity correction	1.334	1	0.248
Likelihood ratio	1.972	1	0.160
Linear-by-linear association	1.931	1	0.165
N of valid cases	99		

Table 51: Chi-Square tests between students' age group and their reported level of stress.

VI.5/ Comparison of the OSCE and questionnaire results

The data collected allows for a multitude of tests and comparisons to be carried out using the OSCE results, the questionnaire data, and the demographic information.

VI.5.1/ Effect of perceived confidence and stress on the OSCE improvement score

Table 52 summarises the cross-tabulation results of the students' perception of confidence about working in a technological environment with their improvement in OSCE performance. In order to meet the minimum Chi-Square requirements and ensure an even distribution of the number of participants the analysis was performed with the improvement in OSCE performance divided into two categories corresponding approximately to the median point between 7% and 14% (i.e. under 11% and over 11% in improvement). No significant tendency emerged from this analysis and the results of Chi-Square tests confirmed that there was no statistically significant relationship between students' confidence and their improvement in OSCE performance (Table 53, p=0.374).

		Score difference between the two OSCEs				Total	
		Less than 11% improvement		More than 11% improvement			
		Freq.	Percent	Freq.	Percent	Freq.	Percent
Perception of confidence	Confident	7	58.3%	5	41.7%	12	100.0%
	Not sure	17	40.5%	25	59.5%	42	100.0%
	Not confident	24	53.3%	21	46.7%	45	100.0%
	Total	48	48.5%	51	51.5%	99	100.0%

Table 52: Cross-tabulation table of the OSCE score improvement divided in two categories versus the students' reported perception of confidence.

Over all participating students	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.968	2	**0.374**
Likelihood ratio	1.977	2	0.372
Linear-by-linear association	0.086	1	0.769
N of valid cases	99		

Table 53: Chi-Square tests between the OSCE performance improvement and the students' reported perception of confidence.

		Score difference between the two OSCEs						Total	
		Less than 7% improvement		7% to 14% improvement		Over 14% improvement			
		Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent
Perception of stress	Stressed	3	13.6%	11	50.0%	8	36.4%	22	100.0%
	Not Stressed	27	35.1%	24	31.2%	26	33.8%	77	100.0%
	Total	30	30.3%	35	35.4%	34	34.3%	99	100.0%

Table 54: Cross-tabulation table of the OSCE score improvement divided in two categories against the students' reported perception of stress.

Over all participating students	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4.343	2	**0.114**
Likelihood ratio	4.702	2	0.095
Linear-by-linear association	1.516	1	0.218
N of valid cases	99		

Table 55: Chi-Square tests between the OSCE performance improvement and the students' reported perception of stress.

A similar analysis was carried out to compare the students' perception of stress with the improvement in OSCE performance. The cross-tabulation presented in Table 54 does not appear to present a relationship between the latter two parameters. The number of students is almost equally distributed across the table. However, the Chi-Square value is low (Table 55, p=0.114) and while this does not confirm any strong

statistical significance in the results obtained, this may show that there is a trend. The comparable level of stress reported by both study groups should mean that none of the groups were advantaged from that perspective.

VI.5.2/ Effect of gender on the OSCE improvement score

Table 56 shows the mean score improvement between the two OSCEs versus the students' gender as a whole, and also by individual study group.

	Less than 7% improvement		7% to 14% improvement		Over 14% improvement		Total	
	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent
All participating students								
Male	6	37.5%	8	50.0%	2	12.5%	16	100.0%
Female	24	28.9%	27	32.5%	32	38.6%	83	100.0%
Total	30	30.3%	35	35.4%	34	34.3%	99	100.0%
Control group:								
Male	4	44.4%	5	55.6%	0	0.0%	9	100.0%
Female	20	48.8%	13	31.7%	8	19.5%	41	100.0%
Total	24	48.0%	18	36.0%	8	16.0%	50	100.0%
Experimental group:								
Male	2	28.6%	3	42.9%	2	28.6%	7	100.0%
Female	4	9.5%	14	33.3%	24	57.1%	42	100.0%
Total	6	12.2%	17	34.7%	26	53.1%	49	100.0%

Table 56: Cross-tabulation table of the students' gender versus their mean score improvement between the two OSCEs.

A succinct analysis of the results presented in Table 56 suggests that male students were less likely to improve their first OSCE performance by more than 14% during second OSCE than female students. However this hypothesis is not statistically confirmed by the Chi-Square tests (Table 57, p=0.124) and the observed difference may simply be due to the very small sample of male students who took part in the study (16 out of 99 participants). The cross-tabulation by study group presented in

Table 56 did not meet the minimum requirements for a Chi-Square test to be carried out as there were too few male students involved in the study, hence too many cells with a count inferior to 5.

Over all participating students	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4.136	2	**0.126**
Likelihood ratio	4.718	2	0.095
Linear-by-linear association	2.471	1	0.116
N of valid cases	99		

Table 57: Chi-Square tests of the students' gender versus their mean score improvement between the two OSCEs.

		Less than 11% improvement		**More than 11% improvement**		Total	
		Freq.	Percent	Freq.	Percent	Freq.	Percent
All participants	**Age≤26**	13	38.2%	21	61.8%	34	100.0%
	26<Age<34	16	50.0%	16	50.0%	32	100.0%
	Age≥34	19	57.6%	14	42.4%	33	100.0%
	Total	48	48.5%	51	51.5%	99	100.0%
Control group	**Age≤26**	9	75.0%	3	25.0%	12	100.0%
	26<Age<34	12	70.6%	5	29.4%	17	100.0%
	Age≥34	14	66.7%	7	33.3%	21	100.0%
	Total	35	70.0%	15	30.0%	50	100.0%
Experimental group	**Age≤26**	4	18.2%	18	81.8%	22	100.0%
	26<Age<34	4	26.7%	11	73.3%	15	100.0%
	Age≥34	5	41.7%	7	58.3%	12	100.0%
	Total	13	26.5%	36	73.5%	49	100.0%

Table 58: Cross-tabulation table of the students' age versus their mean score improvement between the two OSCEs.

Age is also a factor that could have influenced the OSCE performance of the students. A cross-tabulation table was designed to explore the relationship between age of the students separated in three categories and their mean score improvement between the

two OSCEs (Table 58). The improvement in OSCE score has been divided into two categories (i.e. improvement less than 11%, and improvement over 11% for the overall results) in order to satisfy the minimum Chi-Square requirements. Overall the tendency seemed to be that the oldest group were less likely to achieve higher score improvements than the younger group. The Chi-Square tests however showed that overall there is not a statistically significant effect of the students' age on the improvement in OSCE performance (Table 59, p=0.279). For the purpose of the analysis, the results are also presented by study group in Table 58 but the significance cannot be statistically verified.

Over all participating students	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.551	2	**0.279**
Likelihood ratio	2.570	2	0.277
Linear-by-linear association	2.488	1	0.155
N of valid cases	99		

Table 59: Chi-Square test between the students' age versus their mean score improvement between the two OSCEs

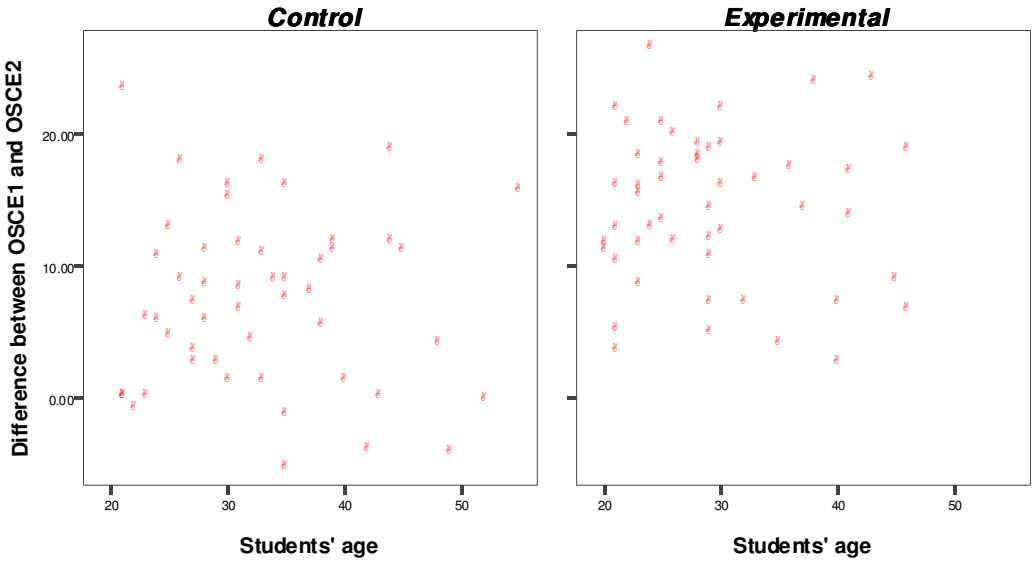

Figure 23: Scatterplot of the students' age versus their improvement in OSCE performance for the two study groups.

The scatterplot presented in Figure 23 confirms the conclusion drawn just above as no obvious relationship can be observed between the students' age in their performance improvement between the first and second OSCE.

VI.5.3/ Effect of previous healthcare experience on the OSCE improvement score

An analysis of the relationship between students' previous healthcare experience and improvement in OSCE performance was carried out. Table 60 shows the number of students with and without prior healthcare experience for each category of score improvement for all the participating students, and also by individual study group. This analysis was done to test the hypothesis that students with previous experience were less likely to make higher improvements in their OSCE performance than students without experience. This hypothesis is in fact noticeable in Table 60 where a higher proportion of inexperienced students have achieved a score improvement of over 14% in comparison to students with prior healthcare experience.

	Less than 7% improvement		7% to 14% improvement		Over 14% improvement		Total	
	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent
All participating students								
Experience	13	36.1%	13	36.1%	10	27.8%	36	100.0%
No experience	17	27.0%	22	34.9%	24	38.1%	63	100.0%
Total	30	30.3%	35	35.4%	34	34.3%	99	100.0%
Control group:								
Experience	**12**	**60.0%**	**6**	**30.0%**	**2**	**10.0%**	**20**	**100.0%**
No experience	**12**	**40.0%**	**12**	**40.0%**	**6**	**20.0%**	**30**	**100.0%**
Total	24	48.0%	18	36.0%	8	16.0%	50	100.0%
Experimental group:								
Experience	1	6.3%	7	43.8%	8	50.0%	16	100.0%
No experience	5	15.2%	10	30.3%	18	54.5%	33	100.0%
Total	6	12.2%	17	34.7%	26	53.1%	49	100.0%

Table 60: Cross-tabulation table of the mean OSCE score improvement versus the students' previous healthcare experience.

Over all participating students:	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.349	2	**0.509**
Likelihood ratio	1.357	2	0.075
Linear-by-linear association	1.330	1	0.249
N of valid cases	99		

Table 61: Chi-Square test between the mean OSCE score improvement versus the students' previous healthcare experience.

The Chi-Square tests shown in Table 61 shows that this tendency is not statistically significant (p=0.509). The OSCE stations were often testing skills that even students who had worked as healthcare care assistants or carer would not have been familiar with.

VI.6/ Chapter Summary

The data collected as part of this study alongside a wide array of statistical tests have been presented throughout this chapter. The final results of the study show that there is a significant difference in improvement in OSCE performance on a pre-test/post-test basis between the students who participated in the simulation training sessions against those who did not. The OSCE results show that the experimental group's students improved their performance by 14.18 percentage points whereas the control group's students only improved by 7.18 percentage points. Despite students from the experimental group achieving a greater improvement in their OSCE performance, their perception of confidence and stress level about working in a "high-tech" environment was very similar to that of the students from the control group. Although it is based on a very small number of male students and bears no statistical significance (p=0.112), it should be noted that they expressed being more confident about working in a technological environment than female students. Based on the limited sample used, no significant conclusions could be drawn with regards to the effect of students' gender or age on their OSCE performance

Although the general outcome of this study was very positive as students who were exposed to simulation significantly improved their OSCE performance in comparison to students who did not benefit from any simulation exposure, it had some limitations. The study involved students from only one institution and relied on a convenience sample as the sessions could not be made compulsory for all students on the programme for logistical reasons. Organising such a rigorously standardised study across several institutions would be a very complex task outside the scope of this partially funded study but may be a consideration for future research. This study was also hugely demanding on human resources to run the OSCE and simulation sessions because of the number of examiners required and due to the fact that each simulation session was only organized for a few students at a time and hence needed to be repeated many times to put students through. Making the study compulsory for all students would not have been possible due to multiple interactions with each student, and more particularly so for the experimental group students who attended the simulation in even smaller groups.

The study provided some encouraging results supporting the use of simulation followed by a debriefing discussion as an educational methodology in undergraduate nursing education. The way students were made to engage in the scenarios in very small teams encouraged them to adopt an active learning mode and to think as they were interacting with the “patient” (Brown and Chronister, 2009, McCausland et al., 2004, Alinier, 2007a).

Students were briefed about teamwork and communication but the fact that the scenarios involved primarily one healthcare profession appeared to have limited their scope of learning from the experience and the way the scenario could evolve. Although it was not among the objectives of the study, it is now felt that a greater emphasis could have been placed on the scenario participants’ behavioural and communication skills because of the realism of the simulation experience for the students.

Although the key limitations could not be avoided in the context of this study, important lessons were learnt from the work conducted for future work. The simulation experience was perceived very positively and it was felt that further efforts should be invested in researching other aspects of this training methodology. The scenarios could be made more realistic and the students’ learning opportunity could potentially be enhanced if students from more professions were represented in the scenarios and the debriefings. This would hence allow students to observe a longer ‘window’ of the

patient care pathway and hopefully help them to enhance their understanding and experience of teamwork and communication.

This in turn creates more opportunities for students to better appreciate the contribution of the various healthcare team members. This work conducted with students from a single profession prompted the second study presented in Chapter VII with a view to enriching the students' learning opportunities by facilitating a learning experience for them work as part of multiprofessional teams.

Chapter VII
Multidisciplinary Study

Another study which has been carried out as part of this research programme between 2006 and 2008 related to the organisation of interprofessional scenario-based simulation sessions to look at the effect of exposing multidisciplinary teams of undergraduate students to scenario-based simulation training on their knowledge of each others' roles and skills and on their perception towards working as part of a multidisciplinary team. This was supported by a grant from the Higher Education Academy (HEA) Health Sciences and Practice Subject Centre, and subsequently by a Learning and Teaching Enhancement Award from the University of Hertfordshire. Mainly the term multidisciplinary is used in this thesis although not only were the educational sessions involving students from different disciplines, they also had students representing different professions.

In contrast to the main study which involved the facilitation of uniprofessional simulation sessions with relatively short scenarios, it was thought that the simulation experience could be enhanced and better reflect clinical practice by also involving students from other professions and bring up important aspects such as teamwork and communication. This was linked to a simple research study in order to determine the educational impact of such training opportunity. Lessons from the earlier work were key to this study and informed its design and means of delivery from a practical point of view. This chapter will explain how this project was carried out and what its importance has been in enhancing the students' learning experience and making better use of the simulation training facilities of the University.

VII.1/ Background

Interprofessional simulation education is still a rare training opportunity, especially at the undergraduate level, because of a number of issues relating to the logistics of managing large student cohorts with different timetables and curricula. The nature of the main project carried out with only adult branch nursing students somehow limited the scope and duration of the scenarios that were run. Very rapidly during the scenarios, and as expected in reflection to real clinical practice, students were calling for help which was provided in the form of one or more of the facilitators playing the role of a senior nurse, doctor, or resuscitation officer. When people have such a role within a scenario they are often referred to as confederates (Dieckmann et al., 2007a, Streufert et al., 2001, Alinier, 2011). Also all the scenarios run at the time of the study were ward-based, it would have been very easy to change them to an A&E setting, for example, with a hand over from a crew of paramedic students. This showed that there was the potential to involve students from other professions instead or in addition to confederates and this needed to be explored further. The opportunity afforded by involving students from other professions in the scenarios was seen as an ideal way of broadening their potential scope of learning from each simulation session as they would become exposed to each other's scope of practice and be given opportunities to discuss aspects of teamwork and patient care. While it was recognised that introducing additional variables (students) in the scenarios could influence aspects of their standardisation and anticipated learning outcomes, it is not necessarily detrimental to the students, but reflects what they also experience in their clinical placements where they benefit from widely varying learning experiences.

Defining the terms used is important so one can appreciate and understand the type of learning experience that the participants are exposed to as argued by Alinier (2007b). According to the adopted mode of simulation facilitation used in the studies presented, the author of this thesis' definition of "interprofessional simulation education" has been adapted from that well accepted of "interprofessional education" by Freeth et al (2002). The proposed definition reads as follows:

> "*Interprofessional simulation education is when members (or students) of two or more professions associated with health or social care are engaged together and in a leading capacity in highly realistic scenarios to learn, with, from, and about each other from these simulated patient cases which occur in*

a safe and controllable environment and are immediately followed by a facilitated debriefing."

This type of simulation in healthcare education corresponds to "high-fidelity simulation" Level 3 and 4 with a student-led mode of delivery as explained in Chapter II because participants are not prompted or guided but are immersed in a realistic environment while they are providing treatment to their patient, whether it is an actor (simulated patient) or patient simulator (Alinier, 2007b). The way to achieve interprofessional simulation learning is to engage students in simulation sessions requiring them to work together in multidisciplinary scenarios whereby the input from multiple healthcare professionals is required at various stages.

The University of Hertfordshire has a large portfolio of undergraduate health related courses ranging from pharmacy through to all branches of nursing and diverse allied health professional groups. Interprofessional education (IPE) has been integrated as a module within the healthcare students' curriculum in their first year of study in 2004 and in the final year in 2006. Each year, close to 800 students from 10 different disciplines take part in each module. The management of the programme encompassing these first and final year IPE modules is supported by a small core team of staff with a fractional central appointment within the Faculty of Health and Human Sciences and its delivery is supported by a number of staff from different disciplines.

Since the opening of its Hertfordshire Intensive Care & Emergency Simulation Centre (HICESC) in 1998 (Alinier, 2008a) and alongside the strong emphasis for the delivery of quality IPE, the University has pioneered the use of realistic scenario-based simulation training in disciplines such as nursing and paramedic science as a result of the main study presented in this thesis (Chapters IV, V and VI). From early 2001 through to 2005, the centre acquired two adult Laerdal patient simulators (SimMan) and one Laerdal baby simulator (SimBaby), which have controllable physiological parameters to recreate a large range of medical conditions and pathologies, and other features such as operator controlled voice, auscultation sounds, and bodily fluid outputs.

In 2006 the simulation centre was relocated in a much larger and purpose built facility (Figure 24), which was part of a larger building project within the Faculty of Health and Human Sciences. The design of the new HICESC was influenced by the experience acquired during the main study in terms of layout and features, and is particularly well

suited for the delivery of IPE thanks to the range of simulated clinical and non-clinical settings it houses, hence enhancing the students' learning opportunities (Alinier, 2007a). At the time, although limited to medical and nursing students, others and our published experiences unsurprisingly revealed, according to the students' feedback, that the facilitation of interprofessional simulation training had the potential to be a powerful learning experience for undergraduate students (Ker et al., 2003, Huish et al., 2005).

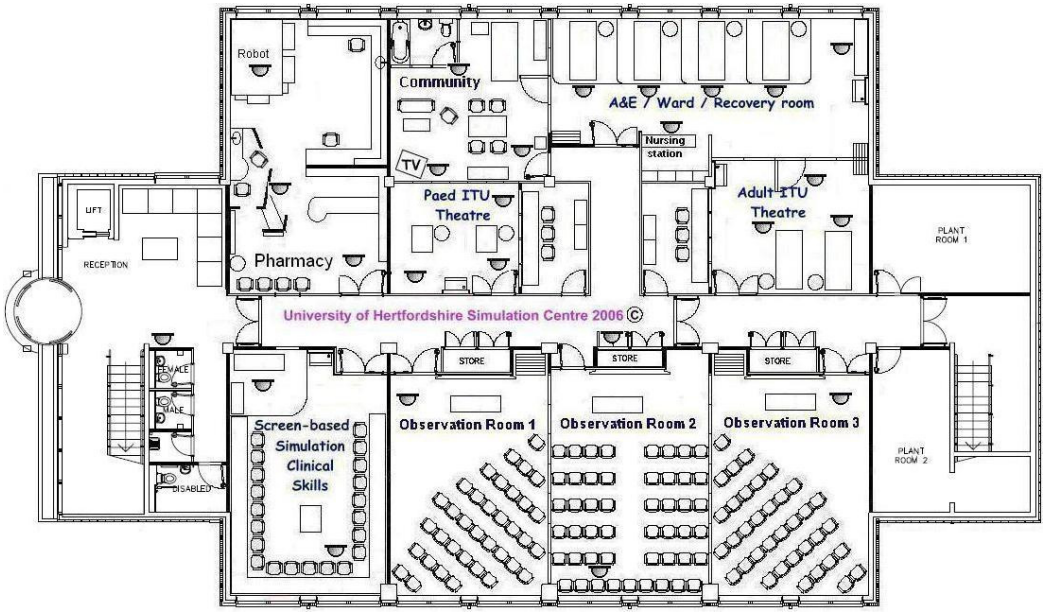

Figure 24: Floor plan of the new Hertfordshire Intensive and Emergency Simulation Centre (HICESC).

VII.2/ Design of Multidisciplinary Study

VII.2.1/ Study objectives

Having demonstrated the effectiveness of scenario-based simulation training using a RCT in the main study, the primary aim of this project, when submitted to the HEA, was to demonstrate the feasibility of organising and running scenarios involving a wide

range of healthcare disciplines. This involved the development and piloting of a programme to facilitate simulation-based training with multidisciplinary groups of final year undergraduate students. It required the creation of a number of relevant and challenging multidisciplinary scenarios to enhance the students' learning experience and to better prepare them to join the healthcare workforce after graduating. This was expected to be achieved by providing them with an opportunity for students to observe aspects of the work carried out by other healthcare professionals which they may not normally witness and also to interact with them when it was appropriate during a scenario (Appendix VIII).

In the context of this thesis, the primary objective was also to investigate the effect of exposing multidisciplinary teams of undergraduate students to scenario-based simulation training on their knowledge of each others' roles and skills and on their perception of working as part of a multidisciplinary team. Another objective of this project, at a local level, was to offer access to HICESC to a much greater number of students than have had access to it until then and to enhance the teaching and learning aspect of the IPE programme currently offered to final year students as well as encourage colleagues from other institutions to engage in similar activities. For the first time, students and lecturers from different disciplines (e.g. nursing, paramedic, physiotherapy, radiography…) were to take part in a joint training activity in the simulation centre for realistic scenario-based simulation training. Students were to learn to work as a team in the simulation centre in order to manage the situations and sometimes had to "save the life" of the computer controlled patient simulator. The ultimate goal of such learning experience is to hopefully improve collaboration between healthcare professionals and the quality of care provided to real patients once these students become part of the active healthcare workforce.

VII.2.2/ Study design and ethical approval

Due to the potentially large number of students that could take part in this project, the opportunity was seized to develop a research strategy to evaluate the benefit of such sessions on the students' acquisition of knowledge with respects to the other healthcare disciplines involved in the simulation sessions. Based on the experience of using the highly demanding OSCEs in the first study and the potential number of students that could agree to take part in the multiprofessional sessions, a simpler

approach was adopted for the evaluation aspect of this second study to minimise the time demand on lecturers from the various professions(and hence the associated costs implications). The study was granted ethical approval by the Research Ethics Committee for Nursing, Midwifery, Paramedic Sciences, Social Work and Counselling under references NMPSC 2003/04/A for a pre/post-simulation session evaluation questionnaire regularly used in the centre, and NMPSC 2005/10/A for a discipline knowledge questionnaire (Appendix IX) and overall design of the study. The ethical approval was for a period of two years in the first instance but was further renewed in 2007 to allow for ongoing collection of data.

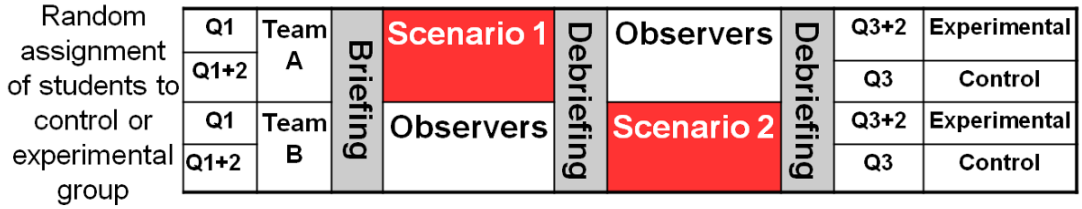

Figure 25: Succession of events during an interprofessional simulation session.

The study included a questionnaire designed to test the students' knowledge of the various professions potentially involved in the scenarios (Q2). It was developed using a Delphi technique with input from two academic staff with appropriate expertise from each profession. The involvement of a panel of subject matter experts enhanced the validity of the individual statements and accuracy of the expected answers (True or False). The fact that these were different academic staff from those involved in the design of the scenarios helped in preventing some of the scenarios being specifically developed around these statements or vice versa. As the scenarios used during each session varied depending on the disciplines represented among the students, it was not possible to ensure that all statements about each profession constituting the questionnaire could fit every single scenario. Given this known limitation, the subject matter experts of each professional group were allowed to choose what they thought were the key statements to include in the questionnaire in relation to their profession that could demonstrate that some observation or exchange of information had taken place during an interprofessional learning activity. To address this, the panel met to agree on the statements to include to ensure their clarity and appropriateness in terms of difficulty. Validity is a key component of questionnaire design (Fallowfield, 1995) and

the reliability can be enhanced if a sufficient number of valid items has been developed (Palmer and Devitt, 2007). An element of the research question of this second study being in relation to the effect of exposing multidisciplinary teams of undergraduate students to scenario-based simulation training on their perception towards working as part of a multidisciplinary team, a section of this questionnaire incorporated 5 statements each with a Likert scale to collect information about the students' view with regards to learning and eventually working alongside people from other healthcare professions. Although it is recommended to use as wide a scale as possible to improve its reliability, the more commonly used Likert scale of 5 points (Jamieson, 2004) was chosen as opposed to an even or 7-point scale due to the anticipated sample size of participants to the project. Wide Likert scale responses can later be condensed into less categories for statistical analysis (Allen and Seaman, 2007), but it was not judged necessary nor advantageous for this study. The use of a questionnaire with a True/False design to test knowledge is very easy to score and has been used successfully in many other studies (Reponen et al., 2004, Dixon, 1994, Van der Vleuten, 1996a, Palmer and Devitt, 2007), sometimes offering a "don't know" option to avoid having participants having to guess an answer (White et al., 2006). This type of dichotomous variable produces nominal data to be analysed with non-parametric tests (Fallowfield, 1995), however the overall scoring of the questionnaire can be used to produce ordinal data and enable the use of parametric tests. The OSCE used in the first study was a very rigorous assessment tool, however such approach would not have been possible in the second study because of the various professions involved and the fact that the investigation was around knowledge acquisition rather than performing practical skills.

All participating students had to complete a consent form before they could be invited to take part in a session and, following participation, they were rewarded with a certificate of attendance to enhance their portfolio. The research element consisted of two questionnaires filled in at different times during the session, one being a test of their knowledge of various healthcare professions in the form of a true/false questionnaire and the other being a general questionnaire about the simulation session. This study was also designed as a RCT whereby volunteers were randomly administered the test before or after the educational intervention to determine its effect. This strategy was again adopted in order to maximise recruitment to the study (Treweek et al., 2010). At the start of every session, based on their discipline, half of the students were randomly selected to fill in a 45-item questionnaire testing their knowledge of other disciplines (Q2) (Appendix IX) before the start of the session

(Control group) and the others after the scenarios and discussions (Experimental group) as illustrated in Figure 25. Although students were asked to fill in the whole questionnaire, they were only assessed on the questions relating to the disciplines represented by the students taking part in each session. In addition, there was a generic simulation session evaluation questionnaire in two parts that all students filled in at the start (Q1) and at the end (Q3) of the session as shown in Figure 25.

The other stages of each simulation session included an introduction and a tour of the facilities in the form of a briefing with an orientation period to the facilities, equipment, and patient simulator. The students were then split into teams (Team A and Team B) to take part in the scenarios regardless of whether they had been allocated to the control or experimental group. The separation into teams was done according to their preference while also ensuring equal mix of the disciplines among the teams to create an equitable experience. As illustrated in Figure 25 each scenario, which could last up to 1 hour, was followed by a facilitated debriefing of approximately 30-60 minutes.

Figure 26: Students from different disciplines remotely observing their peers taking part in a scenario.

VII.2.3/ Methods and simulation session programme

Students were informed about the project through the final year IPE module via email sent using the University's managed learning environment, StudyNet, with an accompanying information letter and consent form (Appendix X). This was thought to

be a better approach than the use of the students' notice board and doing in-class presentations, especially due to the number of programmes it involved and the fact that StudyNet and the use of emails was a much better established communication channel than it was at the time of the first study. Students were asked to volunteer to take part in this project by responding to the email with their availability and identifying their professional discipline. Recruited students were then separated in multidisciplinary groups and invited to attend a 3 to 4-hour session wearing their respective uniform. As illustrated in Figure 25, before taking part in their first scenario and after having been allocated to a team and completed the required questionnaires, students received a 30-minute briefing about the session and introduced to the environment, equipment, and patient simulator. Each session had three to four disciplines represented and each student observed and took part in one long and relevant high-fidelity scenario. This allowed the students from one team to take part in a scenario as and when required while the students from the other team could remotely observe the whole scene through the camera system and take notes about what they observed as shown on the picture in Figure 26, and vice versa. Each scenario was immediately followed by a facilitated debriefing session during which a discussion took place to explore the experience and perspective from the different team members, analyse the scenario events and participants' actions, and discuss the points noted by the observers. Each scenario was different for each session even if the same professions were represented in both teams.

The scenarios were developed with input from staff with simulation experience and from all relevant disciplines to enhance accuracy and validity of the cases. As the scenarios were a key component of each session forming the basis of the overall study, a multistage review process was put in place whereby the brief, patient medical history, patient flow, physiological parameters, and expected students' actions for each scenario were critiqued by academics with clinical experience from the relevant disciplines. At the same time, any material or document (e.g. laboratory results, X-ray, referral letter...) required in the scenario was sourced and attached to the scenario for evaluation. This process ensured the validity of all aspects of each scenario before it could be tested by the team. The scenarios needed to be as realistic as possible to require the input from a combination of three to four disciplines they were each designed for, as illustrated in Figure 27 and presented in Appendix VIII. For example, scenarios starting in the community setting with physiotherapists, learning disability nurse or midwifes, each had a specific referral letter from a General Practitioner and sometimes some additional notes to brief the students about the patient they were

going to visit. If the input from radiographers was built into the scenario, the appropriate X-rays were sourced to correspond with the actual patient of the scenario by the radiography lecturer appointed to the scenario design aspect of the study. This allowed us to display a credible image on the X-ray viewing screen after the radiographers had finished exposing the patient with the decommissioned mobile X-ray machine of the centre. The was achieved by creating an emulated patient record monitor placed in the simulation environment and connected to computer located in the control room and on which we could display any information or image required for any given patient.

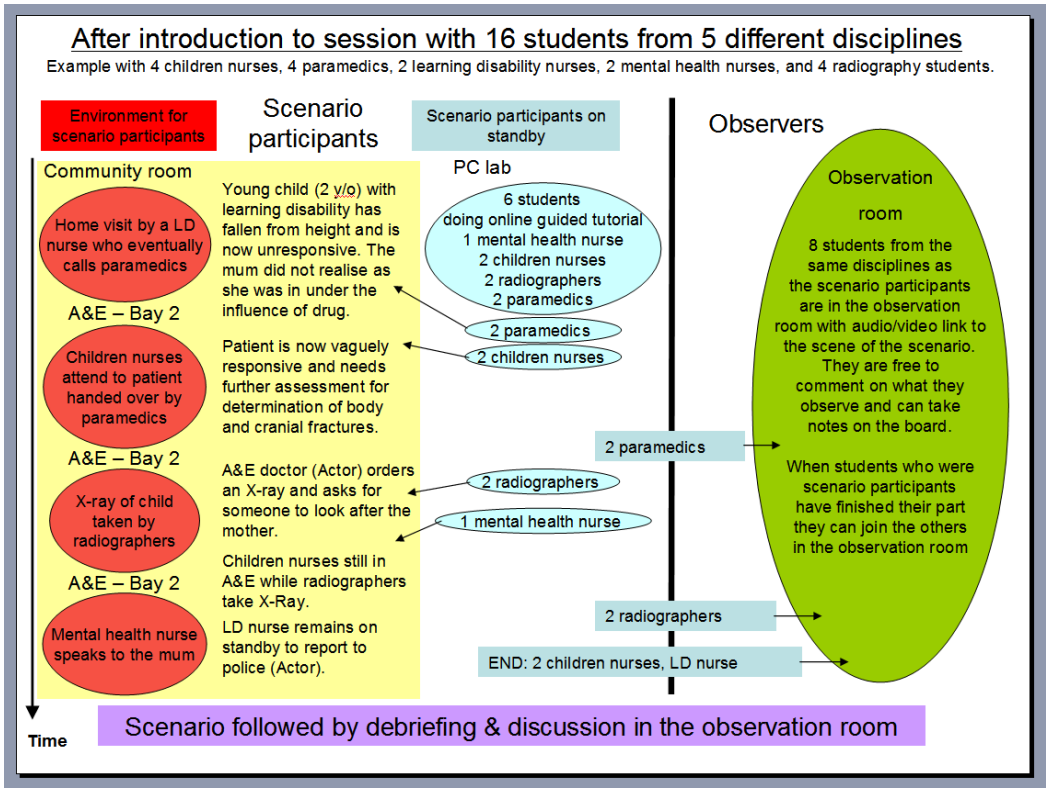

Figure 27: Schematic representation of the location and role or activity of students during a multidisciplinary scenario.

