

Human patient simulation manikins and information and communication technology: Use and quality indicators in Australian schools of nursing.

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Thesis submitted for the degree of Master of Philosophy (Nursing)

Date

30th September, 2013

Statement of Originality

The thesis contains no material that has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. I give consent to the final version of my thesis being made available worldwide when deposited in the University's Digital Repository, subject to the provisions of the Copyright Act 1968.

Carol Arthur

Declaration: Thesis by Publication

I hereby certify that this thesis is submitted in the form of a series of published papers of which I am a joint author. I have included as part of the thesis a written statement from each co-author; and endorsed by the Faculty Assistant Dean (Research Training), attesting to my contribution to these joint publications.

Carol Arthur

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I would also like to thank all the study participants, both those who completed the survey of Australian schools of nursing, and also the members of the expert Delphi panel, for their time and the insights provided.

I hereby certify that the work embodied in this thesis has been conducted as part of an Australian Learning and Teaching Council (ALTC) funded project (Project number CG10-1678). As such this work has been conducted solely by myself as the Master of Philosophy candidate, with consultation with the project group members and project reference group being utilised only for advice and validation of the survey instruments. I would like to thank the project and reference group members for their contribution.

Carol Arthur

List of publications included as part of the thesis

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In the case of paper one the nature and extent of contribution to the work was the following:

Carol Arthur prepared and submitted the application for ethics approval for the research to proceed, reviewed the literature, developed the survey instrument, conducted the online survey, analysed the data and drafted the manuscript for publication. Associate Professor Ashley Kable and Professor Tracy Levett-Jones contributed to the above in their capacity of the role of Master of Philosophy supervisors.

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Declaration by co-authors

The undersigned hereby certify that:

1. the above declaration correctly reflects the nature and extent of the candidate's contribution to this work, and the nature of the contribution of the co-authors;
2. they meet the criteria for authorship in that they have participated in the conception, execution, interpretation and publication in their field of expertise;
3. they take public responsibility for their part in the publication, except for the responsible author who accepts overall responsibility for the publication;
4. there are no other authors of the publication according to these criteria;
5. any potential conflicts of interest have been disclosed to (a) granting bodies, (b) the editor or publisher of journals or publications, and (c) the head of the responsible academic unit.

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2. they meet the criteria for authorship in that they have participated in the conception, execution, interpretation and publication in their field of expertise;
3. they take public responsibility for their part in the publication, except for the responsible author who accepts overall responsibility for the publication;
4. there are no other authors of the publication according to these criteria;
5. any potential conflicts of interest have been disclosed to (a) granting bodies, (b) the editor or publisher of journals or publications, and (c) the head of the responsible academic unit.

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Kable, A., Arthur, C. and Levett-Jones, T. and Reid-Searl, K. (2013). Student evaluation of simulation in undergraduate nursing programs in Australia using quality indicators. *Nursing and Health Sciences* 15(2), 235-243.

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Conference Presentations:

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Arthur, C., Levett-Jones, T. and Kable, A. (2010). Australian simulation and technology survey. 3rd International Nurse Education Conference, Sydney. 11th-14th April, 2010.

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Synopsis

Against a background of escalating complexity within the Australian health care system related to the health needs of an ageing population, combined with a shortage of nurses, Australian schools of nursing have been asked to provide education and training for increasing numbers of students. However busy and at times overstretched clinical venues with high levels of patient acuity and a lack of experienced nursing staff have resulted in clinical learning environments that are unpredictable in quality and availability. Simulation has been proffered as a strategy that can address some of these issues.

Simulation in its simplest forms has been used for many years in nursing education. Technological advances over the last decade have provided high fidelity human patient simulation manikins (HPSM) that are able to mimic patients' physiological changes as well as provide life-like characteristics such as breathing, blinking and talking. These manikins, along with advances in information communication technology (ICT), provide increased opportunities for nursing students to engage in realistic clinical scenarios in a safe learning environment. In particular, the ability to simulate the physiological changes occurring in a deteriorating patient, combined with student access to current information through ICT, provides a learning experience that has the potential to improve higher order thinking, clinical reasoning and clinical communication, as well as basic psychomotor skills.

At the inception of this study in 2009 Australian schools of nursing were beginning to embrace HPSM and ICT as new and exciting teaching strategies, but little was known about the way in which these new strategies were being utilised. There was also a lack of clear direction as to what constituted quality teaching in the use of simulation manikins and ICT. The overall aims of this study were therefore to explore the use of simulation and ICT in Australian schools of nursing undergraduate programs, in particular in relation to clinical laboratory and simulation unit activities, and to determine what constituted quality use of simulation and ICT for teaching and assessment of undergraduate nursing students.

A pragmatic, mixed method approach was adopted to achieve the stated aims, with the study conducted in two phases. A cross sectional survey of Australian schools of nursing provided a snapshot of current use of simulation and ICT. This was followed by a Delphi study, in which an international panel of experts were utilised to achieve consensus regarding what constituted quality in the use of HPSM and ICT in simulation learning activities within an undergraduate nursing curriculum. The outcome of this study was a set of Quality Indicator Statements which can be used to guide the design and implementation of simulation activities within nursing curricula, as well as evaluate the quality of existing simulation programs. These statements have demonstrated applicability to a range of simulation modalities and have potential for use in nursing education, research and policy development.

This thesis is present as a hybrid thesis by publication. A comprehensive literature review and an overview of the study method are provided. These are followed by two chapters that present published papers, including findings from the cross sectional survey and the Delphi study. The final chapter draws together key aspects of both phases of the study and discusses the overall significance and implications.

Chapter 1 Introduction and Overview

1.1 Introduction

Simulation can be defined in its broadest sense as the imitation of a real-world process or situation. Interactive simulation is a type of physical simulation which includes human operators and/or participants in a synthetic environment. It has been used as a training device in a number of industries including aeronautics, space and military operations (Banks, Carson, Nelson and Nicol, 2001). Simulation in nursing can be defined as “an attempt to mimic essential aspects of a clinical situation” (National League for Nursing, 2010). It has been used in simple low technology forms over many years to teach nursing students psychomotor clinical nursing skills.

When this study began in 2008, the use of complex technology for simulation activities in Australian schools of nursing was in its early stages of development. Interest in the development of simulation as a teaching strategy was influenced by a number of factors. Growing awareness among many nurse academics of the importance of clinical reasoning in achieving safe patient outcomes led to identification of the need to provide complex scenario based learning experiences. The need to educate greater numbers of nurses without increasing the burden of training responsibilities for increasingly busy clinicians was also a factor driving the development of simulated learning environments. Simulation was seen as offering a way to replicate aspects of clinical situations so that students could practice in a safe environment and be better prepared for the reality of clinical practice. Australian university schools of nursing were beginning to embrace simulation and purchase new technology, but published evidence at this time was inconclusive regarding the benefits of simulation learning experiences, and somewhat limited in the identification of quality design components and their implementation.

As a registered nurse, clinician and clinical nurse teacher of long standing, my passionate interest has always been the provision of quality nursing education that informs quality clinical practice. Exploring what constitutes quality in simulation design

and implementation has important implications for both quality teaching and learning in nursing education, and also for the future of simulation in nursing curricula.

There are many ways to simulate a clinical situation, including the use of case studies, computer programs, role plays, actors and task training devices. This study has focused on the use of Human Patient Simulation Manikins (HPSM), which are three dimensional models of either full or part-body representation of human patients, in undergraduate nursing clinical teaching laboratories. It has also considered the use of information communication technology (ICT), used in association with HPSM.

The aims of this study were to investigate the current use of human patient simulation manikins (HPSM) and associated information communication technology (ICT) in Australian university schools of nursing clinical laboratories, and to identify the indicators of quality in simulation design and implementation.

The study design utilised a mixed method approach which consisted of two sequential phases. An Australia wide cross sectional survey of the use of HPSM and ICT was conducted in 2009. In 2010 a Delphi study, utilising a panel of Australian and international experts in the use of simulation, was conducted to achieve consensus on a set of quality indicator statements for the design and implementation of clinical simulation.

This thesis is presented as a hybrid form of a thesis by publication, with the results of both phases of the study presented as papers that have already been published in peer reviewed nursing journals. These papers are preceded in the thesis by a review of the literature which informed the design of the study instruments, and a presentation of the overall study design. The thesis concludes with a discussion of key study outcomes, their significance, and implications for future nursing education and research.

1.2 Background to the study

1.2.1 Contemporary challenges in the clinical learning environment

Since the transfer of nursing education from hospital based training into the tertiary sector there has been a tension between the requirement for a strong academic foundation for nursing education, and the need for students to develop competence and confidence in the application of knowledge and skills in the clinical setting. Advances in scientific and nursing knowledge and the expansion of the role of the nurse into more specialised and highly technical areas have increased educational requirements. Reductions in patient's length of hospital stay for routine procedures, combined with an ageing population with more chronic and co-morbid health problem, has resulted in increased in-patient acuity and the need for more community based care. Nursing shortages brought about by staff attrition and the aging of the workforce, have combined to further increase the demand for the education of more nurses to meet increasing health care demands.

The combined factors of high acuity patients with multiple age related co-morbidities and lack of experienced nurses in the workplace has resulted in increased challenges in providing adequate clinical learning experiences for increasing numbers of students. Busy, understaffed clinical venues with high levels of patient acuity result in clinical learning environments that are varied and unpredictable in quality and availability (Levett-Jones, 2007; Levett-Jones and Bourgeois, 2007).

1.2.2 The role of the clinical laboratory and simulation activities in nursing education

Within the context of the constraints and pressures currently present in the clinical environment, the importance of students' clinical laboratory learning experience becomes increasingly significant. Clinical skills laboratories have traditionally provided students with a safe environment where they can practice their skills under supervision (Jeffries, 2007). However, competent nursing requires more than psychomotor skills. Recent research highlights the importance of critical thinking and problem solving

capabilities in enabling effective clinical decision making. Nurses with effective clinical reasoning skills have been shown to have a positive effect on patient outcomes (Aiken, Clarke, Cheung, Sloane and Silber, 2003). However current approaches to nursing education may not always facilitate the development of adequate clinical reasoning skills (Levett-Jones et al., 2010). Concerns have been expressed by nurse academics about the level of competence of newly graduated nurses, their ability to use critical thinking, and the number of cases in which failure of clinical judgement has resulted in “failure to rescue” the deteriorating patient (de Bueno, 2005). A report from the NSW Health Patient Safety and Clinical Quality Program identified poor clinical reasoning by graduate nurses as a contributing factor to adverse patient incidents (NSW Health, 2006). Simulation plays a crucial role in providing reality based scenario situations that allow students to practice clinical decision making in a safe environment that will not lead to patient harm (Jeffries, 2007).

1.2.3 Development of new human patient simulation manikin (HPSM) technologies

Simulation has been used in a variety of forms in nursing education for many years. There is a wide variety of simulation techniques including full and part body manikins, various types of role play, and more recently computer based and virtual reality programs (Decker, Sportsman, Puetz and Billings, 2008). The focus of this study is the use of high fidelity manikin simulation (HPSM) and related information communication technology (ICT), specifically in undergraduate nursing school clinical laboratories.

The term **fidelity** is used to describe the degree to which a simulation approaches reality. Simulation fidelity refers to the “physical, contextual and emotional realism” (National League for Nursing, 2010) created that allows the participant to become immersed in the simulated situation. It includes the clinical realism of the scenario, the laboratory environment and equipment, and the technical capacity of the manikin to mimic human responses. Full scale **immersive simulation** is when the student is exposed to a clinically realistic situation that requires them to respond to the developing scenario in real time. The situation is made as realistic as possible to allow the student an experience that requires them to utilise a range of cognitive, technical and non-

technical skills (Seropian, 2004a), with the potential to develop clinical reasoning skills in a safe, controlled environment.

There are a number of definitions in the literature for manikin fidelity, but most categorise simulator manikins as either low, medium (or moderate) or high fidelity based on similar criteria. The following definitions, based broadly on the National League for Nursing (2010) criteria were utilised in this study, and made available to study participants.

Low fidelity manikins have a basic anatomical structure, either full or part body, are static, and have no capacity to display physiological signs or respond to nursing interventions.

Medium fidelity manikins are more realistic, and have breath sounds (but no chest movement), heart sounds and pulses. Physiological signs can be controlled by a manually operated remote control, but can also have computerised scenario building capabilities. An example is Laerdal's Nursing AnneTM or Nursing KellyTM with VitalSimTM.

High fidelity simulators outwardly appear to be more realistic, but perhaps more importantly have a greater capacity to display physiological signs and respond to students' interventions. The latest models have chest and eye movement, can sweat, bleed and pass urine. They have computer programmable complex physiological parameters that respond to interventions including medications with a bedside screen display for physiological monitoring. An in-built audio system allows the operator to remotely communicate in the role of the patient, or to utilise a range of programmable vocalisations. An example is Laerdal's SimMan 3GTM (Seropian, 2004a; Laerdal, 2010).

While low fidelity HPSMs have been used in nursing clinical learning laboratories for many years, the use of newer medium and high fidelity HPSMs can be seen as a valuable tool for the development and testing of higher order clinical thinking and competence (Jeffries, 2007). Medium fidelity manikin technology such as Laerdal's MegaCode KellyTM with VitalSimTM allows simulation of pulses, heart beats and breath sounds, and can be a valuable tool for teaching specific clinical skills. The introduction

of high fidelity HPSM such as Laerdal's SimMan 3GTM allows individualised computer programming to create real-to-life clinical situations, requiring students to respond with sophisticated clinical reasoning skills. These new technologies have the greatest potential for the development of students higher order thinking and non-technical skills such as communication and collaboration. They provide a challenge to nursing academics and clinical educators to integrate these new teaching strategies into curricula and thus improve educational outcomes. The level of usage of this technology in Australian university schools of nursing was largely unknown prior to 2008. Only one study had been published that explored the Australian use of HPSM in clinical teaching laboratories. McKenna, French, Newton, Cross and Carbonnel (2007) completed a Victorian state government funded report into the use of simulation and clinical placements for increasing undergraduate nursing students' clinical competence. Studies in other countries had identified time, space, cost, lack of technical expertise and sufficient training for staff as some of the factors that may impact on the effective use of high fidelity HPSM devices (Jeffries, 2007). Literature exploring the effectiveness of HPSM was accumulating, but clear indicators of best practice usage were not available.

1.2.4 The role of information communication technology (ICT) within clinical laboratories and simulation environments

Clinical reasoning and patient outcomes have also been linked to the ability to use ICT and to incorporate best practice information into critical thinking and decision making (Goldsworthy, Lawrence and Goodman, 2006; Stagers, Gassert and Curran, 2001). However many nursing students were still not confident with ICT including the use of hand held personal data assistants (PDAs) and other mobile and point of care devices (Hegney et al, 2007). There is at times an assumption that university students in this century are all ICT literate, but nursing programs in Australia currently have high numbers of mature aged students and students from low socio-economic backgrounds who may not have well developed ICT skills (Levett-Jones et al., 2009). While various forms of ICT may be incorporated into the theoretical components of nursing programs, clinical laboratory and simulation activities provide an additional opportunity for students to practice using point of care technology as part of patient care delivery.

Information regarding the extent and effectiveness of use of ICT across Australian nursing clinical laboratory environments was not reported prior to this study.

1.3 Introduction to the study design¹

1.3.1 Aim of the research

The aims of the study described in this thesis include:

1. To explore the range and types of human patient simulation manikins (HPSM) and information communication technology (ICT) currently used in Australian undergraduate degree nursing programs, and the pedagogical approaches that underpin their use.
2. To investigate how the educational outcomes of HPSM and ICT are assessed and the manner and extent to which these technologies are used for formative and/or summative assessment of students' performance.
3. To identify the principles and practices that contribute to quality teaching and learning using HPSM and ICT.
4. To develop a set of indicators of quality use of HPSM and ICT in schools of nursing clinical laboratories.

1.3.2 Research design

A mixed method approach was used to achieve the stated research aims. Mixed method research may be said to have an underpinning pragmatic philosophical stance, utilising a variety of methods to gain new knowledge and solve identified problems. This pragmatic approach allows the researcher to collect both quantitative and qualitative

¹ This study was commenced in September 2008 as part of a larger project funded by the then Australian Learning and Teaching Council (ALTC) investigating the impact of human patient simulation manikins (HPSM) and information communication technology (ICT) on the development of clinical reasoning in undergraduate nursing students.

data in order to gain practical and useful knowledge and to achieve stated objectives (study aims) (Creswell, 2003).

The research also utilised a strategy of sequential procedures (Creswell, 2003), in which one phase of the study was utilised to inform the next.

1. A review of the literature was initially conducted and utilised to inform the design of the study instruments, and was updated during the research process to reflect accumulating knowledge within the field and to further inform data analysis.
2. A cross sectional survey of Australian schools of nursing was conducted in 2009 to investigate the current use of HPSM and ICT in undergraduate nursing program clinical laboratory activities. (Aims 1 and 2)
3. An international Delphi study was conducted in 2010 to develop a consensus set of quality indicator statements to guide the development and application of HPSM and ICT for undergraduate nursing clinical teaching programs. (Aims 3 and 4)

Both the cross sectional survey and the Delphi study collected numeric and text data and thus the analysis required both quantitative and qualitative approaches. Both open and closed questions were utilised. While questions within the cross sectional survey were predetermined, the Delphi technique used to develop the quality indicator statements used three rounds of iterative questionnaires and feedback that facilitated emerging expert consensus (Creswell, 2003). This mixed method study design was chosen to allow the development of a more complete understanding of both the current use of HPSM and ICT, and the opinions of users and experts regarding the quality implementation of HPSM and ICT into clinical nursing education curricula and learning experiences. Further details of the study designs for both the cross sectional survey and the Delphi study are presented in Chapter 3.

1.4 Structure of the thesis

This study is presented as a hybrid thesis by publication. An extensive literature review was initially conducted, and this review informed the development of the cross sectional survey and Delphi questionnaire instruments. This review is presented in Chapter 2. The study design is discussed in further detail in Chapter 3, and then results of each phase of the study are presented as a separate chapter. Chapters for both the cross sectional survey (Chapter 4) and the Delphi study (Chapter 5) are presented as accepted for publication in peer reviewed journal articles, and each includes a discussion of background literature, study design, study results and discussion of findings. Additional details of study results that were not able to be included in the publications due to publication manuscript word limits are provided as appendices and referred to in the relevant chapters. A concluding chapter (Chapter 6) is provided to discuss the implications and significance of this work.

1.4.1 Summary of thesis structure

Table 1: Summary of Thesis Structure

Chapter	Contents covered	Related publications
Chapter 1.	Introduction, background, introduction to the study design, structure of the thesis	
Chapter 2	Review of the literature	
Chapter 3.	Study design	
Chapter 4.	Cross sectional survey: background, study design, results and discussion	Arthur, C., Kable, A. and Levett-Jones, T. (2011). Human patient simulation manikins and information communication technology use in Australian schools of nursing: A cross-sectional survey. <i>Clinical Simulation in Nursing</i> 7(6), e219-27.
Chapter 5.	Delphi study: background, study design, results and discussion	Arthur, C., Levett-Jones, T. and Kable, A. (2013). Quality indicators for the design and implementation of simulation experiences: A Delphi study. <i>Nurse Education Today</i> , 33(11), 1357-1361.
Chapter 6.	Overall discussion, conclusion, implications and significance of the study for nursing education, curricula and practice, limitations, and recommendations for further studies	
Appendices	Study instruments Tables and graphs of data.	

Chapter 2 Literature Review

2.1 Introduction

An extended review of the literature was conducted and used to inform the construction of the research instruments. The focus of the review was the use of human patient simulation manikins (HPSM) and associated information communication technology (ICT) in nursing education. As simulation is an area of ongoing expansion in nursing education, the body of literature is continually expanding. This chapter presents the initial literature review which formed the foundation for the study. Literature published since the study was commenced that has particular relevance to the results is referred to in the chapters containing the publication of study findings (Chapters 4 and 5) and in the final discussion chapter (Chapters 6).

This literature review discusses practices in the use of HPSM and associated ICT primarily in undergraduate nursing programs, with an emphasis on teaching in clinical laboratories and simulation units. It explores the underlying pedagogical principles employed and the evidence of the effectiveness of these teaching strategies in terms of student learning outcomes, and their contribution to quality teaching and learning. The review will also explore the implementation strategies and curriculum integration of HPSM and associated ICT to further identify recommended indicators of quality teaching practices. For clarity HPSM and ICT are initially discussed separately before relationships between them are considered.

While a considerable amount of literature was located that evaluated the outcomes of simulation, and discussed implementation strategies and frameworks, there was a limited amount of literature that was able to draw conclusive links between the processes employed and the outcomes in terms of improved student competence. Close analysis of a wide range of relevant literature resulted in identifying key issues for consideration in the quality use of HPSM and ICT.

2.2 Search strategy

In order to ensure that all major studies in the area had been considered, a literature search was conducted in December 2009 and updated in August 2010 in CINAHL and Medline databases using the following search terms:

Nursing education/ education, nursing, baccalaureate/ education, nursing, diploma programs

and

Manikin/model, anatomical/simulation/patient simulation/pda/computers, hand held

and

Quality indicator/effectiveness/theoretical framework/conceptual framework/curriculum integration/integrated curriculum/curriculum development.

Limits used in the search were publications in the English language and published after 2000.

Fifty seven papers were identified in CINAHL and 102 in Medline. The same search strategy was also implemented in Mosby's Index in August 2010 and 117 papers were identified that were then cross checked with the initial search results. Hand searching of reference lists was also conducted as well as cross checking with papers identified in two systematic reviews into impact of HPSM (Lapkin, Fernandez, Levett-Jones and Bellchambers, 2010) and ICT (Jeffrey and Bourgeois, 2011) on students' clinical reasoning, that were conducted as part of the wider Australian Learning and Teaching Council (ALTC) project of which this study was a part. These papers were then reviewed to determine whether they met the inclusion criteria.

Inclusion criteria: research studies, both descriptive and experimental, doctoral dissertations, concept analyses, theoretical frameworks and implementation models, project implementation and evaluation studies relating to undergraduate nursing students.

Exclusion criteria: Discussion and opinion papers, literature reviews, critical reviews, studies focusing primarily on medical or other non-nursing health care workers, post-graduate or speciality students, or registered nurses.

In total one hundred papers were identified as meeting the inclusion criteria and were critically reviewed.

2.3 Human Patient Simulation Manikins

2.3.1 Current usage of HPSM

In 2002 Nehring and Lashley conducted an international postal survey of all nursing programs that had been listed by Medical Educational Technologies Inc as having purchased a METI Human Patient Simulator prior to 2002. Participants were from 34 nursing schools (one in Japan and the rest in the United States), and six simulation centres that were involved in nursing education, from Australia, England, Texas, New Zealand and Germany. A wide range of data were collected in relation to curriculum implementation and use of HPSM, staffing issues, student satisfaction and use of HPSM for the evaluation of student performance and competence.

According to this study HPSM was being used mainly in advanced medical-surgical courses and basic skills courses in undergraduate programs. HPSM was for most participants included as part of required clinical courses and counted as part of clinical hours by 57.1% of participants (Nehring and Lashley, 2004). It should be noted that the majority of participants were from the United States, as in the Australian context simulation activities have not as yet been accepted by nursing registration bodies as part of the required clinical hours. Participants believed that HPSM was useful for the development of critical thinking skills, applying theory to practice and providing better transition to clinical placement experiences, but noted the lack of research to affirm these beliefs. The survey also found that 77% of participants believed that HPSM should be used in some circumstances for the evaluation of student's competence, with simulations most frequently used to assess knowledge synthesis, technical skills and the management of critical events (Nehring and Lashley, 2004).

Issues relating to staff were also explored. The degree of acceptance of HPSM as a teaching strategy was variable, with approximately half of participants indicating general acceptance by faculty, although nearly all schools indicated that 25% or less of their faculty used HPSM and 76% of schools had one person designated as primarily responsible for implementing simulation. The complexity of the technology and time required for becoming skilled were identified as limiting factors in the use of HPSM by teaching staff. This study concluded that further research and examination of the best use of this expensive technology in nursing education was needed (Nehring and Lashley, 2004). The study provided a useful overview of practices in the early implementation of HPSM, although the focus was largely on the context within the United States and limited to those using the Medical Educational Technologies Incorporated (METI) manikin.