During any scenario, as illustrated in Figure 25 and Figure 27, one team remained in the observation room while some students from the other team were taken to the waiting room (marked as PC lab) and others briefed about their patient. Looking at it from the perspective of the radiographers, as the scenario unfolded, students from the waiting room were called by telephone to join the other students taking part in the scenario as and when their professional input was required. Hence, for example, only

the radiography students who were part of the observing team could see the patient being handed over by the paramedics to the nurses in the Accident and Emergency (A&E) department (Figure 28). During that time, the radiography students who were involved in that scenario at a slightly later stage were in the waiting room unaware of what was happening in the A&E until they were called in, given a signed X-ray request form, and briefed by the other team members about their expected contribution to the care of the patient in the scenario. After the debriefing of the first scenario, the roles were reversed and a different scenario was prepared for the observers to enact and the other students to observe. This gave all students a chance to observe what their peers were doing and also take part in a scenario. For example, learning disability nurses very rarely have the opportunity to see an X-ray being taken, or radiographers and physiotherapists have normally no opportunities to observe paramedics assess a patient. Depending on the disciplines represented during the sessions and the scenarios run, the situation sometimes evolved from the simulated community setting to the paediatric or adult A&E department as shown in the example of Figure 28. It was not rare during any given scenario to have students in four different rooms of the centre at the same time (i.e. Observation room, waiting room, Community setting, A&E department).

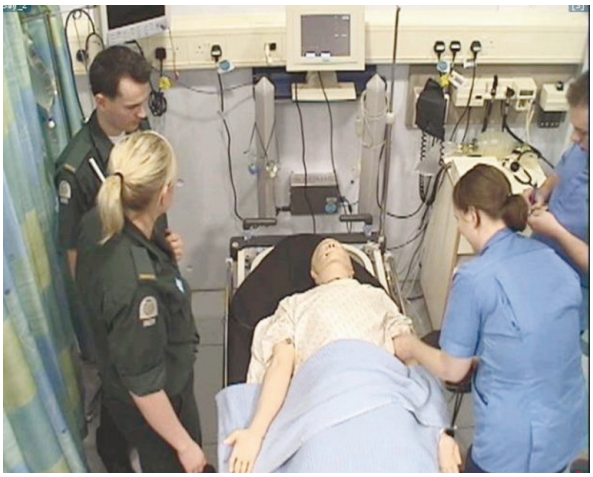

Figure 28: Paramedic students handing over a patient (SimMan) to nursing students in the simulated A&E department.

VII.3/ Results of the Multidisciplinary Study

This section presents the sample of participating students as well as the data collected through the pre- and post-simulation session questionnaires with their comparison, and the results of the discipline knowledge test for the control and experimental group students. Some of data will also be analysed with respects to the students' discipline to determine if it could affect their opinion of simulation-based education.

VII.3.1/ Description of the sample

In 2007-08, out of 598 students on the final year IPE module, 135 students responded to the invitation and volunteered to take part in this project, but in fact only 95 students from 6 different disciplines were able to take part. This self-selected sample of students represented 15.89% of the total population. As the objective was to recruit as many volunteers as possible, no minimum sample size was determined. Although this normally applies to random samples, we can now estimate that assuming a 95% Confidence level, the margin of error or Confidence Interval is 9.2%. Due to the fact that we are not dealing with a real random sample of students, but volunteers, this can be considered a depleted sample and may cause the data to be skewed one way or another in a more significant manner than if more students had been volunteering, or ideally, been randomly selected to take part in the study.

Although more sessions were offered to students, 15 interprofessional simulation sessions were organised and run between November 2007 and May 2008. Two other sessions had to be cancelled because only two students were present.

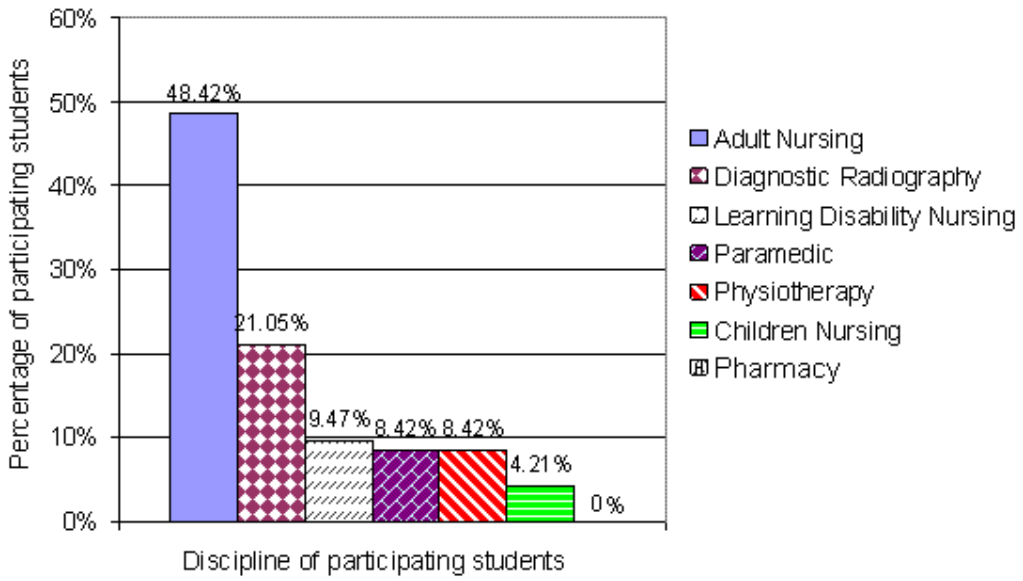

Figure 29: Bar chart representation of the disciplines involved in the project.

	Total number of students	Project participants	Percentage participation from cohort	Students who attended an extra session	Number of scenario participants	Registered students
Adult Nursing	213	46	21.60%	0	46	67
Children's Nursing	38	4	10.53%	0	4	6
Learning Disability Nursing	11	7	63.64%	2	9	8
Mental Health Nursing	33	0	0%	0	0	1
Radiography	120	20	16.67%	0	20	29
Radiotherapy	22	0	0%	0	0	1
Physiotherapy	92	8	8.70%	0	8	14
Paramedics	27	8	29.63%	4	12	8
Pharmacy	42	0	0%	0	0	3
Unknown (extra session)	0	2	-	2	4	
Total	598	95	15.89%	8	103	135

Table 62: Discipline and number of students involved in the interprofessional simulation project.

The disciplines of the students who took part in the project is shown in the bar chart in Figure 29 and includes adult nursing, children's nursing, learning disability nursing,

paramedic science, diagnostic radiography, and physiotherapy. Table 62 shows that 8 students chose to attend two sessions, but they were not given the opportunity to fill in the questionnaires a second time. These students were paramedics (n=4), learning disability nurses (n=2), plus 2 others whose discipline cannot be retrospectively identified as it was not recorded at the time of the session. Although around 16 students (4 students from 4 disciplines) were invited per session, on average only 7 students attended each session. Most students were invited more than once before they were actually able to take part in a session for various reasons, such as difficulty travelling from placements, illness, child care commitments, or lack of motivation to do it in their own time. This often meant that instead of having a pair of students from each required discipline for a given scenario, students were often taking part in a scenario as the sole representative from their profession. On a couple of occasions, the opposite happened and too many students from the same discipline attended the same session in comparison to the other disciplines. This happened in the last two sessions as extra students were invited to attend the sessions to compensate for the generally low attendance level and last minute cancellations from the students.

In total 15.89% of the students registered on the IPE module took part in this project (N=95). Closer analysis of Table 62 shows that the highest level of participation was from learning disability students with 63.64% (n=7), but they were part of a very small cohort of 11 students. Nearly a third of the paramedic students took part in the project (n=8), but they were also part of a small cohort of only 27 students. The largest number of participants were from adult nursing (n=46) and represented 21.60% of their overall cohort. Although only 16.67% of radiography students took part in the project (n=20), they constituted the second largest group of participants. 10.53% of the children's nursing cohort (n=4) and 8.70% of the physiotherapy students (n=8) took part in the simulation sessions of this project. A few students from pharmacy, radiotherapy and mental health nursing registered their interest to take part in the project but they did not attend any of the sessions organised.

In total 45 students were allocated to the control group, and 50 students to the experimental group. This was due to an uneven number of students often taking part in the sessions and because the group allocation was done in turn and in order of arrival of the students in the simulation centre. Overall both groups were comparable in terms of gender (~89.3% female), age (~28.3 y/o) and discipline representation (Figure 30 and Table 63).

		Adult Nursing	Radiography	Learning Disability Nursing	Paramedic	Physiotherapy	Children Nursing	Missing	Total
Control Group	Count	23	11	2	3	4	2		45
	% within Group	51.1%	24.4%	4.4%	6.7%	8.9%	4.4%		100%
	% within Discipline	50.0%	55.0%	22.2%	37.5%	50.0%	50.0%		47.4%
	% of Total	24.2%	11.6%	2.1%	3.2%	4.2%	2.1%		47.4%
Experimental Group	Count	23	9	5	5	4	2	2	50
	% within Group	46.0%	18.0%	10.0%	10.0%	8.0%	4.0%	4.0%	100%
	% within Discipline	50.0%	45.0%	77.8%	62.5%	50.0%	50.0%	100%	52.6%
	% of Total	24.2%	9.5%	7.4%	5.3%	4.2%	2.1%	2.1%	52.6%
Total	Count	46	20	7	8	8	4	2	95
	% within Group	48.4%	21.1%	7.5%	8.4%	8.4%	4.2%	2.1%	100%
	% within Discipline	100%	100%	100%	100%	100%	100%	100%	100%
	% of Total	48.4%	21.1%	7.5%	8.4%	8.4%	4.2%	2.1%	100%

Table 63: Cross tabulation table of the participants' discipline for the control and experimental groups.

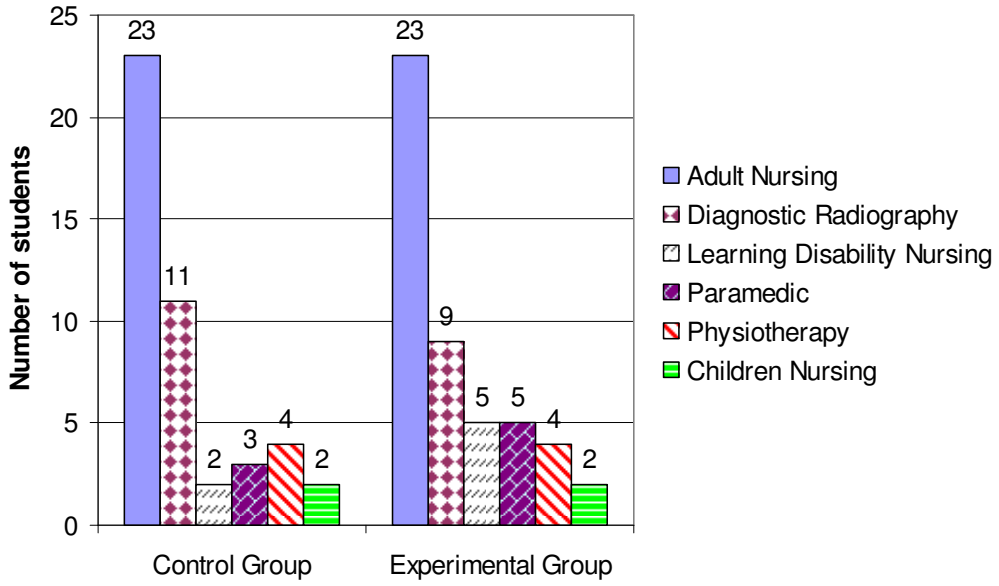

Figure 30: Bar chart representation of the disciplines with the control and experimental groups.

VII.3.2/ Results of the pre-simulation session questionnaire

All students completed a pre-simulation session questionnaire (Q1) at the very beginning of the session (Figure 25). At that point the only information they had about the session was the briefing letter inviting them to take part in an interprofessional scenario-based simulation session (Appendix X). The summary of the students' answers to the questionnaire, which used a 5-point Likert scale with 1=strongly disagree and 5=strongly agree, is presented in Table 64 and Table 65.

According to their responses on the pre-simulation questionnaire, only a minority of students reported being already familiar with the concepts of medical simulation training before the start of the session (22.22%), yet 52.75% expected the session would change their practice significantly (Table 64). They had a fairly high perception that taking part in simulation would improve their clinical skills (4.15 SD±0.92), their clinical knowledge (4.05 SD±0.87), and their skills in managing emergencies (4.13 SD±0.91) (Table 65). Similarly they expressed a positive view about the usefulness of

patient simulators (4.10 SD±0.97) and were looking forward to the session (4.02 SD±0.99).

Further results presented in Table 65 show that students were generally slightly worried about being videoed and performing badly in front of their peers or tutors (~3.6 SD±1.2). Although they were in favour of both potential passive learning opportunities, students seemed to report that they would expect to learn more from watching their peers taking part in a scenario (4.02 SD±0.90) rather than watching themselves on video (3.71 SD±1.04). A paired samples analysis of the above two questions showed a correlation of 0.518 with a significance level $p<<0.001$ which demonstrates that there was no clear relation in the responses provided by the students between these two questions. The students were generally unsure about their ability to work as part of a team in a crisis situation (2.93 SD±0.96), and seem to think it is better to take part in simulation training as part of a multidisciplinary team (3.93 SD±0.92).

The pre-simulation session questionnaire also included a section assessing the students' perception of their awareness of the role and skills of the different disciplines potentially involved in these sessions. From the results presented in Table 65, it is noticeable that students reported being very well aware of the role and skills of their own discipline (>4.75), except adult branch nursing students who reported they were simply aware (4.06 SD±1.10). On average students reported being unsure or not really aware of the role and skills of the other disciplines (<2.81). The least understood disciplines seem to be Learning Disability Nursing (2.36 SD±0.88) and Children's Nursing (2.55 SD±1.00).

	Questions (1=strongly disagree & 5=strongly agree)		***1 or 2***	***3***	***4 or 5***	***Total***
1	I am familiar with the concept of simulation		43 47.78%	27 30.00%	20 22.22%	90
2	Medical simulation will improve my clinical skills		4 4.40%	14 15.38%	73 80.22%	91
3	Medical simulation will improve my clinical knowledge		5 5.49%	11 12.09%	75 82.42%	91
4	Medical simulation will improve my skills in managing emergencies		6 6.59%	8 8.79%	77 84.62%	91
5	Patient simulators are a useful addition to learning from real patients		7 7.78%	11 12.22%	72 80.00%	90
6	I expect that this session will change my practice significantly		8 8.79%	35 38.46%	48 52.75%	91
7	I am looking forward to the session		7 7.69%	13 14.29%	71 78.02%	91
8	Worried about performing badly in front of the camera		16 17.58%	23 25.27%	52 57.14%	91
9	Worried about performing badly in front of my peers		16 17.58%	26 28.57%	49 53.85%	91
10	I am worried about performing badly in front of the instructors		13 14.29%	24 26.37%	54 59.34%	91
11	I expect to learn new concepts that will aid my clinical practice		8 8.79%	17 18.68%	66 72.53%	91
12	Having the opportunity to observe myself on video would be useful		10 10.99%	26 28.57%	55 60.44%	91
13	Expect to learn from watching others perform		8 8.89%	5 5.56%	77 85.56%	90
14	I feel well trained	in leadership and communication	13 14.29%	45 49.45%	33 36.26%	91
15		in working as a team in crisis situation	26 28.57%	43 47.25%	22 24.18%	91
16	I will find difficult to treat the mannequin as a real patient		21 23.60%	32 35.95%	36 40.45%	89
17	It is better to take part in simulation training as part of a multidisciplinary team		6 6.59%	17 18.68%	68 74.73%	91

Table 64: Frequency table of the students' responses to the non-discipline specific items of the pre-simulation questionnaire.

	Questions (1=strongly disagree and 5=strongly agree)	***Mean***	***S.D.***	***Cases***
1	I am familiar with the concept of simulation	2.66	1.24	90
2	Medical simulation will improve my clinical skills	4.15	0.92	91
3	Medical simulation will improve my clinical knowledge	4.05	0.87	91
4	Medical simulation will improve my skills in managing emergencies	4.13	0.91	91
5	Patient simulators are a useful addition to learning from real patients	4.10	0.97	90
6	I expect that this session will change my practice significantly	3.61	0.88	91
7	I am looking forward to the session	4.02	0.99	91
8	I am worried about performing badly in front of the camera	3.63	1.26	91
9	I am worried about performing badly in front of my peers	3.52	1.28	91
10	I am worried about performing badly in front of the instructors	3.65	1.20	91
11	I expect to learn new concepts that will aid my clinical practice	3.87	0.98	91
12	Having the opportunity to observe myself on video would be useful	3.71	1.04	91
13	I expect to learn from watching others perform	4.02	0.90	90
14	I feel well trained in leadership and communication	3.24	0.85	91
15	I feel well trained in working as a team in crisis situation	2.93	0.96	91
16	I will find it difficult to treat the mannequin as a real patient	3.22	1.05	89
17	It is better to take part in simulation training as part of a multidisciplinary team	3.93	0.92	91
18*	I am well aware of the role and skills of an adult nurse	4.06 / 2.78	1.10 / 0.90	46 / 45
19	I am well aware of the role and skills of a mental health nurse	2.63	0.96	91
20*	I am well aware of the role and skills of a learning disability nurse	4.8 / 2.36	0.45 / 0.88	5/86
21*	I am well aware of the role and skills of a children's nurse	4.75 / 2.55	0.50 / 1.00	4 / 87
22	I am well aware of the role and skills of a midwife	2.70	1.00	91
23*	I am well aware of the role and skills of a radiographer	4.75 / 2.75	0.91 / 0.89	20 / 71
24	I am well aware of the role and skills of a radiotherapist	2.69	0.94	91
25*	I am well aware of the role and skills of a paramedic	5.00 / 2.81	0 / 0.94	8 / 83
26*	I am well aware of the role and skills of a physiotherapist	5.00 / 2.81	0 / 0.82	8 / 83
27	I am well aware of the role and skills of a pharmacist	2.65	0.92	91

Table 65: Results of the pre-simulation questionnaire.

* Students from the discipline in question / Students from the other disciplines.

			Other disciplines			Adult nursing			p
	Questions (1=strongly disagree & 5=strongly agree)		Mean	S.D.	N	Mean	S.D.	N	
1	I am familiar with the concept of simulation		2.87	1.36	45	2.44	1.08	45	0.106
2	Medical simulation will improve my clinical skills		4.31	0.67	45	4.00	1.10	46	0.106
3	Medical simulation will improve my clinical knowledge		4.11	0.65	45	4.00	1.05	46	0.547
4	Medical simulation will improve my skills in managing emergencies		4.22	0.74	45	4.04	1.05	46	0.351
5	Patient simulators are a useful addition to learning from real patients		4.33	0.80	45	3.87	1.08	45	**0.022**
6	I expect that this session will change my practice significantly		3.53	0.84	45	3.70	0.92	46	0.381
7	I am looking forward to the session		4.18	0.81	45	3.87	1.13	46	0.138
8	Worried about performing badly in front of the camera		3.49	1.25	45	3.76	1.27	46	0.307
9	Worried about performing badly in front of my peers		3.33	1.37	45	3.70	1.19	46	0.180
10	I am worried about performing badly in front of the instructors		3.51	1.20	45	3.78	1.21	46	0.285
11	I expect to learn new concepts that will aid my clinical practice		3.82	0.81	45	3.91	1.13	46	0.661
12	Having the opportunity to observe myself on video would be useful		3.87	0.84	45	3.57	1.19	46	0.166
13	Expect to learn from watching others perform		4.07	0.78	45	3.98	1.01	45	0.642
14	I feel well trained	in leadership and communication	3.29	0.76	45	3.20	0.93	46	0.603
15		in working as a team in crisis situation	3.07	1.12	45	2.80	0.78	46	0.196
16	I will find difficult to treat the mannequin as a real patient		3.25	1.08	44	3.20	1.04	45	0.824
17	It is better to take part in simulation training as part of a multidisciplinary team		3.98	0.75	45	3.89	1.06	46	0.655
18	I am well aware of the role & skills of	an adult nurse	2.78	0.90	45	4.07	1.10	46	**<0.001**
19		a mental health nurse	2.40	0.96	45	2.85	0.92	46	**0.026**
20		a learning disability nurse	2.36	1.15	45	2.63	0.88	46	0.203
21		a children's nurse	2.51	1.12	45	2.78	1.05	46	0.237
22		a midwife	2.58	0.99	45	2.83	1.02	46	0.241
23		a radiographer	3.58	1.42	45	2.80	0.83	46	**0.002**
24		a radiotherapist	2.80	1.10	45	2.59	0.75	46	0.282
25		a paramedic	3.16	1.26	45	2.85	0.89	46	0.182
26		a physiotherapist	3.07	1.18	45	2.93	0.80	46	0.532
27		a pharmacist	2.49	0.94	45	2.80	0.88	46	0.104

Table 66: Analysis of the pre-simulation questionnaire results by discipline.

Results from the pre-simulation session have also been analysed in relation to the students' discipline by comparing adult branch nursing students versus the others' responses. The data is reported in Table 66. Although it is not statistically significant, it suggests that adult branch nursing students are less familiar (2.44 SD± 1.08 versus 2.87 SD±1.36, p=0.106) and have a positive yet slightly lower expectation of the potential learning benefits from simulation-based training than students from the other disciplines (Question 1: 4.00 SD±1.10 versus 4.31 SD±0.67, p=0.106, question 4: 4.04 SD±1.05 versus 4.22 SD±0.74, p=0.351). This tendency is confirmed by the statistically significant difference in the response to question 5 about the usefulness of patient simulators in addition to learning from real patients which was more positive for students from the other disciplines than for the adult branch nursing students (4.33 SD±0.80 versus 3.87 SD±1.08, p=0.022). Responses to the other questions reported in Table 66 are relatively similar irrespective of the students' discipline.

VII.3.3/ Results of the post-simulation session evaluation questionnaire

The post-simulation session evaluation questionnaire (Q3) was completed by all the students at the very end of each session as shown in Figure 25 and contained 40 questions across four sections. The frequency and mean results of sections A and B are presented in Table 67, Table 68, and Table 73, while sections C and D data is collated in Table 70, Table 72, and Table 74. Overall students were positive about their experience. For reporting purposes the questions relating to the disciplines not represented among the participating students have been removed as students did not have an opportunity to observe or work alongside them as part of the simulation sessions (Questions 14, 15, 20 and 22).

The first section of the post-simulation questionnaire related to the familiarisation period. The results of the first question presented in Table 67 showed that in fact 25.28% of students reported being already familiar with the concepts of medical simulation, which confirms what the students initially reported in the pre-simulation questionnaire (22.22%, Table 64). From Table 68 we can see that students generally felt the familiarisation period, which was part of the briefing, helped to reassure them (3.64 SD±1.03) but they were unsure that they had enough time to familiarise

themselves with the patient simulator (3.12 SD±0.93). 40.00% of the students reported feeling comfortable in the simulated environment, and 41.11% were unsure, which corresponded to 3.28 (SD±1.03) on the Likert scale results presented in Table 68.

Questions (1=strongly disagree and 5=strongly agree)		***1 or 2***	***3***	***4 or 5***	***Total***
A	**The familiarisation period with medical simulation training:**				
1	I was familiar with the concepts of medical simulation training	34 37.36%	34 37.36%	23 25.28%	91
2	The familiarisation period helped to reassure me	12 13.64%	20 22.73%	56 63.63%	88
3	I had enough time to familiarise myself with the patient simulator	20 22.22%	41 45.56%	29 32.22%	90
4	I felt comfortable with the simulated environment	17 18.89%	37 41.11%	36 40.00%	90
B	**The medical simulation session:**				
5	The scenarios were realistic and believable	8 8.79%	12 13.19%	71 78.02%	91
6	The presence of a video camera made me under-perform	46 51.11%	29 32.22%	15 16.67%	90
7	The presence of my peers made me under-perform	61 67.03%	22 24.18%	8 8.79%	91
8	The presence of the instructors made me under-perform	54 60.00%	28 31.11%	8 8.89%	90
9	I found it difficult to treat the mannequin as a real patient	37 40.66%	23 25.27%	31 34.07%	91
10	The response of the mannequin to treatment was realistic	9 9.89%	21 23.08%	61 67.03%	91
11	The scenario prompted realistic responses from me	9 9.89%	19 20.88%	63 69.23%	91
12	It is better to take part in simulation training as part of a multidisciplinary team	3 3.37%	6 6.74%	80 89.89%	89

Table 67: Frequency table of the students' responses to the non-discipline specific items of the post-simulation questionnaire (Section A and B).

Questions (1=strongly disagree and 5=strongly agree)		***Mean***	***S. D.***	***Cases***
A	**The familiarisation period with medical simulation training:**			
1	I was familiar with the concepts of medical simulation training	2.8	1.17	91
2	The familiarisation period helped to reassure me	3.64	1.03	88
3	I had enough time to familiarise myself with the patient simulator	3.12	0.93	90
4	I felt comfortable with the simulated environment	3.28	1.03	90
B	**The medical simulation session:**			
5	The scenarios were realistic and believable	3.99	0.99	91
6	The presence of a video camera made me under-perform	2.47	1.05	90
7	The presence of my peers made me under-perform	2.16	0.95	91
8	The presence of the instructors made me under-perform	2.24	1.00	90
9	I found it difficult to treat the mannequin as a real patient	2.89	1.27	91
10	The response of the mannequin to treatment was realistic	3.81	0.99	91
11	The scenario prompted realistic responses from me	3.78	0.97	91
12	It is better to take part in simulation training as part of a multidisciplinary team	4.40	0.76	89
13 *	Simulation allowed me to learn more about the role and skills of an adult nurse	4.36 / 4.20	0.89 / 0.90	33 /35
16 *	Simulation allowed me to learn more about the role and skills of a radiographer	4.23 / 3.73	0.93 / 0.86	13 /64
17 *	Simulation allowed me to learn more about the role and skills of a learning disability nurse	4.33 / 3.81	0.58 / 1.18	3 /27
18 *	Simulation allowed me to learn more about the role and skills of a paramedic	2.00 / 4.03	1.41 / 0.90	2 /34
19 *	Simulation allowed me to learn more about the role and skills of a physiotherapist	4.00 / 4.00	1.67 / 0.86	6 /31
21 *	Simulation allowed me to learn more about the role and skills of a children's nurse	4.00 / 3.67	0 / 2.31	1/3

Table 68: Results of the post-simulation questionnaire section A and B.

* Students from the discipline in question / Students from the other disciplines.

Although this is not reported in Table 68, but looking more closely at the data collected, the physiotherapy students appeared to be the group the most satisfied with the time for the familiarisation with the patient simulator (3.63 SD±0.92) while the paramedic

students were the least satisfied (2.63 SD±0.92). An analysis of variance was used to test for differences in the students' satisfaction with the duration of the familiarisation period versus their discipline and showed it was not statistically significant (One-way ANOVA F=1.085, p=0.375) as some disciplines were represented by too few students. The difference noticed may be due to the fact that physiotherapists rely less on the functionality and monitoring aspect of the patient simulator than paramedic students who may have required more time to understand the extensive capabilities of the patient simulator. The learning disability students were the group who reported feeling the most comfortable in the simulated environment (3.80 SD±0.84) while the radiography students were unsure (3.00 SD±0.94).

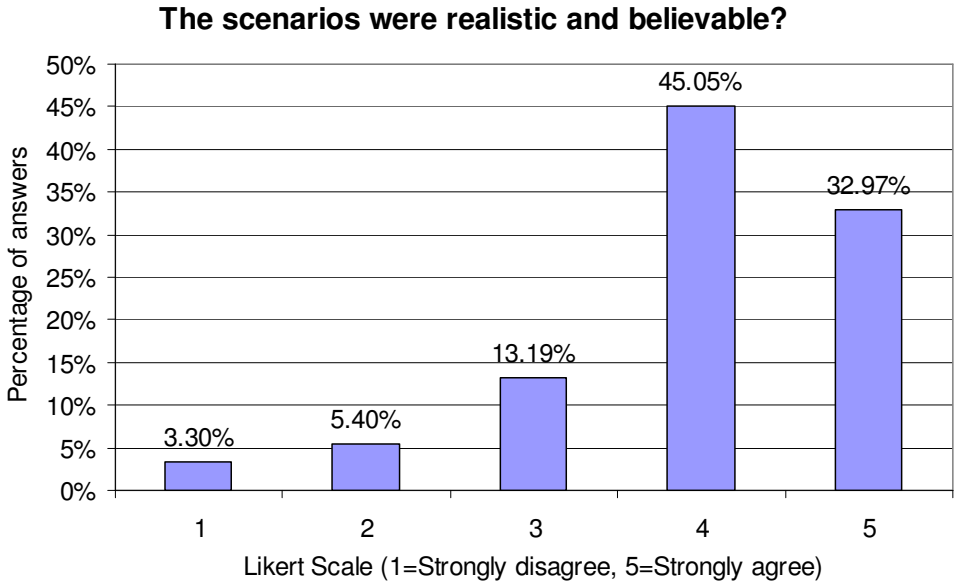

Figure 31: Bar chart representation of the students' perception of realism of the scenarios.

The second section of the post-simulation session evaluation questionnaire related to the scenarios. 78.02% of the students thought the scenarios were realistic and believable (Table 67 and Figure 31). Students tended to disagree with the statement that the presence of a video camera, their peers, or the tutors made them under-perform, which they respectively scored 2.47 SD±1.05, 2.16 SD±0.95, and 2.24 SD±1.00 (Table 68). This contradicted their impression prior to them taking part in a scenario when they respectively scored the same items 3.49 SD±1.25, 3.33 SD±1.37 and 3.51 SD±1.20 (Table 66). They seemed to be the least worried about the presence

of their peers (2.16 SD±0.95) in comparison to the other elements (Table 68). They generally found it less difficult than they anticipated to treat the mannequin as a real patient (3.22 SD±1.05 before versus 2.89 SD±1.27 after). A paired samples t-test showed that the difference in the students' opinion from before to after simulation exposure was statistically significant (p=0.026, Table 69). Due to the use of ordinal data, this finding was also validated by a non-parametric test (Mann-Whitney U-test, p=0.025). Students also thought the mannequin responded realistically to treatment (3.81 SD±0.99). The students reported that the scenarios prompted fairly realistic responses from them (3.78 SD±0.97) and that it is better to take part in simulation training as part of a multidisciplinary team (4.4 SD±0.76) as clearly illustrated in the bar chart in Figure 32 totalling 89.89% agreeing with the statement (Table 67).