More recently a small scale survey was conducted of the use of simulation by associate degree nursing programs in a Western USA state (Adamson, 2010). The aim of this study was to identify current use and resources in HPSM, and to examine faculty perceptions of barriers and facilitators. Of 27 schools of nursing contacted, only four responded to the survey. Money spent on the purchase of simulation equipment ranged from \$51,000 to \$300,000, but only \$2,000 to \$5,000 had been spent on maintenance and training, a very small percentage of the budget. Simulation utilisation was reported to be 0-4 hours per week, with no apparent relationship between expenditure and use. Seventy six faculty members from the identified schools completed questionnaires about their current use and knowledge of simulation and perceived barriers and facilitators. Lack of time, lack of support and lack of accessory equipment such as audio visual, software and hospital supplies were identified as barriers, with recommendations made for additional paid time for designing scenarios and running simulations, as well as additional training and resources, including technology support staff.

Another US study which aimed to identify obstacles to the implementation of simulation into undergraduate nursing curricula was conducted by Jansen, Johnson, Larson, Berry and Brenner (2009) as an online survey of 25 self-selected nursing faculty from 10 Wisconsin university and college nursing schools. Content analysis of responses identified seven categories of obstacles to the use of simulation: time,

training, attitude, lack of space/equipment, funding, staffing and difficulties engaging large groups of students at one time. A number of proposed solutions to these obstacles generated from the literature and experience are discussed by the authors. The need for ongoing funding to maintain simulation facilities, train staff and develop scenarios was identified. Collaboration between educational and health care facilities was also recommended, as was sharing of resources with other facilities and via related Web sites. Creative approaches to staffing included utilising retired faculty, nursing or other relevant discipline students, drama students and volunteers to fulfil various roles during simulations. Education of faculty in manikin use and scenario development was highlighted, with a “train-the-trainer” model of staff development recommended to minimise cost. The appointment of a simulation coordinator or “champion” who is endorsed by the school and who liaises with the curriculum committee was recommended to guide curriculum integration and assist other staff. Finally multiple ways of utilising simulation were recommended, including demonstrations, broadcasting of simulations to larger groups in classrooms, and creating multi-station activities through which students can rotate. The main limitation of this study was the small local group of participants, which limits the ability to generalise these findings.

In Australia, prior to 2010, only one study had been published that explored the Australian use of HPSM in clinical teaching laboratories. McKenna, French, Newton, Cross and Carbonnel (2007) completed a Victorian state government funded project into the use of simulation for increasing undergraduate nursing students’ clinical competence. Study methods included conducting focus groups with nursing educators within university and vocational education and training (VET) sectors in Victoria to explore current and potential use of simulation in nursing curricula. Telephone interviews were also conducted with key educators within health services that had simulation laboratories available for the use or potential use of undergraduate nursing students. Finally coordinators of existing simulation centres were interviewed to explore capacity to meet identified needs. A range of qualitative and quantitative data was collected.

Simulation was seen by undergraduate educators in this study as a valuable way to provide a safe and inclusive learning environment for students to apply theory to

practice and develop higher order cognitive skills. An alternative way of providing these experiences was not readily available in the clinical setting. However, a lack of resources, both physical and human, was a major issue in terms of providing high fidelity simulation opportunities. A list of core clinical objectives, skills, knowledge and attitudes were generated by the researchers, and participants were asked to identify their teaching strategies. Very limited use was made of high fidelity HPSM at the time of this study, with other strategies such as videos, low fidelity manikins, role play, actors and computerised scenarios being more commonly used. Hospital based simulation laboratories were seen by the researchers as having limited viability for supporting undergraduate nursing students due to competition with medical schools and issues of responsibility for the cost of staff and consumables. Existing simulation centres identified some potential to further develop learning experiences for nursing students in their final or new graduate year, but there was an emphasis in these centres on management of emergency situations, teamwork and higher order thinking skills, and it was felt that extensive work would need to be done to develop scenarios more suitable for undergraduate students. Recommendations of the study included the development of a bank of scenarios, conducting a pilot study on the benefits of high fidelity HPSM for nursing students, and acceptance by nursing regulation authorities of simulation experiences to replace missed clinical hours, providing the students had already passed the remainder of the relevant clinical placement (McKenna, French, Newton, Cross and Carbonnel, 2007). This study gave insight into the situation in Victoria only, with limited insights into the use of HPSM in other Australian states.

2.3.2 Pedagogical principles

Underpinning pedagogical principles for HPSM can be found in a range of learning theories and nursing frameworks. Some key concepts of learning that can be applied to simulation include learning as a cognitive skill, an experiential personal growth or a socio-cultural dialogue (Jeffries, 2007). In the literature experiential learning theory as outlined by Kolb (1983) was the most common theoretical construct used for both research and practice in nursing simulation. Experiential learning theory supports the view that knowledge is created through transforming experiences. Kolb's theory describes this process as having four stages – concrete experience, reflective

observation, inductive reasoning and active experimentation or application. Simulation can be seen to provide ideal opportunities for experiential learning in a safe environment by giving students a realistic, concrete situation, the opportunity to interact, observe and collect cues, the chance to logically problem solve, both during the simulation and also during the debriefing, and a safe environment in which to practice interventions, as well as discuss the application of learning to future clinical practice (Kolb, 1983).

A discussion paper by Parker and Myrick (2009) explores the application of both behaviourist and constructivist educational philosophies to high fidelity HPS. The authors discuss behaviourist philosophy as the historical foundation of nursing pedagogy, with desired student outcomes and behaviours determined by staff, and manipulated by rules and environmental influences. Students learning was characterised as occurring as a result of staff responses to their actions, and reinforced by frequent repetition. Behaviourist based simulation was seen as appropriate for the acquisition of psychomotor skills and rote knowledge acquisition. Parker and Myrick suggest that simulations designed using this approach should focus on key learning objectives and avoid unrelated complexity. Repetition, prompt instructor feedback and reinforcement and supplementation by theoretical knowledge given prior to the simulation were also recommended to allow proper cognitive structuring.

By contrast, a constructivist educational approach is based on the concept that students create their own learning and sense of meaning through interaction with the environment. New knowledge is shaped by the individual, resulting from the integration of new experiences into the learners' existing cognitive schema. New constructs are the result of conflict between experiences and existing beliefs. The use of complex, realistic scenarios which require students to create their own hypotheses, think critically and solve problems make the best use of constructivist learning principles. This type of simulation is considered by the authors as most beneficial for facilitating the development of clinical reasoning, collaboration and teamwork. Interaction with the teacher and group processes are a valuable part of the simulation in facilitating the exchange of new information with the learners existing cognitive schema. Parker and Myrick (2009) further state that both behaviourist and constructivist approaches may be

appropriately combined, depending on the learning objectives of the particular simulation.

2.3.3 Theoretical frameworks

2.3.3.1 The Nursing Education Simulation Framework - National League for Nursing (NLN)

A number of nurse academics have developed frameworks based on education theory to guide the implementation of simulation. In 2003 the National League for Nursing in the United States of America and the Laerdal Corporation collaborated to conduct a national multi-site, multi-method study to develop and test models for the implementation of simulation that would promote student learning. As part of this project Jeffries and Rizzolo (2006) developed the Nursing Education Simulation Framework. This framework identifies characteristics of the teacher and the student, as well as educational practices that impact on simulation design and outcomes. Recommended educational practices which are based on Chickering and Gamson's (1987) principles of good practice in undergraduate education include active learning, feedback, student/faculty interaction, collaboration, high expectations, accommodation of diverse learning styles and time on task. The framework identifies five key characteristics of simulation design: objectives, fidelity, problem solving, student support and debriefing utilizing reflective thinking. The effectiveness of simulation can be evaluated by measuring the outcomes of knowledge acquisition, skill performance, learner satisfaction, critical thinking and self-confidence (Jeffries, 2007).

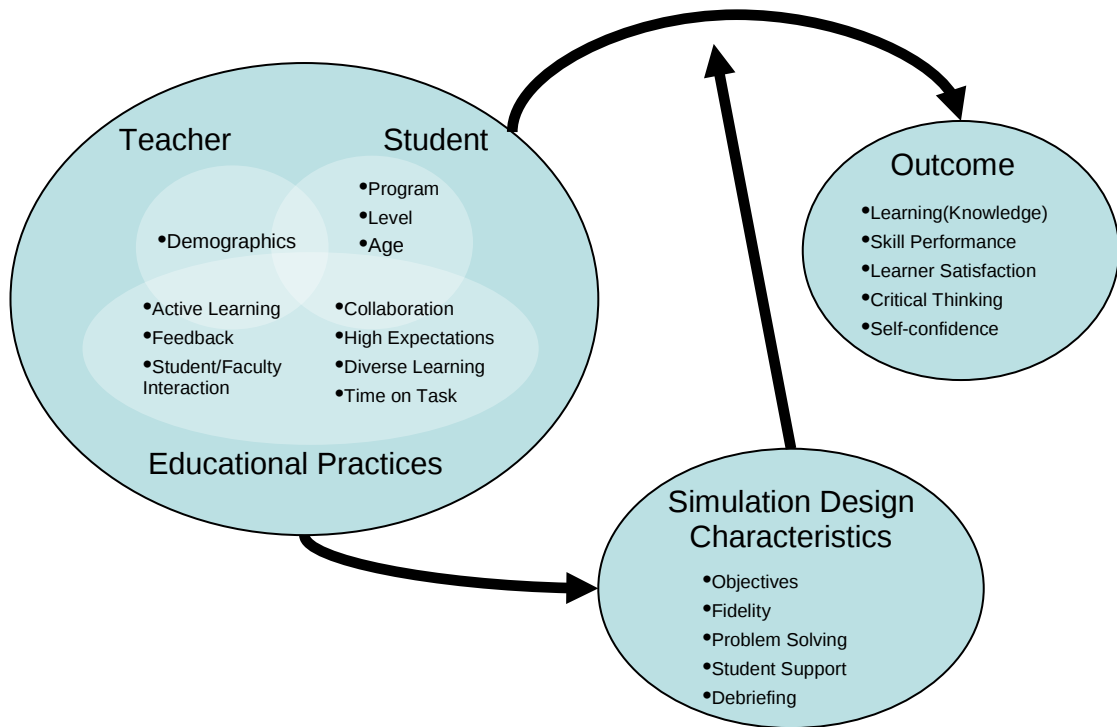


Figure 1: The Nursing Education Simulation Framework

Adapted from Jeffries, 2007

This simulation design framework was initially tested by Jeffries and Rizzolo (2006). Four hundred and three undergraduate students from multiple campuses were randomly allocated to three groups to learn about post-operative nursing care. One group utilised paper and pencil case studies for group work, the second had hands on simulation of the scenario with a static manikin, and the last group had hands on experience with high fidelity HPSM. All groups had a facilitator who guided reflective debriefing. Students then completed an Educational Practices Simulation Scale (EPSS) and a Simulation Design Scale (SDS) as well as a knowledge test, self-confidence scale, judgement performance scale and satisfaction survey. Key findings included improved student satisfaction and confidence with high fidelity simulation, and more perceived opportunities for active learning and problem solving. Interestingly, there was no significant difference in learning outcomes or satisfaction whether the student was an active participant or observer in the high fidelity HPSM. Since this time the Nursing Education Simulation Framework and its associated evaluation tools have been widely

used in designing and evaluating simulations and as a theoretical framework for many studies including Kardong-Edgren, Starkweather and Ward (2008), Thompson and Bonnel (2008), Grant, Moss, Epps, and Watts (2009) and Reese, Jeffries and Engum (2010).

2.3.3.2 Other theoretical frameworks utilised in simulation

The Nursing Process has also been used as a framework for the implementation of simulation. Burns, O'Donnell and Artman (2010) conducted a study in which the Nursing Process was used to structure a simulation activity for 125 first year undergraduate nursing students. The aim of the study was to test the effectiveness of high fidelity simulation to facilitate understanding of problem solving using the Nursing Process model of Assessment, Diagnosis, Planning, Implementation and Evaluation, with the addition of Communication as a key interlinking element (ADPIE-C). This model was used to structure the simulation experience and also as a programming template within the simulator software. The study used a pre-test/post-test design. Students received a two hour lecture on the Nursing Process as part of their course, and one week later completed a multi-choice knowledge test and an attitude to the nursing process survey that assessed perceptions of the model in relation to cognitive, affective, psychomotor, communication and safety issues. A three hour simulation activity included several complex scenarios. Students had the opportunity to view the scenarios via video link, as well as participate as a small group in one scenario with the guidance of a post graduate student, followed by structured debriefing. Students were guided through the simulation and the debriefing using the ADPIE-C construct. At the end of the simulation activities students completed post-tests using the knowledge and attitude scales. Results demonstrated significant improvement in the knowledge of the Nursing Process and improved attitude to the Nursing Process in terms of critical thinking skills, knowledge, specific care skills, communication and confidence. Course evaluations showed that students were very satisfied with the simulation experience. The main limitation of the study was that no comparison group was used to assess whether simulation was a better alternative to other teaching methods. However the project illustrated successful application of the Nursing Process as a design framework for simulation activities.

Another simulation design model was created at the University of Maryland, based on Patricia Benner's Novice to Expert theory (Larew, Lessans, Spunt, Foster and Covington, 2006). This model is based on Benner's (1984) concept that beginners are not as skilled as expert nurses in cue recognition, and will require further time and more prompts to identify patient problems and required actions. Therefore the key design feature for this model is scripted patient and team member prompts built into each scenario that proceed from vague to specific depending on the amount of cueing the student requires. The model was tested on experienced critical care nurses and novice students, with results supporting the theory, as the experienced nurses identified the patient problems from baseline cues, while the novices often required second level prompts. When using this model the simulation pace is student directed, with students varying in how much time they require to gather cues, identify the problem and plan care. Constant facilitator observation is needed to determine the correct timing of prompts. Creating a template for the simulation in this way has the potential also for use as an assessment tool to rate the students' level of competence.

The application of Benner's theory to simulation is further discussed by Waldner and Olson (2007). Simulation is explained as an experiential opportunity for students to inter-relate theory and practice and provide a context for gaining the experience needed to move to a higher level of practice. Based on the levels of experience described by Benner the authors recommend that novice level students should begin with situations that are simple to allow them to focus on details, for example practicing the assessment of vital sign on fellow students, with the use of medium fidelity HPSM to experience abnormal physiological signs. Novice students also need opportunities to discuss their findings and relate them to theoretical concepts, so adequate debriefing discussion is essential. As students progress to the level of advanced beginners they are able to apply protocols to take action in response to findings, so high fidelity HPSM can be used to allow them to see the consequences of their actions. As advanced beginners are focused in the present, feedback can be given during the simulation using a pause and discuss method, or at a final debriefing. As the student becomes more competent simulations can become more complex, with actors playing the role of family members, or members of the multidisciplinary team. Interruptions should be avoided to make the simulation as

realistic as possible. Reflective debriefing at the end allows for reconfiguring of the cognitive schema. Video replay can be used to focus reflection.

Lasater (2007a) conducted a qualitative study of novice students' experience of high fidelity simulation in order to identify its potential to support the development of clinical judgement. Two groups of twelve students had weekly laboratory sessions involving pre-simulation teaching, active participation in simulation scenarios in groups of three, the opportunity to view other simulations from the debriefing room, and participation in group debriefing. Data on the students' experience of the simulation was collected through focus groups, and content analysis of transcripts was conducted. Key findings included the value of simulation as an integrator of learning as it brought together theoretical knowledge, psychomotor skills and clinical practice, provided a breadth of learning opportunities, and heightened awareness of possible situations in the clinical environment. Limitations identified by the students were the lack of non-verbal communication cues from the manikin, and the use of only a female voice for the manikin voice in all scenarios. Students also identified the anxiety producing effect of the simulation situations, and feelings of inadequacy if correct actions were not taken, but identified that learning resulted from discussion of these issues during debriefing. Students identified debriefing as a key aspect of the learning and expressed a desire for more direct and honest feedback. Students found collaboration with others during the simulations, and also during debriefing discussions to be beneficial. They found watching other students at times boring, and did not always feel actively engaged in this process. The quality of learning was not valued as highly by those not actively involved. This is contrary to the findings of Jeffries and Rizzolo (2006) who found no difference between the learning of active participants and observers.

Lasater (2007b) also used observation of the simulations to design a Rubric for measuring clinical judgement based on Tanner's (2006) Clinical Judgement Model. This model divides the clinical judgement process into four phases: noticing, interpreting, responding and reflecting. Using a theory driven cycle of description, observation and revision, a rubric was created that classified students' performance as either beginning, developing, accomplished or exemplary for eleven dimensions of clinical judgement. The rubric was then pilot tested and further revisions made. The

resultant rubric supplies a language for teaching and evaluating clinical judgement, and has the potential for use in simulation planning, evaluation of students' performance, and as a measurement tool for research studies.

The application of the Lasater Clinical Judgement Rubric to the evaluation of students' performance during simulation is described by Dillard, Sideras, Ryan, Carlton, Lasater and Siktberg (2009). This study had three phases: examining the effectiveness of a faculty development workshop to implement the use of the rubric, use of the rubric to evaluate student learning during a simulation of a patient with congestive heart failure, and exploration of student and faculty perceptions of the impact of simulation on clinical practice. Staff who participated in the workshop and were involved in implementing the simulations and rating the students' clinical judgement with the rubric found that the change in approach was able to be understood and applied, and that it enhanced their teaching. Students were asked to self-assess their performance in the simulation against the six learning objectives set for the simulation. Students rated themselves highly in their understanding of the material (overall mean 3.55 on a scale of 1-4). These scores could not be compared directly with the performance scores given by the faculty, as different tools were used. Faculty rubric scores were not reported in this paper. This is a weakness in the study design as the opportunity was lost for comparison. Many studies have relied on student self-report as an outcome measure but the validity of this is questionable. This design limitation becomes more significant when considering the results of the final stage of the study; analysis of students' reflective diaries on the care of a real patient with congestive heart failure in the clinical setting using the Lasater rubric. Exemplars given show a disturbingly low level of clinical judgement, and were rated at a beginning, or at most a developing level. This poor transfer of knowledge into practice despite self-report of high confidence level is of concern. Key conclusions drawn by the authors relate to the importance of ongoing teaching strategies in the clinical setting of concepts relating to clinical judgement. Pattern recognition practiced in simulation needs to be reinforced in clinical practice and clinical judgement concepts taught throughout the curriculum (Dillard et al, 2009).

A model for the development of clinical reasoning based on the cognitive development theory of Piaget has been developed by Arwood and Kaakinen (2009). SIMBaLL

(SIMulation Based on Language and Learning) proposes that Piaget's four stages of cognitive development (sensory-motor, preoperational, concrete and formal) can be used to classify student nurses' acquisition of clinical reasoning. This paper further discussed the use of this model to scaffold the acquisition of conceptual knowledge throughout the curriculum, with simulations specifically targeted toward the students' developmental level. The authors also discuss the use of this model to evaluate and grade students' progress, based on their ability to use language to explain the concepts underpinning their decision making, as well as strategies to assist students struggling with concept development. This paper shows great potential for further work to evaluate its application.

2.3.4 Effectiveness of simulation as a teaching strategy

There have been a number of studies undertaken to determine the effectiveness of high fidelity simulation as a teaching strategy. As the employment of high fidelity simulation is costly in terms of equipment, staffing and time, it is appropriate that nurse educators examine its effectiveness for student learning and also compare this to other teaching strategies.

The outcomes of high fidelity simulation have been measured in terms of skill acquisition, knowledge acquisition, and student self-report of confidence and satisfaction. Measurement of clinical reasoning has been more difficult, largely due to the lack of validated measurement tools. Development of non-technical skills such as communication and teamwork during simulation have also been studied and linked to patient safety outcomes. Each of these outcomes measures will be discussed below; however as individual studies have most commonly used more than one outcome measure, some intertwining of these will be apparent in the discussion. Many of these studies also contribute to an understanding of what aspects of simulation design lead to positive learning outcomes and thus inform our thinking about quality use of simulation technology. It will be noted that some but not all of these research outcomes align with the outcome measures identified in Jeffries (2005) Nursing Education Simulation Framework.

Study designs are variable, as are the types of simulation being evaluated, with some studies focusing on one particular type of simulation, and other studies comparing outcomes for differing types, such as low, medium and high fidelity manikins. As studies are usually conducted within an undergraduate curriculum context, control group activities are also variable. A range of evaluation instruments to measure learning outcomes have been used, with a need identified for the production of standardised, validated evaluation tools (Kardong-Edgren, Adamson and Fitzgerald, 2010). These complexities limit efforts to synthesise study results. Overall, studies in simulation may also be criticised for not using a theoretical framework which limits their value for theory development (Rourke, Schmidt and Garga, 2010). Studies are also needed to demonstrate whether learning from simulation is transferable to clinical practice.

1) Student satisfaction

A number of studies have reported about the level of student satisfaction with simulation experiences, usually as a secondary outcome measure. Overall undergraduate nursing students have been shown to enjoy simulation learning activities. Jeffries and Rizzolo (2006) found student satisfaction with learning was greater when using high fidelity simulation compared with a pen and pencil case study or low fidelity static manikin simulation. Similarly, Bruce, Scherer, Curran Urschel, Erdley and Ball (2009) found a high level of student satisfaction in the use of SimManTM for mock cardiac arrest training, and Hoadley (2009) found greater qualitative reporting of enjoyment when using high fidelity simulation compared with low fidelity task trainers for life support training, despite no significant differences in quantitative satisfaction scores or knowledge and skill acquisition. While these studies compared high fidelity simulation to low fidelity alternatives, Kardong-Edgren Lungstrom and Bendel (2009) found no significant difference in student satisfaction when comparing high fidelity simulation using SimManTM to medium fidelity simulation using VitalSim. This is supported by a number of studies using medium fidelity manikins. An Australian study by Reilly and Spratt (2007) found a high level of student satisfaction with simulations using the computerised scenario building capabilities of Laerdal's Nursing KellyTM and Nursing AnneTM with VitalSimTM. A study comparing lecture supplemented with laboratory scenarios with medium fidelity manikins and role play with lecture only (Sinclair and

Ferguson 2009) found 91% student satisfaction in the intervention group (simulation) compared with 68% for the control group (role play). Kardong-Edgren, Starkweather and Ward (2008) undertook an evaluation study of the implementation of three simulations in a first year foundations nursing program. The simulations were designed using the Jeffries (2007) Nursing Education Simulation Framework and utilised medium fidelity manikins with VitalSim. High levels of student satisfaction were reported, as well as high scores for the Educational Practices Questionnaire and Simulation Design Scale, indicating that the design principles advocated by Jeffries can be implemented using a medium fidelity manikin. These studies lend support to the potential value of the less expensive medium fidelity manikins when used to their full capacity. However, while satisfaction is a useful measure of student engagement in learning, no studies have shown a direct relationship between students' report of satisfaction with simulation and other outcome measures.

2) Student self-confidence and overall competence

The idea of self-confidence as a nurse attribute is considered important by many nurse educators and self-report of confidence levels has been used as an outcome measure in a number of studies of the effectiveness of simulation as a teaching method. Ravert (2004) examined the impact of human patient simulation on student's self-efficacy, measured by self-confidence ratings. Participants in the study were involved in additional enrichment activities as well as their usual curriculum activities; either classroom discussion of case studies, or use of HPSM to simulate actual patient cases and perform nursing actions. Both groups showed increased rating of self-confidence, with no significant difference between them (n=25). The small sample size may have made demonstration of statistical significance difficult, however the simulation group were noted to be more enthusiastic about learning and stated that learning by doing was helpful to their confidence level. In contrast Jeffries and Rizzolo (2006) were able to demonstrate a significantly greater increase in self-reported self-confidence in the students involved in high fidelity simulation compared to the pen and pencil case study control group (n=403). Gore, Hunt and Raines (2008) reported improved confidence and skills and less anxiety during their first clinical placement for first year students who had participated in a four hour simulation activity involving a high fidelity

simulator, however evaluation was only anecdotal reporting by faculty and students. This is also supported by Bambini, Washburn and Perkins (2009) who studied 112 first year nursing students who undertook a three hour laboratory involving eight stations of high, medium and low fidelity simulations and computer programmed learning activities as well as preparatory reading and videos. Comparison of pre and post activity scores for self-assessed self-efficacy found a significant increase in self efficacy and confidence for the skills addressed. Qualitative data showed that the students found the experience valuable in increasing their confidence prior to clinical placement. The study was limited in that it relied on self-report only, and there was no comparison of various methods of teaching. Similarly, Kardong-Edgren, Starkweather and Ward's (2008) study of medium fidelity simulations also showed high levels of student perceived self-confidence with mean scores for the three simulations undertaken of 38, 35 and 38 out of a possible 40 points.