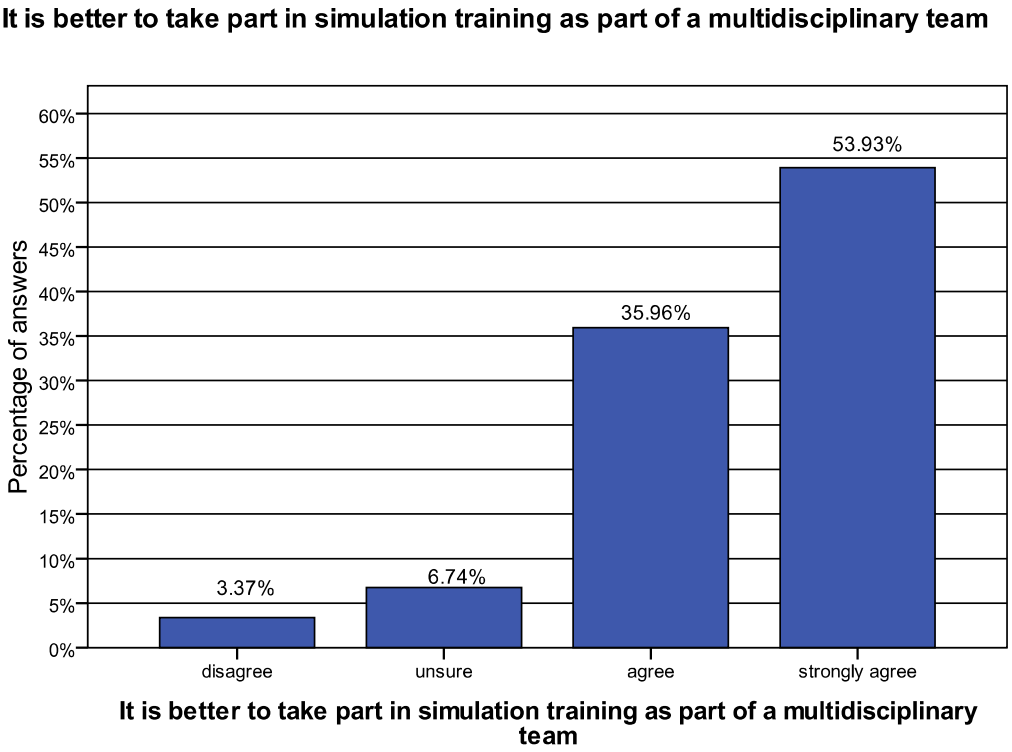

Figure 32: Responses of students as to whether it is better to take part in simulation training as part of a multidisciplinary team.

Another series of questions explored whether students thought they had learnt about the different professions involved in their scenario or the scenario they observed (Table 68). The discipline for which students reported learning the most was Adult Nursing (4.20 SD±0.9). All students thought that simulation allowed them to learn more about the role and skills of their own and other disciplines (3.67<mean<4.36, Table 68).

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Dev.	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
I will find it difficult to treat the mannequins as real patient - I found it difficult to treat the mannequin as a real patient.	0.360	1.494	0.158	0.045	0.674	2.270	88	**0.026**

Table 69: Paired samples t-test of the differences in students' view of their difficulty in treating the patient simulators as a real patient before and after exposure to simulation training.

The next section of the post-simulation session evaluation questionnaire was about the debriefing session (Table 70). Students felt that they learnt from the debriefing following each scenario (4.39 SD±0.69). They also felt that it is beneficial to have multidisciplinary scenario debriefings (4.42 SD±0.74) as much discussion was taking place among students about their differing practices on issues such as patient handling or patient assessment. According to students the debriefing illustrated important behavioural aspects (4.27 SD±0.76) and enhanced their technical knowledge (4.10 SD±0.82) as the debriefing discussions often covered aspects of communication, teamwork, use of equipment, bioscience, and pharmacology The majority of students thought that seeing themselves on video would have allowed them to reflect better (4.08 SD±1.09). Because of time constraints, this was not possible on the day students were taking part in the scenarios, however all students were given the opportunity to come back to the simulation centre to view the recording of their scenario. A total of 12

students from 2 different sessions out of a total of 15 interprofessional simulation sessions actually returned to view the video of their scenario in their own time in HICESC.

	Questions (1=strongly disagree and 5=strongly agree)	***Mean***	***Std. dev.***	***Cases***
C	**The debriefing session:**			
23	I learnt from the debriefing session	4.39	0.69	90
24	It is beneficial to have multidisciplinary scenario debriefing session	4.42	0.74	91
25	The debriefing session illustrated important behavioural aspects	4.27	0.76	90
26	The debriefing session enhanced my technical knowledge	4.10	0.82	90
27	Seeing myself on video would allow me to reflect better	4.08	1.09	86
D	**Your opinion on medical simulation training:**			
28	I enjoyed the session	4.59	0.80	91
29	I found it useful to learn alongside peers from other disciplines	4.63	0.66	90
30	I learnt from participating in my own scenario	4.49	0.78	90
31	I learnt from watching others take part in the scenario	4.54	0.75	90
32	It reinforced aspects of my clinical practice important to patient safety	4.38	0.73	91
33	The course will help me to practise more safety	4.34	0.81	90
34	I will change my clinical practice because of what I have learned today	3.90	1.02	89
35	Today's course has improved my clinical skills	4.02	0.97	91
36	Today's course has increased my clinical knowledge	4.16	0.76	90
37	Patient simulators are a useful addition to learning from real patients	4.48	0.71	89
38	Simulation training should be available to all trainees from my discipline	4.69	0.61	91
39	Simulation training should be part of the IPE module	4.66	0.71	89
	Likert scale does not apply to the following question (Non-ordinal data)			
40	How regularly would you find it useful to repeat such a session per year?	3.80	3.12	86

Table 70: Results of the post-simulation questionnaire section C and D.

The fourth and final section of that questionnaire explored further the views of the students about medical simulation training and the project in general (Table 70 and Table 72). The students very much enjoyed the session (4.59 SD±0.80) with 90.11% agreeing with the statement. They reported learning from taking part in their scenario (4.49 SD±0.78, and 86.67% in agreement) as much as they did from observing their peers (4.54 SD±0.75, and 90.00% in agreement). They found it very useful to learn alongside students from other disciplines (4.63 SD±0.66, and 92.22% in agreement). According to them the sessions reinforced aspects of their clinical practice important to patient safety (4.38 SD±0.73) and will help them to practise more safely in the future (4.34 SD±0.81). Over 67% of students reported they would change aspects of their clinical practice because of what they learnt during the session (3.90 SD±1.02) (Figure 33 and Table 70) such as the use of a communication tool like SBAR (Situation – Background – Assessment – Recommendation). Students reported that the session improved their clinical skills (4.02 SD±0.97) and knowledge (4.16 SD±0.76) and that patient simulators are a useful addition to learning from real patients (4.48 SD±0.71, Table 70) to an even greater degree than they thought before the simulation session (4.10 SD±0.97, Table 65). A paired samples t-test showed that this difference was statistically highly significant (df=87, p=0.001) (
Table 71). A Mann-Whitney U- test was also performed and provided the same level of statistical significance (p=0.001). Further results from Table 70 and Table 72 show that students were strongly in agreement that the type of simulation training they were exposed to should be available to all trainees from their discipline (4.69 SD±0.61, 94.50% in agreement) and be part of the IPE module (4.66 SD±0.71, 94.38% in agreement). On average students would like to take part in such sessions 3.8 times per year (SD±3.12). Students' response to this open question ranged from 1 to 18 sessions per year (Table 72). The average was 10 for the paramedic students and approximately 2 to 4 times per year for the students from the other disciplines.

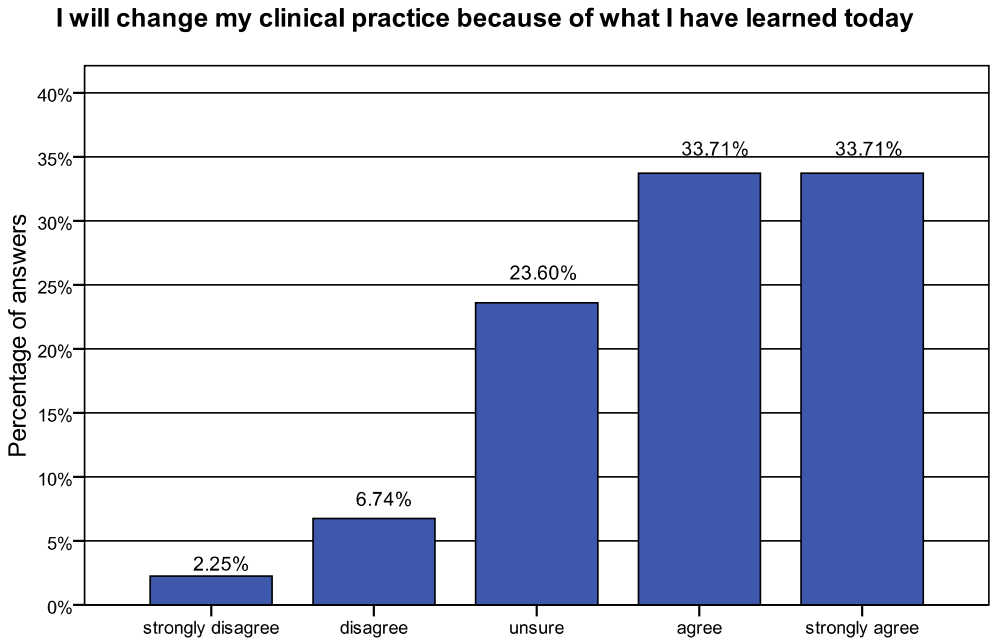

Figure 33: Bar chart representation of students' intention to change their clinical practice as a result of participating in the simulation session.

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Dev.	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Patient simulators are a useful addition to learning from real patients – Difference of the before and after simulation exposure.	-0.375	0.975	0.104	-0.581	-0.169	-3.610	87	0.001

Table 71: Paired samples t-test of the differences in students' view of the usefulness of patient simulators before and after exposure to simulation training.

	Questions (1=strongly disagree and 5=strongly agree)	***1 or 2***	***3***	***4 or 5***	***Total***
C	**The debriefing session:**				
23	I learnt from the debriefing session	2 2.22%	4 4.45%	84 93.33%	90
24	It is beneficial to have multidisciplinary scenario debriefing session	3 3.30%	5 5.49%	83 91.21%	91
25	The debriefing session illustrated important behavioural aspects	2 2.22%	11 12.22%	77 85.56%	90
26	The debriefing session enhanced my technical knowledge	2 2.22%	20 22.22%	68 75.56%	90
27	Seeing myself on video would allow me to reflect better	9 10.47%	11 12.79%	66 76.74%	86
D	**Your opinion on medical simulation training:**				
28	I enjoyed the session	3 3.30%	6 6.59%	82 90.11%	91
29	I found it useful to learn alongside peers from other disciplines	1 1.11%	6 6.67%	83 92.22%	90
30	I learnt from participating in my own scenario	2 2.22%	10 11.11%	78 86.67%	90
31	I learnt from watching others take part in the scenario	1 1.11%	8 8.89%	81 90.00%	90
32	It reinforced aspects of my clinical practice important to patient safety	2 2.20%	7 7.69%	82 90.11%	91
33	The course will help me to practise more safety	2 2.22%	10 11.11%	78 86.67%	90
34	I will change my clinical practice because of what I have learned today	8 8.99%	21 23.60%	60 67.41%	89
35	Today's course has improved my clinical skills	6 6.59%	17 18.68%	68 74.72%	91
36	Today's course has increased my clinical knowledge	1 1.11%	17 18.89%	72 80.00%	90
37	Patient simulators are a useful addition to learning from real patients	1 1.12%	8 8.99%	80 89.89%	89
38	Simulation training should be available to all trainees from my discipline	1 1.10%	4 4.40%	86 94.50%	91
39	Simulation training should be part of the IPE module	2 2.25%	3 3.37%	84 94.38%	89
	Likert scale does not apply to the following question (Non-ordinal data)				
40	How regularly would you find it useful to repeat such a session per year?	Mean=3.80, SD±3.12, n=86 (min=1, max=18)			

Table 72: Frequency table of the students' responses to the post-simulation questionnaire (Section C and D).

			Adult nursing			Other disciplines			*p*
	Questions (1=strongly disagree & 5=strongly agree)		***Mean***	***S.D.***	***N***	***Mean***	***S.D.***	***N***	
A	**The familiarisation period with medical simulation training:**								
1	I was familiar with the concept of simulation		2.80	1.13	46	2.80	1.22	45	0.986
2	The familiarisation period helped to reassure me		3.58	1.06	45	3.70	1.01	43	0.588
3	I had enough time to familiarise myself with the patient simulator		3.11	1.01	45	3.13	0.87	45	0.911
4	I felt comfortable with the simulated environment		3.22	1.01	46	3.34	1.06	44	0.572
B	**The medical simulation session:**								
5	The scenarios were realistic and believable		3.89	1.08	46	4.09	0.90	45	0.346
6	The presence of a video camera made me under-perform		2.49	1.14	45	2.44	0.97	45	0.842
7	The presence of my peers made me under-perform		2.28	0.96	46	2.04	0.93	45	0.232
8	The presence of the instructors made me under-perform		2.39	1.06	46	2.09	0.91	44	0.155
9	I found it difficult to treat the mannequin as a real patient		2.85	1.37	46	2.93	1.18	45	0.750
10	The response of the mannequin to treatment was realistic		3.76	1.14	46	3.87	0.81	45	0.612
11	The scenario prompted realistic responses from me		3.80	0.88	46	3.76	1.07	45	0.813
12	It is better to take part in simulation training as part of a multidisciplinary team		4.33	0.85	45	4.48	0.66	44	0.378
13	Simulation allowed me to learn more about the role & skills of	an adult nurse	4.36	0.90	33	4.20	0.90	35	0.455
16		a radiographer	3.88	0.83	42	3.74	0.95	35	0.499
17		a learning disability nurse	3.95	0.89	20	3.70	1.57	10	0.579
18		a paramedic	4.09	0.75	22	3.64	1.34	14	0.205
19		a physiotherapist	3.88	0.93	17	4.10	1.07	20	0.517
21		a children's nurse	/	/	/	3.75	1.89	4	NA

Table 73: Results of the post-simulation questionnaire section A and B for adult branch nursing students and students from the other disciplines.

		Adult nursing			Other disciplines			p
	Questions (1=strongly disagree & 5=strongly agree)	***Mean***	***S.D.***	***N***	***Mean***	***S.D.***	***N***	
C	**The debriefing session:**							
23	I learnt from the debriefing session	4.24	0.71	45	4.53	0.63	45	**0.044**
24	It is beneficial to have a multidisciplinary scenario debriefing session	4.20	0.86	46	4.64	0.53	45	**0.004**
25	The debriefing session illustrated important behavioural aspects	4.21	0.97	46	4.33	0.73	45	0.447
26	The debriefing session enhanced my technical knowledge	4.02	0.84	45	4.18	0.81	45	0.372
27	Seeing myself on video would allow me to reflect better	3.98	1.27	45	4.20	0.84	41	0.357
D	**Your opinion on medical simulation training:**							
28	I enjoyed the session	4.50	0.96	46	4.69	0.60	45	0.264
29	I found it useful to learn alongside peers from other disciplines	4.53	0.76	45	4.73	0.54	45	0.152
30	I learnt from participating in my own scenario	4.31	0.90	45	4.67	0.60	45	**0.030**
31	I learnt from watching others take part in the scenario	4.46	0.86	46	4.64	0.61	44	0.259
32	It reinforced aspects of my clinical practice important to patient safety	4.43	0.81	46	4.33	0.64	45	0.509
33	The course will help me to practise more safety	4.41	0.93	46	4.27	0.66	44	0.414
34	I will change my clinical practice because of what I have learned today	3.95	1.14	44	3.84	0.90	45	0.614
35	Today's course has improved my clinical skills	4.02	1.14	46	4.02	0.75	45	0.998
36	Today's course has increased my clinical knowledge	4.22	0.81	46	4.09	0.71	44	0.435
37	Patient simulators are a useful addition to learning from real patients	4.47	0.79	45	4.50	0.63	44	0.826
38	Simulation training should be available to all trainees from my discipline	4.72	0.66	46	4.67	0.56	45	0.694
39	Simulation training should be part of the IPE module	4.64	0.84	44	4.69	0.56	45	0.728
	Likert scale does not apply to the following question (Non-ordinal data)							
40	How regularly would you find it useful to repeat such a session per year?	3.37	2.14	43	4.23	3.84	43	0.203

Table 74: Analysis of the post-simulation questionnaire section C and D for adult branch nursing students and students from the other disciplines.

The data from the post-simulation session questionnaire was also analysed by comparing the responses from the adult branch nursing students and the other students. Responses to the different sections from the questionnaire (A, B, C, and D) were generally very similar between adult branch nursing students and other students (Table 73 and Table 74). Excluding the discipline specific questions, mean responses to sections A and B for adult branch nursing students and students from the other disciplines had a maximum variation of 0.30 point on the 5-point Likert scale. Although relatively small, this difference was for the question relating to the influence of the presence of the instructors on the students' scenario performance, but it was not statistically significant (p=0.155, Table 73). Split this way the data for the discipline specific questions of Table 73 is not very meaningful except for question 13 which relates to adult branch nursing students. Even with a more detailed presentation of the discipline specific questions (Questions 13 to 21), due to the low level of participation or total absence from certain disciplines such as radiotherapy, mental health nursing, midwifery, children nursing, and pharmacy, the statistical analysis of the results would be insignificant.

Looking at sections C and D of the post-simulation session questionnaire (Table 74), non adult branch nursing students generally reported gaining slightly more from the simulation experience than the adult branch nursing students (Questions, 23, 24, 28, 29, 30 and 31). For example, students from the other disciplines scored "I learnt from participating in my own scenario" (Question 30) 4.67 (SD±0.60) versus 4.31 (SD±0.90) for the adult branch nursing students (Independent sample t-test, p=0.030), and similarly for "it was beneficial to have a multidisciplinary scenario debriefing session" (Question 24) with 4.64 (SD±0.53) versus 4.20 (SD± 0.86) (Independent sample t-test, p=0.004). Although it was not statistically significant, students from the other disciplines would like to take part in simulation sessions on a more regular basis than the adult branch nursing students (4.23 SD±3.84 versus 3.37 SD±2.14 sessions per year, p=0.203, Table 74) and all students enjoyed the session (4.50 SD±0.96 and 4.69 SD±0.60) and felt simulation training should be part of the IPE module (4.64 SD±0.84 and 4.69 SD±0.56 out of 5).

VII.3.4/ Results of the discipline knowledge questionnaire

The discipline knowledge questionnaire was referred to as Q2 in Figure 25 and was composed of 45 questions (Appendix IX). The first 5 questions were relating to students' opinion whereas the other 40 questions were "True/False" statements relating to a total of 10 healthcare disciplines. Since no student from Pharmacy, Radiotherapy, Midwifery and Mental Health took part in any session, the students' answers to these questions are not reported here. The students' responses to the first five questions are reported in Table 75 and show that students from the experimental group generally expressed a more positive attitude toward interprofessional learning and multidisciplinary working than students from the control group. For example, and as illustrated in Figure 34 and reported in Table 75, by having filled in the questionnaire after their exposure to multidisciplinary scenarios, students from the experimental group reported feeling more confident about working as part of a multidisciplinary team than their peers from the control group (3.79 SD±0.90 versus 3.33 SD±0.80), and an independent sample t-test showed that this difference is statistically significant (df=91, p=0.011). Another question which resulted in a statistically significant difference of perception (Independent sample t-test p=0.036, Table 75) was when students from the control and experimental groups were asked if interprofessional learning before qualification helps them to become better team workers which they respectively scored 3.96 (SD±1.24) and 4.42 (SD±0.77). The bar chart in Figure 35 clearly shows the difference in the responses between the two groups for the above question.

Although the small differences noticed for the responses to the other questions did not reach statistical significance, they are worth considering as they are very close to the significance level of 0.05. Their anticipation that working as part of a multidisciplinary team would make them feel anxious was 2.67 for the control group students (SD±1.17) and 2.25 for the experimental group students (SD±1.04), (independent sample t-test p=0.073); the perception of their knowledge of what other healthcare professionals can or cannot do was 3.00 for the control group students (SD±0.91) and 3.35 for the experimental group students (SD±0.93), (independent sample t-test p=0.066); their view that learning with other healthcare students before qualification will improve their relationship after qualification was 3.93 for the control group students (SD±1.14) and 4.33 for the experimental group students (SD±0.81), (independent sample t-test p=0.055).

1=strongly disagree and 5=strongly agree	Group	N	Mean	Std. Dev.	P value
I am confident when working as part of a multidisciplinary team	Control	45	3.33	0.80	**0.011**
	Experimental	48	3.79	0.90	
Working as part of a multidisciplinary team would make me feel anxious	Control	45	2.67	1.17	0.073
	Experimental	48	2.25	1.04	
I feel I know what other professionals can and cannot do	Control	45	3.00	0.91	0.066
	Experimental	48	3.35	0.93	
Learning with other healthcare students before qualification improves relationships after qualification	Control	45	3.93	1.14	0.055
	Experimental	48	4.33	0.81	
Interprofessional learning before qualification helps me become a better team worker	Control	45	3.96	1.24	**0.036**
	Experimental	48	4.42	0.77	

Table 75: Control and experimental group students' view of multidisciplinary team working and interprofessional education.

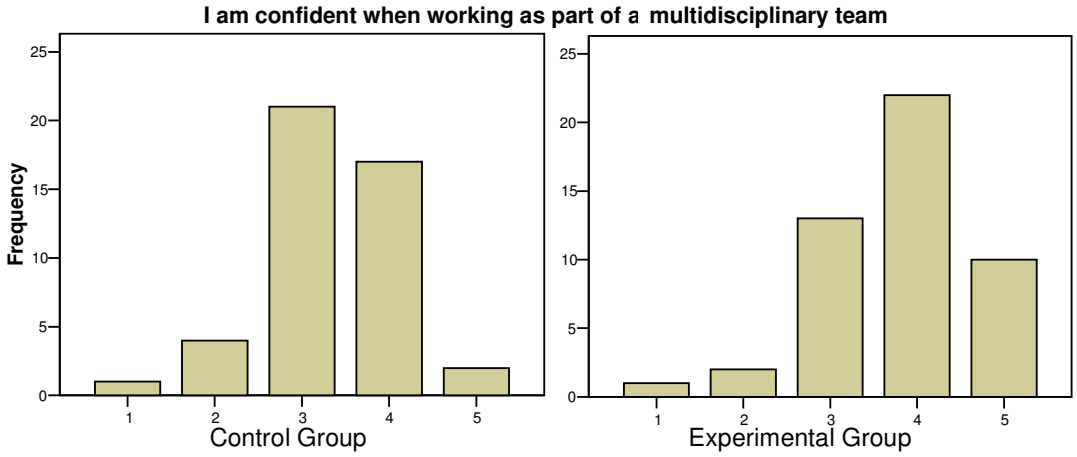

Figure 34: Control and experimental group students ' confidence about working as part of a multidisciplinary team.

(with 1=strongly disagree and 5=strongly agree).

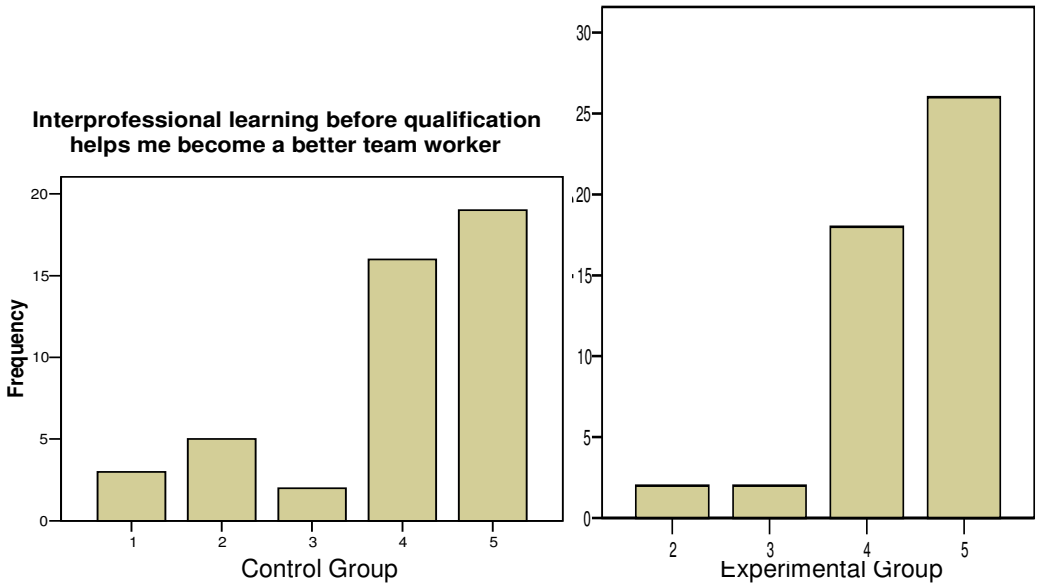

Figure 35: Control and experimental group students' view of interprofessional learning prior to qualifying as healthcare professionals.

(with 1=strongly disagree and 5=strongly agree).

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
I am confident when working as part of a multidisciplinary team	753.00	1788.00	-2.69	**.007**
Working as part of a multidisciplinary team would make me feel anxious	867.50	2043.50	-1.70	.090
I feel I know what other professionals can and cannot do	870.50	1905.50	-1.71	.088
Learning with other healthcare students before qualification improves relationships after qualification	886.00	1921. 00	-1.60	.109
Interprofessional learning before qualification helps me become a better team worker	884.00	1919.00	-1.65	.100

Table 76: Non-parametric test comparing the control and experimental group students' responses to the multidisciplinary team working and interprofessional education questions.

Due to the use of ordinal data (Likert scale) for the responses to the multidisciplinary team working and interprofessional education questions, a Mann-Whitney U-test was used to validate the results reported in Table 75. The results from this non-parametric test are presented in Table 76 and only validate the statistical significance for the question relating to the students' confidence in working as part of a multidisciplinary team (p=0.007). The data from Table 75 can also be analysed by comparing the responses of the adult branch nursing students from each study group versus the responses from the students from the other disciplines to determine if their views differ. This new dataset is presented in Table 77 and Table 78 and will be used to determine if the adult branch nursing students views are similar to that of the students from the other disciplines from the same group.

1=strongly disagree and 5=strongly agree	**Control Groups**	**N**	**Mean**	**Std. Dev.**	**P value**
I am confident when working as part of a multidisciplinary team	Adult nursing	23	3.26	0.91	0.539
	Others	22	3.41	0.67	
Working as part of a multidisciplinary team would make me feel anxious	Adult nursing	23	2.48	1.16	0.273
	Others	22	2.86	1.17	
I feel I know what other professionals can and cannot do	Adult nursing	23	3.30	0.88	**0.019**
	Others	22	2.68	0.84	
Learning with other healthcare students before qualification improves relationships after qualification	Adult nursing	23	3.65	1.11	0.090
	Others	22	4.23	1.11	
Interprofessional learning before qualification helps me become a better team worker	Adult nursing	23	3.70	1.18	0.154
	Others	22	4.23	1.27	

Table 77: Control group students' view of multidisciplinary team working and interprofessional education with regard to being from adult branch nursing or from the other disciplines.

Due to the way the data is now being analysed, the small numbers make it more difficult to reach statistical significance. The exception relates to the adult branch nursing students' perception of what other professionals can and cannot do, in which case both control and experimental group adult branch nursing students scored higher than their peers from the other disciplines with respective scores of 3.30 SD±0.88 versus 2.68 SD±0.84 for the control group students (Table 77) and 3.52 SD±0.99 versus 3.20 SD±0.87 for the experimental group (Table 78). An independent sample t-

test only demonstrated statistical significance for that question when comparing the data of the control group between the adult branch nursing and students from the other disciplines (p=0.019, Table 78).

1=strongly disagree and 5=strongly agree	**Experimental Groups**	**N**	**Mean**	**Std. Dev.**	**P value**
I am confident when working as part of a multidisciplinary team	Adult nursing	23	3.70	1.10	0.483
	Others	25	3.88	0.66	
Working as part of a multidisciplinary team would make me feel anxious	Adult nursing	23	2.22	1.17	0.838
	Others	25	2.28	0.94	
I feel I know what other professionals can and cannot do	Adult nursing	23	3.52	0.99	0.237
	Others	25	3.20	0.87	
Learning with other healthcare students before qualification improves relationships after qualification	Adult nursing	23	4.26	0.86	0.557
	Others	25	4.40	0.76	
Interprofessional learning before qualification helps me become a better team worker	Adult nursing	23	4.30	0.93	0.336
	Others	25	4.52	0.58	

Table 78: Experimental group students' view of multidisciplinary team working and interprofessional education with regard to being from adult branch nursing or from the other disciplines.

			Statistic	Std. Error
Percentage of correctly answered questions over all disciplines (40 questions)	Control	Mean	66.67	.888
		95% Confidence Interval for Mean Lower/Upper Bound	64.88 / 68.46	
		5% Trimmed Mean	66.77	
		Median	67.50	
		Std. Deviation - Variance	5.96 - 35.51	
		Minimum / Maximum	52.50 / 77.50	
		Range - Interquartile Range	25.00 – 10.00	
		Skewness	-.396	.354
		Kurtosis	-.376	.695
	Experimental	Mean	69.58	.910
		95% Confidence Interval for Mean Lower/Upper Bound	67.75/71.41	
		5% Trimmed Mean	69.93	
		Median	70.00	
		Std. Deviation - Variance	6.30 – 39.72	
		Minimum / Maximum	50.00 / 80.00	
		Range - Interquartile Range	30.00 – 5.00	
		Skewness	-.993	.343
		Kurtosis	1.239	.674
Percentage of correctly answered questions over disciplines represented (12-16 questions)	Control	Mean	73.80	1.435
		95% Confidence Interval for Mean Lower/Upper Bound	70.90 / 76.69	
		5% Trimmed Mean	74.02	
		Median	75.00	
		Std. Deviation - Variance	9.63 – 92.62	
		Minimum / Maximum	50.00 / 91.67	
		Range - Interquartile Range	41.67 – 16.66	
		Skewness	-.511	.354
		Kurtosis	-.426	.695
	Experimental	Mean	78.81	1.537
		95% Confidence Interval for Mean Lower/Upper Bound	75.72 / 81.90	
		5% Trimmed Mean	79.19	
		Median	83.33	
		Std. Deviation - Variance	10.65 – 113.35	
		Minimum / Maximum	50.00 / 100.00	
		Range - Interquartile Range	50.00 – 8.33	
		Skewness	-.760	.343
		Kurtosis	.342	.674

Table 79: Descriptive statistics of the control and experimental group students' results for the discipline knowledge questionnaire

	Nbr	Mean (%)	Std. dev.	Std. Error Mean	Levene's Test for equality of Variances		t-test for Equality of Means (Equal Variances assumed		
					F	Sig.	df	T	Sig. (2-tailed)
Control	45	66.67	5.96	0.89	0.026	0.873	91	-2.29	0.024
Experimental	48	69.58	6.30	0.91					

Table 80: Control and experimental group students' results for the discipline knowledge questionnaire.

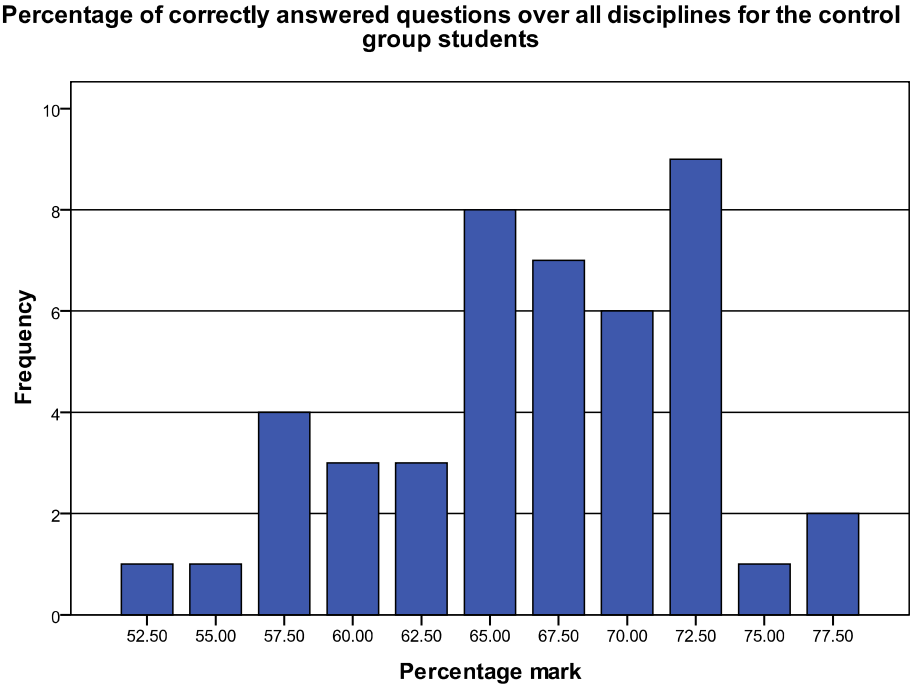

Figure 36: Bar chart representation of the results obtained by the control group students over the 40 questions.

One of the key parts of this project to determine the benefits of taking part in interprofessional simulation training sessions relates to the results of the discipline specific questions. The results for the two study groups, taking into account the 40 questions or 12 to 16 questions of the discipline represented, are reported in Table 79. The overall results for the control and experimental group were respectively 66.67% (95% CI 64.88-68.46) and 69.58% (95% CI 67.75-71.41). Students from the experimental group scored on average 2.91 percentage points more than students

from the control group who completed the questionnaire before the simulation session. An independent sample t-test showed that this score difference, although small, is statistically significant (p=0.024) (Table 80). Experimental and control group students' results to the overall discipline knowledge questionnaire are illustrated in the bar charts on Figure 36 and Figure 37, which almost show a Gaussian distribution for both study groups.

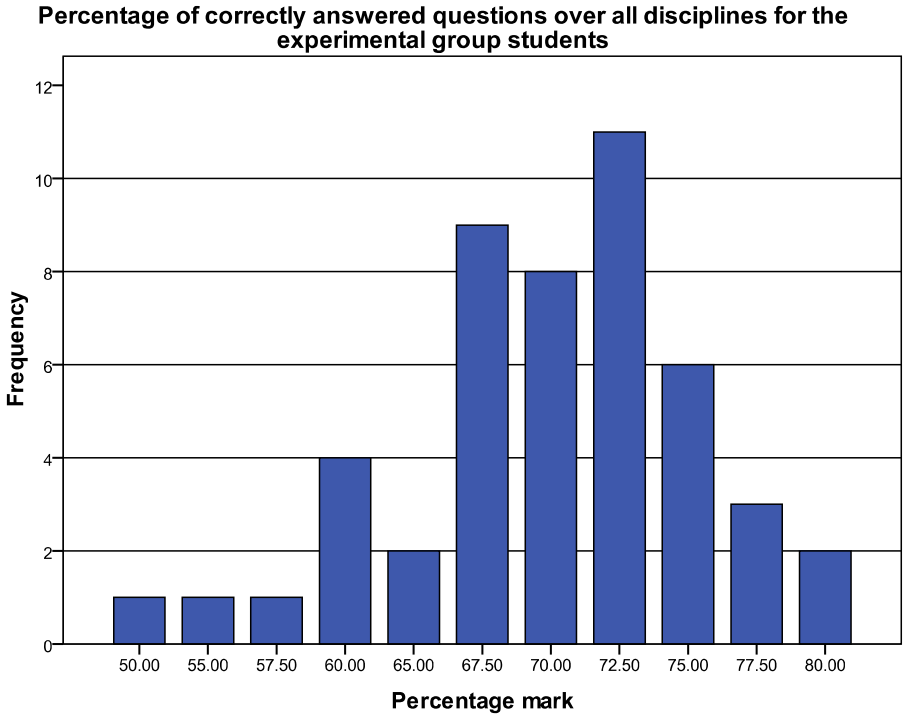

Figure 37: Bar chart representation of the results obtained by the experimental group students over the 40 questions.

Each simulation session involved students from 3 to 4 different disciplines; hence we are mainly interested to find out the score difference between the control and experimental group students using the four questions related to each discipline represented by the students per session (12 or 16 questions) as it was only these disciplines' related questions that could be affected by the intervention. Analysis of the students' results for the discipline knowledge questionnaire shows that students from the control group correctly answered 73.80% (95% CI 70.90-76.69) of the questions relating to the disciplines represented during their session whereas students from the experimental group scored 78.81% (95% CI 75.72-81.90) (Table 81). The 5.01

percentage points difference between the two groups was also significant (independent sample t-test, df=91, p=0.02) and proves that students from the experimental group benefited from observing and taking part in a scenario and the associated debriefings when completing the questionnaire. As could be expected, the score difference between the two study groups was greater when considering the smaller sample of relevant questions than when comparing the marks over the complete set of 40 questions relating to 10 different disciplines, with over half of them having no relevance to the scenarios students were exposed to during their simulation session.

	Nbr	Mean (%)	Std. dev.	Std. Error Mean	Levene's Test for equality of Variances		t-test for Equality of Means (Equal Variances assumed		
					F	Sig.	df	T	Sig. (2-tailed)
Control	45	73.80	9.62	1.43	0.348	0.557	91	-2.38	0.020
Experimental	48	78.81	10.65	1.54					

Table 81: Control and experimental group students' results for the discipline knowledge questionnaire over the disciplines represented per session.

		N	Mean	Std. Dev.	P value
Mean percentage score to IPE questionnaire for nursing students	Control	23	75.78	10.58	0.150
	Experimental	23	79.78	10.69	
Mean percentage score to IPE questionnaire for students from the other disciplines	Control	22	72.34	8.51	0.057
	Experimental	25	77.92	10.74	
Mean percentage score to IPE questionnaire for control group students	Nursing	23	75.78	10.58	0.329
	Other disciplines	22	72.34	8.51	
Mean percentage score to IPE questionnaire for experimental group students	Nursing	23	79.78	10.69	0.550
	Other disciplines	25	77.92	10.74	

Table 82: Results of the discipline knowledge questionnaire for the adult branch nursing students and students from the other disciplines with respects to their study group.

Additional analysis was carried out with regards to the students' performance on the discipline knowledge questionnaire. Table 82 shows their performance by study group and by comparing the adult branch nursing students versus students from the other disciplines. Although none of the results reached statistical significance after having performed an independent sample t-test, the data indicates that adult nursing students tended to obtain greater marks than students from the other disciplines within the control and experimental groups. This could be attributed to the fact that nursing students spend half of their time in clinical placements, and in a broader range of settings than students from the other disciplines, which may have given them more experience in terms of interactions with professionals from other healthcare disciplines.

VII.4/ Chapter Summary

This chapter reported on the organisation and facilitation of interprofessional education simulation sessions for undergraduate healthcare students from six disciplines. This second study emerged from the first one to enhance the students' learning experience. The simulation sessions were run with the same facilitation approach whereby it started with an introduction and familiarisation period before moving to the student-led scenarios and debriefings. The main difference with the main study was that all sessions were truly interprofessional and the study design did not include any OSCE. Because of the range of scenarios and disciplines involved, this project made almost full use of the space and equipment of the new simulation centre. Although a RCT design was adopted, it simply consisted of students undertaking a questionnaire based knowledge test immediately before (Control group) or after the simulation session (Experimental group).

Despite an anticipated series of obstacles such as timetable issues, equity among all students in any given programme to attend the sessions, and facilitation by appropriately trained tutors from different healthcare professions, fifteen interprofessional simulation sessions were run applying the experience acquired during the main study in terms of delivering and facilitating the simulation experience. With regards to fulfilling this project's objectives, the feasibility of organising and running simulation sessions for 95 students from different disciplines was demonstrated even if some of the issues faced may remain permanent challenges, such as the difficulty in

timetabling the sessions so it is convenient for the different disciplines involved. With adequate preparation and input from appropriately trained staff from different disciplines, it is possible to plan and run highly realistic scenarios. They are usually more complex to prepare and last longer due to the duration of the patient care pathway reproduced and the number of students potentially involved. The logistics of running such sessions and scenarios requires experience and planning but proves to be a stimulating educational experience for the students as it enabled them to consider aspects of patient care provided by other team members they may not be familiar with. The recruitment of the students was a challenge due to the timing of the sessions. Some disciplines were proportionally more represented than others with respects to their cohort size thanks to the encouragements from some of their tutors to take part in this simulation-based activity. The results of this study show that students gained knowledge of other disciplines and changed their attitude towards multidisciplinary team working simply by being given the opportunity to take part in an interdisciplinary education simulation session and observe another one, as well as take part in the debriefings of these scenarios.

Chapter VIII
Discussion and Conclusions

The main study covered in chapters IV, V and VI has had a great impact on the development and adoption of simulation training and the use of OSCEs at the University of Hertfordshire across a range of healthcare disciplines (Evans et al., 2011) as well as in Engineering (Alinier and Alinier, 2006a). It provided the educational and logistical foundations for the design and opening of a specialised teaching facility at the University (Alinier, 2007a) and for the second study (Chapter VII) which involved the facilitation of interprofessional simulation sessions for final year healthcare students. The work carried out as part of these studies has also been recognised externally in many ways and has already been cited in over 200 peer reviewed papers, not only about the training of nursing students and use of OSCEs but also with regards to the training of simulation facilitators (Cannon-Diehl, 2009, Fanning and Gaba, 2007, Issenberg, 2006). The argument made in the final paper published about the main study regarding the need to adopt new ways of teaching when new training tools are used (Alinier et al., 2006b) is supported by other authors (Brydges et al., 2010, Johannesson et al., 2010).

Although there are two distinctive studies presented in this thesis, they are very closely related and their relationship will be further emphasised in the discussion. Aspects of the work carried out, primarily relating to results of significant importance, will be discussed in the next pages alongside the limitations as well as the key contributions to knowledge.

VIII.1/ Discussion

The increasing use of technology in healthcare, the higher expectations on the part of patients, and concerns for minimising risks have encouraged the development and adoption of new training tools and methodologies within the healthcare education

sector. Because of the advance in simulation training, it is hoped that newly qualified professionals will be much more competent practitioners from the time they meet their first clients or patients than they currently are. In comparison and although it is done alongside a senior airline pilot, newly qualified pilots directly fly passenger filled planes after having only flown flight simulators, and without a transition to flying an empty passenger plane! Trainees' experience gained by practice with time spent in contact with real patient has been diminished for patient safety and ethical reasons (Ziv et al., 2000, Ziv et al., 2003), and in some professions this has been further impacted upon by the adoption of the European Working Time Directive (European Association of Neurosurgical Societies, 2006, Johannsson et al., 2005). Because of the increased demand for clinical placements and the limited availability of practice supervisors, especially in nursing, and the reduction in working hours for junior doctors, student involvement with patient care and their opportunities to deal with incidents has reduced. Hence there has been a need to reproduce that experience by some other means, and one of the avenues is through the exposure of learners to realistic simulated incidents or scenarios. It is important to note that depending on the type of scenario or simulation medium used (simulator or simulated patient), all aspects of real life patient care interactions such as look, feel, and smell cannot always be reproduced. This means that even as realistic as we try to make it, it will not be the same as the "real thing", neither does it need to be so. As pointed out by Rudolph et al. *(2007a)*, the physical reality of a simulation encounter is not always a key requirement as long as it does not prevent learners from engaging in the scenario in an emotional and experiential manner. Moreover the degree of simulation reality does not necessarily lead to increased learning or training effectiveness (Beaubien and Baker, 2004). There are several dimensions of fidelity to simulation (Dieckmann et al., 2007a), the balance of which needs to be appropriately achieved by the facilitators to provide trainees with a valuable learning experience and for them to reach the expected learning outcomes. The importance of the physical and psychological elements of scenario-based simulation training were recognised from the onset of the first study while observing colleagues run what would now be called low or medium-fidelity simulation sessions. This immediately resulted in a different facilitation approach of the scenarios run for the main study which also involved a facilitated debriefing rather than a critique of what the students may have attempted to do when being immediately corrected. From a physical fidelity perspective, the environment was reconfigured to take the observers away from the simulation environment by using a simple video link. For example, instead of speaking to the facilitator who was controlling the voice of the patient simulator during the pilot sessions, the addition of a partition to hide the control desk

and operator forced the students to speak directly to the patient simulator, making the interaction more natural and the simulator easier for them to treat as a real patient (Figure 11). This type of arrangement is in fact viewed as an important component of facilitating a “high-fidelity” or “full-scale” simulation experience (Levett-Jones et al., 2011, Seropian, 2003). Reporting on the findings from interviews with scenario participants, Dieckmann et al. (2007b) suggest that the perceived realism of a simulation experience as a whole is determined by the interaction between the various components of a scenario such as the patient, the environment, and role play of the confederates. If one of these components is not as could be expected in real life, it can reduce the overall perceived realism of the scenario experience. To that effect simple props such as bed linen were added to enhance the environmental fidelity and whenever students required senior help during a scenario, the facilitators were doing so in an acting capacity as part of the healthcare team rather than as a lecturer interfering with the scenario and students’ actions. Although this was not studied as part of work conducted, these elements certainly had an impact on the psychological realism of the scene for the scenario participants.

Simulation in healthcare is currently in its “adolescent period” in the sense that it is growing rapidly and being tried out in various areas. For example, at the University of Hertfordshire a range of simulation training initiatives have resulted from the studies and further developments have been summarised in Appendix XI. Despite several historical initiatives starting in the 1960’s, the development of patient simulator technology and its use has been very sporadic until recently and as depicted in chapter II. The net result is that not much has changed over a very long period of time from a student point of view. The patient simulators have the same features (operator controlled voice, chest movement, palpable pulses, auscultation sounds, ECG...) and appearance as they had decades ago, but have simply become better integrated (more compact hardware), easier to use (computer interface), and more reliable. In the last few years the technology has become much more affordable, and the patient simulators have become more portable thanks to wireless technology, greater use of microprocessors, and better battery technology. The main other addition to recent patient simulators is their integration with audio and video recording systems whereby physiological parameters, event logs, and bookmarks can be saved for review and evaluation. The variety of simulation technology now available and the different ways they are being used has led to the development of a typology of educationally focused medical simulation tools (Alinier, 2007b) which has been presented in chapter II alongside the advantages and limitations of this training method (Table 1). Simulation

is integral to an overarching educational continuum (Maran and Glavin, 2003), from basic to much more complex skills' practice and acquisition so learners can develop their skills and knowledge without causing harm to real patients. The integration of the various simulation modalities and their use with learners needs to be facilitated by well informed educators and offered in a timely manner to be an effective teaching approach (Alinier, 2007b).

Although the use of simulation is increasingly becoming common practice in nursing (Jensen et al., 2009, McGaughey, 2009, McCallum, 2007, Starkweather and Kardong-Edgren, 2008, Leigh, 2008) and other undergraduate healthcare educational programmes (Jensen et al., 2009, McGaughey, 2009, Morgan et al., 2006, Issenberg and Scalese, 2007, Dow, 2008), its use was still very limited at the time that the main study was designed and carried out. In 2001, high-fidelity simulation was mainly accessible for Continuing Medical Education or CPD and has a history of being developed and used initially for anaesthesia training (Gaba, 1992, Gaba and DeAnda, 1988, Chopra et al., 1994b, Holzman et al., 1995, Murray and Schneider, 1997, Gaba et al., 2001) as presented in chapter II.

The three key components often identified as part of a simulation training session are: *observation*, *participation*, and *debriefing* (Rothgeb, 2008, Seropian et al., 2004). A fourth component, which should in fact occupy the prime position and has been adopted following the piloting of the scenarios for the main study, is the *orientation* or *familiarisation* period. It helps scenario participants relax and familiarise themselves with the environment, the patient simulator, and the simulation principles (McCausland et al., 2004, Alinier et al., 2004, Alinier et al., 2006b). It is particularly important if it is their first simulation exposure (Hawkins et al., 2008). "*It is of utmost importance that students understand what the capabilities of the patient simulator are before the scenario starts. This will greatly affect their experience of participating in the scenarios and influence their behaviour. The whole learning exercise could be jeopardised if students were not adequately briefed and prepared for the simulation*" (Alinier et al. 2004, p.203). This component or phase helps students engage more rapidly in the simulation activity as it helps them to bridge and understand the gap between simulation and real clinical practice in the sense that all the limitations are exposed and explained to allow them to suspend disbelief more easily during the scenario, and clarifies the educators' expectations from the participants. For example students need to know that they can physically assess the patient rather than rely on an instructor updating them on his/her condition. It then becomes easier for learners to relate what

they are experiencing through simulation with real clinical practice. As a result of the work conducted in the first study this orientation phase is now a core element of all scenario-based simulation sessions taking place in the University's simulation centre.

Setting up a study to evaluate the effectiveness of scenario-based simulation training with undergraduate nursing students proved a key element in learning how to master the art of high-fidelity simulation training, but also the development of OSCE stations. The use of OSCEs to compare the students' performance based on whether they had benefited from simulation exposure or not ensured the robustness of the main study. It provided an objective measure of the students' acquisition of skills and knowledge over time to observe the effect of the simulation exposure for some of them. However it is important to point out that the OSCE contained a large enough number of stations to capture a wide range of skills, some of which related to aspects of the care provided during the scenarios and others not at all. After completion of the study the same OSCE stations were utilised for a further two years by a colleague with final year students of the degree in nursing programme. The acquired OSCE expertise also served on the Paramedic, Pharmacy, Radiography, and Electronic Engineering programmes.

Overall it was expected that all students would perform better on the second OSCE as they had benefited from 6 months of additional clinical experience while on placement and attended lectures at the University. This second assessment enabled us to determine whether or not the simulation experience made a difference to the experimental group students' knowledge and skills acquisition. The intervention enabled students from the experimental group to make an extra 7 percentage points improvement compared with those who did not attend the simulation training sessions ($p<0.01$), which allow us to conclude that it was beneficial (Table 21). Table 23 demonstrates in another way the fact that students from the control group made smaller improvements in their OSCE performance than students from the experimental group. A Chi-Square test between the OSCE improvement categories and both study groups also shows that this difference in performance was statistically significant (Table 24, $p=0.002$). Students from the experimental group have more significantly improved on their OSCE performance than students from the control group. The exact score improvement presented in chapter VI between the control and experimental groups is not really relevant, neither can it be generalised as it is totally dependent on the assessment tool used. The experiment was carried out with a convenience sample of students from a single Higher Education Institution (HEI). Hence students from

another HEI may have benefited from a different day to day learning experience which may have led to a different improvement percentage score difference between the two study groups. The significant result is that the study demonstrated the benefit of simulation learning on the students' acquisition of skills and knowledge assessed using an OSCE. It was mainly in the theoretical stations that students did not make high improvements in their OSCE performance (Stations 2, 9, 11, and 15). The poor improvement in performance on some of the stations can be explained by the fact that students probably did not have the opportunity to practise the skills examined (i.e. Station 11: use of a particular syringe driver) or to learn more on some theoretical aspects (i.e. Station 15: recognition of cardiac arrest signs). Students from the experimental group noticeably improved their performance in comparison to the other students on half of the stations (Table 20: Stations 1, 2, 4, 5, 6, 7, 9, 10, and 14). This difference in improvement was statistically significant ($p<0.05$) for stations 1, 2, 4, 7, 9, 10 and 14.

A station by station comparison of the students' improvement in performance between the two series of OSCEs showed a statistical difference between the two study groups in four practical (1,4,9,14) and three theoretical (2,7,10) stations which related mainly to ECG monitoring, safe use of a defibrillator, and problem solving (See Table 2 and Table 20). The difference in performance in these stations can probably attributed to the nature of the scenarios the students experienced during the simulation sessions.

The last column of Table 20 shows a higher and statistically significant improvement in performance in seven out of fifteen OSCE stations. Hence we can deduce that the simulation training to which the experimental group students were exposed made a significant difference in their skills, knowledge and understanding in comparison to the control group students in the areas of:

- ECG monitoring (Stations 1; practical, $p=0.046$ and 2; theoretical, $p=0.012$, and 4; practical, $p=0.023$)
- The safe use of a defibrillator (Station 7; theoretical, $p=0.007$)
- How to troubleshoot and report a technical problem (Station 9; theoretical, $p=0.008$)
- How to set-up a volumetric infusion pump (Station 10; practical, $p=0.016$), and
- How to safely manipulate an electric bed (Station 14; practical, $p=0.008$).

With regards to age and score improvement between the two OSCEs, in the experimental group, the younger students generally seem to have made a higher

improvement between the two OSCEs than the older students. For the control group, it almost appears to be the opposite as there are a higher proportion of more mature students who have improved their OSCE score by more than 11% in comparison to younger students (Table 58). Hence it cannot be assumed that older students are less likely to achieve a greater score improvement between the two OSCEs than younger students because of previously acquired knowledge. Earlier findings revealed that in fact older students from this sample were less likely to have had previous healthcare experience than younger students (Table 46) as they may have come from a different professional domain.

Probably due to the limited intervention, comparison of the questionnaire results between the two study group with respects to their perceived level of stress and confidence about working in a technological environment shows no statistically significant difference after the limited exposure to simulation-based training provided. Similar findings were reported by Morgan and Cleave-Hogg (2002) when exposing medical students to anaesthesia simulation scenarios as the results of their study showed that there was no correlation between the students' experience, level of confidence, and performance. In a similar study Graham and Scollon (2002) concluded that '*improvements in the training of specific advanced life support techniques does not lead to improved overall confidence in using these skills*'. In drawing these conclusions, the fact that students' exposure and participation in the simulation sessions was relatively limited needs to be emphasised.

An expected and statistically significant result is that irrespective of whether they were engaged in simulation or not, the study reported here has shown that there was a statistically significant relationship between students' perception of confidence and how stressful they would find it working in a "high-tech" environment (Table 35, p=0.002). Students who are not confident with technology also admitted to being stressed when exposed to working in a technological environment (Table 35). 77.3% of the students who would be stressed declare they would also not be confident about working in a "high-tech" environment (Table 34). This highly statistically significant relationship is logical and shows that students who are stressed in a highly technological environment are very likely not to be confident. Similarly, although it was not confirmed by the Chi-Square test (p=0.162), it is possible that previous experience in healthcare helps students to gain confidence (Table 37), whilst not influencing their perceived level of stress (Table 38 and Table 39). It was also noticed that there could be a relationship between students' gender and their level of stress concerning a technological

environment. The number of male students taking part in the study was limited, hence limiting the validity of the conclusions that can be drawn from the data analysed, but in general they appear to be less likely to feel stressed than female students when asked how they would find it working in a "high-tech" environment (Table 43, p=0.112). A study by Grady et al. (2008) demonstrated that although male students were more receptive to high-fidelity simulation, it did not affect their procedure performance in comparison to female students.

Overall, the fact that students' knowledge and skills were significantly increased by their exposure to scenario-based simulation training and their positive attitude and comments provides an argument to suggest that the adoption of this experiential learning approach should be supported in nursing education to complement the other training methods currently used to better prepare students for clinical practice. It is becoming increasingly recognised that the experiential learning opportunity that simulation can provide is an ideal way to bridge the gap between theory and practice (McCallum, 2007, Maran and Glavin, 2003, Bradshaw and Merriman, 2008, Prion, 2008). This very point is in fact related to a Nursing and Midwifery Council's (NMC) call for projects to evaluate the potential simulation in nursing education (Nursing and Midwifery Council, 2006) which emerged after the publication of the main study results which concluded that it was hoped that *"this study will encourage recognition of the time spent by students taking part in simulation training exercises as counting towards practice or placement hours*," (p.376) (Alinier et al., 2006b). Following the completion of the NMC simulation projects by the different Universities involved throughout the UK, the NMC published a new circular allowing up to 300 hours of the 2,300 hours of real clinical practice component to be provided within a simulated practice learning environment (Nursing and Midwifery Council, 2007).

Much of the early simulation research efforts were made towards uniprofessional training, whether it was in anaesthesia (Gaba, 1992, Abrahamson et al., 1969, Gaba and DeAnda, 1989, Byrne et al., 1994, Chopra et al., 1994b) or nursing as presented in the main research work of this thesis. There is now a growing focus on interprofessional and interdisciplinary team training at pre- and post-registration levels with an aim of improving teamwork and hence patient safety (Freeth et al., 2006, Kozmenko et al., 2008, Wisborg et al., 2005, Miller et al., 2008). The involvement of multidisciplinary teams during simulation training better reflects the reality of patient care, especially with regards to team working and communication. The second research aspect of this thesis was about the conduction of scenario-based simulation

sessions for groups of undergraduate healthcare students from different professions and disciplines in order to determine if it would help them to learn about the skills and roles of other health professions and influence their perception about working as part of a multidisciplinary team.

This multidisciplinary study relied again on a convenience sample of students from a single institution. This may have biased the subjective elements of this study such as the responses to the questionnaires, but also the objective difference in performance to the discipline specific knowledge questions (Figure 25, Q2) because it may have been impacted upon by elements of the interprofessional education curriculum that the students will have experienced as part of their programme of study. Although a reasonable number of students were involved in the project overall (n=95), the poor representation from some of the disciplines imposed limits to the statistical tests that could be carried out. For example only one session had children's nursing students, so only a very small proportion of students from the other disciplines have been able to learn about that particular discipline. Despite these limitations, the objective findings as well as the feedback obtained from the students were very supportive of this type of activity which was organised and facilitated based on the previous experience of running high-fidelity simulation sessions for undergraduate students in the first study. This forced the students to adopt an active learning mode requiring them to "think on their feet" (Brown and Chronister, 2009, McCausland et al., 2004, Alinier, 2007a) and encourage reflection (Jones and Alinier, 2009) especially during the debriefing phases. It showed that by observing, and taking part in scenarios and their debriefings, students gained knowledge about the skills and roles of the professions represented. For example most non-radiography students had not realised that radiographers are trained to perform basic life support or that for non-paramedic students, the paramedic profession has developed well beyond the scope of an ambulance driver as they now possess advanced skills.

Paired analysis showed that students found it less difficult to treat the mannequin as a real patient than they first thought ($p=0.026$). Although the students already had a positive view and the difference was only 0.38 on a 5-point Likert scale, students' view of the usefulness of patient simulators in addition to learning from real patient improved between the pre- and post-simulation questionnaire ($p=0.001$). Students found the opportunity to take part in a highly realistic interprofessional simulation session very valuable and this was further demonstrated by their improved knowledge of the role and skills of the other health professions involved in their session. Although the

difference was relatively small (5.01% percentage points), this result was statistically significant ($p<0.05$). Students gained knowledge of other disciplines simply by being given the opportunity to take part in a multidisciplinary scenario and observe another one, as well as take part in the debriefings of these scenarios. This finding is also supported by a recent study from Hallikainen et al. (2007) involving only medical and paramedic students and who concluded that students judged the interprofessional education experience they were exposed to to be an effective way of improving their knowledge of emergency medicine and medical skills and that this interprofessional activity should be included in their educational curriculum.

Although it was not statistically significant, a comparison of the questionnaire results by profession seem to suggest that adult branch nursing students are more aware of the role and skills of the other healthcare disciplines. This observation is limited by the poor participation level from many of the represented disciplines and by the fact that this was based on only four questions per discipline. It can be argued that for results which are not statistically significant, "*absence of evidence is not evidence of absence" (Altman and Bland, 1995).* Had a larger sample of students been recruited for the other disciplines, other significant results could have emerged. With insight, the discipline knowledge questionnaire should have been designed differently in the sense that it should have contained more questions about the different disciplines, and students should only have been required to fill in the questions relating to the disciplines represented at any given session, instead of all the questions. This would have increased the reliability, and validity of the test.

As with the main study, it is not the actual score difference to the questionnaire completed by the control and experimental group students that matters, but simply the fact that there was a difference in the results which was statistically significant, depending on whether or not they answered the test before or after having observed and taken part in the interprofessional simulation session. The other significant results were that after being exposed to interprofessional simulation training the students' attitude towards interprofessional learning and multidisciplinary working was significantly improved following observation and participation in the multidisciplinary scenarios. Students from the experimental group expressed a significantly more positive views about interprofessional learning than their peers who had not yet been exposed to simulation, and that in particular students felt it would make them better team workers. The different and statistically significant results between the two study groups about their reported perception concerning multidisciplinary team working

suggest that following scenario-based simulation training students feel better prepared to enter the multiprofessional healthcare workforce. The results of the discipline specific knowledge questionnaire also demonstrated that the simulation experience increased the students' knowledge of the role and skills of the other healthcare disciplines involved in the same simulation session. The data collected also shows that students who completed the questionnaire before taking part in their multidisciplinary scenario did not report feeling as confident about working as part of a multidisciplinary team as their peers who had been exposed to interprofessional simulation training. As written by Ker et al. (2003): "*The development of a controlled, structured and realistic clinical environment provides a useful step in the development of confidence and competence in interprofessional working for clinical practice*." (p.253). This combined with the high relevance of the scenarios and appropriate physiological responses of the patient simulator or behaviour of the simulated patient contribute to the creation of a realistic learning experience for the students which helps them fully engage in the learning process.

Comparing the students' responses regarding their view of multidisciplinary team working and interprofessional education (Table 77 and Table 78) it seems that there is a greater difference of opinion between the adult branch nursing students and the students from the other disciplines within the control group than there is within the experimental group. Adult branch nursing students from the control group often responded in a slightly more negative way to the questions than the other students. The data shows that taking part in the interprofessional simulation session re-aligned the students views related to the questions asked by making a remarkable impact on the adult branch nursing students with regards to multidisciplinary team working.

Discussions during the debriefings highlighted the fact that interprofessional simulation training is valuable. The briefing and familiarisation period at the beginning of each session was deemed to be very important for the students so they could feel more at ease during the scenarios. This was already implemented as part of the main study, but the students' view about that part of the simulation session had not been explored then. Students reported that the familiarisation period with the mannequin and environment helped to reassure them before starting the scenarios. Surprisingly, despite being the less familiar with the simulation centre, it was the learning disability students and not the paramedic students who reported feeling the most comfortable in the simulated environment. It was also surprising that the paramedic students reported not having had enough time to familiarise themselves with the patient simulator and

environment given that most of them should have had already at least one simulation session in the centre using SimMan during the same academic year (See Appendix XI) and that they are very regularly exposed to the Laerdal ALS simulator which has many similar features.

This multidisciplinary study proved to be very resource intensive and time consuming to organise and facilitate. Each scenario was fairly complex to develop due to the number of disciplines to be involved in a realistic manner and the fact that people with the relevant expertise had to be consulted to enhance their validity. The scenarios were generally of one hour in duration and often had to be "spatially dynamic" in the sense that the patient (simulated patient and/or patient simulator) had to move from one setting to another for students from various professions to become involved in their most natural working environment. The scenarios also proved to be very resource intensive to run as at least three to four people were involved at any one time to either control the patient simulator and its voice, act as a relative or the patient, act as the doctor, control the camera system for the observers to follow what was happening, or make sure the scenario participants were in place at the right time when the scenario evolved to their environment. Although it was extremely exhilarating to see how the students enjoyed the experience while taking it extremely seriously at the same time, it was also sometimes discouraging to run the sessions in the evening for a relatively small number of participants due to last minute student cancellations and the fact that these sessions were optional for the students.

Although making high-fidelity simulation training part of the final year students' IPE curriculum would be recommended based on the results from the multidisciplinary study, it may be physically difficult to implement due to high student numbers, staffing, and timetabling issues. All programme timetables would need to be jointly considered to lend themselves to the planning of interprofessional simulation sessions on particular days while students are on campus. Introducing such type of learning opportunity in the undergraduate curriculum should facilitate its future implementation as Continuing Professional Development once these students become qualified healthcare professionals. At the present time interprofessional simulation sessions need to be organised at the end of the day in order not to clash with timetabled teaching sessions and this caused problems for students with child care commitments or who were not motivated to attend these sessions in their own time. This is a widely recognised constraint viewed as a barrier or inhibitor of IPE opportunities (Reeves et al., 2007, Williams et al., 2009, Cooper et al., 2001, Reeves et al., 2006).

In relation to scenario-based simulation training, it is said that the debriefing component is an essential part of the learning process that should never be omitted (Rothbeg, 2008). It provides a protected time period when scenario participants and observers can critically analyse and discuss what happened and why, and learn from it (Alinier et al., 2004, Fanning and Gaba, 2007, Leigh and Hurst, 2008, Beaubien and Baker, 2004). It is a facilitated discussion that helps students connect the events with their actions, and hence encourage reflection so they can learn from the experience (Childs and Sepples, 2006, Rush et al., 2008, Rudolph et al., 2008, Thiagarajan, 1998, Jones and Alinier, 2009). According to the students' feedback, allowing them to observe scenarios being tackled by their peers is as important as allowing them to take part in the scenarios (Table 70). This point is supported by the findings of another study (Lambton and Prion, 2009) and may also be derived from an earlier study comparing experiential (scenario-based simulation) versus visual learning (Morgan et al., 2002). Enabling a group of learners to observe others take part in a scenario is relatively easy to organise and should be further studied. It is certainly to be considered seriously as it may open up new educational opportunities to learners and enhance their clinical reasoning and general experience especially if it can be facilitated in an engaging way.

Simulation offers a key opportunity for students to practise and experience not only what they will routinely do so it becomes second nature, but also to be exposed to rare events so they can be better prepared and more familiar with how to respond and act in such situations (Issenberg et al., 2005, Gaba, 2004, Rall and Dieckmann, 2005).