A study by Alinier, Hunt, Gordon and Harwood (2007) gives another perspective on the issue of student self-confidence. This study used a pre-test, post-test design to compare the improvement in OSCE performance of undergraduate nursing students. The OSCEs included both theoretical and practical stations, and thus evaluated a range of competencies, including knowledge and its application to skill performance, as well as self-rating of self-confidence. The control group received only the standard teaching while the experimental group received a three hour scenario based simulation experience as well. Data analysis showed a statistically significant mean improvement for the experimental group compared with the control group. The study was conducted over three years with a large number of participants (n=344) and provides good evidence of overall improvement in competence, including knowledge recall and application following simulation. Interestingly, there were no significant differences between the groups in reported stress and confidence levels. This finding is important to the understanding of the significance of self-confidence as an outcome measure, as self-report of confidence may actually be a poor predictor of actual nursing competence.

This inconsistency between self-reported confidence and externally assessed competence is supported in the study by Dillard et al (2009) mentioned previously. Students self-assessed their performance in the simulation against the six learning

objectives set for the simulation. Students rated themselves highly in their understanding of the material (overall mean 3.55 on a scale of 1-4). Staff rated the students' performance using Lasater's Clinical Judgement Rubric. Student self-assessment could not be compared directly with the performance scores given by the faculty, as different tools were used. This design limitation becomes more significant when considering the results of the final stage of this study; staff analysis using the Lasater rubric of students' reflective diaries on the care of a real patient with congestive heart failure in the clinical setting. Exemplars given show a low level of clinical judgement and competence. Conclusions drawn by the authors relate to the importance of ongoing teaching strategies in the clinical setting and reinforcement of concepts taught in simulation. However the lack of consistency between the students' high self-rating of their understanding after the simulation and their subsequent poor application of the concepts in clinical practice also suggests lack of validity for self-rating as an outcome measure of clinical competence, and the need for the development more effective outcome measures.

An exploratory study by Lambton, O'Neill and Dudum (2008) investigated the impact of simulation on second year students' confidence in communication, collaboration and assessment skills during a paediatric course. Forty seven students participated in four simulation scenarios, each replacing a six hour clinical day and comprising in total 25% of the total clinical hours allocated for the course. After each simulation students completed a 10 question survey using a Likert type scale, as well as open questions to evaluate their perceived improvement in collaboration, communication, error recognition and age appropriate assessment. Students reported high levels of confidence in their communication and collaboration following all simulations, despite faculty observers noting many instances of poor communication and failure to collaborate with the team. This appears to indicate that students overestimated their abilities and performance. However the one outcome that did improve over the four simulations was recognition of clinical error, supporting the value of embedding errors into simulation scenarios. The main limitation of this study in terms of measurement of outcomes was the self-reported nature of the data, and further highlights the need for the development of objective outcome measures.

In the United Kingdom, where simulation currently replaces up to 300 clinical placement hours in undergraduate nursing courses, Moule, Wilford, Sales and Lockyer (2008) conducted a two phase mixed method study to evaluate the use of simulation in the development of pre-registration students' clinical skills. In phase one, 69 first and third year students participated in five days of simulation activities related to basic life support, manual handling, infection control, clinical decision making and managing violence and aggression. The type of simulated activity undertaken was not clearly stated, only that the activities were student led, that students worked in groups on topic related scenarios, were facilitated by a member of clinical staff, and were given feedback from student observers. Pre-test and post-test multi-choice questions were used to assess changes in knowledge levels for basic life support and manual handling, with no significant change demonstrated. On the last day of the program students completed multi choice questions from topic related vignettes, with scores ranging from 45% to 85% with a mean of 68%. Students also participated in 15 minute OSCEs, with marks of between 50% and 95% with a mean of 77.8% achieved. There was no control group for comparison. This study is limited by its small sample size, lack of control group in the study design, and lack of clarity about details of the simulation intervention.

3) Skill acquisition

The literature provides some support for the effectiveness of simulation in teaching psychomotor skills however there are limited studies demonstrating any advantage in using high fidelity over low fidelity manikins or part task trainers for teaching basic skills. Rogers (2007) undertook a quasi-experimental study evaluating the effects of high fidelity compared to low fidelity manikin simulation on nursing students' learning outcomes during the American Heart Association advanced cardiovascular life support (ACLS) course. Participants were 34 senior nursing students from three nursing programs. Skill performance was rated by an expert panel and no significant difference was found between the two groups

Hoadley (2009) also conducted a quasi-experimental study to compare learning outcomes for an ACLS course using low or high fidelity simulation. Participants consisted of 53 doctors, nurses and other health care providers. For technical skill

performance, the high fidelity group received a higher mean score, however the difference was not statistically significant.

This lack of evidence for using high fidelity manikin for teaching basic skills is further supported in a study by Blum, Borglund and Parcells (2010), who compared traditional methods, with task trainers and role play, to scenario based simulations with SimMan™ to teach basic skills to 53 first year nursing students. It was not clear in this study how the beginning level students had been prepared to complete tasks during the high fidelity simulation, or the extent of support given by faculty during the simulation. From the example given, the scenarios appeared to be fully immersive, with prompting given via the patient (simulator) and his wife (actor). Skill competence was rated by staff and self-confidence was rated by students, before and after the training, using Lasater's Rubric. Interestingly, there was greater improvement in both competence and confidence in the group taught by traditional methods, although statistical significance was not reached. This study highlights the need to justify the use of expensive high fidelity equipment. There is also some indication that immersive scenario based simulation may not adequately support the acquisition of beginning level skills, unless there has been adequate prior preparation.

In contrast to these findings a study by Grady, Kehrner, Trusty, Entin, Entin and Brunye (2008) concluded that high fidelity manikins were more effective for teaching nursing skills and that any additional effort and cost was worthwhile. A crossover study design was used in training two groups of first year students (n=52) in the skills of naso-gastric tube insertion and urinary catheterisation. Part task trainers were used for one group and high fidelity manikins for the other, then groups reversed for the second skill. The high fidelity manikins were able to display physiological responses, to gag or cough when appropriate during naso-gastric tube insertion, to produce urine when the urinary catheter was inserted correctly, and to respond to questions and show discomfort. Both groups received instruction and support from faculty during the training. At the end of semester students were assessed on the procedures using the high fidelity manikin and specific observational rating scales. Students who had trained on the high fidelity manikin scored significantly higher in the performance ratings, and reported more positive perceptions about the training.

4) Knowledge acquisition

Study results relating to the impact of simulation on knowledge acquisition are variable and inconclusive. Those studies that attempt to measure knowledge application tend to support the value of high fidelity scenario based simulation, while simple knowledge recall testing is less likely to support the use of high fidelity. Several studies also show deterioration in knowledge over time following the simulation experience, indicating the need for repetition and reinforcement of students' learning.

Scherer, Bruce and Runkawatt (2007) conducted a study to compare the impact of computer controlled simulation manikins against case study presentations on nurse practitioner students' knowledge and confidence in managing a cardiac event, using a pre-test/ post-test study design. Twenty three volunteers were randomly allocated to two groups. Both groups received instruction in atrial arrhythmias via a sixty minute PowerPoint presentation prior to the initial pre-test. The experimental group attended individual simulation scenarios and a group debriefing, while the control group attended a case study based seminar. Knowledge tests were conducted prior to the intervention, and one week and one month after. Mean knowledge scores on both post-tests were higher in both groups, but did not reach statistically significant levels, with no significant difference between the groups.

Similar results were obtained in Hoadley's (2009) study of low and high fidelity manikins for ACLS training. Participants consisted of 53 doctors, nurses and other advanced health care providers. Knowledge was assessed with a written pre-test/post-test. Both control and experimental groups showed significant improvement in knowledge after the training. However, while the high fidelity group had higher mean improvement scores than the low fidelity group, these differences were not statistically significant. Rogers (2007) examined the impact of low and high fidelity simulations on students' knowledge acquisition as well as knowledge application and performance in acute life support (ALS) by both a written knowledge test and scores relating to knowledge application in performance assessment. Knowledge tests were administered before and immediately after the simulations and showed a significantly greater mean improvement for the high fidelity group.

Another study that demonstrated improvement in knowledge levels was conducted by Thompson and Bonnel (2008). The authors aim was to improve novice level nursing students' pharmacology knowledge and their ability to safely apply this knowledge in the clinical environment by integrating experiential learning through simulation into an otherwise didactic pharmacology course. The theoretical content had been taught in class four weeks prior to the simulation, and a multi-choice knowledge pre-test completed. Jeffries framework (2005) was used as a simulation design model and the METI high fidelity manikin as the simulator. Seventy two students participated in a simulation scenario related to narcotic action and over dosage in groups of six, with roles assigned as nurses, family members and observers. The simulation was followed immediately by a group debriefing lasting up to 50 minutes. During the simulation class days students also worked on a self-directed learning module while not involved in the simulation. Immediately following the simulation the same multi choice exam was used as a post-test. Average pre-test scores of 80% increased to 96% in the post-test. Limitations of the study design were that there was no control group and that the self-directed learning package would need to be considered as part of the independent variable as repetition of content material in any format could be argued to potentially improve outcomes.

Kardong-Edgren, Lungstrom and Bendel (2009) evaluated student learning outcomes, comparing medium and high fidelity manikin simulation with traditional lecture only, in the topic area of acute coronary syndrome. The participants were 103 nursing students divided into three groups. The control group received the standard lecture only, while the other two groups undertook a 15 minute simulation experience, followed by a debriefing. Group 2 used the medium fidelity VitalSim manikin, while group 3 used the high fidelity SimManTM. A paper based multi-choice test was used to assess knowledge levels before, and at 2 weeks and six months after the intervention. Knowledge test scores improved in the first post-test for all three groups, with no significant difference between the groups. The repeat post-test scores at six months were lower than the initial post-test scores, but still higher than the pre-tests. The results of this study raise questions about the cost value of expensive simulation modalities when outcome benefits cannot be demonstrated or do not have lasting value. The authors also acknowledged that a paper and pencil knowledge test may not be a valid tool to evaluate

the potential higher order thinking benefits of simulation activities. This study highlights the importance of appropriate modalities to achieve cost effective learning outcomes as well as using rigorous and appropriate instruments.

Deterioration in knowledge over time was also identified in a study by Bruce, Scherer, Curran, Urschel and Ball (2009), who examined the effectiveness of a mock cardiac arrest simulation using high fidelity SimManTM for improving the knowledge, confidence, competence, crisis management and teamwork of a mixed group of 107 undergraduate and 11 graduate nursing students. Students were given theoretical and practical instruction prior to the simulation. The undergraduate students were given a knowledge test prior to the simulation, immediately following debriefing, and again between four and eight weeks after the simulation. While knowledge scores improved significantly immediately following the simulation, the test at four to eight weeks showed no significant difference compared to the pre-test scores. The study design without a control group did not clearly differentiate whether the initial improvement in scores was due to the simulation itself, or the overall package, including the preparatory instruction and the debriefing.

Knowledge deterioration over time was also identified by Elfrink, Kirkpatrick, Nininger and Schubert (2010). Participants in this study were 41 second year undergraduate nursing students who undertook a simulation related to post-surgical mastectomy care, and 43 third year students whose simulation involved a ventilated patient with Adult Respiratory Distress Syndrome (ARDS). Both groups had theoretical preparation, orientation to the environment, a group planning session before the simulation and debriefing after. There was also the opportunity to repeat the simulation following debriefing if the simulation objectives were not met the first time. All students completed a two question knowledge test relevant to the content before and immediately after the simulation, and two questions with similar content were asked in the end of semester final exam. While both groups had significantly improved knowledge after the simulation, 93% of the second year group retained the knowledge at the final exam, compared to only 50% of the third year students. The researchers concluded that these differences may have related to the cues that students focused on during the simulations

and pointed to the need for further research to guide facilitators in structuring cue sets and debriefing discussions to meet learning objectives.

5) Critical thinking and clinical reasoning

Lack of adequate clinical reasoning skills has been identified as a serious concern in graduate nurses and has been implicated in adverse patient outcomes and “failure to rescue” events (del Bueno, 2005). The simulation environment is seen as a safer option than clinical placement for students to encounter deteriorating patient situations and practice clinical reasoning and decision making (McCallum, 2006). However demonstrating the impact of simulation on critical thinking or clinical reasoning has created challenges for researchers, not the least of which have been defining the terms and determining valid means of measuring clinical reasoning.

A number of studies have reported student perception of increased clinical judgement following simulation activities (Gordon and Buckley, 2009; Horan, 2009), but these provide weak evidence of measurable change. A pilot project by Rhodes and Curran (2005) developed a simulation activity for senior level nursing students with the aim of improving critical thinking and clinical judgement. The program included pre-simulation orientation, a twenty minute high fidelity manikin simulation based on a case scenario of haemorrhagic shock, followed by debriefing. Students were asked to talk aloud during the simulation, and faculty observed students critical thinking through their actions and decision making during the simulation and through their discussion at debriefing. No formal evaluation or rating of this appears to have been carried out. Students were surveyed post simulation for their perception of the experience, and overall the experience was rated as positive. This study illustrates the challenges of quantifying clinical reasoning.

Self-rating of clinical judgement was further developed by Cato, Lasater and Peeples (2009), who used Lasater’s Rubric and faculty feedback to further develop student’s ability to reflectively self-assess their simulation performance and foster critical thinking. They found these reflections to be deeper and more significant than debriefing discussions, illustrating that valuable reflective thinking about simulation experiences may continue for a long time after the actual simulation.

In a doctoral dissertation Howard (2007) compared gains in knowledge and critical thinking abilities for students undertaking either a high fidelity simulation or a case study. The sample consisted of 49 undergraduate nursing students from two nursing schools. Both groups completed a Health Education Systems Incorporated (HESI) exam relevant to the topic areas as a pre-test, and then viewed a PowerPoint presentation on acute coronary syndrome (ACS) and cerebral-vascular accident (CVA). One group then experienced an orientation to the simulation laboratory, manikin and equipment, a 15 minute simulation on ACS, and a video assisted debriefing lasting up to 45 minutes. After a short break the simulation process was then repeated with the CVA scenario. The other group undertook two paper based case studies on the same scenarios, with facilitator led discussion. A post-test with the HESI tool was administered at the completion of the interventions. The results strongly supported the benefits of the simulation for knowledge acquisition, with the simulation group showing significant gains in the knowledge post-test compared to the case study group who actually scored less compared to their pre-test. Critical thinking sub-scores of the HESI score were also calculated based on the HESI predictability model using the difficulty level of the questions and critical thinking theory. These scores also showed significant gains by the simulation group compared to losses by the case study group. One variable factor that may have influenced these positive results was that the debriefing for the simulation group was conducted by the researcher, while the facilitation of the case study group was attended by either a clinical instructor or a graduate student. This factor may have influenced the quality of the discussion and favoured the simulation group.

In Rogers' 2007 study on the impact of low and high fidelity simulations on students' knowledge acquisition, application and performance in acute life support (ALS) were also examined. In the performance assessment of students, while the competency outcome areas of basic psychomotor skills were similar for both the low and high fidelity groups, areas relating to decision making, confidence and leadership were rated significantly higher for the high fidelity group by the expert panel. This result supports the value of high fidelity simulation for improving students' higher order thinking and knowledge application.

This impact of high fidelity simulation on higher order thinking was supported by Brannan, White and Bezanson (2008), who compared the effectiveness of simulation to traditional lecture for teaching content related to acute myocardial infarction to junior level undergraduate nursing students. The researchers developed the Acute Myocardial Infarction Questionnaire: Cognitive Skills Test (AMIQ) with four main content domains: diagnostic evaluation, pathogenesis and prevention, acute nursing care, and recovery and discharge teaching. Content validity was confirmed by expert clinicians, and the tool was pilot tested for reliability. An aspect of this study design that is somewhat different from others is that the experimental group did not receive the traditional lecture, thus all learning beyond students' own reading of the prescribed text could be attributed to the simulation activity. The two hour simulation activity consisted of five stations, with an evolving written case study and clinical decision making questions guiding activities at four of the stations. The fifth station involved interaction with a HPS manikin, programmed to replicate the illness progression and physiological changes of the case study patient. Faculty were available for consultation during the activities, and a ten minute structured debriefing followed the simulation. Post-test AMIQ scores showed significantly greater improvement of scores in the experimental group than the lecture only control group. Interestingly post-test confidence levels improved less uniformly in the experimental group than the control group, although the difference was not statistically significant. This study supports the value of HPSM in helping students acquire complex concepts relating to nursing. The cognitive skills tool utilised (AMIQ) could be argued to be testing aspects of knowledge acquisition and also clinical decision making. It also supports other studies which question the value of self-reported confidence. In terms of faculty input time the two hour simulation activity was an effective and efficient replacement for the previous two hour lecture.

Ravert (2008) attempted to measure differences in critical thinking in three groups of undergraduate nursing students during their first medical/surgical course. Two experimental groups were given enrichment activities, either weekly one hour small group discussion of patient situations (n=13) or weekly one hour simulation activity caring for the patient in groups of four (n=12). It is not clear how these simulations were structured or whether debriefing was part of the activity. The control group (n=15) participated in the regular education process only. A pre-test/ post-test study design was

conducted, using the California Critical Thinking Disposition Inventory (CCTDI) and the California Critical Thinking Skills Test (CCTST). These tools were developed by the American Philosophical Association (Facione, Facione and Sanchez, 1994)). Students preferred learning styles were also assessed using Kolb's Learning Style Inventory. Results showed moderate to large increases in both the CCTDI and CCTST for all groups. The control group had the greatest increase in CCTDI, while the small discussion group had the greatest increase in CCTST, but none of the comparisons were statistically significant.

This study had several important identified limitations. Sample sizes were small which made demonstration of statistical significance difficult. There was no control of variables such as normal classroom activities or clinical experiences during the study. The instruments used to measure critical thinking are not nursing specific, and may not be measuring clinical reasoning as it relates to nursing practice. Also it is not clear from the description of the simulation activity how the simulation was designed to develop critical thinking skills. The author states that the simulation "required different priorities, such as completing tasks" (Ravert, 2008: page 561) and that there were issues with the simulator due to either equipment or operator error that may have impacted on the experience. Also there is no discussion of whether debriefing was part of the simulation and whether this was used to encourage critical reflection. This study concluded that simulation did not improve critical thinking, but that further studies are required using other techniques and tools that can better measure critical thinking as it applies to nursing practice.

Sullivan-Mann, Perron and Fellner (2009) used the Health Sciences Reasoning Test (HSRT) to measure whether critical thinking scores improved in associate degree nursing students after participation in multiple clinical simulation scenarios as part of a medical-surgical course. The HSRT is a standardised multi-choice test of core critical thinking skills essential for health care professionals. Fifty three participants were randomly allocated and undertook either five simulation scenarios (experimental group) or two scenarios (control group) using the METI high fidelity simulator and scenarios from the Program for Nursing Curriculum Integration software available from METI. Simulations were scheduled throughout the semester, and other aspects of the

curriculum schedule remained unchanged. All students completed the HSRT pre-test at the beginning of the semester and the post-test at the completion of all simulations.

There were no significant differences in mean group scores on pre-test. Post-test scores improved for both groups but the experimental group improvements were significantly greater than the control group. This study supports the value of simulation for improving students' clinical reasoning and also supports the value of repeated opportunities for this form of experiential learning.

A complex study by Brown and Chronister (2009) aimed to demonstrate the effect of simulation on critical thinking and self-confidence of senior undergraduate nursing students related to electrocardiogram (ECG) assessment, interpretation and related therapeutic interventions. The study also examined correlations between critical thinking, self-confidence and additional clinical placement and employment related clinical experience. The treatment group (n=70) received a total of 350 minutes of didactic instruction plus 150 minutes of high fidelity simulation activities with Laerdal's SimManTM and appropriate technical equipment, followed by instructor led debriefing, over a five week period. The control group (n=70) received 100 minute weekly lectures for four weeks. On completion of these activities both groups completed a demographic form and self-confidence tool followed by an ECG SimTest. The ECG SimTest was a 30 item multi choice test compiled by a panel of experts and designed to measure critical thinking specifically related to the course objectives at the application level or higher. Self-confidence was measured using a five item questionnaire and Likert type scale that focused on the various components of the simulation activities. Following this testing the control group was given a total of 100 minutes of simulation and debriefing activities, followed by a post-test with self-confidence tool.

Results demonstrated no statistically significant differences in the ECG SimTest scores between the two groups, although the control group's scores were slightly higher. From this the researchers concluded that didactic instruction may be a more effective way to teach basic ECG concepts. However when scores were compared between students undertaking the course in first and second semester, second semester students scored significantly higher. Also overall students who had job related experience with telemetry scored slightly higher than those who did not, but the difference was not

statistically significant. These findings suggest that clinical experience as students progressed through the curriculum, and to some extent employment related clinical experience may improve critical thinking skills. In relation to the self-confidence tool there were no significant differences between the experimental and control groups for items 1, 2 and 3, but in the post-test items 4 and 5 scored significantly higher in the control group. This was seen by the researchers as indicating that simulation at the end of the theoretical component of the course may be more beneficial than weekly interaction. Again self-confidence scores were statistically higher in the treatment group for second semester students and overall for those with employment related telemetry experience. Significant positive correlations were found between post-test self-confidence and ECG SimTest score. This finding is contrary to studies by Alinier, Hunt, Gordon and Harwood (2007), Dillard, Sideras, Ryan, Carlton, Lasater and Siktberg (2009) and Lambton, O'Neill and Dudum (2008). The fact that the participants were senior students with possibly clear insight into their capabilities, and also the fact that self-confidence questions were very content specific, may have contributed to this finding.

6) Non-technical skills: communication, collaboration and teamwork

A number of authors have recommended using simulation for teaching non- technical skills such as communication, collaboration and teamwork, and recent studies have been directed towards evaluating outcomes in these areas. Studies have also been conducted to determine the effectiveness of simulation for improving interdisciplinary collaboration. Dillon, Noble and Kaplan (2009) aimed to determine the usefulness of an interdisciplinary approach by analysing students' perceptions of interdisciplinary collaboration using a pre-test/ post-test study design with a convenience sample of fourth year nursing students (n=68) and third year medical students (n=14). A cardiac arrest scenario was used followed by debriefing that focused on clinical skills, decision making and feelings. The Jefferson Scale of Attitudes Towards Physician-Nurse Collaboration was used to measure perceptions of collaboration, along with qualitative data from open ended questions. Post test results showed a greater appreciation by the medical students of the nurses' role, and a more collaborative, less subservient attitude in the nursing students.

Reese, Jeffries and Engum (2010) utilised the Nursing Education Simulation Framework (Jeffries, 2005) to design a simulation for the collaborative management of a surgical patient experiencing chest pain escalating to cardiac arrest. Participants in the study were third year medical students (n=15) and senior nursing students (n=13). Medical and nursing students were paired, with one pair involved as active participants and another pair observing the simulation via closed circuit link. The 20 minute simulation was followed by debriefing involving both the active participants and the observers. All students then rated the simulation using the Simulation Design Scale (Jeffries, 2007), and completed a satisfaction and self-confidence scale, and a collaboration scale. Mean scores in all outcomes measures were high, with no significant differences between the medical and nursing students. This study supports the use of simulation for developing interdisciplinary collaboration, and also supports the use of Jeffries' Nursing Education Simulation Framework.

Core communication and interpersonal skills are a vital part of nursing, and simulation can be used to facilitate opportunities for practice of these skills. Leighton and Dubas (2009) described the use of high fidelity simulation to allow students to practice communication in end-of- life care in a small elective course (n=16). The scenario used was from the METI Program for Nursing Curriculum Integration, and a faculty member played the role of a family member. Students had read the case history and worked through preparatory questions in the preceding week and a group debriefing immediately followed the simulation. Following the simulation students evaluated the experience using an open ended questionnaire and the data were subsequently thematically analysed. Three main themes emerged: the positive impact of the family member role play on learning related to providing family support; the realistic nature of the simulation, including the simulation of physiological signs associated with dying; and the impact of the experience on the students' self-efficacy as they reflected on their need for more practice in the care of the dying patient. This study highlights some of the advantages of using creative, blended approaches to simulation, and illustrates that both role play and manikin simulation have features that contribute to students' learning experiences within the non-technical domain.

Interdisciplinary communication is critical to patient safety and the ability of nurses to identify and “rescue” the deteriorating patient. Krautscheid (2008) reports on the utilisation of high fidelity simulation with Laerdal’s SimMan™ as part of a program to improve senior undergraduate students’ communication competence using the Situation-Background-Assessment-Recommendation (SBAR) communication tool. Outcome evaluation using a performance checklist showed between 25 and 34% improvement in cohorts of students over a three year period.