VIII.2/ Conclusions

From the first study we can conclude that using realistic scenario-based simulation to train nursing students improves students' psychomotor and cognitive skills that were tested during the Objective Structured Clinical Examination.

As a recommendation, and in the spirit of the educational continuum (Maran and Glavin, 2003), students should be given the opportunity to take part in uniprofessional training before embarking onto highly realistic or high–fidelity interprofessional simulation sessions which can be placed at the top of Miller's pyramid (1990)

presented in Figure 5. A stepwise approach to the various modalities of simulation will help learners become used to this experiential learning approach. As argued in Chapter II, the trainees' learning journey should ideally include sequentially all the stages of the framework for acquisition of experience and skills presented in Figure 6, from low to high-fidelity simulation modalities (Alinier 2007b). All healthcare programmes have integrated forms of low-fidelity simulation training for the students' acquisition of practical skills for a number of years. One of the key contributions of the main study has been the expansion of the use of scenario-based simulation training well beyond the adult branch nursing programme, to the other nursing branches like mental health, learning disability, and child branch, but also other allied healthcare professional groups such as paramedics, midwifes, pharmacists, bioscientists, physiotherapists, and radiographers. These uniprofessional implementations of simulation have not been linked to any particular research strategies, hence have only been reported in Appendix XI to illustrate the range of ways in which simulation is now being used at the University of Hertfordshire as a result of the main study.

Overall, due to the number of people involved as OSCE examiners, this study has had a significant impact on the University's use of OSCEs in diverse disciplines (Alinier and Alinier, 2006b, Evans et al., 2011). Several lecturers adopted formative OSCEs in their programme as a result of having served as an examiner in the first study and one nursing lecturer carried on using the stations developed for the study for a further two years. It also had a strong and lasting impact in the area of scenario-based simulation training. It was one of the first of its kind in the literature regarding undergraduate students (Alinier et al., 2006b, Alinier et al., 2004) and helped to determine the potential of student-led simulation training in an objective manner. A by-product of it was to learn how to facilitate such sessions, how to design scenarios (Alinier, 2011), how to use the patient simulators, and how to setup the environment to enhance the students' learning experience. The fact that the University of Hertfordshire opened a large clinical simulation centre in 2006 (Alinier, 2007a) can probably be directly attributed to the success of this study and the experience that was acquired while it was being conducted.

Other recent studies also support the use of simulation in nursing education (Moule et al., 2008), however it is increasingly recognised that to maximise the students' learning and make the best use of the resources (Leigh and Hurst, 2008) "each nursing faculty group needs a champion for simulated technology use, a faculty member who believes in the technology, is informed and excited about its use, and has a "contagious" effect

on other faculty members." (Medley and Horne 2005, p.34). For high-fidelity simulation, scenario design has been mentioned by Rudolph et al. (2007a) as an "art and science" (p.162) as the scenarios need to engage its participants in various modes (Physical, conceptual or semantic, and emotional and experiential) (Dieckmann et al., 2007a). Scenarios need to address pre-defined learning objectives and match the level of the intended participants (Alinier, 2011). They cannot be improvised at the last minute but need to be prepared and tested in advance to ensure and maximise the learning experience for the students (Alinier, 2011, Dieckmann and Rall, 2008b), hence the importance of a dedicated team who understands simulation training and takes responsibility for the students' learning experience they help facilitate. To that effect several simulation facilitator courses have been developed by Universities and simulation centres around the world to help educators develop the new skills which are so particular to high-fidelity simulation education (Issenberg, 2006, Vollmer et al., 2008, Fanning and Gaba, 2007, Dieckmann and Rall, 2008a, Alinier, 2007a). The expertise required to facilitate such training has also been supported in a report from the Chief Medical Officer (2009) as part of one of his recommendations regarding simulation and safer medical practice whereby he proposes that "a *skilled faculty of expert clinical facilitators should be developed to deliver high-quality simulation training*." (p.55). The importance of preparation and skills mix among the team facilitating the session is emphasised in a paper by Lambton and Prion (2009). The "faculty" need to possess: educational, clinical and technical expertise. The latter point can be illustrated by the fact that the environment and patient simulators were subjected to technical alterations in order to enhance their functionality for particular scenarios such as enabling unilateral chest movement of the patient simulator during spontaneous breathing or the remote control of an electronic patient record monitor to display X-rays for example.

The various stages of scenario-based simulation training form an effective learning method as long as their key educational principles are rigorously followed. These key phases to the students' simulation experience are:

- The introduction and familiarisation period (O*rientation*) – 30 to 45 minutes,
- The participation in one scenario or more (*Participation*) – 10 to 30 minutes per scenario,
- The peers remotely observing scenarios (*Observation*) – 10 to 30 minutes per scenario,
- The participation in the debriefing of scenarios (*Debriefing*) – 20 to 30 minutes per scenario.

The beginning of each high-fidelity simulation session is crucial in preparing the students for the experience so they understand what is expected from them, what roles the facilitators will take during the scenarios, and so they can have a chance to experience what the simulated environment and patient are like. As scenario participants, not being demonstrated what to do or not receiving prompts and unsummoned help from facilitators forces them to think on their feet and allows them to put in practice within a realistic context, in a safe and controlled environment, the knowledge and skills they have previously acquired. As observers, they are relieved of the pressure of being involved in the scenario and can critically observe the events, think "outside the box", formulate their plan and see how it compares with what is actually happening when under pressure. Each scenario debriefing encourages students to reflect on their actions and observations, learn from the experience, and helps to answer any questions they may have about the case or scenario. It also helps them to understand how they could have better dealt with the situation based on the experience of the other participants, observers, and facilitators.

From a facilitator's point of view, the planning of a simulation session needs to take into account:

- the duration and timetable of the session and its overall objective,
- the number of participants,
- their discipline and level of experience,
- the number of scenarios to develop (with all the required paperwork such as the script, specific props, patient notes, laboratory and blood results...) and their respective learning objectives,
- the resources required and available (equipment, patient simulator, environment...),
- the commitment and expertise of other facilitators,
- if the participants have already been exposed to this educational approach
- and if they require some pre-briefing information before the session such as signing a video-consent form or be asked to come with their uniform (Alinier, 2011).

Despite the fact that the studies presented had limitations such as involving students from only one Higher Education Institution and relying on self-selected volunteers, their results were useful in determining the effectiveness of scenario-based simulation training for the students' acquisition of knowledge and skills of their own discipline but also of other healthcare professions. It also demonstrated that students' attitude

towards multidisciplinary team working can be improved following participation in high-fidelity simulation scenarios involving students from different healthcare disciplines. The experiential learning nature of simulation makes it an attractive educational method for students once the facilitators have gained their confidence by establishing a positive learning atmosphere. When facilitated in the appropriate manner by an experienced team of facilitators, simulation can be both enjoyable and highly educational for students as expressed in the following comment: *"This is an amazing experience and I believe that ALL healthcare professional students would benefit from it"*. The key issue is that it is extremely costly to facilitate due to the duration of the sessions and the relatively high staff to students ratio required for all students to actively take part in at least one highly realistic scenario. Other issues such as timetabling and scenarios becoming more complex to design may also arise when trying to organise interprofessional simulation training sessions.

These studies have helped the University of Hertfordshire develop its reputation in the area of simulation training, primarily in undergraduate healthcare education, and hence has directly contributed to the development of the purpose built simulation centre (Alinier, 2007a) and its sustained use, but also more recently to the development of a new postgraduate programme to train simulation facilitators (MSc in Medical and Healthcare Simulation). An increasing number of healthcare programmes are now integrating simulation sessions as part of the students' training curriculum in various ways. Among the undergraduate students, groups who are engaged in scenario-based simulation training as part of a module include: pharmacists, paramedics, adult and children nursing students, midwives, physiotherapists, and bioscientists. In a 12-month period, over 10,000 undergraduate and postgraduates learners access the centre for various courses (Workshops, seminars, industry courses, low to high-fidelity simulation sessions) because of the facilities on offer, with 1,000 taking part in high-fidelity simulation training for a total of over 340 clinical scenarios. In addition the centre has received over 1,000 visitors annually, many of whom are from overseas, from the government, academia, industry, and representing various healthcare professions.

Simulation is now developing everywhere at a rapid pace with support from healthcare professional bodies and government authorities worldwide. There is increasing evidence of the benefits of simulation-based education, notably with published studies regarding improved patients outcomes thanks to reductions of catheter related bloodstream infections (Barsuk et al., 2009a) and improved management of shoulder dystocia (Draycott et al., 2008). The next big step will be the design of regulations,

standards, and guidelines regarding best practice for the implementation and use of simulation training at undergraduate and post-graduate levels, and also for Continuing Professional Development of healthcare practitioners. This is currently looked at by the Department of Health who commissioned a national scoping exercise on the use of simulation in healthcare education and training as an initial phase project which was completed in March 2010, and who subsequently worked on the development of national guidelines on the use of simulation by the National Health Service and the Higher Education Institutions.

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Appendices:

Appendix I

Information letter and consent form

British Heart Foundation Project

An evaluation of the effectiveness of simulation in nurse education

Information letter

Y Cohort, Adult Branch

The Department of Nursing & Paramedic Sciences in collaboration with the Department of Electronic, Communication & Electrical Engineering are currently undertaking a research program funded by the British Heart Foundation (BHF). The overall aim of the research is to evaluate the effectiveness of high technology simulation in nurse education with an emphasis on cardiac monitoring and the use of technological equipment.

The management of acute cardiac emergencies is often dependent on the use of complex technological devices. Simulation involving the ever-increasing medical technology in the education of all healthcare professionals will inevitably become a necessity to increase students' experience before they come in contact with real patients and to help them getting familiar with the more complex pieces of equipment.

During the current academic year you will have a few opportunities to interact with real medical equipment at the University. The sessions will take place in a specialised laboratory called "HICESC", which stands for "Hertfordshire Intensive Care & Emergency Simulation Centre" and situated between the Wright and Hutton buildings (room E406). Your cohort tutor will inform you of the dates.

The following paragraphs explain what those sessions involve:

Two sessions of Objective Structure Clinical Examination (OSCE) consisting of series of lab exercises will be organised during the year. Those sessions will be separated by a few months. Each session will require around 2 hours of your time and will take place in HICESC. Prior to the second OSCE half of the cohort' students will be required to attend a 3-hour training and simulation session involving a sophisticated patient simulator in HICESC. You will also be asked to fill in a short questionnaire so as to determine your feelings about working in a technological environment. This should take approximately 10 minutes of your time.

The outcomes of the questionnaire and of the OSCEs will be entirely confidential (you will be allocated an anonymity number) and, although a report of the findings will be written, no names will be mentioned at any stage and it is not linked to any assessment strategy used in your Diploma course. Participation in the above is on a voluntary basis. However the benefits of the experience will be valuable now and in your future progression. Attendance will result in a certificate for your portfolio. Feedback session with "eats" at completion.

If you are not interested in participating in this research programme, please let me as soon as possible. A consent form will have to be filled in to confirm your agreement to participate in the study.

If you would like further information please contact me or refer to the following website: http://www.health.herts.ac.uk/depts/naps/hicesc/

You will require the following username and password to access it:

Username: uhstudent
Password: nursing

Yours Sincerely,

Mr Guillaume Alinier.
Research Co-ordinator, *Tel: 01707 286395 (Ext:3395), E-mail:G.Alinier@herts.ac.uk*

UNIVERSITY OF HERTFORDSHIRE
FACULTY OF HEALTH & HUMAN SCIENCES

ETHICS COMMITTEE FOR NURSING, MIDWIFERY, PARAMEDIC SCIENCES, SOCIAL WORK AND COUNSELLING

CONSENT FORM FOR STUDIES INVOLVING HUMAN SUBJECTS

I, the undersigned, agree to take part in
(Protocol Number: NM2000 / 09I)

An evaluation of the effectiveness of high technology simulation in nurse education

to be carried out by: Mr Guillaume Alinier,
Research Co-ordinator at the University of Hertfordshire.

The outcomes of the questionnaire and of the OSCEs will be entirely confidential and, although a report of the findings will be written, no names will be mentioned at any stage. All data will be made anonymous by allocating a unique numeric code. Participation in the questionnaire and the OSCEs does not require any preparation from you, is entirely voluntary and is, in no way, linked to any assessment strategy used in your Diploma course. All computer files relating to any aspect of the study will only be accessible to the researcher via a unique security password. If you have any reason not to participate in this study you will be free to withdraw at any time without penalty and without the need to justify your decision.

I confirm that I have been given a full explanation of the purpose of the study by the investigator and that I have been informed of the details of my involvement in the study.

I confirm that I have been informed that I may withdraw from the study at any stage without the need to justify my decision.

Signature of Volunteer: .....

Name of Volunteer: .....
(Please print)

Signature of Investigator: .....

Name of Investigator: *Guillaume Alinier*

Appendix II

OSCE stations & Marking scales

This document presents the different types of exercises that students were undertaking whilst participating in the BHF study. Each station was independent and related to skills that students might not have yet been taught. So as not to cause any distress, students were informed prior to the OSCE that they were not expected to know how to solve all the problems presented. They were reminded that they were not only being evaluated on the outcome but also on their approach to solving the problem.

List of OSCE stations:

1 – Practical: Positioning of ECG electrodes and leads on a simulated patient (mannequin).

2 – Theoretical: Outcome of incorrect ECG electrodes positioning? Points to consider on a male patient.

3 – General: Recognition of five selected heart rhythms on a monitor.

4 – Practical: a) Switching ON monitor and b) determination of current alarm settings.

5 – Practical: Use of the monitor reference manual to find a specific function and modify the alarm limits.

6 – Practical: a) Put together the three main components of an Ambubag (spare parts added to the jigsaw)

b) Sizing & inserting an oropharyngeal airway in a mannequin.

7 – Theoretical: Important things to remember when you are next to a patient who is going to be defibrillated?

8 – Practical: Role & positioning of pulse oximeter.

9 – Theoretical: What should you do or check if an electrical piece of equipment you are using is not working?

10 – Practical: Ask a student to set up an electrical piece of equipment (Volumetric infusion pump) which appears not to be working (either disconnected from the main or out of order) and observe his/her action.

11 – Practical: Mute a syringe driver that is alarming because it reached the end of infusion.

12 – Practical: Install the tubing of a ventilator and empty the trap.

13 – Practical: Correct positioning and inflation a blood pressure cuff on a simulated patient's arm.

14 – Practical: Reposition patient's bed using controls so that it is now raised and the patient is sitting at 30° from the horizontal.

15 – Theoretical: List signs and symptoms of a cardiac arrest.

Station 1

list

Positioning of ECG electrodes and leads on a simulated patient.

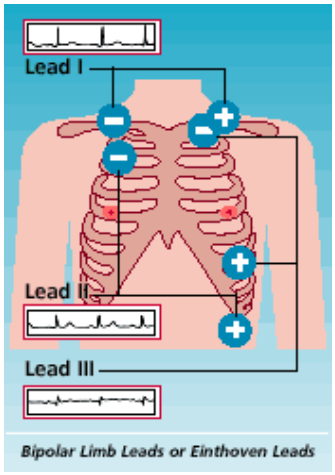
Time allowed: 5min.

Resources required:

- Examiner:
- Equipment:
  - 3-lead ECG
  - 3 adhesive pre-gelled electrodes
  - Resusci Ann torso mannequin
  - Paediatric Bed

Task description:

Treat the mannequin as a real unknown conscious patient, having this procedure for the first time.
Position the electrodes on the mannequin for a 3-lead ECG.
Attach the ECG leads to the electrodes.



Points being observed:

Correct positioning of electrodes
Correct allocation of the three leads
Confidence (Time to place electrodes and leads)
Communication with the "patient"

Answer:

Although an ECG trace may be obtained with the electrodes attached in a variety of positions, conventionally they are placed in a standard position each time so that abnormalities are easier to detect. Most monitors have 3 leads and they are connected as follows:

- **Red** - right arm, (or second intercostal space on the right of the sternum)
- **Yellow** - left arm (or second intercostal space on the left of the sternum)
- **Black** (or Green) - left leg (or more often in the region of the apex beat.)

This will allow the Lead I, II or III configurations to be selected on the ECG monitor. Lead II is the most commonly used. (See below for other lead positions and their uses).

STATION 1

Positioning of ECG electrodes and leads on a simulated patient.

Time allowed: 5 minutes

Task description:

Treat the mannequin as a real unknown conscious patient, having this procedure for the first time.
Position the electrodes on the mannequin for a 3-lead ECG.
Attach the ECG leads to the corresponding electrodes.

Points being observed:

Correct positioning of electrodes.
Correct allocation of the three coloured leads.
Confidence (Time to place electrodes and leads).
Communication with the “patient”.

OSCE Marking Sheet

Station 1

Date:

Candidate number: | | | | | | | |

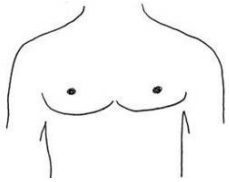
Student Cohort:

Examiner:

Positioning of ECG electrodes and leads on a simulated patient.
Graded using 0 – 5 scale. (0 – very bad, 5 – very good)

Correct localisation of electrodes:	0	1	2	3	4	5

0 – No electrode on the torso
1 – Only one or electrodes placed on the torso
2 – All electrodes on the torso but incorrectly placed
3 – One electrode correctly positioned
4 – Two electrodes correctly positioned
5 – Three electrodes correctly positioned



Please, reproduce electrodes *and leads positions on the following figure:*

Colour code of leads respected:	0	1	2	3	4	5

0 – The student did not place any of the leads correctly
2 – One lead correctly allocated
3 – Two leads correctly allocated
5 – Three leads correctly allocated

Confidence:	0	1	2	3	4	5

0 – The student did not perform the task
1 – The student hasn't had enough time to complete the exercise
2 – The student took between 3 and 5 minutes to place the electrodes and leads #
3 – The student took between 1 and 3 minutes to place the electrodes and leads #
4 – The student took between 40 seconds and 1 minute placed the electrodes and leads #
5 – The student placed the electrodes and the leads in less than 40 seconds #

Even if incorrect

Communication:	0	1	2	3	4	5

0 – The student did not speak at all to the patient & even ignored him
1 – The student did not speak at all to the patient
2 – Minimum effort to communicate was made by the student
3 – Some effort to communicate was made by the student
4 – Real effort to communicate made by the student
5 – The student introduced himself/herself to the patient and explained what he/she was doing

Total score	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

Comments:

Station 2

Outcome of incorrect ECG electrodes positioning? Points to consider on a male patient?

Time allowed: 5min.

Resources required:

- Equipment:
  - Pen & Paper

Task description:

Explain in details the outcome of an incorrect positioning of ECG electrodes in the three following cases:- Swapped leads,
- Electrodes not properly connected, and
- Electrodes not placed where they should be on the patient.

What are the possible considerations you may have to think of to take an ECG of a male patient?
Explain in details what would be the outcome of inadequate preparation of the skin.

Points being observed:

Awareness of the importance of correct positioning of ECG electrodes, the preparation of the skin, and the problems that can be faced when dealing with a male patient.

STATION 2

Outcome of incorrect positioning of ECG electrodes

Points to consider on a male patient

Time allowed: 5 minutes

Task description:

Explain in details the outcome of incorrect positioning of ECG electrodes in the three following cases: - Swapped leads,

- Electrodes not properly connected, &

- Electrodes not placed where they should be on the patient.

What are the possible considerations you may have to think of when taking the ECG of a male patient?

Explain in details what would be the outcome of inadequate preparation of the skin.

Points being observed:

Awareness of the importance of correct positioning of ECG electrodes, the preparation of the skin, and the problems that can be faced when dealing with a male patient.

OSCE Answer Sheet

Station 2

Date:

Candidate number: | | | | | | | |

Student Cohort:

Task description:

Explain in details what may be the outcome of an incorrect positioning of ECG electrodes in the three following cases: 1 - swapped leads,
2 - electrodes not properly connected, and
3 - electrodes not placed where they should be on the patient.

1: ----------

2: ----------

3: ----------

4: What are the points to consider when taking the ECG of a male patient?

5: Explain in details what would be the outcome of inadequate preparation of the skin.

OSCE Marking Sheet

Station 2

Date:

Candidate number: | | | | | | | |

Examiner:

Student Cohort:

Task description:

Explain in details what may be the outcome of an incorrect positioning of ECG electrodes in the three following cases: - Swapped leads,
- Electrodes not properly connected, and
- Electrodes not placed where they should be on the patient.

Outcome of swapped leads:	0	1	2	3	4

- ☐ Incorrect reading, or misdiagnosed (2)
- ☐ Inverted ECG signal (2)

Outcome of electrodes not properly connected:	0	1	2	3	4

- ☐ Poor trace or no reading
- ☐ Artifact or wrong reading (2)
- ☐ Intermittent reading

Outcome of electrodes not placed where they should be	0	1	2	3	4

- ☐ Wrong information on ECG, or misdiagnosed (2)
- ☐ Abnormal ECG signal (2)

What are the points to consider when taking the ECG of a male patient?

ECG of a male patient:	0	1	2	3	4

- ☐ Hairy chest
- ☐ Shave areas for electrodes (2)
- ☐ Clean the skin

Explain in details what would be the outcome of inadequate preparation of the skin.

Outcome of inadequate preparation of the skin:	0	1	2	3	4

- ☐ Poor trace
- ☐ Poor conduction (2)
- ☐ Dislodgement of electrode

Total score	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

Comments:

Station 3

list

Recognition of five selected heart rhythms on a monitor.

Time allowed: 5min.

Resources required:

- Examiner:
- Equipment:
  - HeartSim 2000
  - Kontron monitor

Task description:

Name and describe the specific characteristics of the 5 different heart rhythms shown on the monitor.

Points being observed:

Familiarity of the students with the different possible arrhythmia observable on a patient being monitored.

Marking Scales:

Recognition of arrhythmia (Grade 0 to 5: number of heart rhythms recognised)

Description of particularities (Grade 0 to 5: number of arrhythmia for which a specific features was identified)

Answers:
1 – Atrial Flutter
2 – 3rd degree A.V. Block
3 – Atrial Fibrillation
4 – 1st degree A.V. Block
5 – Ventricular Fibrillation

STATION

3

Recognition of five selected heart rhythms on a monitor

Time allowed: 5 minutes

Task description:

Name and describe a specific characteristic of each of the 5 different heart rhythms shown on the monitor.

Points being observed:

Familiarity of the students with the different possible arrhythmia observable on a patient being monitored.

Description of particularities of each dysrhythmia.

OSCE Marking Sheet

Station 3

Date:

Candidate number: | | | | | | | |

Examiner:

Student Cohort:

Task description:

Name and describe the specific characteristics of the 5 different heart rhythms shown on the monitor.
Graded using 0 – 5 scale.

Recognition of arrhythmias:	0	1	2	3	4	5

0 – None of the arrhythmias have been recognised
1 – One of the arrhythmias has been recognised
2 – Two of the arrhythmias have been recognised
3 – Three of the arrhythmias have been recognised
4 – Four of the arrhythmias have been recognised
5 – Five of the arrhythmias have been recognised

Description of specific features of displayed arrhythmias:	0	1	2	3	4	5

0 – None of the arrhythmias have been correctly described
1 – One of the arrhythmias has been correctly described
2 – Two of the arrhythmias have been correctly described
3 – Three of the arrhythmias have been correctly described
4 – Four of the arrhythmias have been correctly described
5 – Five of the arrhythmias have been correctly described

Total score	0	1	2	3	4	5	6	7	8	9	10

Comments:

Station 4

list

a) Switching ON monitor

And

b) Find out the current alarm settings.

Time allowed: 5min.

Resources required:

- Examiner:
- Equipment:
    - Patient monitor (Kontron Colormon Plus)

Task description:

- Switch ON the monitor.
- Find out the current alarm settings.
- Return to normal display.

Points being observed:

Approach of the student toward the monitor.
Did the student take the time to read the information on each button of the keypad?
Was the student panicking or confident? (Time to perform the task)

STATION 4

Operating a monitor to find out the current alarm settings

Time allowed: 5 minutes

Task description:

Switch ON the monitor

Find out the current alarm settings of the different parameters

Return to the normal display screen (Patient monitoring)

Points being observed:

Operating a monitor without a reference manual

Confidence when confronted to use a monitor (Time to perform the task)

OSCE Marking Sheet

Station 4

Date:

Candidate number: | | | | | | | |

Examiner:

Student Cohort:

Task description:

Switch ON the monitor (Kontron Colormon Plus).
Find out the current alarm settings.
Return to normal display screen (Patient monitoring).
Graded using 0 – 5 scale. (0 – very bad, 5 – very good)

Operating the monitor:	0	1	2	3	4	5

0 – No action taken by the student
1 – Student could not switch ON the monitor
2 – Student made an attempt to switch ON the monitor with the wrong button or pressed twice on the power button but succeeded
3 – Student was not confident switching ON the monitor but succeeded
4 – Student switched ON the monitor without hesitation
5 – Student switched ON the monitor without hesitation & returned to the normal display page in the end.

Alarm state of the different parameters:	0	1	2	3	4	5

0 – Settings were modified by mistakes (improper use of keypad)
1 – Student could not find the alarm settings and did not try very hard
2 – Student could not find the alarm settings despite several attempts or did not recognise the individual settings
3 – Student went to the correct display with the overall settings but did not recognise the information
4 – Student found the individual alarm settings
5 – Student found overall alarm settings

Time to perform task:	0	1	2	3	4	5

0 – The student hasn't had enough time to perform the task successfully
1 – Student took between 3 and 5 minutes to complete the exercise from the time the monitor was ON
2 – Student took between 2 and 3 minutes to complete the exercise from the time the monitor was ON
3 – Student took between 1 and 2 minutes to complete the exercise from the time the monitor was ON
4 – Student took between 30 sec. and 1 minute to complete the exercise from the time the monitor was ON
5 – Student finished the exercise in less than 30 seconds from the time the monitor was ON

Total score	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

Comments:

Station 5

Use of the monitor reference manual to find a specific function and modify the alarm limits.

Time allowed: 5min.

Resources required:

- Examiner:
- Equipment:
    - ECG monitor (Hewlett Packard Model 66S)
    - Corresponding set of reference manuals
    - Kontron reference manual

Task description:

With help from the reference manual:

- Set heart rate/pulse lower alarm limit to 45 beats per minute.
- Set temperature with low alarm limit to 37'C, and upper limit at 39'C.
- Return to normal display (Patient monitoring screen).

Points being observed:

Use of the Hewlett Packard reference manual.
Use of the table of content or index if appropriate.
Was the student panicking or confident? (Time to perform the task)
Were the new settings entered correctly?

STATION 5

Use of the monitor reference manual to find a specific function and modify the alarm limits

Time allowed: 5 minutes

Task description:

With help from the reference manual:

- Set heart rate/pulse lower alarm limit to 45 beats per minute.
- Set temperature alarms with lower limit at 37'C, and upper limit at 39'C.

Return to normal display (Patient monitoring screen)

Note: *Don't spend too much time on the manuals*.

Points being observed:

Operating a monitor with a reference manual / Input of new settings

Confidence when confronted to use a monitor (Time to perform the task)

Good use of the time allocated to perform the task

OSCE Marking Sheet

Station 5

Date:

Candidate number: | | | | | | | |

Examiner:

Student Cohort:

Task description: With help from the reference manual:
- Set heart rate/pulse lower alarm limit to 45 bpm.
- Set temperature alarms with lower limit at 37'C, and upper limit at 39'C.
- Return to normal display (Patient monitoring screen.

Graded using 0 – 5 scale. (0 – very bad, 5 – very good)

Use of the Hewlett Packard reference manual:	0	1	2	3	4	5

0 – The student did not used a reference manual and failed to complete the exercise
1 – The student used the wrong reference manual (Kontron)
2 – The student started by looking in the Kontron manual and then changed to a HP manual
3 – The student used the correct manual but did not find the information needed
4 – The student used the correct manual but took over 2 minutes to find the relevant information
5 – The student made good use of the reference manual (find the relevant information in less than 2 minute) and/or succeeded to perform the task without using it

Use of the monitor keypad:	0	1	2	3	4	5

0 – The student did not use the controls on the monitor
1 – The student could not work out how to operate the monitor
2 – The student tried the "Parameters" path but failed to change the alarm limits
3 – The student tried the "Alarms" path but failed to change the alarm limits
4 – The students went through the path: Parameters/HR-Pulse/Adjust alarms/Low & High limit modification and succeeded and similarly for the temperature, and succeeded
5 – The student went through the path: Alarms/Alarm limits/Select parameter or navigation arrows with confirmation/Low & High limit modification and succeeded

New settings:	0	1	2	3	4	5

*From the time the student started to use the monitor
0 – The student did not turn ON the monitor
1 – The student had not enough time to modify the alarm limits
2 – The student took over 3 minutes to modify the alarm limits *
3 – The student took between 2 and 3 minutes to modify the alarm limits *
4 – The student took between 1 and 2 minutes to modify the alarm limits *
5 – The student entered the new settings in less than 1 minute *

Total score	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

Comments:

Station 6

a) ***Put together the three main components of a resuscitator***

And

b) ***Insertion of an oropharyngeal airway of the correct size in a mannequin.***

Time allowed: 5min.

Resources required:

- Examiner:
- Equipment:
    - 2 sets of disassembled Laerdal Resuscitators
    - Set of different oropharyngeal airways
    - Laerdal airway management trainer

Task description:

- Assemble the Resuscitator and make sure it operates properly
- Select an oropharyngeal airway and position it in the patient's mouth

Points being observed:

How agile did the student appear to be in assembling the Resuscitator?
Was the oropharyngeal airway inserted correctly?
Was the oropharyngeal airway selected of the correct size?
How quickly was the task performed?

STATION

6

Putting together the three main components of a resuscitator

And sizing & insertion of an oropharyngeal airway in a mannequin

Time allowed: 5 minutes

Task description:

Assemble a resuscitator and make sure it operates properly

Select an oropharyngeal airway and position it in the patient's mouth

Points being observed:

Agility and confidence to assemble a resuscitator

Sizing and insertion of the oropharyngeal airway

How quickly the tasks are performed

OSCE Marking Sheet

Station 6

Date:

Candidate number: | | | | | | | |

Examiner:

Student Cohort:

Task description:

- Assemble a resuscitator and make sure it operates properly
- Select an oropharyngeal airway and position it in the patient's mouth

Graded using 0 – 5 scale. (0 – very bad, 5 – very good)

Time to Assemble Resuscitator:	0	1	2	3	4	5

0 – The student did not finish to assemble the Resuscitator
1 – It took over 4 minutes for the student to assemble the Resuscitator
2 – It took between 2 and 4 minutes for the student to assemble the Resuscitator
3 – It took between 40 seconds and 2 minutes for the student to assemble the Resuscitator
4 – It took between 20 and 40 seconds for the student to assemble the Resuscitator
5 – The student assembled the Resuscitator in less than 20 seconds

Assemble Resuscitator correctly:	0	1	2	3	4	5

0 – The student did not manage to assemble the Resuscitator correctly
1 – Two pieces assembled correctly
2 – Three pieces assembled correctly
4 – The Resuscitator was correctly assembled but was not tested (by squeezing the bag)
5 – The Resuscitator was correctly assembled and tested

Size Oropharyngeal airway OA:	0	1	2	3	4	5

0 – The student inserted an OA different from sizes 9,10 or 11
1 – The student inserted an OA size 11
2 – The student inserted an OA size 9
3 – The student took between 15 seconds and 1 minute before reverting to an OA size 10
4 – The student took less than 15 seconds to select the correct OA (size 10)
5 – The student used the correct OA (size 10) straight away

Insertion of Oropharyngeal airway:	0	1	2	3	4	5

0 – The student did not insert the OA or inserted it with effort or without care
1 – The student inserted the OA gently without twisting it & without opening the airway
2 – The student inserted the OA with a twist but without opening the airway
3 – The student inserted the OA without twisting it but with an open airway
4 – The student inserted the OA properly (Twist and open airway) but took over 5 seconds to insert it
5 – The student inserted the OA properly (Twist and open airway)

Total score	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

Comments:

Station 7

Safety aspect:

Important things to remember when you are next to a patient who is going to be defibrillated?

Time allowed: 5min.

Resources required:

- Equipment:
  - Pen & Paper

Task description:

List as many recommendations as you can concerning the safe use of a defibrillator for the patient, yourself and the people around (Give at least seven answers).

Points being observed:

Do the recommendations listed by the student show that he/she is aware of the danger?
Were some of the recommendations completely erroneous?

STATION 7

Safety:

Important things to remember when you are next to a patient who is going to be defibrillated

Time allowed: 5 minutes

Task description:

List as many recommendations as you can concerning the safe use of a defibrillator for the patient, yourself and the people around(Give at least seven answers).