Another area of nursing where nurses’ communication skills are paramount is mental health. Sleeper and Thompson (2008) used a creative approach with SimMan™’s vocal function to program a scenario that would allow practice in communication skills prior to students’ clinical placement in a psychiatric setting. A programming algorithm was used to allow SimMan to respond with short comments illustrative of major depression with suicidal ideation. Staff running the simulator could direct the algorithm progression by entering the student’s communication as either “correct” or “incorrect” based on principles that had been taught as part of the course. Two trial demonstrations of the simulation were run for a group of faculty and two nursing students. The simulation was evaluated using a form designed for the purpose. The results were very positive, indicating that the simulation could help students to relate theory to practice and prepare for clinical placement. Participants also reported a sense of realism during the scenario. Disadvantages identified for this form of teaching were the significant amount of time required to design and program the algorithm and educate faculty in its use, and the fact that only one student can participate in the simulation at a time, although observers could potentially be included. This study did not report the implementation of this program. More studies would be needed to evaluate the practicality and effectiveness of this approach.

7) Transferability to clinical practice

Although studies have been able to demonstrate some improved outcomes as a result of simulation activities, evidence that there is transferability of learning into the clinical environment is limited. In a study evaluating both undergraduate nursing student and faculty perceptions of high fidelity simulation by Feingold, Calaluce and Kallen (2004) participants were asked to score the simulation activity they had undertaken in three

main areas: realism, transferability of learned skills to practice, and value. Interestingly although the majority of students agreed that the simulation activity was realistic and valuable as a learning experience, only just about half felt that the simulation experience increased their confidence or clinical competence, and only a just above half felt that it prepared them for clinical practice. In contrast, all the faculty members involved felt that the learning from simulation activity would transfer. The researchers suggested that this difference may relate to the students' novice status causing them to focus on fragments of information rather than a more integrated picture. The researchers also commented that it may be impossible to quantitatively measure transferability because of patient safety issues.

Radhakrishnan, Roche and Cunningham (2007) conducted a small quasi-experimental study with the stated aim of evaluating the impact of simulation practice on clinical performance in the areas of patient safety, basic assessment, focused assessment, prioritisation, interventions, delegation and communication. Participants were twelve senior nursing students during their final semester, six in the intervention group and six in the control group. All students were involved with 320 hours of clinical placement practice. In addition the intervention group undertook two sessions of one hour complex high fidelity simulation. All students were then evaluated during a simulation session using an observational evaluation tool. Students in the intervention group achieved significantly higher scores for safety and basic assessment skills. There were no other significant differences in performance. Weaknesses in this study are the small sample size and the variability of the students' experiences on clinical placement. Also although it purports to evaluate the effects of simulation on clinical performance, it may in reality be measuring either the effects of familiarity with the simulation process, or the effects of clinical experience on simulation performance. The fact that only two out of the six performance categories evaluated showed significant differences suggests that 320 hours of clinical practice may have more impact than two hours of simulation; however the very small sample size and lack of control of variables make it difficult to draw any reasonable conclusions.

The study by Dillard et al (2009) previously discussed in relation to issues of self-rating confidence and competence also highlighted the poor transferability of concepts taught

through simulation into clinical practice in the student exemplars given. These researchers concluded that there needs to be stronger reinforcement of theoretical components during clinical placement and greater integration of theory and practice throughout the curriculum.

2.3.5 Indicators of quality use of HPSM.

As stated before, there is very little literature specifically addressing indicators of quality use of HPSM. Most literature which addresses the “how” of simulation use is descriptive in nature, giving examples of particular nursing programs’ implementation strategies and methods, but not giving any empirical data to support the benefits of one strategy over another. Other literature is qualitative in nature and based primarily on students’ feedback and focus groups. Because of this paucity of specific research, study results are discussed below in order to provide a beginning understanding of what is seen as quality implementation of HPSM.

1. Student preparation for simulation

Cantrell (2008) conducted qualitative focus group discussions with 11 senior level nursing students following simulation activities. Feelings of stress and intimidation related to the need to perform in front of faculty were highlighted by students. Content analysis of the discussion found three critical components of simulation that influenced student learning: adequate preparation, the demeanour of the faculty involved, and debriefing at the conclusion. In this study, the use of a case study which was reviewed and discussed in class prior to the simulation was seen by the students as better preparation than a list of questions for self-directed learning. These findings are similar to those of Elfrink, Nininger, Rohig and Lee (2009) in their evaluative study which aimed to identify and address issues relating to high anxiety levels in senior students undertaking simulation activities as part of an acute care nursing course. Based on a mid-semester evaluation questionnaire and focus groups, feelings of anxiety about being expected to perform with limited preparation, and not knowing where to begin were identified. The strategy employed to overcome this problem was the addition of a group planning session after the handover of patient information and prior to commencing the

simulation, and this was identified by students at the final evaluation as the most helpful aspect of the simulation.

The importance of preparation is also highlighted by the research of Blum, Borglund and Parcells (2010). Their study found that using simulation as the primary mode of learning nursing assessment and skills for first year students was not advantageous, and that confidence and competence levels were actually slightly higher in students taught by traditional methods as such lectures. This study draws attention to the need for students to be adequately prepared with basic knowledge and skills before they are able to confidently apply these skills in an immersive simulation.

These concepts are further supported by Arwood and Kaakinen (2009) in their simulation learning model, which identifies the first stage of learning as sensory-motor in nature, involving the reception of information from written and auditory information and demonstrated skills, and the second as pre-operational, involving imitation, replication of skills and repetitive practice. Until these early phases of learning have been achieved, more complex concept formation and application in a realistic simulated situation are not possible.

Alfes (2008) discusses the use of a brief video filmed in an acute hospital setting and using staff and students to role play the patient scenario to be presented in the simulation as an introduction to the simulation activity. Feedback from students and staff indicated that this was a positive way to provide visual and auditory input to orient and prepare the students for the simulation scenario to increase the fidelity of the experience. This approach also provided an opportunity of students to begin planning care before the simulation began.

Orientation to, and familiarity with the technology of the manikin being used are also important aspects of preparation for simulation reported by most authors as an integral part of most study designs. However the importance of this has not been tested as a controlled variable, probably because of tacit awareness of the essential nature of the need for familiarity with the technology for student learning.

2. Learning objectives and scenario complexity.

Clear learning objectives are regarded by many nurse educators as critical to designing any teaching strategy, including simulation. Smith and Roehrs (2009) conducted a descriptive, correlational study to examine the effect of high fidelity simulation on student satisfaction and self-confidence, and to correlate these outcomes to student ratings of the simulation for the five key design characteristics from Jeffries' Nursing Education Simulation Framework. Sixty eight undergraduate students participated in a high fidelity simulation scenario, and then completed a Student Satisfaction and Self Confidence in Learning Scale and a Simulation Design Scale (SDS). Results indicated that the design characteristics of clear objectives and an appropriately challenging problem to solve correlated significantly with student satisfaction and self-confidence respectively.

Parker and Myrick (2009) discuss the choice of behaviourist or constructivist teaching strategies based on learning objectives. When learning objectives encompass the acquisition of psycho-motor skills or the rote learning of factual knowledge, a behaviourist approach to simulation is recommended, with the avoidance of any additional distracting information, simple focus with limited complexity, supplementation with didactic classroom teaching, and opportunities for repetition. In contrast, when knowledge application and critical thinking are the objectives of simulation, constructivist approaches should be used, which should include the presentation of a realistic, complex scenario, and as realistic an environment as possible, including the fidelity level of the manikin, and all necessary clinical equipment. The provision of accessible learning resources such as online material, and the facilitation of problem solving through group collaboration and instructor facilitation were also seen as relevant to this style of learning and for developing higher order thinking skills. The complexity of scenarios requiring problem solving was the only design characteristic that was found by Smith and Roehrs (2009) to significantly contribute to the level of students' self-confidence outcome.

3. Ability to accommodate diverse learning styles

Ability to accommodate diverse learning styles is one of the pedagogical practices that the Jeffries model identifies. Fountain and Alfred (2009) explored how learning styles correlate with student satisfaction with high fidelity HPSM. All students in a baccalaureate nursing program had been tested on enrolment to determine their preferred learning styles. The 78 participants in the study attended a lecture on cardiac disease, completed five paper based case studies, and then attended a three hour skills laboratory consisting of 90 minutes reviewing and interpreting dysrhythmias and emergency drug management, followed by a 90 minute group high fidelity simulation activity. Participants then completed the Student Satisfaction and Self Confidence in Learning scale. The results of these scales were correlated with their identified preferred learning styles. Correlations were found between student satisfaction scores and both social and solitary learning styles. The authors concluded that the group approach to the laboratory activity accommodated both learning styles. There was no discussion of other aspects of learning style such as auditory, visual, oral dependent or writing dependent, although the range of activities covered aspects of all these learning styles. The study did not specify which roles, such as active participant or observer, were allocated to students or assumed during the simulation experience.

4. Time on task

The Jeffries (2007) National League for Nursing (NLN) Education Simulation Framework was also used to guide the design and integration of simulation into a first year foundations nursing course of 100 undergraduate students (Kardong-Edgren, Starkweather and Ward, 2008). Three simulation scenarios spread over the semester were designed to help students improve learning of certain basic skills associated with this course: infection control, sterile specimen collection, communication, sterile dressings and cardiopulmonary resuscitation. Overarching course objectives of professional interaction, cultural competence, patient safety, basic assessment and documentation were also included. Students completed learning modules on skills beforehand, were given learning objectives, and had orientation to the medium fidelity VitalSim manikin used for the simulations. Students participated in groups of five and were assigned specific roles. A faculty member was in the room and served as the voice

of the patient, also using this to cue students if they were unsure about how to proceed. On each occasion the scenario ran for approximately 15 minutes followed by a 15 minute debriefing, and then the scenario was repeated with group members taking different roles, and a second debriefing was conducted. Students then evaluated each simulation session using the NLN tools relating to educational practices, simulation design and student satisfaction and self-confidence. All aspects of the simulations were rated positively by students, demonstrating successful application of the Jeffries model to simulations involving medium fidelity manikins. Faculty provided qualitative feedback, from which three key themes were identified. Staff found the simulations to be a creative teaching tool, however it required additional time to coordinate and implement. The opportunity for repetitive practice afforded by the structure of three simulations, each with repetition, was seen by faculty as valuable for consolidation of technical and interpersonal skills as well as reasoning and critical thinking. The main limitation of this study is its reliance on student and staff perceptions without attempting to measure outcomes in terms of skill acquisition or transferability into the clinical setting.

5. Simulation group sizes and allocated roles

Simulation group sizes vary in research studies, with convenience appearing to be the main factor in determining group size. Most groups have various allocated roles such as primary nurse, assistant, transcriber and observer. There is no research comparing the effectiveness of different group sizes, and little research on role allocation and use of observers as part of the process. Jeffries and Rizzolo (2006) found no significant difference in outcomes between active participants and observers in simulation groups. Schoening, Sitter and Todd (2006) found that students perceived observing situations as beneficial. However, in contrast to this Lasater (2007a) found from qualitative focus group interviews that students observing simulation from another room often found this boring and not useful, and that it was difficult to maintain focus on the simulation. In a study focusing on the impact of video-assisted debriefing Grant, Moss, Epps and Watts (2010) found that allocated role (team leader, airway manager, crash cart manager, recorder and medication nurse) significantly affected performance measure scores, with team leader and airway managers scoring higher. The recommendation from this study

was that students should have the opportunity to rotate through different simulation roles to maximize their learning.

6. Student support during simulation

Despite this lack of clarity in relation to group size and role allocation, there is research which supports the value of group process and collaboration in students' learning. Lasater (2007a) identified meaningful collaborative and narrative learning, including working in teams and learning from each other's experiences during the simulation and through shared thoughts and stories during debriefing, as important components of high fidelity simulation. Fountain and Alfred (2009) found that group learning experiences during simulation accommodate both social and solitary learning styles, with the social learner taking the lead in activities and the solitary learner benefitting from thoughtful observation. As discussed above, Elfrink et al (2009) found that group planning for simulation reduced students anxiety and encouraged teamwork and collaboration.

A study by Schoening, Sittner and Todd (2006) examined the design characteristic of support with a focus on the role of the educator in promoting positive student outcomes. Sixty baccalaureate students doing a high-risk obstetric clinical rotation took part in a simulation experience in two four hour sessions over two weeks. The design of the simulation experience was based on Joyce and Weil's (1996) 4-phase teaching model for simulation, which categorises simulation phases as orientation, participant training, simulation operations, and participant debriefing. Using this model students work as a group and the educator acts as a guide, taking the roles of explaining, refereeing, coaching and discussing. In this study the educator was present to support the students throughout the simulation, made possible by the availability of a simulation coordinator who controlled the physiological parameters of the "patient" and took the part of the patient's and doctor's voice. This model of simulation varies from the "fully immersive" model, in which participants must react to the situation presented independently. The simulation was evaluated using a questionnaire of students' perceptions of increased confidence, skill and knowledge, which produced positive responses. Students were also encouraged to write narrative comments on the questionnaire and complete weekly reflective clinical journals. Entries in these journals were content analysed, similar concepts grouped and categories synthesised and

validated by academics external to the project. Major themes identified in the student reflections included: the value of hands-on practical learning, increased confidence and self-efficacy as a result of the non-threatening learning environment, opportunity provided by a realistic scenario to develop knowledge, critical thinking and decision making, clinical transferability of the learning, and the opportunity for the development of teamwork and communication skills. The authors concluded that the data and emergent themes validated the Joyce and Weil model as a successful guide for the implementation of simulation, and the supporting role of the educator during the simulation. The main limitations of this study were that it was based on student perceptions, did not use any tool to measure outcomes such as increased knowledge or skill, and the study design did not include a comparison group.

The demeanour of the faculty involved in the simulation activity was identified as a critical component of students' learning experience by Cantrell (2008). Faculty who provided cuing and coaching for students during the simulation, and who had a supportive, friendly manner lessened students' anxiety and supported learning, while faculty who did not engage with students, assist or encourage them or who were seen to be overly critical of students performance were not viewed by students as helpful to learning.

An experimental post-test only study conducted by Swanson, Nicholson, Boese, Cram, Stineman and Tew (2011) evaluated the impact of three teaching strategies on students' performance, retention performance, satisfaction, self-confidence and educational preferences. Three active learning strategies were utilised in week one of the study in addition to the scheduled lecture and study guide on cardiovascular nursing, with randomly allocated groups of second semester baccalaureate nursing students: written case study and questions, high fidelity simulation, and high fidelity simulation with "narrative pedagogy". Jeffries model (2005) was used as the theoretical framework for the simulation design. Narrative pedagogy was defined by the researchers as mutual dialogue, including cuing and probing questions, to guide students during "time out" periods called during the simulation. This technique creates a higher level of faculty support during the simulation. Outcomes for the three teaching strategies were measured using the Student Performance Demonstration Rubric to score digitally

recorded individual performances using high fidelity simulation and a new cardiac scenario during week 3 and week 8 of the program. The rubric consisted of a checklist of 120 essential care items for the cardiac patient. Students also completed a reflective self-evaluation, an Educational Practices Questionnaire, A Student Satisfaction and Self Confidence scale and a Follow-up Information questionnaire to collect information on student experiences of caring for patients with cardiovascular disease after the teaching interventions. Students in the simulation with narrative pedagogy group scored significantly higher than the other two groups in the first performance test. However a perhaps unexpected result at the second performance test was an overall improvement in scores for all groups with a close clustering of means. Continued improvement in performance could be attributed to reinforcement with further simulations and also clinical experience. The researcher attributed the higher scores for the narrative pedagogy group in the first test to the supportive nature of the teaching method. There were no significant differences in satisfaction and self-confidence scales or education practices scores, and no apparent differences in subsequent patient care experiences. This study supports the benefits of faculty support and guidance for novice students during simulation activities.

7. Fidelity

The issue of fidelity is considered to be very important in the simulation effectiveness debate, as high fidelity manikins are expensive to purchase, and require a purpose equipped simulation unit with audio visual equipment and a separate computer and debriefing room for optimal function, as well as additional staff training in programming and running the scenarios. Much of the research has focused on measuring the impact of manikin fidelity on learning outcomes. In some studies use of high fidelity manikins has shown greater student satisfaction than low fidelity trainers (Jeffries and Rizzolo, 2006; Bruce, Scherer, Curran, Urschel, Erdley and Ball, 2009) but no significant difference in satisfaction has been demonstrated between high and medium fidelity manikins (Kardong-Edgren, Lungstrom and Bendel, 2009). Reilly and Spratt (2007) have demonstrated the value of using medium fidelity manikins with VitalSim capacity and computerised scenario building to achieve a similar outcome to that achieved with high fidelity manikins. Improved student self-confidence has been

demonstrated following high fidelity simulations (Ravert, 2004; Jeffries and Rizzolo, 2006; Bambini, Washburn and Perkins, 2009).

In terms of technical skill acquisition, no statistical significant differences were found between high and low fidelity manikins by Rogers (2007), Hoadley (2009) and Blum, Borglund and Parcels (2010), although a study by Grady, Kehrer, Trusty, Entin, Entin and Brunye (2008) supported the value of using high fidelity manikins. Similarly, for basic knowledge acquisition high fidelity simulation was not found to be better than case studies (Scherer, Bruce and Runkawatt, 2007), low fidelity manikins (Hoadley, 2009) or medium fidelity manikins (Kardong-Edgren, Lungstrom and Bendel, 2009).

However, when considering higher order skills such as critical thinking and collaboration, research indicates the potential benefits high fidelity manikins, although further research is required (Lapkin et al, 2010). High fidelity manikins have been found to promote cognitive skills when compared to case study (Howard, 2007), lecture (Brannan, White and Bezanson, 2008) and low fidelity manikins (Rogers, 2007). However, Ravert (2008) failed to find a significant difference between HPSM and group discussion for improving critical thinking. High fidelity simulation has also been found to improve interdisciplinary collaboration by Dillon, Noble and Kaplan (2009) and Ruse, Jeffries and Engum (2010). While the clinical fidelity of the scenario and the realism of the equipment and environment are mentioned by many researchers as important aspects of fidelity no research studies have been found that addressed the impact of environmental fidelity on learning outcomes.

8. Debriefing

Debriefing is identified as a crucial element of simulation based learning (Jeffries, 2007)). Although debriefing is almost universally regarded as a critical aspect of simulation learning, and there are a number of recommended debriefing frameworks there is very little research evaluating the impact of debriefing methods.

Dreifuerst (2009) conducted a concept analysis to define the essential elements of effective debriefing. Common elements of debriefing were identified as critique, correction, evaluation of performance and discussion of experience. The importance of encouraging reflective thinking in order to gain deeper insight is critical to learning.

Based on reflective practice and constructivist theory Dreifuerst identified and exemplified five key attributes of effective debriefing: reflection, emotion, reception, integration and assimilation. Important attributes that this model adds are the integration of new material into a familiar scaffold or framework that the learner can call upon in future experiences, and assimilating the new learning so that it is transferable to other situations. Antecedents identified for meaningful debriefing to occur are a detailed patient story or scenario, meaningful physiological responses from the manikin and scenario, and defined learning objectives that link to curriculum objectives. The desired consequences of effective debriefing are significant learning that can be demonstrated in improved clinical judgement and decision making, and that is transferable to new situations and clinical practice.

A study by Kuiper, Heinrich, Matthias, Graham and Bell-Kotwall (2008) aimed to determine the clinical reasoning activities involved in HPSM and whether the Outcome Present State-Test (OPT) model (Pesut and Herman, 1999) could be used as a debriefing method to improve clinical reasoning. This model involves determining the client's situation by assessment, creating a web of competing nursing diagnoses, and then choosing a priority focus of care as the keystone for determining goals and actions. This complex mapping is heavily influenced by the Nursing Process from the original North American Nursing Diagnosis Association (NANDA) diagnostic system. In this study 44 senior undergraduate nursing students involved in an acute care course were required to use OPT worksheets to map the care of 5-6 patient they had cared for on clinical placement. They also completed a 4 hour group simulation activity at a variable time during their clinical experience. Following the simulation scenario and group discussion OPT worksheets were completed. Students were allowed to use textbook and PDA resources. Worksheets from the clinical placement experiences and the simulation experience were then compared using a validated rating tool. A comparison of the two groups showed no significant differences in scores. From this analysis the authors discussed the application of cognitive theory in the simulation process, and concluded that the similarity of scores in the two group indicated that the OPT model worksheets supported clinical reasoning and could be used as a method of debriefing. The limitation of this study included the small sample size, the descriptive study design, and the lack of control of variables. There was no measure of the effectiveness or outcomes of the

students' actions during the simulation. As the worksheets were completed retrospectively it was not clear to what extent these reflected the reasoning process followed during the actual simulation experience, or if the arguably cumbersome NANDA diagnoses guided real time action.

A small qualitative study by Cantrell (2008) of senior nursing students (n=11) evaluated the benefits of structured debriefing for students' learning. Following participation in each of three paediatric based simulation scenarios the students received the standard oral debriefing immediately after the simulation. They also participated in one of two structured, investigator-led debriefing sessions using videotapes of the simulations during a focus group interview two weeks after the completion of the simulations. Audio-taping of the focus groups was used to collect data on students' perceptions of the comparative value of the standard and the structured debriefing. The analysis showed that students strongly believed that debriefing immediately after the simulation was critical, and the timing of the debriefing was more important than the format or use of video assistance. Immediate debriefing while the experience was fresh was the key issue. Students also suggested that staff demonstration of the simulation at the conclusion of debriefing would have been helpful.

In terms of the content of feedback given during debriefing Lasater (2007a) found in her study of student experiences of simulation that participants strongly desired direct and specific feedback on their performance. As well as positive and supportive feedback students wanted straightforward information on the likely outcomes of their decisions during the simulation, including discussion of their areas of weaknesses. Students valued discussion and input from the facilitator and their peers. Students also felt that using the video of the simulation to critique their actions was a useful idea. This finding is contrary to the findings of Elfrink et al (2009) who found that students' initial most negative feelings about simulation were related to the use of video and the review of the videotape during the debriefing session. This negativity seemed to relate to an overall high level of performance anxiety in this particular sample. When group planning and collaboration were added to the simulation process students became less anxious and more engaged, and video review of the simulation was able to be reintroduced.

A number of authors have produced guidelines for debriefing. Owen and Follows (2006) recommend using the mnemonic GREAT, representing Guidelines for best practice, Recommendations from the literature, Events during the simulation, Analysis of actions taken, and Transfer of knowledge gained to clinical practice, as a framework for discussion. Henneman and Cunningham (2005) discuss the importance of validating students' feelings following the simulation with the goals of promoting self-assessment, critical thinking and development of confidence. Discomfort of some students with videotaping is also mentioned. They recommended a format of a short debriefing session immediately following the simulation to review students' feelings and answer questions, followed by student private review of the videos and completion of a debriefing questionnaire, and a class discussion of the simulation once all students had completed the activity. Kuiper et al (2008) also recommend a written exercise, involving the creation of an interconnecting web of patient issues based on NANDA diagnoses as an adjunct to verbal debriefing discussion. Cato, Lasater and Peeples (2009) also used written reflection following verbal debriefing to further enhance deep reflection.

A small quasi-experimental study by Grant, Moss, Epps and Watts (2010) evaluated the impact of videotape-facilitated debriefing, compared to standard oral debriefing. Participants were 34 senior undergraduate nursing students and 6 senior nurse anaesthetists. All students participated in their usual didactic coursework and simulation activities, relating to the care of complex pulmonary and cardiac patients. The simulation component was guided by the Jeffries (2005) model. Students were randomised into either the intervention (video-facilitated debriefing) group or the control (oral debriefing only) group. All students participated in two 60 minute simulations, and a third simulation was used at the end of semester to evaluate performance using a validated observational tool. Recorded behaviours related to patient safety, communication among team members, basic and problem focused assessment, prioritization of care, appropriate interventions and delegation. Students in the intervention group had significantly better scores for three behaviours: patient identification, team communication and assessment of vital signs. Mean scores were higher than the control group for 9 of 14 behaviours but did not reach significance

overall, however the sample size was small. This study overall supports the potential for use of video assisted debriefing.