Points being observed:

Awareness of potential risks
Safety procedures concerning defibrillation

OSCE Answer Sheet

Station 7

Date:

Candidate number: | | | | | | | |

Student Cohort:

Task description:

List *as many* recommendations *as you can* concerning the safe use of a defibrillator, for the patient, yourself and the people around (Give at least seven answers).

OSCE Marking Sheet

Station 7

Date:

Candidate number: | | | | | | | |

Examiner:

Student Cohort:

Task description:

List as many recommendations as you can concerning the safe use of a defibrillator, for the patient, yourself and the people around. (Give at least seven answers)

- ☐ Warn people to stand clear before the shock is delivered (2 points)
- ☐ No conductive material (water, metallic floor, bed frame) in contact with the patient
- ☐ The patient has to be in a shockable state (VF) (2 points)
- ☐ Operator's hands must be clear from any gel applied on the pads or chest of the patient
- ☐ No part of the operator or any assistant must be in contact with the patient during the shock
- ☐ Glyceryl trinitrate patches must be removed to avoid risk of explosion
- ☐ IV fluid's bags should not be held by hand during shock/Oxygen removed from patient
- ☐ Correct lubricant or pads should be used
- ☐ A defibrillator should never be charged for more than a few seconds
- ☐ If not used a defibrillator should be discharged
- ☐ Equipment only to be used be a trained person (2 points)
- ☐ Equipment in working condition (passed annual security check)

1 point per correct answer unless otherwise specified.

Total score	0	1	2	3	4	5	6	7	8	9	10

Comments:

Station 8

Role & positioning of pulse oximeter.

Time allowed: 5min.

Resources required:

- Examiner:
- Equipment:
    - 2 Pulse oximeters (A Kontron finger probe, a BCI 3301 ear probe)
    - Mannequin with torso covered (no visible electrodes)

Task description:

Explain to the examiner what the pulse oximeter measures.

Position the two pulse oximeters on the mannequin, considering it as a real unknown conscious patient, having this procedure for the first time.

Note: In a real case only one of those two types of pulse oximeters would be clipped on a patient.

Points being observed:

Does the student know what the pulse oximeter measures?

Positioning of pulse oximeters?

Communication with the patient

STATION

8

Role & positioning of pulse oximeter

Time allowed: 5 minutes

Task description:

Explain to the examiner what a pulse oximeter measures.
Position the two pulse oximeters on the mannequin, considering it as a real unknown conscious patient, having this procedure for the first time.

Note: *In a real case only one of those two types of pulse oximeters would be clipped on a patient.*

Points being observed:

Role & positioning of a pulse oximeter.

Communication with the patient.

OSCE Marking Sheet

Station 8

Date:

Candidate number: | | | | | | | |

Examiner:

Student Cohort:

Task description:
Explain to the examiner what the pulse oximeter measures. Position the two pulse oximeters on the mannequin, considering it as a real unknown conscious patient, having this procedure for the first time.

Graded using 0 – 5 scale. (0 – very bad, 5 – very good)

The pulse oximeter:	0	1	2	3	4	5

0 – The student does not know what a pulse oximeter is used for
1 – The student gives an erroneous answer
2 – The student's explanation is very vague but not wrong
3 – The student demonstrates some understanding (mentions the words "blood" and "oxygen")
4 – The student gives an acceptable explanation
5 – Student well aware of the function of a pulse oximeter ("Haemoglobin saturation with oxygen")

Correct positioning of pulse oximeter:	0	1	2	3	4	5

0 – Both pulse oximeters were not positioned correctly
1 – The student inverted the pulse oximeters (ear probe to finger and vice versa)
2 – Only one of the pulse oximeters was positioned correctly
3 – The student had to reposition one of the pulse oximeters before getting both of them correctly localised
4 – One of the pulse oximeters was positioned correctly and the other one almost at the correct place (thumb)
5 – Both pulse oximeters were correctly positioned on the patient

Communication:	0	1	2	3	4	5

0 – The student did not speak at all to the patient & even ignored him
1 – The student did not speak at all to the patient
2 – Minimum effort to communicate was made by the student (1 statement to the patient)
3 – Some effort to communicate was made by the student (2 statements to the patient)
4 – Real effort to communicate made by the student (3 statements to the patient)
5 – The student introduced himself/herself to the patient and explained what he/she was doing

Total score	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

Comments:

Station 9

What should you do or check if an electrical piece of equipment you are using is not working?

Time allowed: 5min.

Resources required:

- Equipment:
  - Pen & Paper

Task description:

What are the actions you could take if an electrical piece of equipment you are asked to use is not working? (Give at least seven possible actions)

Points being observed:

Behaviour of the student in front of a problem.
Does the students seek for help?
Does the student check that the plug is switched ON?

STATION 9

What should you do or check if an electrical piece of equipment you are using is not working?

Time allowed: 5 minutes

Task description:

What are the actions you could take if an electrical piece of equipment you are asked to use is not working? (Give at least seven possible actions)

Points being observed:

Theoretical action/behaviour in front of a problem.

OSCE Answer Sheet

Station 9

Date:

Candidate number: | | | | | | | |

Student Cohort:

Task description:

What are the actions you could take if an electrical piece of equipment you are asked to use is not working? (Give at least seven possible actions)

OSCE Marking Sheet

Station 9

Date:

Candidate number: | | | | | | | |

Examiner:

Student Cohort:

Task description:

What are the actions you could take if an electrical piece of equipment you are asked to use is not working? (Give at least seven possible actions)

- [ ] Seek help from someone else
- [ ] Check that the mains supply is turned ON (2 points)
- [ ] Check the device is connected to the mains supply (2 points)
- [ ] Get another similar piece of equipment
- [ ] Look for the cause of the problem
- [ ] Check the device is properly switched ON
- [ ] Report the problem to the line manager/ technician (2 points)
- [ ] Put a note on the faulty instrument
- [ ] Read reference manual
- [ ] Report fault in instrument/equipment log book

1 point per correct answer unless otherwise specified.

Total score	0	1	2	3	4	5	6	7	8	9	10

Comments:

Station 10

Ask a student to set up an electrical piece of equipment (volumetric infusion pump) which appears not to be working (either disconnected from the main or out of order) and observe his/her action.

Time allowed: 5min.

Resources required:

- Examiner:
- Equipment:
    - Volumetric infusion pump (Imed Gemini PC1).

Task description:

Set up the volumetric infusion pump so that it is immediately ready to be used (Giving set in place and equipment switched ON).

Points being observed:

Behaviour of the student in front of a problem.

Does the student check that the plug is switched ON?

Did the students proceed to any kind of assessment?

Did the student determine why the piece of equipment would initially not operate?

How quickly the student solves the problem?

STATION 10

Setting up an electrical piece of equipment so that it is immediately ready to be used

Time allowed: 5 minutes

Task description:

Set up the volumetric infusion pump so that it is immediately ready to be used (Giving set in place and equipment switched ON).

Points being observed:

Operating a volumetric infusion pump.

Confidence when confronted to use a volumetric infusion pump.

Time to perform the task.

OSCE Marking Sheet

Station 10

Date:

Candidate number: | | | | | | | |

Examiner:

Student Cohort:

Task description:
Set up the volumetric infusion pump (Imed Gemini PC1) so that it is immediately ready to be used Giving set in place and equipment switched ON).

Assessment:	0	1	2	3	4	5

- [ ] - The student tried to switch the piece of equipment ON
- [ ] - The student checked the power supply
- [ ] - The student took time to have a look around the piece of equipment
- [ ] - The student was calm
- [ ] - Even if unsuccessful, an effort was made in setting up the piece of equipment
- [ ] - The student was methodological and quick

1 point per correct answer unless specified otherwise.

Switching the plug ON:	0	1	2	3	4	5

0 – The student did not switch the wall plug ON
1 – The student took over 2 minutes to realise the wall plug was not ON
2 – The student took between 1 and 2 minutes to realise the wall plug was not ON
3 – The student took between 40 seconds and 1 minute to realise the wall plug was not ON
4 – The students took between 20 and 40 seconds to realise the wall plug was not ON
5 – The student switched the wall plug ON within the first 20 seconds

Setting up equipment:	0	1	2	3	4	5

 # Time counted until the students has finished to put the tubing in place

0 – The student did not successfully complete the exercise
1 – The student took over 3 minutes to complete the exercise #
2 – The student took between 2 and 3 minutes to complete the exercise #
3 – The student took between 1 and 2 minutes to complete the exercise #
4 – The students took between 30 and 1 minute to complete the exercise #
5 – The student finished the exercise in less than 30 seconds #

Total score	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

Comments:

Station 11

Mute a syringe driver that is alarming because it reached the end of infusion.

Time allowed: 5min.

Resources required:

- Examiner:
- Equipment:
    - Syringe driver IVAC P3000

Task description:

Determine why the syringe driver is alarming / mute the alarm.

Points being observed:

Did the student seem afraid to make a mistake?
Did the student have to make several attempts before muting the alarm?
How quickly was the problem solved?

Introduction to the syringe Driver Model IVAC P3000

- Battery or main powered
- ON/Off Switch on the side
- How to insert a syringe
- Confirm syringe size (10, 20, 30, or 50ml)
- Controls:
    - ***Purge & bolus*** (Press & release twice) infusion capability
    - Pumping pressure gauge (modification of pumping pressure limit: Press & hold ***Set alarm level*** + ***pointing down arrow***)
    - Infusion rate setting (use of ***arrows***) up to 99.9ml/hour on display
    - Limit of volume infused setting (Press & hold ***vol limit*** and ***arrows***) with display
    - Clear volume infused display (press twice ***clear***)
    - Clear volume to infuse display (Press ***Vol Infuse*** & ***clear***)
    - ***Start*** button to start infusion
    - ***Stop*** button to stop infusion but also to mute the alarm

- Alarms (specific display and/or audible alarm):

    Pumping pressure too high (Occlusion)

    End of infusion

    If the syringe size has not been confirmed

    Internal error

    Battery running out

STATION 11

Mute the alarm

Determine what is causing the syringe driver to alarm

Time allowed: 5 minutes

Task description:

Imagine you are entering a ward:

Using the controls, mute the alarm and determine why the syringe driver was alarming.

Points being observed:

Operating a syringe driver.

Confidence when confronted to use a syringe driver.

Time to perform the task.

OSCE Marking Sheet

Station 11

Date:

Candidate number: | | | | | | | |

Examiner:

Student Cohort:

Task description:
Mute the alarm and determine why the syringe driver (IVAC P3000) was alarming.

Graded using 0 – 5 scale. (0 – very bad, 5 – very good)

Muting the alarm:	0	1	2	3	4	5

From the time the student finished reading the instructions:
0 – The student did not manage to mute the alarm
1 – The student took over 2 minutes before muting the alarm
2 – The student took between 1 and 2 minutes before muting the alarm
3 – The student took between 30 seconds and 1 minute before muting the alarm
4 – The student took between 10 and 30 seconds before muting the alarm
5 – The student managed to mute in less than 10 seconds

Determining cause of the alarm:	0	1	2	3	4	5

From the time the student finished reading the instructions:
0 – The student did not manage to determine the cause of the alarm
1 – The student took over 3 minutes to determine the cause of the alarm
2 – The student took between 2 and 3 minutes to determine the cause of the alarm
3 – The student took between 1 and 2 minutes to determine the cause of the alarm
4 – The student took between 20 seconds and 1 minute to determine the cause of the alarm
5 – The student determined the cause of the alarm in less than 20 seconds

Total score	0	1	2	3	4	5	6	7	8	9	10

Comments:

Station 12

Install the tubing of a ventilator and empty the trap.

Time allowed: 5min.

Resources required:

- Examiner:
- Equipment:
    - Ventilator (Dräger Babylog 8000 plus)

Task description:

Install the tubing of the ventilator.

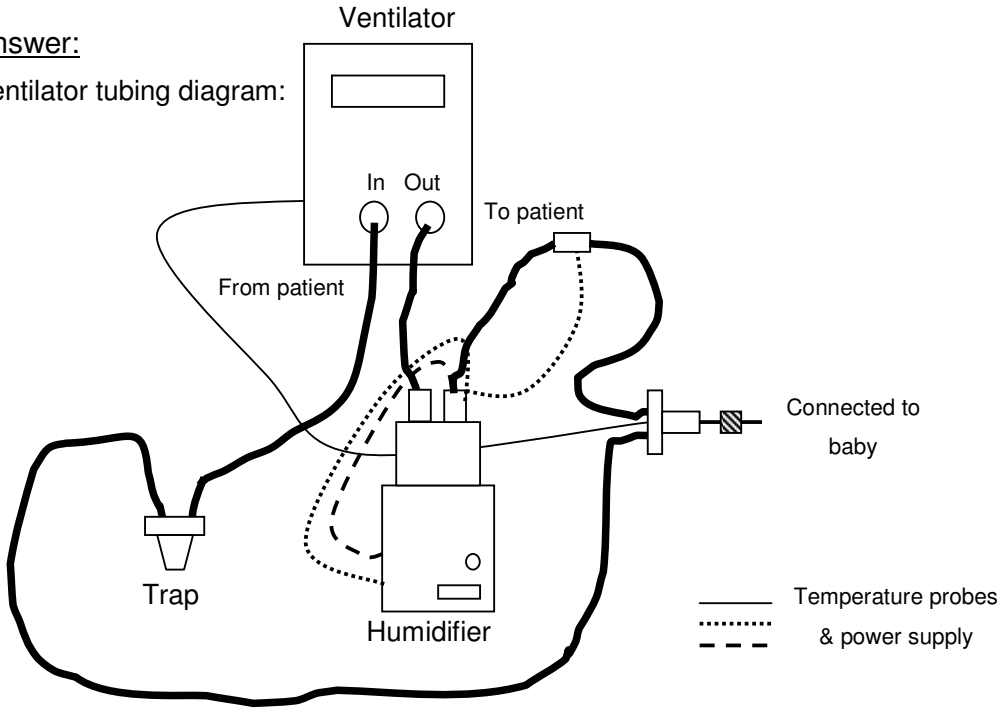
Empty the trap of the ventilator and re-assemble it.

Points being observed:

How confident did the student look while installing the tubing on the ventilator?
Was the set up correct?
Rapidity to install the tubing and to empty the trap.

Answer:

Ventilator tubing diagram:



STATION

12

Installing the tubing of a ventilator & emptying the trap

Time allowed: 5 minutes

Task description:

Install the tubing on the ventilator.

Empty the traps of the ventilator and re-assemble it.

Points being observed:

Confidence when confronted to assemble or take apart a piece of equipment.

Rapidity of the manipulation.

OSCE Marking Sheet

Station 12

Date:

Candidate number: | | | | | | | |

Examiner:

Student Cohort:

Task description:
Install the tubing on the ventilator (Dräger Babylog 8000 plus).
Empty the trap of the ventilator and re-assemble it.

Graded using 0 – 5 scale. (0 – very bad, 5 – very good)

Confidence of the student:	0	1	2	3	4	5

0 – The student did not try to install the tubing
1 – The student did not have enough time to complete the task
2 – The student took over 4 minutes to install the tubing
3 – The student took between 3 and 4 minutes to install the tubing system
4 – The student took between 2 and 3 minutes to install the tubing system
5 – The student installed the tubing system in less than 2 minutes

Installing the tubing:	0	1	2	3	4	5

- ☐ Probes (5) installed correctly (1/2 point per probe) (maximum 2 points)
- ☐ Humidifier container connected to the exit of the ventilator (fresh oxygen)
- ☐ Breathing filter between the trap and the humidifier
- ☐ Humidifier tank on the heater

1 point per correct answer unless specified otherwise.

Taking the trap out and putting it back in place:	0	1	2	3	4	5

0 – The student did not recognise the position of the ventilator trap or made a clinical mistake
1 – The student recognised the ventilator trap but could not get it out
2 – The student had difficulties removing or putting back the trap (over 20 seconds)
3 – The student took too much time to empty the ventilator trap (over 10 seconds)
4 – The student performed well (between 5 and 10 seconds)
5 – The student performed well and very rapidly (less than 5 seconds)

Total score	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

Comments:

Station 13

Size and correctly position a blood pressure cuff on a simulated patient's arm.

Time allowed: 5min.

Resources required:

- Examiner:
- Equipment:
    - Blood pressure cuff
    - Laerdal mannequin
    - Patient monitor (Kontron Colormon Plus)

Task description:

Explain in details to the examiner what the blood pressure cuff measures. Position the blood pressure cuff on the mannequin, as you would do it on a real unknown conscious patient suffering from severe spinal injury and having this procedure for the first time.

Points being observed:

Knowledge of the function of a blood pressure cuff
Correct positioning of the blood pressure cuff
Correct use of controls for NIBP measurement
Communication with the "patient"
Did the student take care of not moving the patient?

STATION 13

Correctly position a blood pressure cuff on a simulated patient's arm

Time allowed: 5 minutes

Task description:

- Explain in details to the examiner what a blood pressure cuff measures.
- Position the blood pressure cuff on the mannequin, as you would do it on a real unknown conscious *patient suffering from severe spinal injury* and having this procedure for the first time.
- Use the equipment to take a blood pressure measurement (The instrument will not give a valid reading).

Points being observed:

Role & positioning of a blood pressure cuff.

Communication with the patient.

Use of controls for NIBP measurement.

Use of controls for NIBP measurement.

Time to perform the task.

OSCE Marking Sheet

Station 13

Date:

Candidate number: | | | | | | | |

Examiner:

Student Cohort:

Task description:

Explain in details to the examiner what a blood pressure cuff measures. Position the blood pressure cuff on the mannequin, as you would do it on a real unknown conscious patient suffering from severe spinal injury and having this procedure for the first time.

The blood pressure cuff:	0	1	2	3	4	5

- [ ] - Measure of two pressures (upper & lower) (1)
- [ ] - Name systolic (1)
- [ ] - Name diastolic (1)
- [ ] - Name brachial artery (2)
- [ ] - Pressure exercised by blood on artery wall (1)

Positioning the NIBP cuff:	0	1	2	3	4	5

- [ ] - Correct placement of NIBP cuff (2-3 cm above brachial artery) (2)
- [ ] - Correct use of equipment for inflation of the cuff (1)
- [ ] - NIBP well adjusted (not too loose or too tight) (2)
- [ ] - NIBP wrapped on patient taking into account the injury (1)

Familiarity with the equipment:	0	1	2	3	4	5

The time to wrap the cuff around the patient is part of the timing.

0 – The student was unable to connect the cuff to the control box or to blow up the cuff
1 – The student took over 3 minutes to connect and blow up the cuff
2 – The student took between 2 and 3 minutes to connect and blow up the cuff
3 – The student took between 1 and 2 minutes to connect and blow up the cuff
4 – The student took between 30 and 1 minute to connect and blow up the cuff
5 – The student managed to connect and blow up the cuff in less than 30 seconds

Communication:	0	1	2	3	4	5

0 – The student did not speak at all to the patient & even ignored him
1 – The student did not speak at all to the patient
2 – Minimum effort to communicate was made by the student
3 – Some effort to communicate was made by the student
4 – Real effort to communicate made by the student
5 – The student introduced himself/herself to the patient and explained what he/she was doing

Total score	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

Comments:

Station 14

Reposition patient's bed using controls so that it is now raised by approximately 20 cm and the patient is sitting at 30° from the horizontal.

Time allowed: 5min.

Resources required:

- Examiner:
- Equipment:
    - Laerdal mannequin
    - Electric bed
    - Obstacle: Intravenous infusion (connected to Ivac 572 Variable Pressure volumetric pump).

Task description:

Considering the mannequin as a real unknown conscious patient:

- Raise the bed by approximately 20 cm (~7 inches).
- Position the patient so that he is now sitting at about 30° from the horizontal.
- Reposition the patient in his/her original position.

Points being observed:

Smoothness of the manipulation / Good use of the controls.

Anticipation/observation of effect of the manipulation on the surrounding environment.

Communication with the patient.

Answer:

The students should make sure that the scene is safe for the bed to be repositioned and should notice that the IV line is entangled in the bed head. The student should introduce him/herself and explain the problem to the patient. The drip stand needs to be moved closer to the bed and the bed should be moved to create access on the head side. The head bed end should be temporarily removed to free the IV line. Then the student is able to safely execute the task while keeping the patient informed.

STATION

14

Positioning of an electric bed

Time allowed: 5 minutes

Task description:

Considering the mannequin as a real unknown conscious patient and using the controls:

- Raise the bed by approximately 20 cm (~7 inches).
- Position the patient so that he is now sitting at about 30° from the horizontal.
- Reposition the patient in his/her original position.

Points being observed:

Use of the controls / Smoothness of the manipulation

Communication with the patient

Time to perform the task

OSCE Marking Sheet
Station 14

Date:

Candidate number: | | | | | | | |

Examiner:

Student Cohort:

Task description:

Considering the mannequin as a real unknown conscious patient and using the controls:

- Position the bed so that the patient is now raised by approximately 20 cm (~7 inches) and sitting at 30° from the horizontal.
- Reposition the patient in his/her original position.

Graded using 0 – 5 scale. (0 – very bad, 5 – very good)

Use of the controls:	0	1	2	3	4	5

0 – The student did not use the controls
1 – The student did not understand how to use the controls / panicked
2 – The student did some manipulation mistakes (speech and positioning uncoordinated) but managed to position the bed without disrupting the patient too much
3 –The positioning of the bed was too brutal for the patient
4 – The student used the controls correctly but the positioning was a bit jerky
5 – The student made good use of the controls and the bed was moved smoothly

Positioning of the bed:	0	1	2	3	4	5

- ☐ The student started by removing the obstacle (2 points)
- ☐ The bed didn't stretch the IV line over the time of the manipulation (2 points)
- ☐ The patient's bed was positioned correctly (up by 20 cm and sitting at 30°)
- ☐ The bed was raised by 20 cm
- ☐ The patient was sat at approximately 30°
- ☐ The bed was repositioned in the initial position
- ☐ The manipulation took less than 1 minute
- ☐ The students removed the bed's end to clear the drip out of the way

1 point per correct answer unless specified otherwise.

Communication:	0	1	2	3	4	5

0 – The student did not speak at all to the patient & even ignored him
1 – The student spoke to the patient but did not warn him before manipulating the bed
2 – Minimum effort to communicate was made by the student (1 warning only when moving the bed)
3 – Some effort to communicate was made by the student (2 warnings for positioning of bed)
4 – Real effort to communicate made by the student (3 warnings: bed up, down, & sitting)
5 – The student introduced himself/herself to the patient and explained what he/she was doing

Total score	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

Comments:

Station 15

List signs of a cardiac arrest.

Time allowed: 5min.

Resources required:

- Equipment:
    - Pen & Paper

Task description:

List the signs that could indicate that a patient has had a cardiac arrest (Give at least eight possible signs).

Points being observed:

Theoretical knowledge of cardiac arrest signs.
Number of points mentioned corresponding to the well established list of signs.

STATION 15

List signs of a cardiac arrest.

Time allowed: 5 minutes

Task description:

List the signs that could indicate that a patient **has had** a cardiac arrest (Give as least eight possible signs).

Points being observed:

Theoretical knowledge of cardiac arrest signs.

OSCE Answer Sheet

Station 15

Date:

Candidate number: | | | | | | | |

Student Cohort:

Task description:

List the signs that could indicate that a patient has had a cardiac arrest.

(Give as least eight possible signs)

OSCE Marking Sheet

Station 15

Date:

Candidate number: | | | | | | | |

Examiner:

Student Cohort:

Task description:

List the signs that could indicate that a patient has had a cardiac arrest.
(Give as least eight possible signs)

- [ ] Absence of the major pulse
- [ ] Absent respiration after a short while / Gasping
- [ ] Loss of consciousness / Unresponsive (2)
- [ ] Skin pale or grey
- [ ] Blue lips / cyanosis
- [ ] Loss of urine at initial phase / Muscle relax
- [ ] Dilated pupils
- [ ] Collapsed person that may rapidly become unconscious
- [ ] Loss of measurable BP
- [ ] Skin becoming cold
- [ ] ECG reading

1 point per correct answer unless otherwise specified.

Total score	0	1	2	3	4	5	6	7	8	9	10

Comments:

Appendix III

Confidence Questionnaire

Using Technology in nurse practice

Please take your time to complete the following questionnaire as honestly as you can. You are not required to put your name on the questionnaire but please ensure that your anonymity number is written correctly. This questionnaire is not intended to judge your competence but simply to assess how comfortable you feel dealing with different aspects of technology in healthcare settings.

If you have any question concerning the study, please fill free to contact the researcher using the contact details given at the end of the questionnaire.

1) Sex? Male ☐ Female ☐

2) Age? ... years old.

3) Personal identification number? ☐☐☐☐☐☐☐
Please, contact me if you are not sure.

4) Did you have any healthcare practice experience prior to your enrolment to the nursing course?
Yes ☐ No ☐

If yes, how long? ... years, ... months .

And in what capacity? (i.e. Healthcare Assistant, home help, etc)
.....

5) In which speciality are you currently doing your placement?
.....
.....

6) Have you ever attended a simulation course in HICESC?
Yes ☐ No ☐

7) How confident do you feel working in a “high-tech” environment?
(Please tick the appropriate box)

Very confident ☐ ☐ ☐ ☐ ☐ Not confident at all

8) How stressful do you find it working in a technological environment?

Very stressful ☐ ☐ ☐ ☐ ☐ Not stressful at all

9) Other comments:
.....
.....
.....

Once completed, please return the questionnaire in the large envelope placed near your cohort notice board or send it to:
*Mr Guillaume Alinier (*G.Alinier@herts.ac.uk)
Dept. of Nursing & Paramedic Sciences. University of Hertfordshire. Hatfield Campus, College lane Hatfield, Herts. AL10 9AB

If you have any questions, do not hesitate to contact me on: 01707 286395
Thank you for your participation.

Appendix IV

Simulation Scenarios and Trends

Samples of simulation Scenarios:

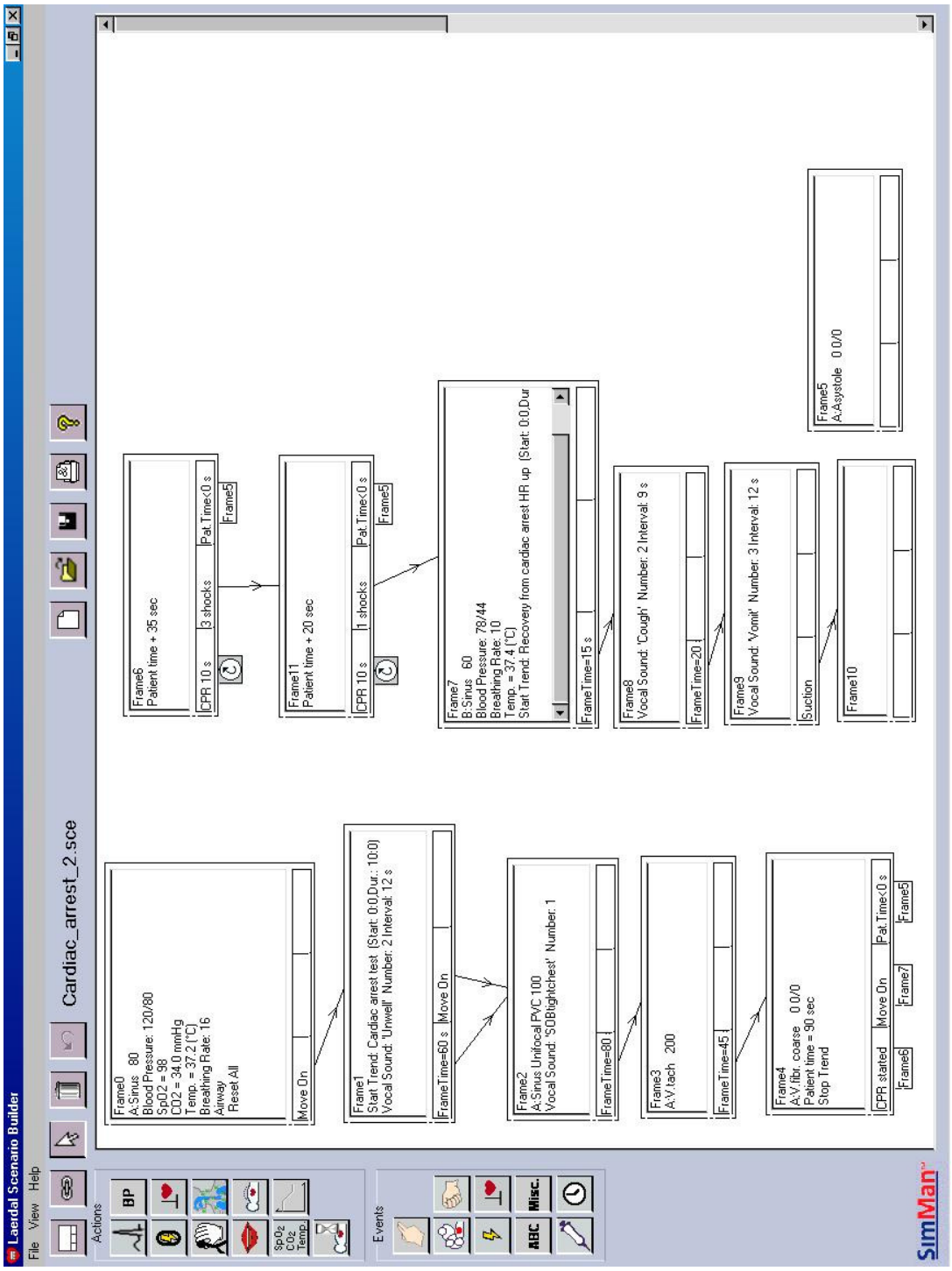
The following two scenarios are a sample of the scenarios that were developed for the simulation training sessions. Another set of two similar scenarios were programmed and used so that students did not get used to them and hence anticipate the critical incident to which they had to respond. Those other scenarios presented patients with a different history, name and initial conditions.