9. Issues with curriculum integration and staffing

The importance of planning for the implementation of simulation activities into a nursing program has been acknowledged, but most recommendations are on the basis of experience, not supported by specific research. Articles are of a descriptive nature, outlining various implementation strategies used. One such paper outlines a model that integrates problem based learning and simulation activities (Murphy, Hartigan, Walshe, Flynn and O'Brien, 2011), focusing on active engagement and student-centred learning. Content is presented as a series of patient problems, which are addressed through problem-based learning tutorials, skills laboratories for the acquisition of psychomotor skills, and finally scenario based simulations. Wilford and Doyle (2006) discuss the process of implementing the METI programme for Nursing Curriculum Integration, which provides a number of pre-programmed scenarios, throughout the curriculum of a UK school of nursing. No studies were found that tested curriculum integration strategies against learning outcomes.

Issues relating to planning, financing and purchasing simulation equipment are outside the scope of this review, but the issues of curriculum integration and staffing of simulation activities do impact on the quality of the educational experience. In a study conducted to evaluate the perceptions of undergraduate nursing students and their faculty regarding high fidelity simulation using Laerdal's SimManTM, Feingold, Calaluce and Kallen (2004), found that the majority of faculty stated that using SimMan required more preparation time than traditional methods used for clinical teaching and assessment. Preparing a well-designed scenario and computer program for SimManTM and providing realistic detail in the environmental set up were considered important but time consuming activities. The study findings support the benefit of employing a full time simulation specialist. This is also supported in a discussion paper by Seropian, Brown, Gavilanes and Driggers (2004b) who include faculty development as a vital part of a simulation development program and recommend that trained simulation specialists guide and support faculty in creating curricula that include simulation. Jones and Hegge (2008) surveyed faculty members from a Midwestern US nursing program to determine

staff perceptions of workload requirements for the implementation of a simulation program using Laerdal's SimManTM. Approximately half of those surveyed indicated that they would need .5 FTE (full time equivalent) release to plan for the introduction of simulation and another .5 FTE to implement high fidelity simulation into nursing courses.

A number of articles discuss ways to improve faculty understanding and acceptance of simulation within the curriculum, but are mainly descriptive and opinion based. Some authors have applied a model or framework to the process of integrating simulation into a program. Starkweather and Kardong-Edgren (2008) utilised Diffusion of Innovation Theory, with five stages of knowledge, persuasion, decision, implementation and confirmation identified.

2.3.6 Use of simulation for student assessment and remediation.

While the most common use of high fidelity simulation is as a teaching strategy, simulation is also being used as part of both formative and summative student assessment, and as an alternative strategy for remediation of students experiencing clinical difficulties. A discussion paper by Haskvitz (2004) outlines a process for using simulation to remediate, emphasising the importance of first clearly identifying the areas of weakness, planning the scenario and simulation to provide practice in these areas, allowing for multiple repetitions until proficiency is achieved, provision of good instructor support, and debriefing that reviews the set learning objectives and evaluates improvement. Simulation was identified as an effective remediation tool, but was also labour intensive and thus a costly activity.

An important issue related to the use of simulation for student assessment is the need to develop valid and reliable assessment tools. Prion (2008) discusses the importance of using effective tools to measure student outcomes and how to develop these using an input/environment/outcome framework. The environment or quality of the simulation experience can be measured using the National League for Nursing Simulation Design Scale and Educational Practices in Simulation Scale (Jeffries, 2004). Prion also discusses a number of methods of evaluating students' performance during simulation,

including verbal and written tests, concept maps, direct observation using behavioural checklists, video review, objective structured examination (OSCE), Lasater's Clinical Judgement Rubric (LCJR), and various satisfaction and self-confidence scales (Prion, 2008).

Lasater's Rubric (2007b) has been used in a number of studies and as part of course requirements to assess clinical reasoning, as discussed previously, however this tool is limited in terms of the scope of competencies being assessed. A broader based assessment tool, which utilizes the American Association of Colleges of Nursing (AACN) (1998) core competencies, and adapts them to simulation situations, has been developed (Todd, Manz, Hawkins, Parsons and Hercinger, 2008). This tool uses the key competency area of assessment, communication, critical thinking and technical skills and identifies critical behaviours within these areas. Content validity was determined by a panel of faculty experts using a rating scale. Six faculty evaluators were formally trained in observational assessment using the tool and inter-rater reliability was tested during 16 simulations, with two evaluators for each simulation. The overall agreement level was 81.3% which was considered acceptable. The lowest levels of agreement were related to correct performance of technical skills. Documentation was considered not applicable, as simulations did not run long enough for effective documentation to occur. Although this study involved a small sample and only one institution, it points to the potential for simulation to be used for competency based assessment.

While various outcomes assessments have been used to give students formative feedback and as an outcome evaluation tool in studies to demonstrate the effectiveness of simulation as a teaching strategy, more recently simulation has been used for summative assessment of students. Clinical Assessment Simulations (CAS) are "structured, purposefully written and levelled for summative evaluation of the learner at a selected point in the curriculum." (Krautscheid, 2008). CAS inform faculty of each student's competency in essential skills, and aggregated performance outcomes can also be used to evaluate the effectiveness of teaching strategies and to prompt curriculum improvement. Krautscheid (2008) discusses the use of CAS to identify inadequate communication techniques in senior undergraduate nursing students leading to a project to improve the teaching of communication skills including the implementation of the

Situation-Background-Assessment-Recommendation (SBAR) communication tool.

Following curriculum changes to improve teaching and opportunities for repeated practice of SBAR, improvements in aggregate communication criteria were used for ongoing program evaluation.

The use of simulation as a final or capstone competency assessment prior to graduation or licensing could be seen as controversial, as transfer of competence from simulation to the real world clinical setting has not been adequately demonstrated. Corbett, Miles, Gantt, Stephenson and Larson, (2008) discuss the implementation of a capstone simulation based assessment into a senior undergraduate course using an engagement theory framework. Key points discussed include collaboration with clinical partners to ensure the development of high quality scenarios with clinical relevance, and engagement of the students in preparation for the assessment through student, faculty and interdisciplinary collaboration, student created learning contracts, availability of online and multi-media learning resources, ongoing discussion of key concepts related to critical thinking and clinical judgement, and multiple opportunities for practice with HPSM. Initial evaluation of the course has shown an improved level of students' mastery in clinical skills, clinical judgement and organisation; and students' self-reported increased confidence in the clinical environment.

2.4 Information communication technology

While there is considerable literature related to ICT in nursing practice, less literature related to nursing education is available, and articles specifically focused on simulation activities are limited. ICT in nursing involves issues of easy access to information, including online books and journals as well as hospital policy documents. Within the Australian context ICT has also been used by nurses in the clinical setting to access some electronic medical records, online pathology results, pharmacology information and in some instances electronic medication ordering systems (Bembridge, Levett-Jones and Jeong, 2010). Person Digital Assistants (PDAs) provide mobile access to uploaded software and also online data bases if wireless internet access is available.

Internationally ICT is more widely used as a care planning tool, and clinical decision making support software systems are also being developed which provide algorithms to

guide diagnostic and treatment decisions (Anderson and Willson, 2008). Some of these developing systems are based on clinical decision making models and attempt to guide clinical decisions based on known theory of critical thinking and novice nurse decision making (O'Neill, Dluhy, Fortier and Michel, 2004). Computers are also being increasingly used for electronic point-of-care or paperless documentation in the United States necessitating the development of core curriculum competencies (Curran, 2008), although Australia is for the most part still developing point-of-care documentation systems such as the electronic medical record . While students may be exposed to a number of these technologies on clinical placements, ideally they need to learn to use and integrate these into their practice throughout their educational program in order to effectively utilize these new technologies and also prepare for future practice requirements.

2.4.1 Current use of ICT in nursing programs

An Australia wide survey of registered nurses was conducted in 2005 to determine the adequacy of ICT training in pre-registration courses and also ongoing post registration education. Ten thousand members of the Australian Nursing Federation were posted questionnaires, with a 43.3% response rate. Fewer than 17% of participants had received formal ICT training during their pre-registration education, and almost half felt they needed more training to effectively meet the ICT requirements of their employment (Eley, Fallon, Soar, Buikstra and Hegney, 2008). A study by Levett-Jones et al (2009) that surveyed 971 students from three Australian universities as well as conducting focus groups, found that only 50% of students were "very confident" in using a computer and 26% were unsure about the relevance of ICT to clinical practice. Lack of ICT skills have been identified as a significant workforce issue (Garling, 2008). While ICT use is part of normal teaching and learning activities in Australian universities and online learning continues to expand, no Australian studies were found at the time of this review that addressed the use and integration of ICT specifically in clinical teaching laboratories or simulation units.

In the United States an online survey was conducted by McNeil, Elfrink, Bickford, Pierce, Beyea, Averill and Klappenbach (2003) of faculty from 266 nursing programs to investigate the level of ICT training being provided in curricula, the preparation of

faculty to teach the material, and perceived requirements for practicing nurses. Results showed a limited level of expectation and training for students, with only one third of programs including skills required for evidence based practice and less than one third addressing standardised languages used in health applications. Many faculty members who were only rated as having novice or beginner levels of ICT skills were involved in teaching ICT. However the majority of faculty identified the need for students to be prepared to use ICT, and that the need would increase with time and technological advances. This study did not address the integration of ICT teaching into laboratory or simulation activities.

The impact of low faculty level of ICT ability is also mentioned in other studies. A study by Scollin, Healey-Walsh, Kafel, Mehta and Callahan (2007) to explore the attitudes of students from two university schools of nursing towards the use of PDAs during clinical placement found two main differences between the campuses. Students at the campus where student ownership of the PDA was higher (as opposed to loaned PDAs), and where most of the clinical instructors were identified as using PDAs had higher levels of student usage and a more positive student attitude. The researchers concluded that the manner of introduction of the technology impacted on students' attitudes and usage. The pre preparation and training of faculty and their ability to act as role models in the use of the technology was crucial. This is supported by an exploratory study of the frequency PDA usage on clinical placement among second-degree undergraduate nursing students by Miller et al (2005). This study found that budget constraints which resulted in the PDAs not being provided to the clinical instructors may have resulted in the faculty not encouraging students' PDA use due to their own lack of experience with the technology. Students' evaluations of PDA usage in this study were mixed, with approximately half the students finding the technology useful. Recommendations included the provision of adequate training and support, including provision of PDAs and training for faculty to promote their comfort level and ability to role model and assist students.

Ip, Jones and Jacobs (2007) conducted a study to evaluate the extent to which students' ICT knowledge was retained and applied over time within programs. Participants were 150 second year undergraduate nursing and midwifery students who had already

completed an introductory course in Microsoft Office. They were then given a further one and a half hour laboratory course in Microsoft Excel. The participants completed a computer attitude scale (CAS) immediately before the training. As part of the training all students were required to demonstrate competence with the basic skills being taught, and then their perception of the applicability of the skills was predicted by measuring the students perceptions of ease of use and usefulness with the Technology Acceptance Model (TAM). A second evaluation was conducted six months later which included a questionnaire on aspects of skills usage and a focus group to discuss in more detail the retention and application of the learned skills and opportunities during their courses to utilise these skills. Results showed that during the six month period only half the students had used Excel to create tables or graphs and a much lower number (19% and 28%) had used the arithmetic or statistical functions. When responses were matched to students it was found that there was no correlation between general attitude to IT (CAS score) and skill usage, but a positive correlation between perception of ease of use and usefulness (TAM score) and ongoing skill usage. There was also a negative correlation between CAS anxiety score and use for arithmetic calculations. Focus group comments highlighted the fact that students rarely used statistical analysis in their degree courses or clinical areas, which led to acquired skills being forgotten. This study points to several requirements for effective teaching of ICT skills in nursing. Skills and programs need to be carefully chosen for usefulness and applicability, and then opportunities need to be available throughout the curriculum to reinforce and practice, and to apply them in real world situations.

2.4.2 Use of ICT by students in clinical placements

There have been a number of studies relating to the use of PDAs by student nurses on clinical placement. While this is not the main focus of this review, selected studies have been included that identify outcomes of ICT use and key issues for quality implementation of ICT into nursing education that are applicable to utilisation in simulation laboratories.

1. Student usage and satisfaction

Elfrink et al (2000) undertook a three year research and development project to introduce computer based electronic communication for the supervision of undergraduate nursing students while on community clinical placement. Participants in the study were 44 students from five nursing schools who were trained by the instructors in the use of the Nightingale Tracker (NT) system. Students then visited at least one community patient per week and electronically documented and submitted the care given. All students completed an attitudinal survey immediately after training and after six weeks of use, and 18 students had usage for 13 weeks and then repeated the survey. Results at six weeks showed better acceptance by students who had received more instruction in use of the system. Scores at 13 weeks had improved, indicating progress with learning the new technology. Several recommendations relating to training in ICT were made as a result of this study, including the need to assess students for baseline ICT ability, to allow adequate, structured training time, and practice in a learning environment with example case studies prior to use in the real world. The need to teach troubleshooting and provide access to technical support was also noted. These findings point to the need to incorporate ICT training into curricula prior to its anticipated use either in simulation or during clinical practice.

A Swedish study by Berglund, Nilsson, Revay, Petersson and Nilsson (2007) identified students' requirements for PDA function and usability. Nursing students (n= 112) completed a questionnaire based on findings from interviews with nurse clinicians. Pharmaceutical resources were the most frequently identified information requested, followed by test results and normal values, and medical records. Functions of calculator, camera and journal recording were also mentioned. This is consistent with the study by Miller et al (2005) who found in a study of PDA usage among second-degree undergraduate students at a US school of nursing that the most used resources, in order of frequency were medication information, medical dictionary, calendar and address/telephone book.

2. Impact on knowledge acquisition

A quasi-experimental Australian study by Farrell and Rose (2008) investigated whether PDAs enhanced pharmacological knowledge of nursing students during a medical-surgical clinical placement, and also factors affecting PDA use in the clinical setting. Seventy six students were randomly allocated to a PDA group (n=41) and control group (n=35). The PDA group attended a training session three weeks prior to clinical placement using Hewlett Packard PDAs with Monthly Index of Medical Specialties (MIMS) drug reference guide and two Excel documents (an appraisal tool and a skills checklist) uploaded. All students completed a multiple choice pharmacology test one week prior to placement and on completion of the placement. Both groups showed marginal mean increases in post-test scores, with the PDA group showing greater improvement but not to a level of statistical significance. Focus groups were also conducted to evaluate student usage and impressions of training and support. Most students had prior computer experience and found the PDAs easy to use. Small screen size was identified as a problem for some students. The MIMS pharmacological database was the most used feature, with calculator and Word functions less used. Excel documents presented formatting problems for some. All students felt that the PDAs enhanced their pharmacological knowledge and most felt they were useful at the bedside to access drug information, although a few found them inconvenient to use and were hesitant about use in front of patients, with some students feeling that this appeared rude. Students did not feel that the PDA enhanced their cognitive or psychomotor skills however there were no preloaded medical-surgical nursing programs. Students commented they would like to have had access to clinical guidelines, pathology results, a medical dictionary, a list of abbreviations and internet access. While this study does not provide conclusive evidence of the benefit of PDA to students' learning it does help to identify the types of software and application that students may find useful.

3. Impact on critical thinking

Newman and Howse (2007) conducted an evaluative study on teaching PDA documentation to fourth-year baccalaureate nursing students with the aim of improving attitudes to electronic documentation and its impact on clinical judgement. Participants

(n=56) were given a three hour training session on use of the PDA and software Patient Tracker documentation system, and Epocrates Rx medication reference. A pre-test, post-test study design was used with the collection of both quantitative and qualitative data. Quantitative instruments were a Professional Autonomy Nursing Scale, an Opinionnaire Computing in Nursing and a satisfaction survey. An open ended question was also included asking students to describe their experience of using the PDA. No statistically significant difference was found in overall attitudes to PDA use following the training; however there was a significant increase in scores for anticipated use of professional judgement. Student satisfaction with the attributes of the PDA and with the training session was high. Qualitative responses were variable with some students judging the PDA as an efficient way to access information and other viewing it as time consuming. As in the study by Farrell and Rose (2008), the size of the screen and eye stress was mentioned by some. Overall the researchers concluded that PDA use has the potential to facilitate effective documentation and support evidence based clinical judgement, although study findings were based on student opinion with no outcome measure for effective PDA usage.

Cornelius (2005) conducted a study to evaluate the impact of using PDAs equipped with a gerontological assessment tool on students' clinical decision making skills. Twenty one undergraduate nursing students were asked to use the PDA based tool to assess a total of 212 aged patients and identify the three highest priority nursing care needs. The same assessments were undertaken by two expert faculty members and in all cases the students identified the same three care requirements. As there was no control group in this study it was not possible to conclude that the competent care need identification was due to the use of the PDA tool. Students were also interviewed and two thirds identified that the use of PDA created a barrier to nurse-patient interaction. This is consistent with some student comments in the study by Farrell and Rose (2008).

2.4.3 Best practice recommendations for ICT education

As well as the type of technology and software the teaching strategies used are important for encouraging nursing students' competent use of ICT. Length of training (Elfrink et al, 2000) and ongoing support from teachers and clinical staff (Farrell and

Rose, 2008; Scollin et al, 2007; Miller et al, 2005)) has been noted. Literature specific to use of ICT in Australian schools of nursing is very limited.

A multidisciplinary, multisite Australian project supported by the Australian Learning and Teaching Council Ltd (ALTC) (Kennedy et al, 2009) investigated university students' and teachers' level of experience with ICT, and their preferences for its use. It also examined issues emerging from the implementation of new technologies into a range of programs. The study found a wide variation in the level of experience with ICT among both students and staff. A number of recommendations made are pertinent to quality implementation of ICT in nursing clinical laboratories. Positive staff and student experiences with ICT were found when the technology had a clear relationship to the overall course and curriculum objectives and assessment requirements. As many staff and students needed to develop new skills, adequate learning support was crucial. The development of ICT learning activities requires a diverse range of skills and knowledge, both technical and discipline based, and a team approach was recommended

A multi stage evaluation of ICT curriculum integration in a US university included a survey of faculty to rate graduating nurses ICT competence and to identify barriers to, and strategies for improving ICT outcomes (Fetter, 2008). The survey had a 45% response rate. Faculty identified that most students had high levels of computer literacy and learned quickly, with older and international students identified as needing more time and support. There were a range of problems associated with student use of ICT in health care settings, including variations in systems and need for additional training, issues relating to access, privacy and security of data, and the need for a system such as the Nightingale Tracker to allow faculty communication with students on remote or community placements. Recommendations arising from this study for best educational practices included computer access, preferably laptop, for all students, with one consistent platform for all coursework and the provision of adequate technical assistance including troubleshooting during evenings and weekends. There were mixed opinions expressed about the value of PDAs, with problems associated with on-site internet access and privacy of patient data, and availability of hospital based systems making student PDAs redundant. Student access to ICT experiences in clinical

laboratories and simulations, including the use of systems that are in use in the clinical setting was recommended.

2.4.4 Curriculum and simulation integration of ICT

Newly graduating nurses require a range of ICT skills to function effectively in the clinical environment. The ability to access policy and best practice information as well as to use any point of care information retrieval or documentation systems is essential. In light of the above studies on students' learning of ICT skills, the need for training, repetition and integration throughout curricula is apparent. A number of projects have addressed methods to integrate ICT into undergraduate programs, including in some cases integration into simulation and laboratory activities. Cornelius and Gallagher (2006) describe the process used to introduce and integrate PDAs into their undergraduate nursing curriculum. The PDAs were equipped with drug and laboratory references and a geriatric assessment tool and were initially introduced in a first year foundations course, along with other basic skills such as measuring blood pressure. A nursing informatics course provided structured laboratory teaching, and this was integrated with library search skills and internet access to data bases. When students went on clinical placement they were encouraged to use the PDAs to access information, as well as to write drafts for nursing notes. The authors also briefly mention that students can use the PDAs in final year simulation laboratories. Key points recommended for successful curriculum integration include adequate administrative support and financial commitment, adequate infrastructure support such as wireless internet and downloading rights, a core informatics team to lead the initiative, and comprehensive training and support for both faculty and students.

Five other papers have been identified which describe projects to integrate ICT into nursing curricula. Curran, Sheets, Kirkpatrick and Bauldoff (2007) describe a project that aimed to improve students' ICT skills and registered nurses' access to and use of reference information at the point-of-care. In a partnership of the university with a local medical centre, a classroom version of the clinical information system was developed that allowed the nursing faculty to embed a mock hospital system of electronic patient records, case studies and policy documents into the curriculum. Patient results and orders could be sent during laboratory simulations, allowing case studies to be applied

to realistic settings with various levels of manikins. Students could access case studies and patient information electronically to prepare for high fidelity simulations. Complexity of simulations increased throughout the curriculum, with second year students learning how to document electronically and also using PDAs for remote access to information, third year students planning and managing all aspects of a patient's care, and final year students managing groups of patients and conducting electronic audits. The simulations were seen by the authors as reinforcing students' learning in the use of ICT, and the access to best practice information was described as promoting improved critical thinking and decision making.

A similar project termed the Advancing Technology in Health Science Education Now at St Scholastica (ATHENS) project was described by Fauchald (2008). The goal was to improve clinical decision making and practice competence of health science graduates by increasing the use of clinical information systems in curricula to improve interdisciplinary teamwork, use of informatics and evidence based practice. This project involved six health disciplines, including nursing. Wireless notebook PCs were used as the hardware in class rooms, skills and simulation laboratories and clinical placements. The ATHENS web based system could be accessed from any computer and was integrated into all courses. Features that were identified as beneficial to nursing students included the ability to view charts and results, document assessment and care plans and conduct chart audits, as well as accessing medication information, medical terminology, normal values and evidence based practice guidelines.

Linder and Pulsipher (2008) describe the implementation of a simulated learning experience in paediatrics for undergraduate nursing students that involved the integration of a simulated electronic medical record. Students participated in a Simulation Day conducted during the first two weeks of their paediatric clinical rotation. This integrated program utilised a range of low, medium and high fidelity manikins along with simulated electronic records. Paediatric assessment skills, basic life support, communication with patients and family, care planning, electronic documentation and SBAR communication with the physician were addressed. Informal student feedback was the only evaluation reported. This indicated high levels of students' overall satisfaction with the learning opportunities provided by the program.

However while students satisfaction with the simulations was high, the use of electronic medical records was less well received. This may be related to the fact that the paediatric clinical placement did not use electronic records, reducing the perceived value of this activity.

Another project that integrated ICT was described by Lucas (2010), with an emphasis on the integration into the simulation laboratory and the results of an outcome evaluation. The project involved a partnership between a health care provider and the university to introduce a specific health-facility based electronic medical record (EMR) into the undergraduate nursing curriculum. Students were able to access a ten patient training unit which allowed the EMR system to be used in classrooms, skills and simulation laboratories or at home. A group of senior students was chosen to pilot the program. They received orientation to the program, training in use of the system, and then a take home assignment which included satisfactory completion of electronic documentation. The next week students completed practice questions on the cardiovascular system, and training in cardiovascular assessment, prior to a two person high fidelity simulation requiring assessment of a cardiac patient, medication administration and electronic documentation. Simulations were videotaped and used as part of a group debriefing. The students' simulation laboratory experience was evaluated immediately afterwards by an online questionnaire. Two weeks later and following clinical placement time students completed an open-ended questionnaire on their perception of the new EMR system training. Student responses were positive in relation to the realism of the simulation and the EMR and they indicated that it provided a good learning experience. Students also identified the benefit of practicing the use of the ICT system used in the clinical environment prior to placement. Staff and clinical instructors on the placement noted an improvement in the students' level of performance. This study gives some support to the transferability of this type of learning to the clinical environment, although tools used relied entirely on student and staff perceptions.

The final descriptive paper reviewed, by Hanberg and Madden (2011), discusses the integration of patient care technology and informatics competency into immersive simulation. Immersive simulation experiences were used to provide meaningful context

to informatics competency training for first year first semester nursing students. The process of development is described, including setting objectives, writing a scenario, creating electronic charts and programming the simulator. Evaluation of the effectiveness of the program was anecdotal self-report and observation of students' positive reactions.

As lack of faculty members' ability, interest and support for ICT use in nursing education is an important barrier to further implementation, a systematic approach to faculty development is required for effective curriculum integration. Griffin-Sobel (2009) describes the ENTRÉE model which includes: the use of Experts as champions, Nursing technology integration achieved by analysing the curriculum to determine the best technology tools to meet desired learner outcomes, Transforming teaching and learning strategies through faculty development, identifying areas suitable for Research and grant application, using appropriate tools to Evaluate outcomes, and Expansion through collaboration and publication.

2.5 Literature review – summary and conclusions

While there have been a number of studies of HPSM and ICT use in undergraduate nursing education, primarily in the USA (Nehring and Lashley, 2002; Jansen et al, 2009; McNeil et al, 2003), only one study of simulation use has been conducted in Australia, and this was focused on Victoria only (McKenna et al, 2007). No Australian studies were found relating to ICT usage for undergraduate education. This clearly highlights an area where further research is needed.

The underpinning educational theories supporting simulation are mainly behaviourist and constructivist (Parker and Myrick, 2009), although constructivism is described as the foundation for the development of higher order thinking, clinical judgement and non-technical skills (Waldner and Olsen, 2007).

Jeffries (2005) Nursing Education Simulation Framework, based on the educational principles identified by Chickering and Gamson (1987) and adopted by the National League for Nursing, has been utilised as a guiding framework for both the design of simulation activities and a number of research studies (Jeffries and Rizzolo, 2006;

Kardong-Edgren, Starkweather and Ward, 2008; Grant et al, 2009). Other models used to guide simulation practice and research have been the Nursing Process (Burns, O'Donnell and Artman, 2010) Benner's Novice to Expert theory (Larew et al, 2006; Walder and Olsen, 2007), Tanner's Clinical Judgement model (Lasater, 2007b; Dillard et al, 2009) and Piaget's learning theory (Arwood and Kaakinen, 2009).

Considerable research has been conducted to establish the effectiveness of simulation as a teaching strategy, with mixed results in terms of outcomes. Many studies report high levels of student satisfaction with simulation, including high fidelity HPSM (Jeffries and Rizzolo, 2006; Bruce et al, 2009; Hoadley, 2009) and medium fidelity HPSM (Kardong-Edgren, Lungstrom and Bendel 2009; Reilly and Spratt, 2007; Kardong-Edgren, Starkweather and Ward, 2008; Sinclair and Ferguson, 2009).

Basic psychomotor skills have been shown to improve as a result of simulation activities, but in most cases no difference was demonstrated between high and low fidelity manikins (Rogers, 2007; Hoadley, 2009; Blum, Borglund and Parcells, 2010), although one study demonstrated improved skills for urinary catheterisation and naso-gastric tube insertion using high fidelity HPSM compared to low fidelity (Grady et al, 2008). Similarly, for basic knowledge acquisition high fidelity manikin simulation was not found to be better than case study (Scherer, Bruce and Runkawatt, 2007), low fidelity manikins (Hoadley, 2009) or medium fidelity manikins (Kardong-Edgren, Lungstrom and Bendel, 2009). Studies also show that knowledge acquired during simulation activities deteriorates over time if it is not reinforced (Kardong-Edgren, Lungstrom and Bendel 2009; Bruce et al, 2009; Elfrink et al, 2010). This research points to the importance of considering the learning objectives in order to design cost effective simulation activities.

However, when considering higher order skills such as critical thinking and collaboration, research suggests there are potential benefits using high fidelity manikins, although further research is required. High fidelity manikins have been found to be significantly better at encouraging cognitive skills than case study (Howard, 2007), lecture (Brannan, White and Bezanson, 2008) and low fidelity manikins (Rogers, 2007), although Ravert (2008) failed to find a significant difference between high fidelity manikin simulation and group discussion for improving critical thinking.

Critical thinking has also been shown to improve more in students who have more simulation experiences (Sullivan-Mann, Perron and Fellner, 2009). High fidelity simulation has been found to improve interdisciplinary collaboration by Dillon, Noble and Kaplan (2009) and Ruse, Jeffries and Engum (2010). The main limitation of these studies relates to the validity of tools used to measure critical thinking and clinical judgement in nursing.

Self-confidence as an outcome measure has some demonstrated limitations. While improved student self-confidence following high fidelity simulation has been reported in a number of studies (Ravert, 2004; Jeffries and Rizzolo, 2006; Bambini, Washburn and Perkins, 2009; Brown and Chronister, 2009) other studies cast doubt on the value of self-reported self-confidence, by demonstrating a lack of correlation or poor relationship between reported self-confidence and other measures of competent nursing practice (Alinier et al 2007; Dillard et al, 2009; Lambton, O'Neil and Dudum, 2008). These findings support the need for further development of validated outcome measurement tools.

There is limited research demonstrating the transferability of skills acquired during simulation to the clinical environment. A study by Feingold, Calaluce and Kallen (2004) was based only on student and staff opinion of the value of simulation to practice. Radhakrishnan, Roche and Cunningham (2007) used simulation laboratory based measurements which could not be seen as a valid measure of hospital clinical practice. Dillard et al (2009) demonstrated poor transference of competencies to the clinical environment and concluded that further reinforcement of learning during the clinical placement was required.

A range of practices associated with the quality use of simulation are identified in the literature. Educational practices which involve adequate time and opportunities for repetition are associated with positive outcomes (Kardong-Edgren, Starkweather and Ward, 2008; Swanson et al, 2010). Adequate preparation for simulation activities (Cantrell, 2008; Elfrink et al 2010), clear learning objectives (Smith and Roehrs, 2009) and sufficient facilitator support (Schoening, Sitter and Todd, 2006; Cantrell, 2008; Swanson et al, 2010) are all reported as important aspects of simulation learning. The impact of manikin fidelity level is discussed above in relation to measured outcomes.

No studies have evaluated other aspects of fidelity such as environment or scenario fidelity.

Findings in relation to the impact of group size and role allocation during simulations are varied and inconclusive. Jeffries and Rizzolo (2006) found no difference in outcome between active participants and observers, and Schoening, Sitter and Todd (2006) found the observer role to be beneficial; however Lasater (2007a) found that students were bored and distracted in the observer role, and Grant et al (2009) found that learning outcomes varied with role allocation. Student group collaboration and planning are however seen as effective learning strategies (Lasater 2007a; fountain and Alfred 2009: Elfrink et al 2009).

Debriefing is acknowledged as a critical part of simulation learning but there is little research on the effectiveness of debriefing methods. Suggested indicators of quality debriefing are that it should occur immediately after the simulation (Cantrell, 2008), should involve reflective thinking (Dreifuerst, 2009; Cato, Lasater and Peebles, 2009) recognition of students' experience (Henneman and Cunningham, 2005) and specific feedback (Lasater, 2007a). The use of video replay of the simulation during debriefing is supported by Grant et al (2009) and with some reservations by Elfrink et al (2009).

While HPSM has been used as a teaching strategy for some time, its use for student assessment and remediation is increasing, simulation is being seen as an option for competency assessment and credentialing. A process for use of HPSM for remediation is discussed by Haskvitz (2004). Prion (2008) identifies the need for good assessment tools to enable valid results. Various assessment tools and methods have been studied, including Lasater's Rubric (2007b), the AACN core competency assessment tool (Todd et al, 2008), targeted Clinical Assessment Simulations (Krautscheid, 2008), and senior student capstone assessment (Corbett et al, 2008). Further studies will be required in this area if simulation assessment is to become part of competency credentialing or as a pre-registration requirement for students.

The integration of simulation throughout undergraduate nursing curricula is also an area where further research is needed to establish best practice for quality teaching and learning. Most articles are of a descriptive nature, based on individual experience.

Murphy et al (2011) discuss implementation of simulation into a problem based learning curriculum. Wilfred and Doyle (2006) discuss the use of the METI pre-programmed scenarios throughout the curriculum. Several studies identified the need for additional staff time for planning and preparing simulation scenarios (Feingold, Calaluze and Kallen, 2004; Jones and Hegge, 2008) and the need for specialised staff (Seropian et al 2004b). Starkweather and Kardong-Edgren describe using Diffusion of Innovation theory to implement HPSM into an undergraduate curriculum. No research studies were found that tested the outcomes of different curriculum models.

In relation to ICT most articles found were descriptive and no research studies evaluating the impact of ICT on undergraduate student learning in clinical laboratories or simulation units were found. Several studies reported on the implementation of PDAs during students' clinical placements, with mixed success evaluated by student satisfaction (Elfrink et al, 2000; Berglund et al, 2007; Miller et al, 2005). Pharmacology resources were reported as the most utilised software programs (Berglund et al, 2007; Miller et al, 2005) and these have been demonstrated to have a positive impact on student medication knowledge (Farrell and Rose, 2008). Newman and Howse (2007) found that the introduction of PDAs into teaching had a positive impact on critical thinking, as measured by students own perception.

Some recommendations for quality use of ICT in undergraduate nursing education from the literature were the importance of adequate length of training time prior to implementation into clinical practice (Elfrink et al, 2000) and the need for reinforcement of learning throughout the curriculum (Ip, Jones and Jacobs, 2007). Several studies discussed the importance of technical support (Fetter, 2008: Scollin et al, 2007; Miller et al, 2005) and teaching staff support and role modelling in the use of ICT (Farrell and Rose, 2008: Scollin et al, 2007: Miller et al, 2005) and this has implications for the level of staff familiarity with ICT (McNeil et al 2003) and the need for faculty development (Griffin-Sobel, 2009). Also recommended is the use of consistent hardware and software throughout the curriculum (Fetter, 2008) that is seen by students to be linked to curriculum objectives and clinical usage (Kennedy et al, 2009; Linder and Pulsipher, 2008; Lucas, 2010).

A number of papers described the integration of ICT in curriculum and simulation design in US programs (Cornelius and Gallagher, 2006; Curran et al, 2007; Fauchald, 2008; Linder and Pulsipher, 2008; Lucas, 2010; Hanberg and Madden, 2011). At the time this review was undertaken evaluation had been by staff and student perceptions only. No Australian literature was found describing the use of ICT in clinical laboratories or simulation activities.

2.6 Limitations of studies reviewed

In the analysis and critique of the literature it is useful to consider that the use of immersive simulation scenarios in nursing education was at an early stage of development during the timeframe of the literature reviewed (2000-2010). Shneider (2009) suggests that scientific disciplines go through four stages of development of their knowledge base, and that these stages are accompanied by four types of research activity. The first stage introduces new phenomena and language, the second develops methods and techniques, and the third and fourth involve the application and testing of new knowledge and methods. Considering the rapid adoption of new simulation technologies that occurred in nursing education, it is not surprising that early research in this area was exploratory in nature and included small scale localised studies that often focused on student satisfaction as the main outcome criteria. Shneider (2009) maintains that first stage research scientists focus on new frameworks and ways of thinking that may be at times imprecise, and that will be further clarified and applied in later studies. As the body of research in the area of simulation in nursing education continues to grow, studies using more rigorous designs that apply and test recently developed methods and techniques, are expected to contribute to the evidence for using simulation in nursing education.

2.7 Conclusion

The literature review and summary of the findings above provided the researcher with an understanding of the current state of knowledge relating to the use of HPSM and related ICT in clinical laboratory teaching for undergraduate nursing students, the underpinning pedagogy and those aspects of usage that were indicative of quality

teaching and learning outcomes. This understanding was used in the construction of the research instruments for a cross sectional survey and a Delphi study.

Since this literature review was undertaken there has been considerable ongoing research in the area of simulation in nursing education. This later literature has not been included, as previously stated, allowing this chapter to accurately reflect the initial stage of the research process, and to provide the background to the development of the study design and research instruments which are outlined in the next chapter.

2.8 Justification for the study

The review of literature conducted at the beginning of the study provided justification for the study aims. The lack of any Australia-wide information relating to the use of HPSM and ICT demonstrate a clear gap in the nursing literature. While the amount of literature surrounding HPSM was considerable, there was no clear consensus on what constituted quality. Very little literature linked ICT to simulation activities. These conclusions supported the usefulness of the proposed study, and its potential contributions to the expansion of nursing knowledge.

Chapter 3 Research Design

3.1 Introduction

Mixed method research has been recognised for some time as the third major research paradigm. It is a synthesis of both qualitative and quantitative approaches to the acquisition of knowledge (Creswell, 2003). The primary underpinning philosophy of mixed method research is pragmatism (Johnson, Onwuuegbuzie and Turner, 2007). This chapter will briefly discuss pragmatism as the underlying conceptual framework for this study, as well as provide details of the overall study design, development of the study instruments, recruitment of participants, data collection, data analysis methods and ethical considerations. A table is provided that outlines the timeframe over which the study was conducted (Tables 2 and 3). The underpinning pragmatic approach has guided all aspects of the study design and conduct.

3.2 Study aims

The aims of the study described in this thesis are:

1. To explore the range and types of human patient simulation manikins (HPSM) and information communication technology (ICT) currently used in Australian undergraduate degree nursing programs, and the pedagogical approaches that underpin their use.
2. To investigate how the educational outcomes of HPSM and ICT are assessed and the manner and extent to which these technologies are used for formative and/or summative assessment of students' performance.
3. To identify the principles and practices that contribute to quality teaching and learning using HPSM and ICT.
4. To develop a set of indicators of quality use of HPSM and ICT in schools of nursing clinical laboratories.

3.3 Pragmatism as a research paradigm and theoretical framework

Pragmatism is a paradigm or philosophical approach to the acquisition of knowledge that places emphasis on shared meaning and joint action. It based on the early work of philosophers and researchers such as Charles Sanders Pierce (1838-1914), William James (1842-1910), John Dewey (1859-1952), and George Herbert Mead (1870-1957). There is an emphasis on the discovery of actual behaviours, the beliefs that stand behind those behaviours and the practical outcomes of those beliefs and behaviours (Morgan, 2007). This practical approach has been linked to cultural aspects of the “American frontier mentality” with the emphasis on the inquiry rather than complex epistemology (Maxy, 2003). This philosophical stance is consistent with the pragmatic approach to the choice of a study design that emphasises “workability” or usefulness. Study design is based, not so much on either a positivist or metaphysical philosophical stance, but on what methods will actually work to achieve the desired knowledge and understanding within a new or complex field (Morgan, 2007).

Morgan (2007) has further described the pragmatic approach as utilising Abductive Reasoning, an Intersubjective approach to the research process, and the Transferability and Usefulness of the knowledge gained. Abductive reasoning allows the researcher to move backward and forward between induction and deduction. Theoretical perspectives may be viewed and used to assist with the collection of data, which may then be used to modify theories or propose workable solutions. Intersubjectivity involves gaining mutual understanding through a process of communication and shared meaning. Transferability relates to the degree to which knowledge gained from research can be transferred to other settings, and whether the knowledge is specific to one setting or applicable to all settings. A pragmatic approach emphasises the practical applicability of the knowledge acquired, and the importance of research producing information that has meaningful use within the field of endeavour.

3.4 Study design – mixed method research

Mixed method study designs are those that combine qualitative and quantitative approaches to the design and conduct of a single study or multi-phased study (Teddle and Tashakkori, 2003).

Johnson, Onwuegbuzie and Turner (2007) conducted a content analysis of 19 definitions of mixed method research found in the literature, as well as conducting online discussion with several leaders in the field. The following definition was provided as a synthesis and summary.

Mixed methods research is a type of research in which a researcher or team of researchers combines elements of qualitative and quantitative research approaches (eg. use of qualitative and quantitative viewpoints, data collection, analysis, inference techniques) for the broad purpose of breadth and depth of understanding and corroboration.

A mixed method study would involve mixing within a single study; a mixed method program would involve mixing within a program of research and mixing might occur across a closely related set of studies.

(Johnson, Onwuegbuzie and Turner, 2007, p. 123)

From a pragmatic perspective a mixed method design was most appropriate to achieve the study aims. A cross sectional survey was chosen as the most appropriate method to achieve aims 1 and 2, and a Delphi study was used to achieve aims 3 and 4.

Seen from this viewpoint, this study qualifies as mixed method research in a number of ways.

- It aimed to gain a broad perspective of both current use of simulation in nursing education in Australia, and indicators of quality in simulation design and simulated learning experiences.
- It was one component of a larger program of related studies investigating the use of simulation to improve undergraduate nursing students' clinical reasoning.

- It utilised two methods of data collection, a cross sectional survey and Delphi technique, to achieve the study aims.
- The cross sectional survey and the Delphi study utilised both quantitative and qualitative methods of data collection and analysis.

Features of mixed method study design can be further described as equal status, qualitative dominant or quantitative dominant (Johnson, Onwuuegbuzie and Turner, 2007). Both the cross sectional survey and Delphi technique are predominately quantitative approaches, utilising questionnaires as the primary method of data collection, and statistical analysis of the results. However, in order to achieve the broadest understanding of the area of investigation, open-ended question were employed in both phases of data collection (cross sectional survey and Delphi rounds), and content analysis was used to identify any key issues raised by participants that had not been identified in the quantitative data, and they were incorporated into the study results.

The use of sequential procedures has also been identified as a sub-type of mixed method studies (Creswell, 2003). In this study two main phases were planned, and each phase was used to inform the subsequent phase. The initial review of the literature, discussed in Chapter 2 provided an understanding of the design and implementation features of HPSM and associated ICT that were influential in student learning. This information was used to assist with the development of the cross sectional survey instrument which was the first phase of the study.

- Phase 1: A cross sectional survey of Australian schools of nursing was undertaken in 2009 to determine the extent of current usage of HPSM and related ICT within their undergraduate nursing programs. The data gained from this survey regarding current design and implementation strategies were used in the development of the items for first Delphi questionnaire.
- Phase 2: Informed by the literature and the results of the cross sectional survey, the Delphi study was used to identify those aspects of simulation design and implementation that are indicative of high quality learning experiences. Expert

opinion was utilised to refine concepts and gain consensus about key indicators of quality use of HPSM and associated ICT.

3.5 The cross sectional survey

3.5.1 Aims of the cross sectional survey

A cross sectional survey was chosen as the most appropriate method to address the first two aims of the research:

1. To explore the range and types of human patient simulation manikins (HPSM) and related information communication technology (ICT) currently used in Australian undergraduate degree nursing programs, and the pedagogical approaches that underpin their use.
2. To investigate how the educational outcomes of HPSM and related ICT are assessed and the manner and extent to which these technologies are used for formative and/or summative assessment of students' performance.

3.5.2 Survey as a research method

Survey is a useful method for collecting a large amount of data from a significant number of people in a relatively short timeframe. A cross sectional survey takes a "snapshot" of information about an area of interest at a specific point in time (Creswell, 2003). Cross sectional survey was chosen as the most appropriate method to gain an overview of the current use of HPSM and related ICT in Australia at a particular point in time. At the time of the study HPSM was just beginning to be introduced into Australian schools of nursing and very little was known about how widely it was being used, or what teaching strategies were being incorporated. The researcher believed that gaining an understanding of current usage was an important starting point prior to further investigation of what constitutes quality usage.

3.5.3 Development of the survey instrument

The first stage in the development of the cross sectional survey instrument was the careful consideration of the study aims and main content areas that needed to be

included. In order to create a survey instrument that would be a valid and reliable tool to collect the information required to meet these study aims, it was necessary to consider key aspects of HPSM and related ICT usage from a broad international and national perspective. Therefore as the second stage in the preparation of the survey instrument a literature search and review of the literature was conducted. Particular attention was directed to searching for any Australian literature on the topic, however this was found to be very limited. To further enhance understanding of the use of simulation within the Australian context the researcher attended a national conference on simulation in the health care environment. Information gathered from the review of the literature and the conference presentations was used to draft the questions in the survey instrument.

When drafting the survey instrument, both open and closed questions were used to collect data, as well as providing additional space for participant comments, thus collecting both numerical and textual data. The survey consisted of a total of 98 questions, presented in 10 sections:

- A. Information about the participant and school
- B. Clinical laboratory staffing
- C. Use of simulation in clinical laboratories
- D. Pedagogical principles and practices
- E. Processes used for medium and high fidelity simulation
- F. Roles and responsibilities of staff
- G. Simulation for student assessment
- H. Evaluation of medium and high fidelity HPSM use
- I. Use of ICT in clinical laboratories
- J. Factors influencing the use of HPSM and ICT

The next stage in the development of the cross sectional survey involved validation and testing of the draft instrument. Content validity is achieved by systematically reviewing

the research instrument to ensure that the overall content of the domain under examination is adequately covered. The process of achieving content validity can include both the development and the quantification stage (Skodol Wilson, 1993). The original development stage of the survey instrument and use of literature and conference presentations to guide content is described above.

Quantification of content validity involved a panel of experts using a rating scale to check that all areas of content had been adequately covered. Face validity was a more subjective judgement by these experts to determine the degree to which the instrument measured the constructs under investigation. The survey was tested and reviewed for face and content validity by a panel of ALTC project team members and members of the ALTC project reference group of experts in HPSM and ICT at a project reference group meeting. Team and reference group members included nurse academics, heads of nursing schools, published Australian experts in clinical reasoning, simulation and ICT and experienced researchers with expertise in survey as a research method. Suggestions from this panel were used to make adjustments to the survey questions, which were resent to the panel members for approval and final comments. Further details of the survey instrument validation process are available in Appendix IV.

Following final adjustments the survey was uploaded onto web based Questionmark PerceptionTM software. The final stage of the development of the cross sectional survey was pilot testing of the online instrument. This was carried out by selected members of the project team and reference group, who completed the online survey to check for any errors or concerns with the face validity of the final online instrument. A copy of the final version of the cross sectional survey instrument is found in Appendix V.

3.5.4 Cross sectional survey sample and recruitment process

All universities and higher education institutions in Australia that had schools of nursing offering Bachelor of Nursing programs were eligible to participate in the cross sectional survey. Heads of School from all Australian nursing schools (n=32) were contacted by email and invited to participate in the study of the use of HPSM and ICT in their schools' undergraduate nursing program clinical laboratories. In order to have

the person in each school of nursing who was in the best position to give accurate information on the topic complete the survey, Heads of School were invited to complete the survey themselves or nominate an appropriate individual within their school to complete the survey who was responsible for clinical laboratory and simulation activities (See letter of invitation in Appendix I). Recruited participants were therefore academic faculty with knowledge of the use of HPSM and ICT within their school, such as head of school, clinical coordinator or course coordinator. Participation in the survey was voluntary.

An information letter was attached to the contact email (see Appendix III). This contained the invitation to participate in the survey and outlined the aims of the project and indicated that participation was voluntary, and that participation could cease at any time. Participants had time to read the information letter and view the web site via a link provided before making their decision. Proceeding with the survey was deemed as consent. A maximum of two reminder emails were sent at one month intervals (see Appendix II). As part of the survey process participants were asked if they consented to have their responses quoted. This gave participants the option to have their intellectual property acknowledged if exemplars of practice were used as part of the reporting of survey results.

3.5.5 Data collection and analysis

The survey was conducted in April-May 2009. Of the 32 nursing schools invited to participate 24 responses were received, giving a response rate of 75 per cent. Responses were received from all states of Australia. The data obtained were electronically transferred to an Excel spread sheet for analysis. Prior to analysis the data were cleaned using logical and statistical checks. Descriptive statistics, mainly in the form of percentages of the sample population, were used as the main method of data analysis, as well as content analysis of any qualitative data provided. Text responses to open ended questions and comments were content analysed. Pedagogical principles underpinning simulation activities were analysed using Jeffries (2008) evaluation framework. These included the provision of: clear objectives, adequate student support, embedded complexity and problem solving, fidelity and debriefing using reflection. The results of

the cross sectional survey are presented in Chapter 4 as published in the journal *Clinical Simulation in Nursing* (Arthur, Kable and Levett-Jones, 2011).

3.6 The Delphi study

3.6.1 Aims of the Delphi study

The aims of the Delphi study were to:

1. To identify the principles and practices that contribute to quality teaching and learning using HPSM and ICT.
2. To develop a set of indicators of quality use of HPSM and ICT in schools of nursing clinical laboratories.

3.6.2 Delphi study design

This section of the project was informed by results gained from the cross sectional survey, as well as the review of the literature. This stage utilised a modified Delphi technique to gain consensus of expert opinion and facilitate the development of the quality indicators. The Delphi technique is so named because in ancient Greece the oracle at Delphi was seen as the god Apollo's "most expert, truthful and trustworthy informant" (Schneider, Whitehead and Elliot, 2007). The Delphi method is defined as

a method for the systematic solicitation and collection of judgements on a particular topic through a set of carefully designed sequential questionnaires interspersed with summarised information and feedback of opinions derived from earlier responses (Delbecq, Van de Ven and Gustafson, 1975).

Delphi technique

Critical aspects of the Delphi technique have been identified as:

1. Anonymity of participants to allow free expression of opinion
2. Iteration through a number of questionnaire rounds refining participants views in light of information provided
3. Controlled feedback informing participants of others' perspectives providing the opportunity for clarification or change

4. Quantitative interpretation of responses using statistical analysis of data.

(Skulmoski, Hartman and Krahm, 2007).