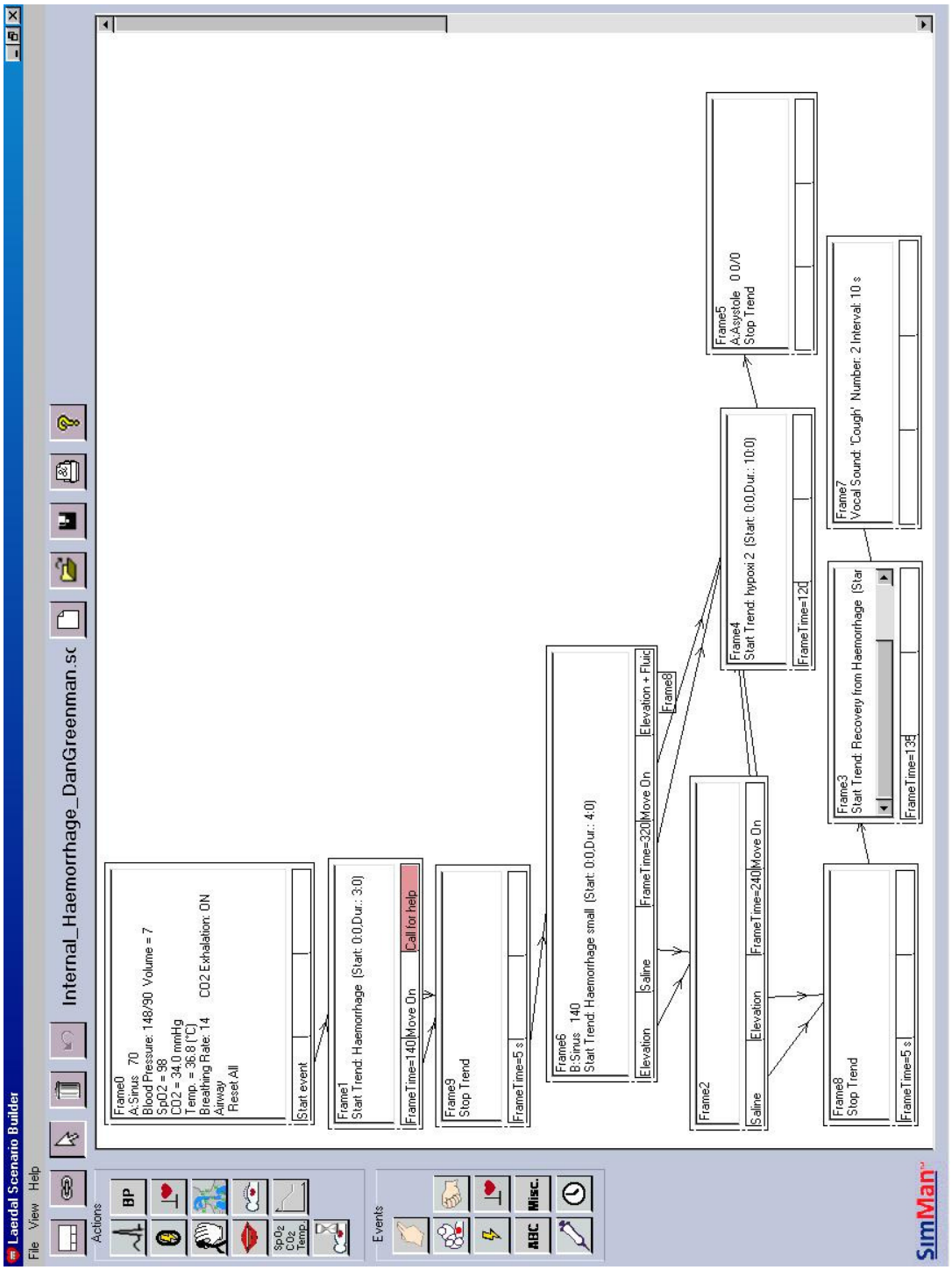
Scenario 1:

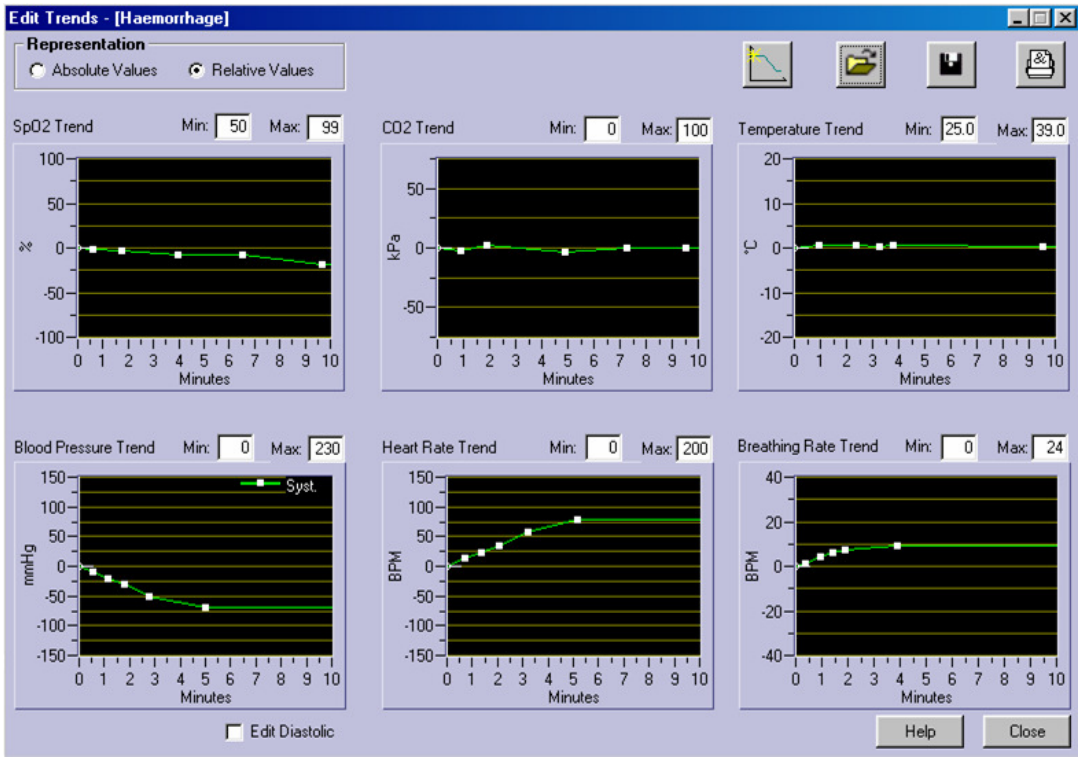
Patient in his late 60s. Cardiac history, he has been hospitalised for a few weeks. He seems in a stable condition and is expecting cardiac surgery on the following day. As he is being treated for catheter care by two nurses he goes in cardiac arrest.

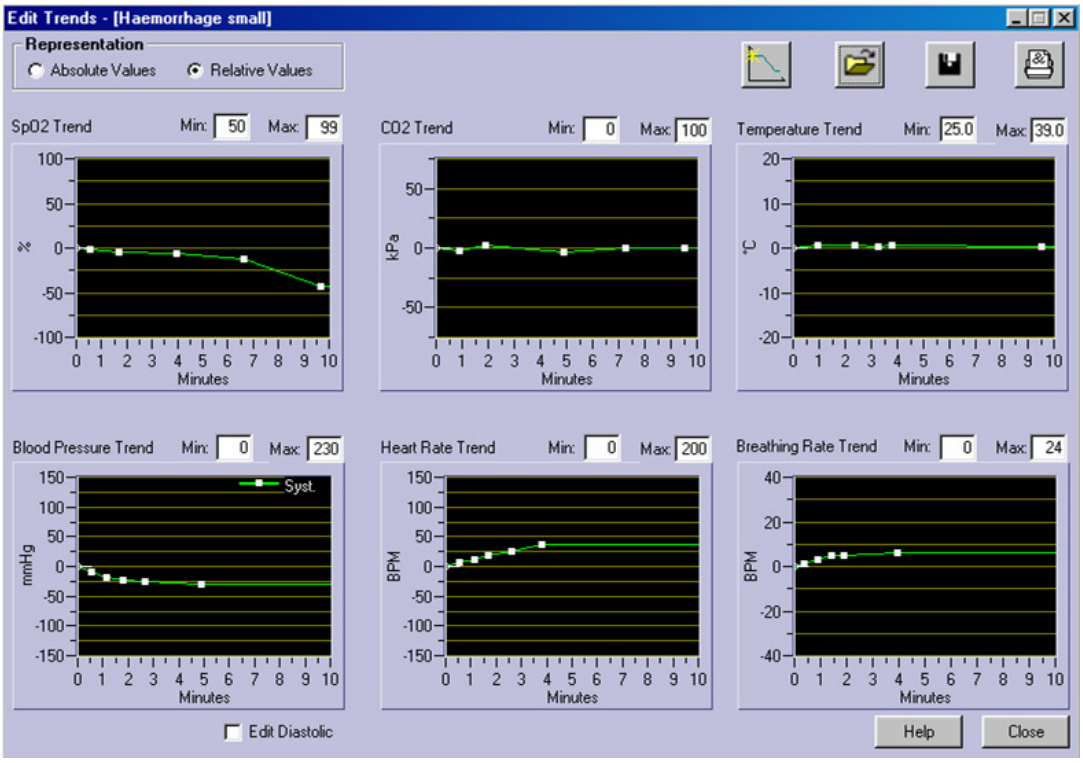
Scenario 2:

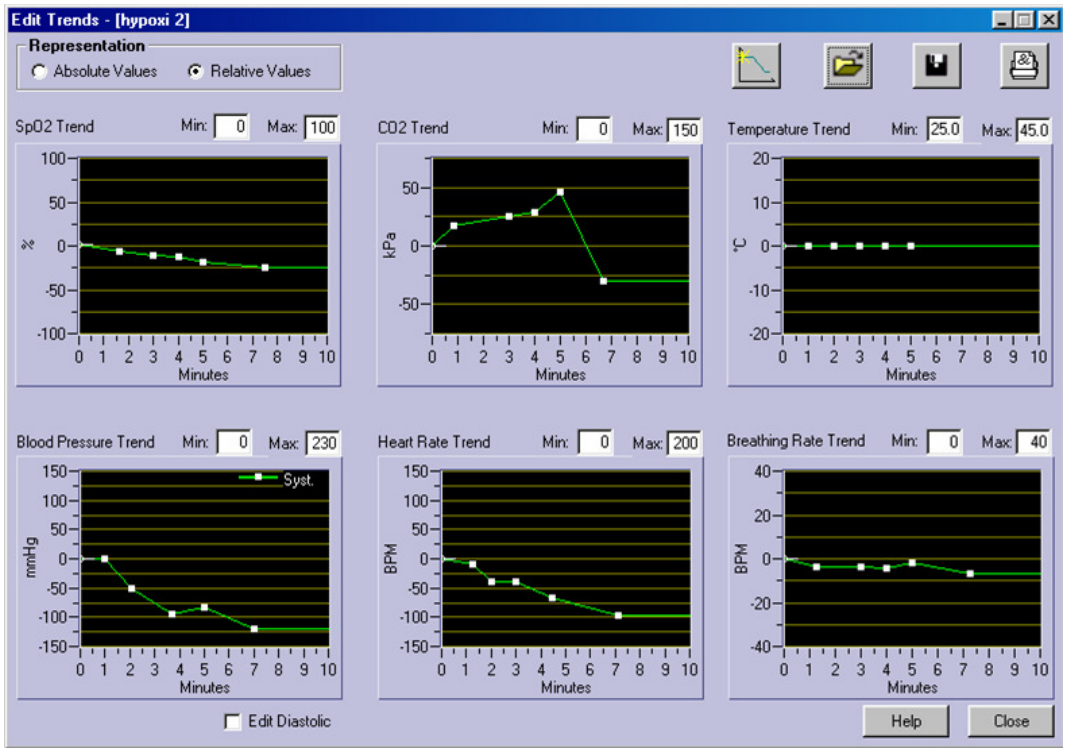
48 y/o, male patient, postoperative with leaking aneurysm. He is just waking up and starts to complain that he feels cold. Nurses are taking his vital signs as his condition deteriorates. He is having an internal haemorrhage and needs fluid resuscitation and to be sent to theatre again.

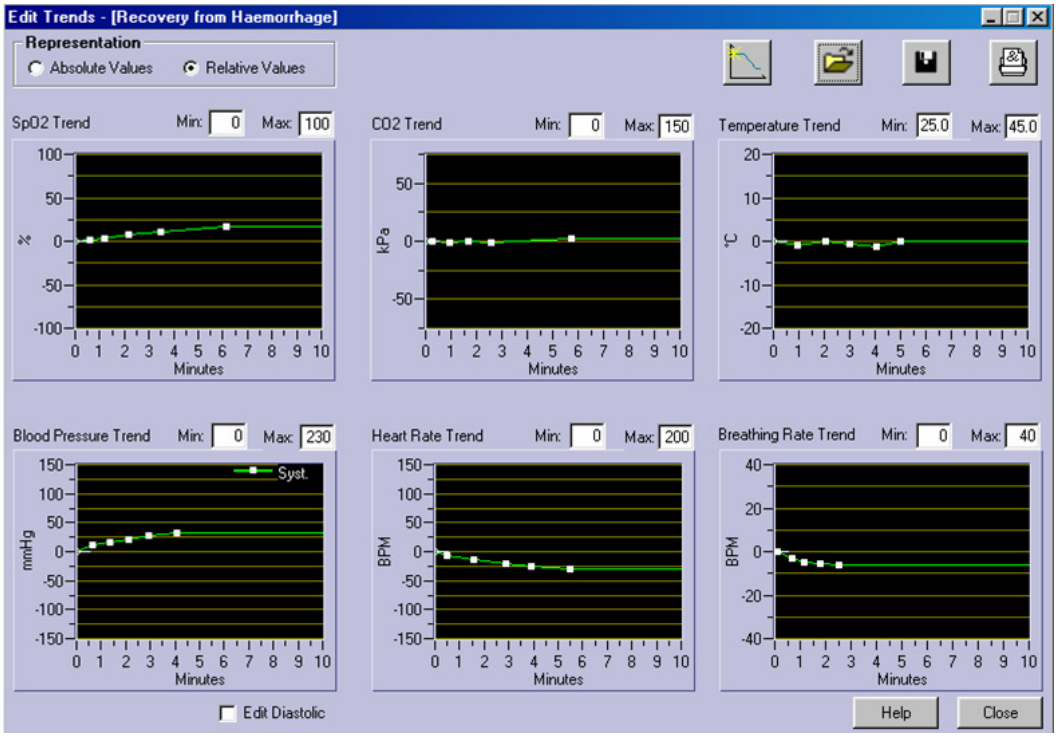

Laerdal Scenario Builder
File View Help
Actions
BP
SpO2
CO2
Temp
Events
ABC
Misc.
Cardiac_arrest_2.sce
Frame0
A:Sinus 80
Blood Pressure: 120/80
SpO2 = 98
CO2 = 34.0 mmHg
Temp. = 37.2 [°C]
Breathing Rate: 16
Airway
Reset All
Move On
Frame1
Start Trend: Cardiac arrest test (Start: 0:0,Dur.: 10:0)
Vocal Sound: 'Unwell' Number: 2 Interval: 12 s
FrameTime=60 s
Move On
Frame2
A:Sinus Unifocal PVC 100
Vocal Sound: 'SOBtightchest' Number: 1
FrameTime=80
Frame3
A:V.tach 200
FrameTime=45
Frame4
A:V.fibr. coarse 0 0/0
Patient time = 90 sec
Stop Trend
CPR started
Move On
Pat.Time<0 s
Frame6
Patient time + 35 sec
CPR 10 s
3 shocks
Pat.Time<0 s
Frame5
Frame11
Patient time + 20 sec
CPR 10 s
1 shocks
Pat.Time<0 s
Frame5
Frame7
B:Sinus 60
Blood Pressure: 78/44
Breathing Rate: 10
Temp. = 37.4 [°C]
Start Trend: Recovery from cardiac arrest HR up (Start: 0:0,Dur
FrameTime=15 s
Frame8
Vocal Sound: 'Cough' Number: 2 Interval: 9 s
FrameTime=20
Frame9
Vocal Sound: 'Vomit' Number: 3 Interval: 12 s
Suction
Frame10
Frame5
A:Asystole 0 0/0
SimMan


Laerdal Scenario Builder
File View Help
Internal_Haemorrhage_DanGreenman.sc
Actions
BP
SpO2
CO2
Temp
Events
ABC
Misc.
Frame0
A:Sinus 70
Blood Pressure: 148/90 Volume = 7
SpO2 = 98
CO2 = 34.0 mmHg
Temp = 36.8 (°C)
Breathing Rate: 14 CO2 Exhalation: ON
Airway
Reset All
Start event
Frame1
Start Trend: Haemorrhage (Start: 0:0,Dur.: 3:0)
FrameTime=140 Move On Call for help
Frame3
Stop Trend
FrameTime=5 s
Frame6
B:Sinus 140
Start Trend: Haemorrhage small (Start: 0:0,Dur.: 4:0)
Elevation Saline FrameTime=320 Move On Elevation + Fluid
Frame8
Frame2
Saline Elevation FrameTime=240 Move On
Frame8
Stop Trend
FrameTime=5 s
Frame3
Start Trend: Recovery from Haemorrhage (Star
FrameTime=135
Frame7
Vocal Sound: 'Cough' Number: 2 Interval: 10 s
Frame4
Start Trend: hypoxi 2 (Start: 0:0,Dur.: 10:0)
FrameTime=120
Frame5
A:Asystole 0 0/0
Stop Trend
SimMan


Edit Trends - [Haemorrhage]
Representation
Absolute Values
Relative Values
SpO2 Trend
Min: 50
Max: 99
%
CO2 Trend
Min: 0
Max: 100
kPa
Temperature Trend
Min: 25.0
Max: 39.0
°C
Blood Pressure Trend
Min: 0
Max: 230
Syst.
mmHg
Heart Rate Trend
Min: 0
Max: 200
BPM
Breathing Rate Trend
Min: 0
Max: 24
BPM
Minutes
Edit Diastolic
Help
Close


Edit Trends - [Haemorrhage small]
Representation
Absolute Values
Relative Values
SpO2 Trend
Min: 50
Max: 99
%
CO2 Trend
Min: 0
Max: 100
kPa
Temperature Trend
Min: 25.0
Max: 39.0
°C
Blood Pressure Trend
Min: 0
Max: 230
Syst.
mmHg
Heart Rate Trend
Min: 0
Max: 200
BPM
Breathing Rate Trend
Min: 0
Max: 24
BPM
Minutes
Edit Diastolic
Help
Close


Edit Trends - [hypoxi 2]
Representation
Absolute Values
Relative Values
SpO2 Trend
Min: 0
Max: 100
CO2 Trend
Min: 0
Max: 150
Temperature Trend
Min: 25.0
Max: 45.0
Blood Pressure Trend
Min: 0
Max: 230
Syst.
Heart Rate Trend
Min: 0
Max: 200
Breathing Rate Trend
Min: 0
Max: 40
Minutes
%
kPa
°C
mmHg
BPM
Edit Diastolic
Help
Close


Edit Trends - [Recovery from Haemorrhage]
Representation
Absolute Values
Relative Values
SpO2 Trend
Min: 0
Max: 100
CO2 Trend
Min: 0
Max: 150
Temperature Trend
Min: 25.0
Max: 45.0
Blood Pressure Trend
Min: 0
Max: 230
Syst.
Heart Rate Trend
Min: 0
Max: 200
Breathing Rate Trend
Min: 0
Max: 40
Minutes
%
kPa
°C
mmHg
BPM
Edit Diastolic
Help
Close

Appendix V

Students' Comments

Students were given the opportunity to write their opinion on a logbook after the simulation training in HICESC (Hertfordshire Intensive care & Emergency Simulation Centre) and the Objective Structured Clinical Examination (OSCE) session they attended.

Those comments have been compiled in the following pages. For anonymity purposes, the students' names were replaced by their initials when they revealed their identity. Similar comments could have been collected from the academics who were and are still involved with the supervision or delivery of the different sessions.

Those encouraging comments demonstrate that students felt that such sessions should be incorporated in their nursing course to help them become familiar with the different pieces of equipment present in HICESC before they have to use them in hospital wards on real patients. The comments collected also reveal that those sessions enabled students to determine their weaknesses and areas on which they should concentrate more efforts to improve their skills or knowledge.

SIMULATION SESSION FEEDBACK

L S (Sept. 99)
I found the session very helpful. More practice sessions would be beneficial to nursing practice.

H T (Sept. 99)
The session is well organised and was very helpful in understanding and prioritising nursing interventions in critical situations.

J B (Sept. 99)
Excellent session, could this not please be incorporated into standard training. Invaluable opportunity to work scenario, especially as there is no harm to 'patient'.

D C (Sept. 99)
This session was of great benefit, very interesting and informative, it was a valuable opportunity. I feel this should be made part of the nursing course.

C P (Sept.99)
Extremely valuable session. Unfortunately I was alone for this occasion but this emphasised to me how important sound knowledge of patient conditions and monitors/equipment are. This type of lesson would benefit all student nurses – if only to teach us not to panic, work as a team and call for help when necessary!

C W (Sept.99)
Once we started the simulation I realised the significance of being able to resuscitate patients as a nurse. Also how important it is to understand how all the monitoring equipment works and the necessity to work as a team. This was a very beneficial session, and one that I would like to expand on. It would be very valuable to have a session like this during Branch.

J P (Sept.99)
Thoroughly enjoyable and beneficial session. It really emphasised our knowledge and skills and highlighted areas that we are not so confident. Nurse education should have more of this type of training as it is a practical profession and team building and acting in emergency situations are essential skills.

C S (Sept.99)
A very valuable session. It consolidates some of the theory to a practical session. The mannequin is excellent. We should have more of these training sessions.

S W (Sept.99)
An excellent session. More of this type of session would be very helpful as it familiarises you with equipment and the scenario gives you a feel of the real thing.

T W (Sept.99)
An excellent session, more sessions with other equipment that is in this lab would be extremely helpful as it is these skills that I feel are lacking.

OBJECTIVE STRUCTURED CLINICAL EXAMINATION FEEDBACK

J B (Sept.99)
Most useful session. Should be incorporated in curriculum. Ward has many monitors that we have never met before and to have more insight would make student life easier and productive.

D C (Sept.99)
Another valuable session, felt I gained a great deal out of this session. These sessions develop confidence and many skills, again this should be included in the nursing course for future students. Thank you.

J P (Sept.99)
Very informative session. Very frightening that we know so little about monitors/pumps etc and we are nearly third year students. Found some stations quite stressful mainly monitors as I did not feel comfortable.

S W (Sept.99)
Extremely useful session although worrying as it made one very aware of how little I know.

T W (Sept.99)
Very good, gained confidence.

C W (Sept.99)
Very useful but quite pressurised. It felt like an exam. However, very well organised and I've taken many important facts away with me. Thank you.

C P (Sept.99)
Most useful – definitely should be incorporated into our curriculum. Shows just how much we should know, but in some cases what we don't. Thanks.

K G (Sept.99)
Very enjoyable. Feel that these tasks should be included in our training as on the wards we don't often get the chance, therefore I find that I lack confidence in dealing with this sort of machinery. However I feel that I have learnt something in the short time spent. Thank you.

N T (Sept.99)
It would really help us to have more hands-on practice with these monitors. If it were part of the timetable there would perhaps also be time to discuss problems and where we are going wrong when using them. It has highlighted what I don't know but also given me confidence that I have leant something. Because of lack of numbers attending it makes you feel a bit pressurised but well worth doing.

D M (Sept.99)
I found the session very useful and I learnt a lot during the session. I found the monitors daunting but other equipment like the ventilator straight forward. This training session should be made part of the timetable as students would gain confidence and would learn from. I am sure students would welcome these sessions. The session was very well organised.

D D (Sept.99)
Wonderful opportunity to experience things such as infusion pumps. Should be part of the curriculum. Helped to identify areas were I need more information and need to improve skills.

Appendix VI

SimMan's Features

Airway features:

- Realistic life-size intubation head.
- Bronchial tree anatomically accurate in size, colour and texture. Features the accurate anatomical landmarks necessary to facilitate realistic fibre-optic bronchoscopy.
- Standard ALS airway skills:
  - Bag/Valve Mask ventilation
  - Oropharyngeal and nasopharyngeal airway placement
  - Endotracheal tube intubation. Fibre-optic, light wand and retrograde intubation
  - Combitube, LMA placement
  - Trans-tracheal jet ventilation
  - Needle and surgical cricothyrotomy
- Spontaneous respiration with variable respiratory rate, auscultation of breathe sounds and CO2 detection.
- Airway complications: Pharyngeal obstruction, tongue oedema, trismus, laryngospasm, decreased cervical range of motion, decreased lung compliance, stomach distension, pneumothorax decompression. Cannot-Intubate-Can-Ventilate or Cannot-Intubate-Cannot-Ventilate conditions.

Cardiac functions:

- ECG library of over 2,500 cardiac rhythms.
- Defibrillation by Automated External Defibrillators (AED) or manual defibrillators
- 3 or 4 lead ECG monitoring.
- External pacing - with variable pacing threshold

CPR:

- Ventilation.
- Chest compression.
- ECG and heart rate can be displayed on monitor.

Pulses:

- Synchronized with ECG or compressions.
- Pulse strength dependent on BP selected and anatomical position.
- Bilateral carotid, brachial, radial and femoral pulses

Blood Pressure:

- Palpated, auscultated, or automatic.
- Blood pressure arm (left) with Korotkoff sounds synchronized with pulse.

Circulatory skills and IV drug administration:

- Articulating right IV training arm with replaceable skin and veins
- IV insertion into peripheral veins of forearm, antecubital fossa and the dorsum of the hand
- Sites for subcutaneous and intramuscular injections

Sounds:

- Heart sounds synchronized with ECG
- Left and right lung sounds, bowel sounds
- Vocal sounds and simulation of patient voice
- Volume adjustment

Genitalia for urinary catheterisation:

- Genitalia for urinary catheterisation procedures.

Software control:

- Mouse and / or remote control
- Software controls all airway management, cardiac functions, CPR, pulse, blood pressure and sounds.
- Each of the airway management functions may be controlled individually or set as a group.

Event log:

- Automatic log system with stopwatch function. Event Log can be saved or printed.

Easy to use scenario and trend tools:

- Standard validated scenarios included
- Design and save your own scenarios.

Simulated patient monitor:

- Displays ECG, BP, SpO2, ETCO2, arterial waveform, respiratory rate, heart rate and temperature readings
- SpO2 sound, variable pitch according to saturation

Air supply available by two alternatives:

- 1) Air compressor (catalogue No. 38 12 00 for 230 Volt or 38 12 10 for 110 Volt) or
- 2) Regulator unit (catalogue No. 38 12 20) allowing connection to wall air supply or pressurised air canister.

Easy to use:

- Does not require a technician and acting participant

Portable:

- Easy storage and transportation.

OPTIONAL FEATURES AVAILABLE FOR MANNEQUIN:

- Trauma modules - A set of trauma modules designed to interchange with the non-traumatic modules for added realism in emergency trauma management.
- Portability kit, allowing for use in field
- Hard-shell carrying cases

PC is not included!
Air compressor is optional!

This summary can be fund on the following URL:
http://www.laerdal.com/simman/simman.htm
(visited on the 01/10/01)

Appendix VII

Early Evaluation of SimMan

Questionnaire

Evaluation of SimMan: Universal Patient Simulator

We would be very interested in knowing your personal opinion concerning SimMan. Your feedback is of interest to us as well as to the manufacturer. Please take your time to complete the following questions as honestly as you can.

1) **Was this month the first time you have had a chance of practising your skills using SimMan?** Yes ☐ No ☐

If not, when, where and for how long have you already used it before?

Date: ..... Place: ..... I Used SimMan for ... hours.

2) How realistic did you find the mannequin?

Very realistic ☐ ☐ ☐ ☐ ☐ Totally inaccurate

3) **Would you like to have more opportunities to practice your skills using SimMan?** Yes ☐ No ☐

4) How would you rate your experience with SimMan?

Very good ☐ ☐ ☐ ☐ ☐ Very bad

5) In question 4, which fact(s) made you give this rating concerning your experience with SimMan?

.....

.....

6) How does SimMan compare with the basic mannequins that you normally use for repeating protocols?

SimMan was really good ☐ ☐ ☐ ☐ ☐ SimMan was inappropriate

7) Do you prefer "high-tech" (Laerdal SimMan) or "low-tech" simulation (Laerdal ALS Skillmaster mannequin)?

☐ "high-tech" simulation.

☐ "low-tech" simulation.

8) What could have improved your experience of using SimMan? (More realistic environment, equipment used, scenario information…)

……
……
……

9) What would you change on SimMan to make it a better training tool?

……
……
……
…….

10) Other comments:

……
……

Thank you for your cooperation. *Once completed, please return the questionnaire to my pigeonhole in Hillside House:*

Guillaume Alinier, Dept. of Nursing & Paramedic Sciences, University of Hertfordshire, Hatfield Campus.

Ethical Approval from the Faculty of Engineering & Information Sciences.

Feedback collected

1) Was this month the first time you have had a chance of practicing your skills using SimMan?

Yes	11	100.00%
No	0	0.00%
Total	11	100.00%

2) How realistic did you find the mannequin?

Very realistic

1	**2**	**3**	**4**	**5**
1	8	2	0	0
9.09%	72.73%	18.18%	0.00%	0.00%

Totally inaccurate

3) Would you like to have more opportunities to practice your skills using SimMan?

Yes	11	100.00%
No	0	0.00%
Total	11	100.00%

4) How would you rate your experience with SimMan?

Very good

1	**2**	**3**	**4**	**5**
2	4	5	0	0
18.18%	36.36%	45.45%	0.00%	0.00%

Very bad

5) In question 4, which fact(s) made you give this rating concerning your experience with SimMan?

Pros:

- Versatility of scenarios, good range of identifiable simulated clinical signs (breath sounds, palpable BP, ECG's).
- Students respond to signs as they occur rather than when the trainer tells what is happening.
- Interaction with treatment, dynamic response, realism of the conditions, signs and symptoms.
- Better for assessment skills as well as practical skills.
- Realistic pulse, breathing, useful for practising ABC assessments as well as scenarios.

Cons:

- Chest with electrodes sites made it less realistic, and difficult to attach defibrillator.
- Unfamiliar technology (Not used to "breathing dummies", unsure of treatment it could accept).
- Carotid BP not always present.

6) How does SimMan compare with the basic mannequins that you normally use for repeating protocols?

Really good

1	**2**	**3**	**4**	**5**
3	8	0	0	0
27.27%	72.73%	0.00%	0.00%	0.00%

Inappropriate

7) Do you prefer "high-tech" (SimMan) or "low-tech" simulation (ALS skillmaster mannequin)?

"high-tech" simulation	10	90.91%
"low-tech" simulation	1	9.09%
Total	11	100.00%

8) What could have improved your experience of using SimMan? (More realistic environment, equipment used, scenario information…)

- More realistic surroundings/environment (it gives clues to what may have happened).
- Have a session to be more familiar with the mannequin.
- Have the mannequin fully clothed t make it look more realistic.
- More programmed scenarios appropriate to pre-hospital care.

9) What would you change on SimMan to make it a better training tool?

- More powerful speakers in the mannequin' s head so that it sounds more realistic.
- Needs to be more durable.
- Ability to cannulate both arms.
- Change of skin colour to reflect what the appearance would really be like given the clinical findings.
- BP sounds not always easy to hear.
- More pre-hospital scenarios included in the software package.
- SimMan requiring to be linked to a computer prevents us to move it too much.

10) Other comments:

- More exposure to SimMan and associated facilities would have been most helpful.
- Low-tech simulation is still very useful in the initial learning phase and I think the benefits of SimMan are more appreciable when you are confident of practical and assessment skills.
- As this was so "high-tech" I was afraid to "break it" and was unsure of its capabilities and whether I had to ask the operator about certain symptoms or not.
- Good. Enjoyed playing on SimMan but needed more time.
- Obviously any piece of equipment that attempts to improve patient management, especially in a life-threatening scenario is of utmost importance. SimMan goes some way to sharpening assessment and evaluation skills. Its use would be beneficial throughout training in conjunction with assessment and management using the traditional mannequins.
- Good idea, just needs to be more realistic in the noises it makes, maybe louder and with more believable surroundings so you are not relying on imagination skills.
- Seemed a useful and promising tool to practice clinical protocols but need more than 20 minutes use to evaluate it properly.

Appendix VIII

Example of Multiprofessional, Multidisciplinary Scenario

Harry Bloggs – Cystic fibrosis

Participants:	- 2 Paramedics, 2 Physiotherapists, 2 Nurses (child), 2 Mental Health Nurses.
Patient:	- Harry Bloggs (D.o.B: 3 months ago)
Actors:	- Mother: Karen past history of post-natal depression. Paediatrician
Environment (s):	- Community Room then Paed A&E
Clinical overview:	- Child with Cystic fibrosis and chest infection
Technical aspect:	- SimBaby in his cot in the community room with cabling ready in Pead A&E to reconnect SimBaby.

Scenario learning points and for discussion during debriefing:

- Decision making
- Calling for help
- Airway management
- Cystic fibrosis
- Post-natal depression
- Teamwork
- Communication (SBAR)
- Leadership
- Keeping the situation under control
- Paediatric BLS/ALS

REFERRAL LETTER:

Dr Jones,
The Surgery,
Common Place Square.
Freds Town,
AB12 3CD

Dear Physiotherapist,

Re Name Harry BLOGGS
DOB 15/08/08
Δ Cystic Fibrosis
PC recent discharge from hospital

I would be very grateful if you could assess this infant to review his physiotherapy routine at home. He was admitted to hospital at 6 weeks old with a chest infection and failure to thrive; he was subsequently diagnosed with cystic fibrosis. I saw him and his mother in the surgery this morning and I am concerned that she is not coping at home. His mother has a history of post natal depression with her previous pregnancies and she is complaining that she is finding it impossible to fit in his physiotherapy treatment into his daily routine. I have asked the community mental health nurse to assess Mrs Bloggs in view of her history.

Thank you.

Yours sincerely,

Dr Jones

Participants		Instructor/controller	Background/Scene	Other students
Harry is a 3-month old male baby born with Cystic Fibrosis, recently discharged from local hospital. He is being visited at home by physiotherapists for discharge follow up. He weighs 4kg. His mother, Karen, visited GP last week because of her post-natal depression.				
Physiotherapists on home visit to assess the child. Expected action: Assessment and call for an ambulance on 3005 and reassure mother.	Community room	Inspiratory stridor. Barking cough RR 50, SpO_2 97 ↘ HR 180 BP 84/39 Temp 38.50 C (tympanic) Harry has a harsh cry, hoarseness.	Phone with sticker 3005 to call ambulance and 8005 for hospital A&E. Harry is in his cot, he is irritable and restless. Karen is at the bedside and gives a history of a runny nose, cough and congestion for 3 days. She is not motivated to care for Harry and finds it more and more difficult to cope with his condition.	- 2 paramedics checking their bags with hands free telephone (3005). - 2 mental health nurses + 2 children nurses in PC lab (Used as waiting room). - All other students in observation room
Paramedics arrive at home. Expected action: Preparation of equipment. Handover communication with physiotherapists. Patient assessment.		RR 60 SpO_2 94 Subcoastal recession (Medium) HR 200 BP 78/32	Harry deteriorates over 4 minutes. IV access is not possible. Mother is anxious and restless, pacing up and down.	- 2 children nurses dispatched to Paed A&E without info yet No change for other students
Expected actions: Paramedics give oxygen, obtain IV access and call hospital A&E on 8005 so nurses can prepare themselves.		RR 60↘ SpO_2 88 Subcoastal recession (Deep) HR 220↘ BP 70/30 On O_2: Reduced stridor	Mother asks questions about condition of Harry and what is being done. She becomes upset tearful and agitated. Harry progressively	

		and chest recession.	becomes quieter and slower to respond.	
Paramedics transport patient to A&E via reception.		SimBaby now disconnected to be reconnected in PITU		- 2 physiotherapists go to observation room
Paramedics arrive in A&E. Expected actions: Handover communication with children nurses who request for mental health nurses and Doctor to come and help. Perform initial assessment, monitor and record of information.	PITU	RR ↘24 SpO_2 80 on O_2 HR ↘85 BP 60/30	Harry is now drowsy. Capillary refill is 4s IV access is not possible. The mother is now demanding, shouting, wailing, aggressive, and is unpredictable. Erratic, irrational, and violent.	- 2 mental health nurses sent to look after mum. - Waiting room now empty
Doctor examines and recognises respiratory arrest.		RR 0 SpO_2 78↘ HR 200 VT BP 55/30	Karen wants to stay in the same room as Harry and cries.	- 2 paramedics go to observation room
Children nurses requested to perform BLS. Mental health nurses calm mother.		RR 0 HR 220 VT B/P 0	Harry arrests.	
Team initiates ALS. Defibrillation at 4j/kg or AED.		If adequate: RR 40 SpO_2 94 HR 160 BP84/39	Karen accepts to leave the room and calms down.	
Doctor asks children nurses to transfer Harry to Paed ICU and inform mother.		RR 40 SpO_2 98 HR 120 BP 85/50	Harry is fine but very weak.	

Appendix IX

Discipline Knowledge Questionnaire

Programme of study & Cohort:_____. Discipline:_____

Gender? Male / Female Age:_____

Questionnaire filled in **before** / **after** taking part in the scenario-based simulation training.

1=Strongly disagree 5=Strongly agree

1. I am confident when working as part of a multidisciplinary team …….. 1 2 3 4 5
2. Working as part of a multidisciplinary team would make me feel anxious 1 2 3 4 5
3. I feel I know what other professionals can and cannot do …….. 1 2 3 4 5
4. Learning with other health-care students before qualification improves relationships after qualification …… 1 2 3 4 5
5. Interprofessional learning before qualification helps me become a better team worker …… 1 2 3 4 5

Knowledge of other professions:

6. Intravenous cannulation can be undertaken by all registered adult nurses ……. True/False
7. Adult nurses may hold the cassette while an X-ray is taken …… True/False
8. Adult nurses are responsible for prioritising care of patients in the A&E True/False
9. All adult nurses can prescribe a limited range of drugs …… True/False
10. Radiographers are trained in Basic Life Support (CPR) …… True/False
11. Radiographers may hold the cassette while the X-ray is taken …… True/False
12. Radiographers only work in the imaging/X-ray department …… True/False
13. All radiographers are able to request X-rays …… True/False
14. Mental health nurses are regularly trained in Basic Life Support (CPR) True/False
15. A&E departments employ mental health nurses …… True/False
16. Mental health nurses can administer oral medication …… True/False
17. Mental health nurses provide support for patients as well as for staff …. True/False
18. Physiotherapists may treat patients with acute respiratory problems ..... True/False
19. Physiotherapists are trained in Basic Life Support (CPR) …… True/False
20. Physiotherapists may treat patients in their home …… True/False
21. Interpretation of X-rays is within physiotherapists' scope of practice …. True/False

22. Learning disability nurses deal with both adults and children …….…….. True/False
23. Learning disability nurses are trained in Basic Life Support (CPR) ……..… True/False
24. Learning disability nurses can assess the physical status of their clients True/False
25. Learning disability nurses can administer oral medication ..…… True/False

26. Radiotherapists are only specialised in treating patients with tumours ... True/False
27. Radiotherapists are trained in Basic Life Support (CPR) ……..…….. True/False
28. Radiotherapists may treat patients on the ward ……..…….. True/False
29. Radiotherapists may diagnose illness and disease …….…….. True/False

30. Administration of drugs is within paramedics' scope of practice ……. True/False
31. Paramedics' priority is the rapid transportation of patients to hospital … True/False
32. Paramedics will not intervene for an incident on the premises of a hospital ……..... True/False
33. Paramedics are able to perform IV cannulation ..……..……..……..… True/False

34. Pharmacists are bound by a code of ethics ……..…… True/False
35. All pharmacists are able to prescribe drugs ……..……..…… True/False
36. Pharmacists are trained in Basic Life Support (CPR) ……..……..…… True/False
37. All pharmacists are now trained to perform basic physical assessment True/False

38. Midwifes routinely carry out post-birth home visits ……..…… True/False
39. Midwifes sometimes work in the A&E department ……..…… True/False
40. Midwifes are trained in Basic Life Support (CPR) ……..……..…… True/False
41. All midwifes can perform suturing of the perineum ……..……..…..… True/False

42. Children's nurses may hold the cassette while an X-ray is taken ….….. True/False
43. Children's nurses can care for patients up to 18 years old ……..…… True/False
44. Intravenous cannulation can be undertaken by all registered children's nurses …… True/False
45. Children's nurses can give consent for a child to have an operation …… True/False

Appendix X

Briefing Letter for the Multiprofessional, Multidisciplinary Simulation Sessions and consent form

Interprofessional Simulation Session

Dear Student,

As a final year health professional student, we are offering you the opportunity to experience a simulation learning session conducted in the Hertfordshire Intensive Care & Emergency Simulation Centre (HICESC F409-F430). ***Please take time to read the following information carefully***. Contact Guillaume Alinier if there is anything that is not clear or if you would like more information.

Why have I been invited to participate?

HICESC realistically simulates several clinical and community settings. It is an ideal place for healthcare students to learn and apply their skills and knowledge in a safe environment. Over the last few years the centre has established itself as an internationally recognised centre of excellence. We are offering you this special training opportunity because previous students' evaluations have been extremely positive and we have strong evidence that they both enjoyed and learned effectively from their experience. We also want you to have the opportunity to use our state of the art simulation facilities before you qualify. We hope that through your participation in this project we will find out more about the usefulness of simulation for learning and about working together in multidisciplinary healthcare teams. These results will help plan future IPE curricula.

What is the purpose of the session?

This session is part of a project aiming to develop, pilot, and evaluate simulation-based training with multidisciplinary groups of final year undergraduate students. This will involve you alternately participating in and observing a number of relevant and challenging healthcare scenarios, debriefing on your team performance, and evaluating your experience.

How do I take part?

In order to take part you need to pick up a consent form from the undergraduate office in the Wright building (1F276), fill it in and return it in the adjacent marked box. You need to do this by the end of Friday 26th October. We will then get in touch to invite you to a 3-4-hour interprofessional simulation session with about 15 other students from 4 other disciplines. This will be scheduled outside your timetabled contact hours. You must come wearing your uniform or clothes you normally wear in placement. You may sign up with a friend from your cohort and who must also complete a consent form.

What are the possible benefits of taking part?

Students who will take part in this project will benefit from the best learning and teaching practice in the field of clinical training. You will be able to relate the main aspects of the session (scenarios and debriefing) to your professional role at work. There is evidence that a simulation experience will help you to be better prepared and more efficient should you have to respond to a critical incident or medical emergency as part of a multidisciplinary team. Recording your participation in this experience in your CV will enhance your employability.

Do I have to take part?

Participation is voluntary but you are strongly encouraged to take this opportunity by your Heads of Schools. If you decide to take part you are free to withdraw at any time without giving a reason and this will not affect your grades in any way.

What about Non Disclosure of Personal Data?

All personal data obtained will be handled in accordance to the Data Protection Act 1998.

What if taking part in the simulation session causes distress or worry?

In the unlikely event that you experience any distress as a result of one of the scenarios, we recommend that you withdraw from the session. Support can be provided by contacting the University counselling service on 01707 285420. You can also contact your personal tutor for support. The simulation team will give support as appropriate at the time.

What will happen to the findings of the research?

After statistical analysis of the feedback questionnaires, a report of the findings will be produced and disseminated. If you would like to be informed about the findings following the completion of the project, simply visit www.health.herts.ac.uk/hicesc.

Thank you very much,

Guillaume Alinier, HICESC Co-ordinator, G.Alinier@herts.ac.uk, 01707286395 (ext: 3395)

EC4HSC

UNIVERSITY OF HERTFORDSHIRE

FACULTY OF HEALTH & HUMAN SCIENCES

ETHICS COMMITTEE FOR NURSING, MIDWIFERY, SOCIAL WORK, CRIMINAL JUSTICE AND COUNSELLING

CONSENT FORM FOR STUDIES INVOLVING HUMAN SUBJECTS

I, the undersigned, agree to take part in

Protocol Number: NMPSC/2005/10

Protocol Title: Interprofessional Simulation Training for Final Year Undergraduate Healthcare Students to be carried out by:

Principal Investigator(s): Guillaume Alinier

I confirm that I have been given a full explanation of the purpose of the study by the investigator and that I have been informed of the details of my involvement in the study.

I confirm that I have been informed that I may withdraw from the study at any stage without the need to justify my decision.

Signature of Volunteer: ..... Date: .....

Name of Volunteer: .....

(please print)

Your programme / branch: .....

Contact Number: .....

Email: .....

If possible, I would like to be invited to a session with (One friend from your programme):

.....

Signature of Investigator: 

Name(s) of Investigators: Guillaume Alinier

Appendix XI

Further Work Emerging from the Main Study

A number of other initiatives directly related to this project have also emerged in post-graduate medical and non-medical education and for the Continuing Professional Development (CPD) of healthcare staff. For example, the junior doctors and even staff from different professions from the local NHS Trusts regularly come to HICESC for scenario-based simulation training, but it falls slightly beyond the scope of this thesis which primarily focuses on undergraduate education. Other relevant developments which have emerged from the main study exposed in chapters IV, V and VI will be briefly described in this Appendix.

1/ Simulation sessions for nursing and medical students

In 2004-2005, a pilot interprofessional education (IPE) project was collaboratively organised for medical and adult branch nursing students between the University of Hertfordshire, University College London, and the East & North Hertfordshire NHS Trust (Alinier, 2005). The aim was to jointly expose these students to scenario-based simulation training to investigate their perception of the value of such learning experience. Qualitative and quantitative feedback was collected to evaluate this form of IPE experience.

In the first instance five pairs of medical and nursing students were split into two groups and were invited to attend one half-day simulation session in HICESC. Students were briefed about the patient simulator (Laerdal SimMan) and the principles of simulation, and took part in a familiarisation scenario. During the rest of the session students were exposed to a range clinical scenarios followed by a team debriefing and some highlights on specific learning points emerging from their performance. Students were taking part in the scenarios without guidance as shown in Figure 38 unless they required interventions from more senior clinicians.

Figure 38: Medical and nursing final year students jointly assessing a patient during a scenario in HICESC

Despite the small sample size of participants, valuable feedback was obtained from the nursing and medical students about their shared scenario-based experience, and written feedback showed that both groups highly thought of the opportunity they were offered. One of the comments reads: "*It allowed me to have a nurse realistic experience about the doctor's and nurse's roles and* [to realise] *the importance of working as part of a team … we shared in decision making*." They all thought the simulation experience was very useful as it encouraged them to work together, and that this is the way they should be learning. Despite most students generally qualifying the first scenario as nerve racking and often a stressful experience, they recognised its benefits, being "fun" and safe, and wanted to take part in such sessions more regularly.

The collaborative teaching of university staff and clinicians with a mixed group of students worked very well and was expected to become a regular practice, however it only occurred for two consecutive years as the hospital funding for the medical students was instead used for the purchase of their own patient simulator.

2/ Scenario-based simulation training with paramedic students

The education of paramedic trainees has made use of some form of more or less advanced simulation learning approaches for a very long time and for a diverse range

of skills (Alinier, 2009, Gordon et al., 1999, Stewart et al., 1984, Stratton et al., 1991, Alinier, 2011). In 1964, the first low-fidelity simulation educational study involving paramedics and lay people was conducted to investigate the acquisition of cardiopulmonary resuscitation skills using a Resusci-Ann mannequin (Winchell and Safar, 1966). Until now, it is not uncommon that during training, to complement the skills that may have been acquired using passive part-task trainers such as airway management models, that paramedic students are given the opportunity to work alongside an anaesthetist in operating theatres to perfect their intubation skills on real patients. To that effect it has been reported that trainee paramedics have been involved in simulation training sessions to perform intubations alongside junior anaesthetists in a simulated environment as part of a scenario (Schwid et al., 2002).

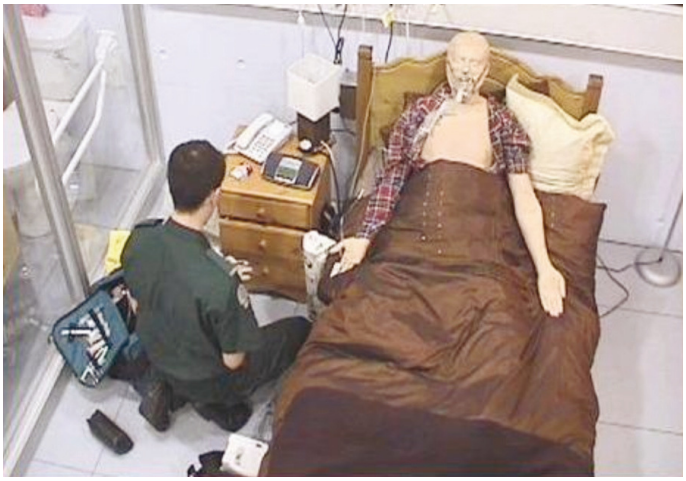


Figure 39: Paramedic student in the role of a first responder during a high-fidelity scenario using a patient simulator.

Since 2006, first, second, and final year paramedic students have had scenario-based simulation training built into one module per year. This gives them the opportunity to come to the simulation centre in groups of ten at a time and enact a series of five scenarios in pairs while their peers remotely observe the scene. The variety of scenarios, simulated settings, and use of either a patient simulator (Figure 39) or standardised or simulated patient (Figure 40) greatly enriches the students' learning experience. Some scenarios lend themselves to having a greater focus on communication especially when the patient is a real person instead of a mannequin, however advanced it might be, while other scenarios focus more on treatment or

intervention such as dealing with a patient with a traumatic leg injury and maybe requiring the use of special equipment such as a traction splint.

Figure 40: Final year paramedic student assessing a simulated patient (actor) during a high-fidelity scenario.

Paramedic students are the only group accessing the simulation centre from the first year of their study. Although they may not have all the knowledge and skills required, they are usually more confident and up for the challenge than students from any other discipline. From the very beginning of their programme, the subjects they cover include patient assessment and management, application of clinical skills, and management of the scene. Figure 41 shows two crews of first year paramedic students attending to a trauma patient suffering from multiple injuries. Paramedic students from all years of the degree and diploma programmes very highly rate the simulation sessions as it matches more closely their future work than any other practical sessions they take part in as they usually focus on a single topic at a time, hence taking away any sense of surprise as to what kind of patients or cases they will be practising.

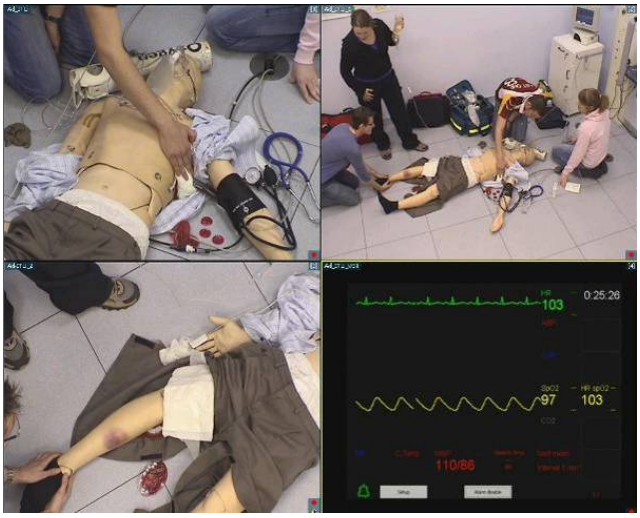


Figure 41: First year paramedic students taking part in a scenario.

3/ Scenario-based simulation training with nursing students

Since 2008, supported by the fractional appointment of nursing simulation specialists to HICESC, degree and diploma adult and child branch nursing students have also had scenario-based simulation sessions built into the final year of their curriculum. Similarly as for students from any other healthcare disciplines, nursing students also have access to other laboratories to learn and practise clinical skills from the very beginning of their study at university, but the sessions in the simulation centre take place with smaller groups than other practical activities such as skills training or lower fidelity simulation training (i.e. trainer led). The number of students is normally limited to a maximum of 14.

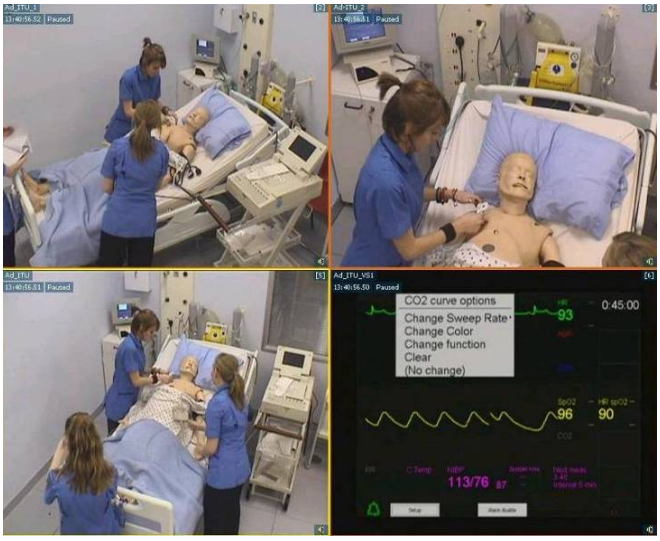


Figure 42: Adult branch nursing students taking part in a ward-based scenario with SimMan.

In the course of a three-hour session, all the students from a given group are given the opportunity to take part in one of three scenarios in teams of three or four students as shown in Figure 42. Scenario participants can summon the help from further nursing students if required. All students are not forced to take part in a scenario if they prefer not, to so they can at least benefit from observing their peers without worrying that their turn is approaching. The students who are remotely watching their peers taking part in a scenario are asked to actively think about what is happening and to take notes on a whiteboard as shown in Figure 43. These notes are then used to guide the debriefing of the students ensuring all positive or negative points have been discussed. As in real life, these usually ward or A&E based scenarios force students to use a broad range of skills. Figure 43 shows a children's nursing student comforting a distressed mother (confederate/actor), hence practising her communication skills, while her peers are looking after the baby by demonstrating their patient assessment skills. The sessions have been highly praised by the students and very well attended.

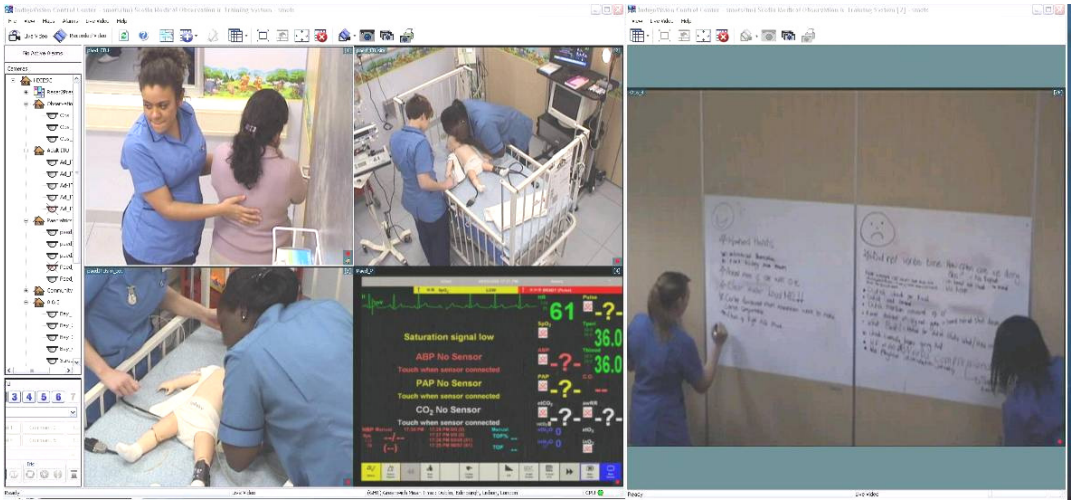


Figure 43: Child branch nursing students taking part in a paediatric A&E scenario and view of the observation room whiteboard.

From personal experience, it appears that nursing students prove more anxious and stressed than their peers from other disciplines about taking part in scenarios without direct guidance as they often report that they feel being “put on the spot” (Scherer et al., 2007) or that it may even be too realistic or unrealistic for them (Childs and Sepples, 2006, McCausland et al., 2004). Literature has previously reported that nursing students lack self-confidence (Leigh, 2008, Heslop et al., 2001). Pilot high-fidelity simulation sessions organised for second year nursing students showed that they were still too limited in the scope of scenarios they could manage without immediate senior assistance due to their lack of experience and confidence. Even after qualification, nurses have issues with the simulation learning environment qualifying it as being stressful, which may be directly related to the two other major issues they have identified in the same study and which are “being videotaped” and being “unfamiliar with equipment” (DeCarlo et al., 2008). Such feeling of anxiety could inhibit their learning which would defeat the whole point of facilitating such experience for them (Rauen, 2001). Hence the importance of allowing for an orientation period to the environment and the patient simulator and running the simulation sessions in a supportive manner and helping students to acquire skills and knowledge through the use of the appropriate type of simulation at the right stage in the educational curriculum (Alinier, 2007b).

4/ Scenario-based simulation training with pharmacy or bioscience students

Simulation has only recently been introduced in pharmacy education in the USA and a few other countries and is valued by pharmacy students (Seybert et al., 2006). HICESC offers students not only the opportunity to take part in ward based scenarios, but also in a highly realistic pharmacy setting for dispensing scenarios as shown in Figure 44.

The School of Pharmacy has made a strong commitment to provide the best training experience possible to their students throughout the four years of their degree programme. To that effect all staff have received some basic training to develop and facilitate scenario-based simulation learning experiences with varying degrees of difficulty and realism depending on the students' year of study. In their third year for example, pharmacy students take part in simulated ward rounds visiting five patients (patient simulators) around the simulation centre, each of whom has a different set of patient notes and medical condition. The scenarios are static and primarily rely on the students doing a medication review, documenting any required changes, and informing the patient's doctor. The ward rounds are facilitated by one pharmacy member of staff for eight students at a time and without any observers.

Figure 44: Pharmacy students doing a dispensing exercise in the simulated pharmacy.

To our knowledge bioscience students are not usually exposed to clinical simulation yet it can be used as a way of providing them with some experience regarding drug interaction for example. Since 2009, bioscience students benefit from a similar experience as the pharmacy students, but only as part of a final year clinical pharmacology module (Brodie et al., 2009). All students attend the same session and are divided into eight teams of six students playing the role of clinical pharmacologists.

This simulation session is linked to team-based activities in that module whereby each student within a team studies the effects of a particular drug and share the findings with the other team members prior to the simulation session. The scenarios developed by the facilitating team are directly related to the drugs studied by the students. During the ward round each team meets a different patient with a nurse (confederate) while the other teams observe remotely with a facilitator. Some of the scenarios are static while other scenarios present a patient with a varying condition induced by what they may be eating or drinking during the medication review. Students are expected to use the knowledge acquired from their personal research and appropriately advise the patient and nursing staff. Each medication review scenario was followed by a debriefing so students could ask further questions about side effects of medications and drug interactions. The session was valued by the students as it helped them to contextualise what they were learning about the different drugs they were studying in a more concrete way than by going through case studies. Post-simulation, each team had to give an assessed oral presentation about the patient they met during their scenario. Linking the simulation session to an ulterior oral presentation encouraged the students to further reflect on the clinical scenario they took part in and the drugs they had to study.

A paper by Seropian et al. (2007) explained the use of mannequin-based simulation to help teach concepts of drug pharmacokinetics and consequences of drug administration to first year medical students and argues that the same method can be used to other healthcare disciplines such as nursing and pharmacy. Thompson and Bonnel (2008), who have used simulation as part of a pharmacology module with nursing students, also found that it provided "*an applied learning experience that promotes knowledge retention, improves clinical judgement, and can produce safe practitioners in the clinical setting*" (p. 518).

5/ Scenario-based simulation training with physiotherapy students

Care of the ITU (Intensive Therapy Unit) patient on a ventilator has been demonstrated and practised using scenarios in the simulation centre since 2005 with final year physiotherapy students. The session is conducted as part of an optional module (Acute respiratory physiotherapy) taken by a fraction of the students. The environment of the simulation centre is the ideal place where to demonstrate how to care for such patients

as all the equipment required, such as the ventilator, can be setup with the patient simulator intubated. Students are able to suction the patient's airway, assist the breathing with positive pressure ventilation, auscultate for breathing sounds, perform chest percussions, and turn the patient on the side without causing any inconvenience to a real patient.

In the last year, a similar session has now been organised for qualified physiotherapists from the local Trusts to ensure they are better prepared to respond to out of hours emergency calls and to assist acutely ill patient in areas such as ITU. This type of Continuing Professional Development activity ensures staff's skills are kept up to date and that their practice is optimum.

Figure 45: Physiotherapy student visiting a paediatric patient at home at the beginning of a multidisciplinary scenario.

Since 2007, in addition to the interprofessional simulation opportunity, physiotherapy students have also been accessing the simulation centre for a simulation-based project part of a final year research module. This project involves first year physiotherapy students as study participants to their final year counterparts who are acting as facilitators and assessors. The protocol is that following some basic training, teams of final year students facilitate a community-based scenario for first year students who act as a convenience sample to examine the effect of different teaching methods on CPR performance. The final year students have derived a basic scenario making use of

SimMan and where the patient ends up going into a cardiac arrest. The first year students take part individually in the scenarios and are timed in their actions. Because the scenarios take place out of hospital and without immediate help available, it forces students to perform a basic patient assessment, make a phone call to inform the emergency services, and initiate CPR if required. Each session is solely facilitated by final year students who take charge of controlling the cameras, patient simulator voice and physiological parameters, and answering the emergency phone call. Further final year students are in the observation room to time different aspects of the first year students' performances such as how long it takes them to initiate chest compressions from the time the patient suffered a cardiac arrest and at which point they call the emergency services.

6/ Scenario-based simulation training with midwifery students

Simulation is perceived as being relatively new in midwifery education (Dow, 2008) despite evidence that it was probably one of the first area of healthcare for which a simulator was developed in the form of the "Birthing machine" from Madame du Coudray in the XVIIIth century (Gelbart, 1998). More recently some real benefits of team-based obstetric simulation training have already been demonstrated through improved performance outcomes of obstetrics emergency situations (Draycott et al., 2008, Draycott et al., 2006, Crofts et al., 2007). At the University of Hertfordshire, the midwifery team has started to use the simulation facilities in 2008, which enable them to make the scenarios more realistic and beneficial for more students than previously possible thanks to the camera system. The sessions were initially supported by one of the simulation specialist but the midwifery team has rapidly become proficient at making good use of the facilities and high-fidelity simulation methods using low-tech technology (a birthing pelvis model) combined with an actor, hence creating a form of hybrid simulation.

The sessions are organised in the same format as with the nursing students whereby a couple of student midwifes attend the expectant mother who is a tutor acting as a standardised patient with a pelvic delivery model and foetus as shown in Figure 46. The students can call for additional help if required, and the students not involved in the scenario observe remotely the scenario with another tutor. The scenarios take either place in a delivery room or in a community setting (Figure 47). After each scenario the participants return to the observation room to take part in the debriefing.

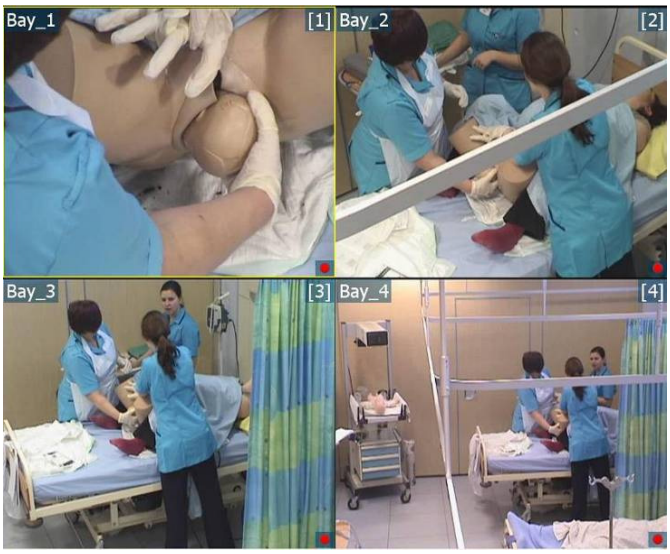


Figure 46: Midwifery students taking part in a delivery scenario making use of hybrid simulation.

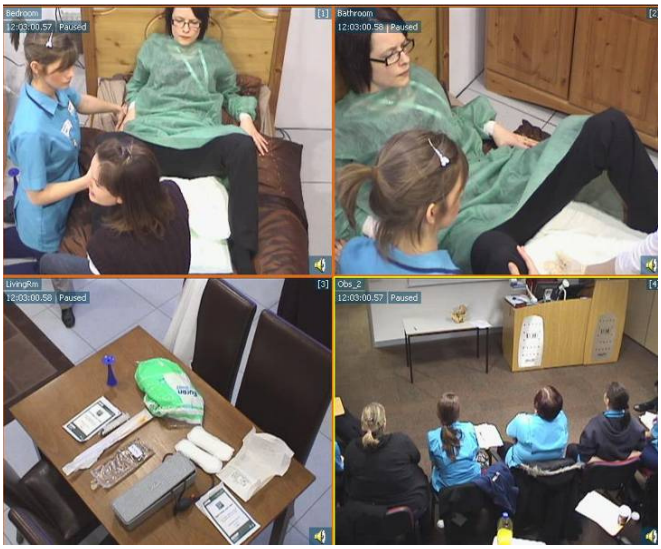


Figure 47: Midwifery students attending a simulated home delivery while being remotely observed by their peers.

Three to four scenarios are run per session and each student is involved in at least one scenario. The sessions received very good feedback from the students as it provides them with a unique experience to assist to a range of complicated deliveries and safely put into practice and discuss the delivery methods and emergency procedures they have been taught.

Appendix XII

Author's key publications

The following list of publications in presented in chronological order and focuses on the main peer reviewed journal articles written in English by the author of this thesis and excludes conference papers and book chapters, written in English or in French.

- Alinier G, 2003. Nursing students' and lecturers' perspectives of OSCE incorporating simulation. Nurse Education Today 23(6), 419-426
- Alinier G, Hunt WB, Gordon R, 2004. Determining the value of simulation in nurse education: Study design and initial results. Nurse Education in Practice 4(3), 200-207
- Alinier G, Gordon R, Harwood C, Hunt B, 2006. 12-Lead ECG training: The way forward. Nurse Education Today 26(1), 87-92
- Alinier G, Hunt B, Gordon R, Harwood C, 2006. Effectiveness of intermediate-fidelity simulation training technology in undergraduate nursing education. Journal of Advanced Nursing 54(3), 359-369
- Alinier G, 2007. Enhancing trainees' learning experience through the opening of an advanced multiprofessional simulation training facility at the University of Hertfordshire. British Journal of Anaesthetic and Recovery Nursing 8(2), 22-27
- Alinier G, 2007. A typology of educationally focused medical simulation tools. Medical Teacher 29(8), e243-e250
- Alinier G, 2009. Skills benefits of advanced simulation training. Journal of Paramedic Practice 1(9), 269-275
- Alinier G, 2010. A guide to setting up a simulation training unit within an ambulance trust. Journal of Paramedic Practice 2(7), 314-320
- Alinier G, 2011. Developing High-Fidelity Health Care Simulation Scenarios: A Guide for Educators and Professionals. Simulation & Gaming 42(1), 9-16