While the classical Delphi technique first round questionnaire utilises open ended questions requiring participants to generate responses, this study utilised a modified Delphi technique, in which the participants were provided with a list of potential quality indicators to rank in relation to importance (Wiersma and Jurgs, 2005). The study was conducted in a web based format, known as a web based Delphi or e-Delphi (Hatcher and Colton, 2007; Wiersma and Jurgs, 2005). This method was chosen to allow best utilisation of time and ease of access for the international experts who formed the Delphi panel.

3.6.3 Selection and recruitment of the Delphi expert panel

The Delphi panel members were recruited from both Australia and internationally. Criterion sampling was used to select panel members who were chosen for their knowledge and expertise in the use of HPSM and related ICT in undergraduate nursing education, including nurse academics and simulation and ICT specialists. Thirty two people were invited by email to participate. Potential participants were selected based on authorship of recognised simulation textbooks, articles in peer reviewed journals, presentations at national or international simulation conferences, or detailed answers to the previous cross sectional survey, indicating significant experience in the use of HPSM and ICT in nursing education.

Potential participants were sent an initial contact email. An information letter (see Appendix VII) was attached to the contact email and contained the invitation to participate in the Delphi panel. This letter outlined the aims of the project and indicated that participation was voluntary, and that participation could cease at any time. Participants had time to read the information letter before making their decision. Participants were directed to a link which connected to the first Delphi questionnaire. Completion of the questionnaire was deemed as consent. A maximum of two reminder emails were sent throughout the course of the Delphi study. The names of expert participants in the Delphi were not disclosed during the Delphi process, as anonymity is considered to be an important component of the methodology (Skulmoski, Hartman and

Krahn, 2007), allowing all participants to freely express their opinions without deference to other panel members. However, at the completion of the study panel members were asked for permission to publish their details to lend further validity to the findings. Those who agreed to this were acknowledged in the brochure produced at the completion of the ALTC project, which is available on the project web site,

<http://www.newcastle.edu.au/project/clinical-reasoning>

3.6.4 Development of the Delphi instruments

The Delphi study was conducted in three rounds and the questionnaires were provided online via the Questionmark PerceptionTM software. (Questionnaires 1 and 2 are attached as Appendices VIII and XI).

Round one: The first round consisted of a Likert type scale for participants to rank the importance of teaching principles and practices for quality use of HPSM and ICT, as well as providing unstructured space to allow the experts freedom to elaborate on issues and make additional suggestions. Statements in the first round were constructed based on the literature review and the results of the survey and participants were asked to rank these 107 statements in relation to their importance for quality use of simulation using the following scale:

1. Not recommended
2. Limited value
3. Undecided
4. Recommended
5. Critical element
6. Don't know (this item was included to allow participants to exclude themselves from any item that they felt unqualified to comment on)

Project team and ALTC reference group members were invited to review the initial questionnaire for face and content validity at an ALTC reference group meeting, using the following framework to critique the content:

- How relevant is the item to the study aim?
- How clear and concise is the item?

- Is the item ambiguous? (if so please suggest alternative wording)
- Is there any unnecessary repetition of items?
- Are there any items that should be included that have been overlooked?

(DeVillis, 2003)

Adjustments were made as recommended. The questions were pilot tested by selected team members. This initial questionnaire consisted of 107 statements grouped into 6 sections and uploaded to Questionmark PerceptionTM software. The six sections of this questionnaire were:

1. Physical resources of simulation units
2. Manikin fidelity level
3. ICT resources
4. Staff resources and training
5. Teaching and learning approaches; preparation, conducting sessions and debriefing
6. Curriculum integration and pedagogical principles.

Round two: The second round questionnaire was derived from the analysis of the first round responses. The initial round statements were allocated mean and median rankings based on the participant responses (see Appendix IX). Statements in the second round were then constructed to allow participants' ranking to confirm high priority quality indicators with high level scores from the first round, as well as clarify areas where consensus was not apparent based on low level scores and related qualitative comments. Additional items were derived from content analysis of the comments from round one. There were 69 statements in this round and it also utilised a Likert type scale and space for additional comments

In order to further polarise opinion the Likert scale descriptors were changes to:

1. Strongly disagree
2. Disagree
3. Undecided
4. Agree

5. Strongly agree
6. Don't know (category for self- disqualification as above).

Round three: The third Delphi round consisted of a list of the 15 most highly ranked quality indicator statements (see Appendix XIV) derived from the analysis of the second round responses, based on means of participants' rankings that were greater than 4.45 out of a possible 5 (see Appendix XIII). The participants were invited to either agree or disagree with these statements and invited to provide rationales for any divergent opinions, and any additional comments they wished to make.

3.6.5 Data analysis

Round one: Mean and median scores of items from the first round questionnaire as well as content analysis of comments (see Appendix IX) allowed for identification of priority issues and areas of consensus and disagreement, as well as additional issues not mentioned in the first round questionnaire. This analysis was utilised to draft the second round Delphi questionnaire. Prior to the second round questionnaire participants were sent a report with detailed statistical analysis of the first round (see Appendix X) to assist in achieving consensus and enhance the rigour of the research findings (Powell, 2003).

Round two: Mean scores of items and content analysis of additional comments were again utilised in the analysis of the second round questionnaire (see Appendix XII). The resulting 17 highest ranking quality teaching statements with mean scores of 4.45/5 or above (see Appendix XIII) were refined into 15 quality indicator statements (Appendix XIV) that were sent to participants for confirmation and comment.

Round three: This list of quality indicator statements derived from round two was then sent to all participants for their agreement or disagreement and comment. This process of feedback and confirmation by participants of the findings is important to enhance the rigour and integrity of a Delphi study (Powell, 2003; Skulmoski, Hartman and Krahn, 2007). At this stage consensus was reached by the expert panel. The statements were then further refined and developed into 12 statements based on the last round of feedback, then organised into five categories: pedagogical principles, fidelity, student preparation and orientation, staff preparation and training, and debriefing. Rationales

and resources to support the Quality Indicator Statements were provided in order to assist with their application to simulation design and implementation. Further details of data analysis and results of the Delphi study are provided in Chapter 5 published in the journal *Nurse Education Today* (Arthur, Levett-Jones and Kable, 2013).

3.6.6 Data storage for the study

Each participant was given a participant number, which was then used as the data identifier. In order to protect the privacy of participants data stored in the web based Questionmark PerceptionTM program was password protected and access was only available to the researchers and project IT assistant. Once data were extracted from the web site they were stored on a password protected computer, or hard copy items were filed in locked storage. Data were identified by participants' numerical codes only during analysis.

3.7 Ethical considerations

Approval was obtained for this study from the University of Newcastle Human Research Ethics Committee. Approval number: H-2009-0016. Essential ethical principles that were considered during the study design included privacy and confidentiality, informed consent, beneficence and non-maleficence

Key ethical issues addressed were obtaining consent from the study participants, the assurance of anonymity and privacy, and confidentiality in the storage, access and reporting of data (Coup and Schneider, 2007). Participants in the cross sectional survey were recruited by using Heads of School (HOS) of the various universities approached, who acted as "gatekeepers" (Creswell, 2003) to recommend the most appropriate person to complete the survey. Letters explaining the purpose of the research and the amount of time estimated to complete the survey were sent to the participating HOS. All participants in both the cross sectional survey and the Delphi study received detailed information statements at the time they were invited to participate via a web link provided, and participation was entirely voluntary. Reminder emails were restricted to two. In order to preserve privacy and confidentiality data were stored in locked areas and on password protected computers. Participants or individual universities were not

identified in reports of study results. Expert participants in the Delphi panel were invited to have their intellectual contribution to the Quality Indicator statements published on the project web site, and acknowledged in the brochure *Quality Indicators for the Development and Implementation of Simulation Experiences* (Arthur, Levett-Jones and Kable, 2010); and only those who consented to this were listed.

Beneficence is the ethical principle of doing good as well as preventing harm (Coup and Schneider, 2007). The generation of knowledge should be the aim of all research activities and is of particular importance within the pragmatic paradigm, where the generation of practical, useful knowledge is a central concept (Morgan, 2007). The information made available throughout the conduct of this study and the publication of the results have the potential to benefit nurse educators involved in the development and implementation of simulation activities within nursing curricula. The conduct of the cross sectional survey increased awareness of nurse educators throughout Australia of the dynamic changes associated with simulation in undergraduate education at the time. The Quality Indicator Statements may be used to assist in the development and implementation of quality educational programs for a range of simulation modalities. Results of the study at completion were also openly shared with participants via the ALTC project web site, <http://www.newcastle.edu.au/project/clinical-reasoning>

Non-maleficence is the directive to do no harm. While this study was considered to involve minimal risk for causing harm to participants, all efforts were made to provide full information to participants about the purpose of the study and what they would be required to do, as well as to protect privacy and identification of individuals and universities in relation to information given. No adverse impacts were identified from the conduct of the research.

3.8 Study timetable

3.8.1 Stage one – cross sectional survey

Table 2: Cross Sectional Survey Timeframe

Initial RHD research proposal	September 2008
Development and validation of the cross sectional survey	November – December 2008
Preparation and submission of ethics application	October 2008 – January 2009
Preparation of participants list and uploading of survey onto web based platform	February – March 2009
Survey distribution and collection	April – May 2009
Survey data analysis	May – October 2009
Presentation of preliminary results at third International Clinical Skills Conference, Prato Italy	July 2009
Results of survey reported to ALTC	November 2009
Submission of article for publication of cross sectional survey results: Arthur, C., Kable, A. and Levett-Jones, T. (2011) Human patient simulation manikins and information communication technology use in Australian schools of nursing: A cross-sectional survey. <i>Clinical Simulation in Nursing</i> 7(6), e219-27.	Submitted 2009, accepted for publication March 2010
Presentation of survey results at NETNEP conference, Sydney	April 2010

3.8.2 Stage two –Delphi study

Table 3: Delphi Study Timeframe

Selection of panel, development and uploading of first questionnaire	November 2009 – January 2010.
Submission of questionnaire for ethics approval	January 2010
1st round questionnaire	January-February 2010
Analysis of 1 st round, development of 2 nd round questionnaire	March – April 2010.
2 nd round questionnaire	May – June 2010
Analysis 2 nd round and development of Quality Indicator statements	July – August 2010
Presentation of selected survey and Delphi findings, SimTecT conference, Melbourne	September 2010
3 rd round Delphi approval/refining of Quality Indicators	September – October 2010
Writing report for ALTC on Delphi results and finalising Quality Indicator statements	November – December 2010
Presentation of Delphi results Simulation and Beyond symposium	November 2010
Submission of article for publication of Delphi results: Arthur, C., Levett-Jones, T., and Kable, A. (2013). Quality indicators for the design and implementation of simulation experiences: A Delphi study. <i>Nurse Education Today</i> , 33(11), 1357-1361.	Submitted March 2012

Chapter 4 Survey Results as Published in Clinical Simulation in Nursing

This chapter contains the results of the cross sectional survey as published in:

Arthur, C., Kable, A., and Levett-Jones, T., (2011). Human patient simulation manikins and information communication technology use in Australian schools of nursing: A cross-sectional survey. *Clinical Simulation in Nursing* 7(6), e219-27.

Word limits associated with journal publications mandate that articles focus on the most important results from the data. Additional results from the cross sectional survey, in the form of graphical representation of the results of all the quantitative data, and content analysis of qualitative data, are included in Appendix VI.

4.1 Abstract

Background: Shortage of suitable quality placements for undergraduate nursing student' clinical experience has motivated Australian schools of nursing to consider alternatives to traditional clinical placements. Human patient simulation manikins and information communication technologies may have the potential to facilitate the development of nursing students' clinical competence within a laboratory environment.

Method: A cross sectional survey of Australian schools of nursing was undertaken to explore the use and types of simulation and information communication technologies, and the pedagogical principles underpinning their use.

Results: This report profiles the facilities, staffing, teaching strategies and underpinning pedagogical principles currently employed

Conclusion: Survey results show substantial variations in simulation and information communication technology resources and teaching strategies in current use. Additional funding and staff training opportunities will be required to ensure adequate facilities and staffing are available to support quality use of these technologies.

4.2 Introduction

Human patient simulation manikins (HPSM) and information communication technology (ICT) are important innovations in the education of nursing students. The ongoing challenge of sourcing sufficient quality clinical placements for increasing numbers of undergraduate nursing students, as well as the need to improve students' clinical reasoning skills and overall competence, have created a perception among many nurse educators that these technologies will be a crucial to the future of nursing education. This paper describes a cross sectional survey conducted of Australian schools of nursing, to examine the current use of HPSM and ICT in clinical laboratories, and the pedagogical principles underpinning their use.

4.3 Background

Since the transfer of nursing education in Australia from hospitals to universities it has become apparent that students face challenges in transferring their academic preparation to competence and confidence in the clinical setting. Advancements in scientific and nursing knowledge and the expansion of the role of the nurse into more specialised and highly technical areas have increased these educational requirements. At the same time reductions in patients' length of stay, increased patient acuity and nursing shortages have resulted in clinical learning environments that are varied and unpredictable in quality (Levett-Jones, 2007; Levett-Jones and Bourgeois, 2007). These factors have exacerbated the challenge of providing adequate clinical learning experiences for increasing student numbers.

Against this background the importance of students' clinical laboratory learning experiences has become increasingly significant. Clinical laboratories have traditionally provided students with a safe environment where they can practice their skills under supervision (Jeffries, 2007). However, competent nursing requires more than psychomotor skills. Recent research has highlighted the importance of critical thinking and problem solving capabilities in enabling effective clinical decision making (Levett-Jones et al, 2011). Nurses with effective clinical reasoning skills have been shown to have a positive effect on patient outcomes (Aiken et al, 2003). However, current educational approaches may not always facilitate the development of adequate clinical

reasoning skills. A recent report from the New South Wales Health Patient Safety and Clinical Quality Programme (2006) identified poor clinical reasoning by graduate nurses as a contributing factor in adverse patient incidents. This reflects similar results to those obtained by del Bueno (2005), who demonstrated that 70 per cent of graduate nurses in the United States scored at an unsafe level in clinical reasoning skills as assessed by the Performance Based Development System (PBDS). The role of simulation in providing reality based scenario situations which allow students to practice clinical decision making in a safe environment that will not lead to patient harm is seen by some as crucial (Jeffries, 2007). Clinical reasoning and patient outcomes have also been linked to the ability to use ICT and to incorporate best practice information into critical thinking and decision making (Goldsworthy et al , 2006; Staggers et al, 2001); however many nursing students are still not confident using ICT (Hegney et al, 2007).

Simulation in health care education has been defined as an attempt “to replicate some or nearly all of the essential aspects of a clinical situation so that the situation may be more readily understood and managed when it occurs for real in clinical practice” (Morton 1995, p76). The term “fidelity” refers to the degree of reality achieved in a simulation (Jeffries, 2007, p 3). While low fidelity HPSM have been used in nursing education laboratories for many years, the use of newer medium and high fidelity manikins are increasingly seen as valuable tools for the development and testing of higher order clinical thinking and clinical competence (Jeffries, 2007). There is no clear agreement in the literature about the factors that are most critical to define the level of fidelity. From a review of international literature the following definitions of manikin fidelity level were adopted for this study:

- Low fidelity HPSM include simple task trainers such as intravenous arms and resuscitation torsos, and anatomically correct full body static manikins that replicate the external anatomy and joint movement of humans, but have no interactive capacity.
- Medium fidelity HPSM are full body manikins that have embedded software that is controlled by an external, hand held device. They have the capacity to have set breath sounds, heart sounds, pulse and blood pressure, and are also capable of

coughing, moaning or basic verbal communication. An example is Laerdal's MegaCode Kelly™ with VitalSim™ capability.

- High fidelity HPSM are more realistic and have embedded software that can be remotely controlled by computer to allow for individualised, programmed scenarios, real-time interactions and cue response. They allow the operator to set physiological parameters and respond to students' interventions with changes in voice, heart rate, blood pressure and other physiological signs. Examples include Laerdal 3GSimMan™ and METI™ manikins.

In order to provide quality teaching and learning outcomes the importance of designing simulation activities based on strong pedagogical principles is crucial. There are a variety of theories, models and frameworks that have been developed as a structural basis for simulation activities. Pivotal theories identified by O'Donnell and Goode that have influenced the development of simulation include Benner's *From Novice to Expert*, Kolb's model of learning styles, and models of situated and experiential learning (O'Donnell and Goode, 2008). As a result of a partnered project with Laerdal Medical Corporation and the National League for Nursing Jeffries devised a simulation design framework integrating the following key educational principles: active learning, diverse learning styles, collaboration, and high expectations. In addition, Jeffries' model identifies five key simulation design features which should be addressed when developing a simulation: clear objectives, adequate student support, embedded complexity and problem solving, fidelity, and debriefing using reflection (Jeffries, 2008).

The extent of use of HPSM and ICT and the educational quality of this use in Australian schools of nursing is largely unknown. A study commissioned by the Victorian Department of Health explored the potential use of simulation across Victorian educational institutions and health care organisations (McKenna et al, 2007). This study concluded that there was extensive and growing use of simulation in nursing schools in the state of Victoria. A range of different levels of simulation were identified, with the availability of resources being a major influencing factor. This finding is supported in the literature, with time, space, cost and lack of technical expertise and sufficient training for staff identified as factors that may impact on the effective use of high

fidelity HPSM (Jeffries, 2007). However, no studies of the extent and types of simulation, or the underlying pedagogical principles used in nursing education have been conducted on a national level. Similarly, information regarding the extent and effectiveness of the use of ICT in clinical laboratories throughout Australia is very limited with no major studies in this area identified.

4.4 Study aims

A large, funded project is being undertaken to examine the conditions under which HPSM and ICT have a positive impact on nursing students' clinical reasoning and to develop quality indicators to guide implementation. As an initial part of this project the cross-sectional survey reported in this paper aimed to explore the use and types of HPSM and ICT currently employed in Australian undergraduate nursing programs, and to identify the pedagogical principles that underpin their use in clinical laboratories.

4.5 Research design

A cross sectional survey was utilised to investigate the scope of current educational practices in an area where there was limited existing information available. Cross sectional surveys are a research method recommended for the collection of data that is descriptive of a situation at a given point in time (Schneider et al, 2007). A web based format was chosen to facilitate ease of response.

A review of the literature and consultation with an expert panel were used to design the questions in the survey. Panel members were Australian academics known to have an interest and expertise in HPSM, ICT and clinical reasoning. Ninety eight questions were included, within the following sections:

- details about school size and infrastructure, staffing of clinical laboratories and roles of staff,
- types and levels of simulation used,
- pedagogical principles and practices,
- use of simulation for assessment,

- use of ICT in clinical laboratories,
- evaluation and research.

Both open and closed questions were used to gather data. Face and content validity were confirmed by testing and review by the project team and panel members. Ethics approval was obtained from the University of Newcastle Human Research Ethics Committee. Issues of consent and privacy were addressed by a step through process of online information statement provision followed by online consent before participants could access the survey.

The survey was conducted in April-May 2009. Heads of School from all nursing schools in Australia were invited to participate in the survey themselves or to forward the survey to the most appropriate member of staff. Of the 32 nursing schools invited to participate 24 responses were received, giving a response rate of 75 per cent. Responses were received from all states of Australia. The data obtained were electronically transferred to an Excel spread sheet for analysis. Text responses to open ended questions and comments were thematically analysed. Pedagogical principles underpinning simulation activities were analysed using Jeffries (2008) evaluation framework. These included the provision of: clear objectives, adequate student support, embedded complexity and problem solving, fidelity and debriefing using reflection.

4.6 Results

4.6.1 Clinical laboratory facilities

The number of students at participating schools of nursing ranged from 170 to 5,100 with a median of 1,137. Many schools had multiple campuses, often distributed over wide geographical areas. The number of campuses per school varied from 1 to 5, with a median of 3.5. The number of clinical laboratories available in each school ranged from 2 to 16. Interestingly the number of laboratories available was not related directly to the number of students (see *Figure 1*). These variations could not be explained by any single factor such as number of campuses, or individual laboratory or class sizes, which also showed marked variations. Clinical laboratories varied in size from 4 to 30 beds with a median of 6 beds. Class sizes (number of students) within these laboratories also

varied considerably from 12 to 30 with a median of 20. There was no obvious relationship between the number of students in a class and the number of beds available in the clinical laboratory.

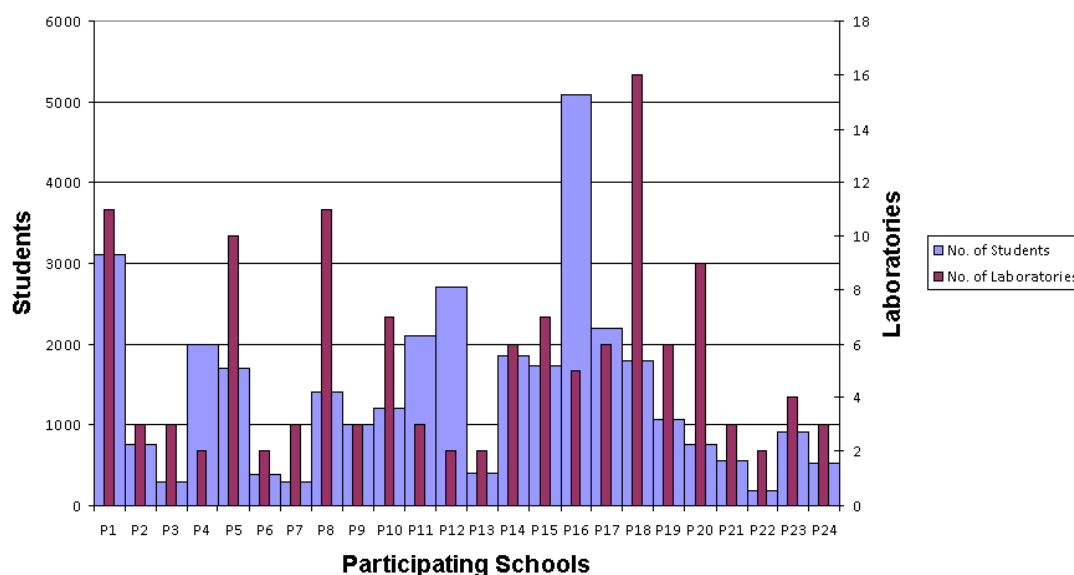


Figure 1 – Comparison of student numbers to laboratory numbers

Figure 2: Figure 1 – Comparison of student numbers to laboratory numbers

These data demonstrate that there are substantial variations between the clinical learning facilities available within schools of nursing across Australia, in terms of basic infrastructure. This is important when considering the resources required to implement high fidelity simulation into a teaching program. Many schools would require additional laboratory space, or the provision of purpose-built facilities. Of the schools that indicated that they currently use medium or high fidelity simulation (n=22), only 45 per cent had access to a purpose built laboratory, indicating the use of temporary arrangements in existing premises or in alternative locations.

4.6.2 Types of HPSM used and extent of use for teaching and assessment

A range of HPSM and equipment were used in participating schools. Ninety one per cent of schools reported use of part task trainers; 95 per cent use low fidelity manikins; 86 per cent use medium fidelity manikins; and 45 per cent were using high fidelity manikins at the time of the survey (n=22). It should also be noted that 74 per cent of

participants stated that they used some form of role play as a form of simulation, with 61 per cent using student role play, 57 per cent utilising staff as actors, and 17 per cent using standardised patients (actors) (n=23). Cost was reported as a limiting factor in the use of standardised patients. The pattern of utilisation of the different simulation modalities in teaching was varied, suggesting that simulation may not always be utilised to its full potential. *Table 1* shows the pattern of simulation usage targeting specific learning objectives or clinical skills identified by participants.

Table 4: Table 1 - Targeted learning objectives (n=15)

	Role Plays	Actors	Computer based simulation	Part task trainers	Low fidelity manikins	Medium fidelity manikins	High fidelity manikins
Therapeutic communication skills	80%	20%	13%	13%	53%	27%	27%
Patient assessment	73%	27%	20%	33%	73%	67%	33%
Clinical psychomotor skills	47%	13%	13%	60%	80%	67%	33%
Knowledge acquisition	60%	20%	27%	33%	53%	53%	27%
Clinical reasoning/ decision making	80%	20%	7%	53%	53%	60%	33%
Teamwork/ organisation and prioritisation	73%	20%	0%	20%	53%	53%	33%
Other	0%	7%	0%	0%	0%	0%	0%

The high use of low fidelity manikins which have no capacity to respond verbally or show physiological signs to teach therapeutic communication and patient assessment skills is a suboptimal teaching strategy when other forms of HPSM were available. Medium fidelity manikins are not being utilised to their full potential it would seem, being more often used to teach basic physical assessment skills such as auscultation of heart and lung sounds rather than clinical reasoning skills and teamwork. It is interesting to note that computer assisted simulation was identified infrequently as a method of teaching clinical reasoning.

There was a high level of simulation used for student assessment with 62 per cent of participants (n=21) using some form of simulation as an assessment strategy. Simulation was used for both formative and summative assessments and a range of methods were used to grade students in simulation activities. The most common

methods were predetermined marking criteria, Australian Nursing and Midwifery Council (ANMC) National Competency Standards for the Registered Nurse (2005), Objective Structured Clinical Examinations (OSCEs), and skills checklists. Simulation was also identified as a strategy for remediation and re-testing following unsatisfactory clinical performance.

Few participants viewed simulation as a viable alternative to clinical placements. Only nine per cent of participants stated that simulation was currently used to replace clinical hours, and this was for additional remediation only. Australian state nursing registration bodies do not allow simulation to be substituted for mandatory clinical placement hours. However, 57 per cent of participants stated that they would consider replacing some clinical placement hours with simulation. Issues influencing this view included: difficulty finding enough suitable clinical placements, the quality of the learning environment in some clinical placements, adequacy of facilities and resources for simulation programs, philosophical stance as to whether simulation should replace or supplement clinical placement, and the requirements of the registration body, including potential changes due to 2010 nationalisation of nursing registration.

4.6.3 Clinical laboratory staffing and staff responsibilities for simulation and technology

The participating schools of nursing varied in the staffing provided to support clinical laboratories and the roles assigned to various staff members in relation to simulation and technology. While 83 per cent of schools utilised at least some full time academic staff for teaching in clinical laboratories, 75 per cent employed some casual laboratory teaching staff, and 17 per cent of schools had all clinical laboratories staffed by casual staff. In the Australian context casual clinical laboratory teachers are usually nurse clinicians with less post graduate academic qualification than full time academic faculty. These casually employed staff teach for a small number of hours at an hourly remuneration rate. While the employment of casual staff may have some advantages in terms of currency of clinical practice, there are implications for the quality and consistency of teaching, and training in the use of new technologies associated with simulation. Participants identified that casual staff may not “have the skills to support”

simulation. In addition to teaching staff ninety two per cent of schools have an appointed laboratory manager, with 54 per cent of those being identified as an administrative position, and 29 per cent as academic staff member. Laboratory technical support staff numbers ranged from 0 to 10 with a median of 1.25.

Staffing responsibilities are an important factor in the effective use of medium and high fidelity simulation. Participants identified staff related factors as constraints to effective implementation of simulation more often than any other factors (including availability of manikins, equipment, space, scenarios or implementation frameworks). The two highest ranking constraints identified were level of staff training in simulation and ICT (n=18), and adequate time for development and implementation within the academic workload (n=17). Important staffing related issues included staff numbers, training, time, availability of designated simulation staff and technical support. Considering this, the patterns of workload responsibility assigned to various staff members are of particular interest. Preparation of the laboratory and maintenance of the manikins was most commonly assigned to the laboratory technicians. Only 50 per cent of respondents had ICT technical support. Academic staff were strongly involved in writing scenarios and running simulation sessions. Most role variation occurred in the programming of computer software (see *Table 2*). The need for a “dedicated member of staff who adopts manikin programming and use as part of their workload” was identified.

Table 5: Table 2 – Staff roles and responsibilities (n= 12)

	Clinical laboratory technician	IT Technician	Supplying company representative	Casual laboratory educator	Simulation specialist staff	Lecturer/ permanent academic
Preparing physical environment	83%	0%	8%	8%	8%	33%
Maintenance of manikins	75%	0%	25%	0%	17%	33%
Maintenance of computer and audio- visual equipment	42%	50%	17%	0%	8%	8%
Writing simulation scenarios	0%	0%	8%	8%	25%	100%
Programming computer software	25%	42%	8%	0%	25%	42%
Controlling the computer during simulation	17%	8%	0%	17%	25%	75%
Supporting students in simulation room	8%	0%	0%	33%	17%	83%
Debriefing students after simulation	0%	0%	0%	33%	8%	83%

4.6.4 Pedagogical principles, processes and frameworks for medium and high fidelity simulations

Several of the simulation pedagogical principles identified by Jeffries (2008) were identified in the survey. Eighty three per cent of participants (n=23) stated that their simulation sessions had written objectives and that these objectives were embedded in or aligned to specific course or subject outcomes, and documented curriculum objectives (refer to *Table 1* for the categories of objectives identified).

Lectures, tutorials, written and computer based learning packages, psychomotor and communication skills training were identified by participants as preparation for the simulation experience. Ninety five per cent of participants (n=22) stated they provided some form of briefing prior to the simulation.

The level of support provided to students during the simulation varied, with only one participant indicating the use of fully immersive (real time and unassisted) simulations from the first year of the undergraduate program. While beginning level students usually require more guidance and support, during complex full scale simulations facilitator discussion is likely to interrupt the flow of the scenario and reduce student independent problem solving (Waldner and Olson, 2007). Forty one per cent stated that they had a facilitator in the room, 9 per cent used the “pause and discuss” technique, and 18 per cent identified the level of immersion as “ad hoc”. Twenty seven per cent of participants stated that the level of support provided was variable, depending on the level of students’ experience.

The number of students actively involved in a simulation at one time ranged from 2 to 30, with a median of 4.5. Those who stated that they had very large numbers involved in a simulation were not explicit about the roles allocated to such large numbers. Sixty eight per cent of participants stated that there were other students present in the simulation room as observers. Numbers ranged from 2 to 21 with a median of 11. When observers were present 50 per cent of participants allocated them a specific role, and 64 per cent reversed roles between active participants and observers during the simulation. Roles allocated to observers included evaluation of the team performance and providing critical feedback during debriefing. Twenty-seven per cent of participants stated that

they had facilities for students in another room to view the simulation through video link or one-way glass. Research indicates that observers may gain significantly from simulation, particularly from the debriefing discussion, but that they may not gain as much as those actively involved in the simulation (Lasater, 2007a). This has significant implications for the availability of sufficient resources to allow all students an opportunity to actively participate.

Eighty-three per cent of participants stated that their simulation sessions became more complex and immersive as students progressed through the undergraduate program. Some participants commented that they focused in first year on basic skill acquisition with static manikins, and patient assessment and communication and history taking. Most used role play for this, but immersive simulation for the development of communication skills was mentioned by one participant. In the second year students were introduced to more complex clinical skills and problem solving requirements, such as wound assessment and management. Simulation sessions for third year students often involved deteriorating patient scenarios requiring real time response and clinical reasoning, patient resuscitation and multi-disciplinary teamwork.

Twenty-seven per cent stated that clinical reasoning, clinical decision making or clinical judgement was not specifically addressed as a discrete topic in their undergraduate program. Of those that did teach clinical reasoning specifically, only 25 per cent used a clinical reasoning model. Models of clinical reasoning reported were the nursing process, Tanner's model of clinical judgement, and reflective practice.

Strategies employed to increase the fidelity of simulation, in addition to the actual manikin, included patient notes, X-ray and pathology results, patient identification and allergy bands, clothing, moulage, makeup, wigs, masks, hospital equipment, patient's personal belongings, smells and noises. Fidelity relating to the clinical realism of the scenarios was enhanced by the design of scenarios reflective of typical local practice situations; an activity undertaken by 96 per cent (n=23) of participants

Eighty-two per cent of participants stated that students were engaged in debriefing following simulation, which lasted between 10 and 60 minutes. Of those that debriefed students 65 per cent did so with one facilitator, the remainder with two, and 50 per cent

utilised video recording of the simulation as part of the debriefing. Ninety-four per cent of those that debrief identified reflection on practice as a technique used, while comparison with predetermined best practice criteria, structured questions and learning logs were less frequently used.

Less than half of the participants, 48 per cent, indicated that they used a theoretical framework or model as a basis for their simulation teaching and learning. Theoretical frameworks and models mentioned included curriculum based frameworks such as the nursing process or problem based learning, nursing theories such as Benner's (1984) novice to expert theory, models of clinical judgement such as Tanner (2005) and Lasater (2007b), experiential learning models and Jeffries' (2007) simulation framework.

4.6.5 Use of ICT in clinical laboratories

The use of ICT in clinical laboratories was low overall. While 55 per cent of participants stated that they have ICT available the actual use of ICT as part of clinical laboratory activities is limited. For of those with ICT, 92 per cent had only desktop computer/s available, and very few had laptops, personal digital assistants (PDAs) or other forms of ICT provided. Of those who had some form of ICT available 42 per cent stated that the technology was used in conjunction with simulation activities. However, comments indicated that the use of ICT referred to computer control of the high fidelity HPSM in some instances, or to virtual reality computer programs or online discussion boards such as Blackboard. While this use of ICT is valuable, other ICT applications including access to online information such as best practice guidelines, health service protocols, pharmacology information or computer based clinical decision support systems are more useful to inform practice at the point of care.

Those who had computers in the clinical laboratories had internet access to library facilities and nursing journal data bases. One school reported an electronic pharmacology program which they found ineffective and planned to abandon. Another school reported electronic access to simulated patients' test results during high fidelity simulation and two reported utilising a computer based clinical decision support system. This low level of ICT use in laboratories appears inadequate to produce nurses competent in the use of point of care technology. Lack of space for computers and lack

of staff with ICT literacy were mentioned as constraints. Several participants stated that new laboratories were being designed to include more ICT, or that further use of ICT in laboratories was being developed.

4.6.6 Evaluation and research

Evaluating the effectiveness of simulation was undertaken by 77 per cent of participants. Of those who evaluate outcomes (n=17) the most frequently used method was student satisfaction surveys (94 per cent), followed by subjective staff input (82 per cent) and outcomes of skills tests (47 per cent). Smaller numbers of participants stated that they measured outcomes in relation to competency standards (35 per cent), clinical reasoning (29 per cent), knowledge acquisition (18 per cent) and clinical performance (18 per cent).

Forty five per cent of participating schools are conducting or have conducted research related to the use of simulation. Areas of research included: the use of simulation in enrolled nurse programs, evaluation of large group simulation sessions, the impact of simulation on detection of patient deterioration, investigation of an evaluation framework for simulation, exploration of the potential use of simulation in Victoria, history taking skills, video assessment of clinical skills, the effectiveness of Second Life™ as a virtual learning environment, and staff development needs.

4.7 Discussion

Overall survey results demonstrate that Australian schools of nursing are actively involved in and committed to the development of simulation, and to a lesser extent ICT. Recognised problems of access and quality of clinical placements have motivated universities to explore alternative ways to achieve quality educational outcomes. The National Workforce Taskforce (2009) has identified an expected 4.3 million shortfall in healthcare worker numbers during the period 2007-2017, related to the ageing population, increases in chronic disease, and additional resources required by advances in health care technologies (Brook, 2009). Australian universities are being required to educate more nurses, and this is putting further pressure on clinical teaching facilities. Both simulation training and increased use of ICT are seen by the Health Workforce

Taskforce as key strategies to effectively educate larger numbers of health care workers and improve the effectiveness and efficiency of the workforce. Significant amounts of government funding are becoming available for the development of simulation and ICT (Brook, 2009).

The results of this study indicate that the adequacy of facilities in nursing clinical laboratories is a crucial issue. Many nursing schools in Australia have large numbers of students, geographically isolated campuses, and large clinical laboratory class sizes. Access to high fidelity manikins is limited. Facilities need to be developed that allow adequate space, manikins, supporting technology and equipment. Consideration should be given to the most effective methods to integrate simulation into curricula and to the provision of these educational opportunities to all students.

It is also important to note that adequate staff and staff training were considered by the survey participants as the greatest constraining factor for the implementation of HPSM and ICT. These findings are consistent with the literature, which identifies the need for significant financial and personal resources and the need for teaching staff to develop new skill sets for effective development and implementation of HPSM (O'Donnell and Goode, 2008). A study by Jones and Hegge (2008) concluded that all academic staff would need additional time and training in order to plan, implement and evaluate simulation use in their courses. Thus, at a time when there is stimulus to implement simulation and ICT into nursing curricula in Australia, it is vital to ensure that, not only are physical resources and infrastructure available, but also adequate staffing, training, and research so that quality teaching and learning outcomes are achieved.

Pedagogical principles suggest that the use of a theoretical framework to guide the implementation of simulation activities is critical to achieving effective learning (Guimond and Salas, 2009). Although limited in some respects, the results from this study indicate that while some have identified underlying pedagogical principles few schools are using a suitable framework to guide the implementation of simulation activities.

From the perspective of Jeffries' (2008) evaluation framework the survey results indicate that the majority of schools have set objectives for their simulations, support is

provided to students through a variety of pre-learning and briefing activities, and through varying levels of facilitator support during the simulation activity. Levels of complexity and problem solving requirements tended to increase as students progressed through their programs. Not all schools taught students clinical reasoning, and only a quarter of those that did so used a formalised model or clinical reasoning framework. The majority of participating schools provided post simulation debriefing, and appropriate strategies such as reflection and evaluation against best practice criteria.

True fidelity in simulation is subjective and exists “in the eye of the beholder” (Lampotang, 2008) and is thus difficult to gauge from a questionnaire. Achieving fidelity is dependent not only on the type of HPSM but also the realism of the environment provided, the clinical authenticity of the scenario, and the skill of the person conducting the simulation and responding to students. Although less than half of the participants were using high fidelity HPSM at the time of the survey, a range of equipment, moulage and scenario designs were being employed to achieve a degree of clinical realism.

High fidelity simulation is a relatively new technology in nursing education. Research has yet to adequately demonstrate its impact on the development of students’ clinical reasoning (Lapkin, 2009), and whether skills and confidence gained in simulation laboratories transfer to improved clinical practice (Leigh, 2008). Further research is needed to guide nurse educators in the choice of the most appropriate teaching strategies, and also to validate the current use of simulation as a form of competency assessment (Jeffries, 2007).

The incorporation of ICT into clinical laboratories and its use as part of a simulation scenario was reported to be poorly developed. Most clinical laboratories provided some computer facilities and often access to intranet or internet capabilities, however there was limited use of ICT to simulate point of care clinical systems and prepare students for the utilisation of ICT in the clinical environment. There is scope for considerable development of technology and also integration into curriculum development to provide students with opportunities to access simulated electronic diagnostic reports and health records as well as best practice literature and guidelines; and use this to plan, deliver

and document at the point of care, (i.e. at the bedside) in simulated environments (Curran et al, 2007; Fauchald, 2008).

The main strengths of this study are its high response rates, scope and evaluation of pedagogical principles used during simulation sessions. All university schools of nursing in Australia were invited to participate and the response rate was 75 percent. Questions covered a broad range of issues and responses provided a 'snap shot' of the current use of HPSM and ICT in Australia. Limitations and weaknesses of this study are those common to the survey methodology. Information gathered is limited to the questions asked and the accuracy of the information given. Only one person completed the survey for each institution, which may have limited access to information, although every effort was made to direct the survey to the most suitable person.

4.8 Conclusion

There is currently much discussion in Australia regarding the potential for simulation to replace some required clinical placement hours. Simulation is recognised as a partial replacement for clinical placement hours in many parts of the United States (Nehring and Lashley, 2004). In the UK, following recommendations from the Nursing and Midwifery Council Simulation and Practice Learning project (2007), up to 300 clinical placement hours can be replaced with simulation (McCallum, 2006; Nursing and Midwifery council 2006). The increase in student numbers and decrease in availability of quality clinical placements in Australia provide a strong argument for the replacement of some clinical placement hours with simulation activities. However, the current variations in levels and methods of simulation and ICT activities employed at different nursing schools contribute to the difficulty in clearly articulating registration body requirements. Nationalisation of nurse registration in 2010 presents an opportunity for these issues to be further explored. Australian schools of nursing need to ensure that the funding provided to support clinical teaching is used, not only for infrastructure and equipment, but also for staff training and research to ensure quality educational outcomes for nursing students.

Chapter 5 Delphi Results as Published in Nurse Education Today

This chapter contains the results of the Delphi study as published in:

Arthur, C., Levett-Jones, T., and Kable, A. (2013). Quality indicators for the design and implementation of simulation experiences: A Delphi study. *Nurse Education Today*, 33(11), 1357-1361.

5.1 Abstract

Simulation is widely used in nursing education. Previous studies have examined the impact of simulation on the acquisition of psychomotor skills, knowledge, critical thinking and non-technical skills such as teamwork.

Challenges associated with the integration of simulation into nursing curricula have also been examined, however only limited research addresses the most effective simulation design and teaching strategies for quality educational outcomes.

This paper reports a Delphi study that synthesises expert opinion on the pedagogical principles and teaching strategies that are indicative of quality in simulation based learning activities. The resultant set of Quality Indicator Statements is presented and opportunities for application and further research are discussed.

5.2 Introduction

Simulation is an educational strategy which provides students with realistic clinical situations, and allows them to practice and learn in a safe environment. Technological developments have provided nursing academics with a range of options for designing simulations, including human patient simulation manikins (HPSM) of varying levels. High fidelity manikins (HF-HPSM) can be programmed to show physiological deterioration and be controlled by the operator to respond to students' interventions. When combined with a realistic simulated environment they allow the student to assess, plan, implement and evaluate care in real time.

Although there is evidence supporting the efficacy of simulation technologies and the contribution these approaches can make to engaged teaching and learning, educators need guidelines for effective implementation and curriculum integration. This necessity has been recognised by the Nursing and Midwifery Council of Great Britain (Wilfred and Doyle, 2006) as well as the International Nursing Association for Clinical Simulation and Learning (INACSL) (Sando et al, 2011). As part of a larger project funded by the Australian Learning and Teaching Council (ALTC), a Delphi study was undertaken in 2010 in which international expert opinion was used to identify quality indicators for the use of simulation. The aim of this research was to develop a set of quality indicator statements that would be applicable internationally and could be used to guide the development, implementation and evaluation of simulation experiences in undergraduate nursing curricula.

5.3 Background / Literature

Educational theories supporting simulation have behaviourist and constructivist origins (Parker and Myrick, 2009). While behaviourist approaches emphasise the acquisition of demonstrable skills, constructivism is described as the foundation for the development of higher order thinking, clinical judgement and non-technical skills (Waldner and Olsen, 2007). Jeffries' (2005) Nursing Education Simulation Framework has been adopted by the National League for Nursing as the recommended framework to guide simulation activities. It has been utilised by many nurse educators for both the design of simulation activities and research studies (Jeffries and Rizzolo, 2006; Kardong-Edgren et al, 2008). Essential simulation design characteristics identified in this framework are: clear objectives, fidelity, scenario complexity requiring student problem solving, adequate student support, and debriefing. Some design characteristics that have been reported by other researchers as practices associated with positive learning outcomes include adequate time and opportunities for repetition (Kardong-Edgren et al, 2008; Swanson et al, 2010), adequate preparation for simulation activities (Cantrell, 2008; Elfrink et al, 2010), clear learning objectives (Smith and Roehrs, 2009) and sufficient facilitator support (Cantrell, 2008; Swanson et al, 2010).

The impact of manikin fidelity level on learning outcomes has received considerable attention in the literature. Overall, studies have failed to demonstrate the benefits of using HF-HPSM to achieve simple knowledge acquisition (Hoadley, 2009; Kardong-Edgren et al, 2009) or psychomotor skills (Rogers, 2007; Hoadley, 2009). When considering higher order skills such as critical thinking and collaboration, research suggests that HF-HPSM appears to support acquisition of these abilities (Howard, 2007; Rogers, 2007). However, there is a lack of evidence regarding the impact of environment or scenario fidelity on student learning.

Recommendations about group size and role allocation during simulations are varied and inconclusive. Jeffries and Rizzolo (2006) found no difference in outcomes between active participants and observers, and Schoening et al (2006) found the observer role to be beneficial. However Lasater (2007) found that students were bored and distracted in the observer role; and Grant et al (2009) found that learning outcomes varied with role allocation. Group collaboration and care planning are however seen as effective learning strategies (Lasater 2007; Elfrink et al, 2009).

Debriefing is acknowledged as a critical part of simulation learning but there is little research on the effectiveness of debriefing methods. Suggested indicators of quality debriefing are that it should occur immediately after the simulation (Cantrell, 2008), and should involve reflective thinking (Dreifuerst, 2009), recognition of students' experience (Henneman and Cunningham, 2005) and specific feedback (Lasater, 2007). The use of video replay of the simulation during debriefing is supported by Grant et al (2009) and with some reservations by Elfrink et al (2009).

The integration of simulation throughout undergraduate nursing curricula is also an area where further research is needed to establish best practice. Murphy et al (2011) discuss implementation of simulation into problem-based learning tutorials, skills laboratories, and finally scenario based simulations. Wilfred and Doyle (2006) discuss the use of the Medical Education Technologies Inc. (METI) pre-programmed scenarios integrated through the UK pre- registration curriculum to overcome the difficulties for academic staff in writing multiple new simulation scenarios. Other authors suggested that additional staff time is needed for planning and preparing simulation scenarios (Feingold et al, 2004; Jones and Hegge, 2008) and the importance of using specialised

staff in these roles (Seropian et al, 2004b). No research studies were found that tested the outcomes of different curriculum models or linked curriculum integration of simulation to quality teaching and learning outcomes.

Minimal research has been conducted to evaluate the use of ICT during simulation. Some research has described the integration of ICT in curriculum and simulation design in US programs (Cornelius and Gordon, 2006; Lucas, 2010) with evaluation by staff and student perceptions only. The use of consistent hardware and software throughout the curriculum is recommended (Fetter, 2008). Software programs should support curriculum objectives and where possible electronic record systems should be the same as those in clinical settings (Lucas, 2010). The need for adequate staff and student training and support for ICT use has also been frequently described (Fetter, 2008; Miller et al, 2005).

5.4 Method

A modified Delphi technique was selected as the most suitable study design to meet the research aim to achieve consensus of expert opinion both nationally and internationally regarding quality use of HPSM, and this formed the basis for the development of the quality indicator statements. The Delphi technique is so named because in ancient Greece the oracle at Delphi was seen as the god Apollo's informant (Schneider et al, 2007). Delphi technique has been frequently used in areas of policy development where expert opinion from a variety of people at potentially distant geographical locations is required. It was initially used in the military, but has also been applied to the development of education and health care policy (Skulmoski et al, 2007; Rayens and Hahn, 2000). The Delphi method involves the systematic solicitation and collection of expert opinions on a particular topic through sequential questionnaires interspersed with feedback derived from earlier responses (Delbecq et al, 1975). Essential components of the classical Delphi method are anonymity of participants to allow free expression of opinion, iteration to refine views, controlled feedback to inform participants of other perspectives, and statistical analysis of responses.

While a classical Delphi technique first round questionnaire utilises open ended questions requiring participants to generate responses, this study utilised the modified

Delphi technique of three rounds, in which the participants were provided with a list of potential quality indicators to rank in relation to importance (Wiersma and Jurgs, 2005). This study design and the use of the online software application Questionmark PerceptionTM were chosen to maximise participation of the experts and also facilitate statistical data analysis. A similar modified Delphi technique has been used in previous studies for the development of health care quality indicators (De Bie et al, 2011) and practice competencies (Staggers et al, 2002; Clay-Williams and Braithwaite, 2009).

5.4.1 Round 1: Development of the questionnaire tool

The first round questionnaire was developed based on a review of the international literature as briefly summarised above, and relevant issues identified by participants in a prior survey of simulation use in Australian schools of nursing (Arthur et al, 2011). Statements were generated to cover the range of opinions expressed in the literature and survey (Wiersma and Jurgs, 2005; Skulmoski et al, 2007). A 5 point Likert type scale and score value was used for participants to rank the importance of simulation teaching principles, practices and resources:

1. Not recommended
2. Limited value
3. Unsure
4. Recommended
5. Critical element

A total of 107 statements were grouped under the following headings:

- Physical resources of simulation units
- Manikin fidelity level
- Information and communication technology (ICT)
- Staff resources and training
- Teaching and learning approaches
- Curriculum integration and pedagogical principles.

Space for additional comments and suggestions was also provided. As part of the process for the development of the initial questionnaire and to ensure face and content validity it was reviewed by an expert panel comprised of academics with particular knowledge and experience in simulation, ICT and survey design. Reviewers were asked to assess the questionnaire items for clarity, conciseness, relevance and ambiguity, and adjustments were made as required.

5.4.2 The study sample and participation

A purposive sample of thirty two international experts in HPSM use in nursing education was invited to participate in the Delphi study. Participants were selected based on the following criteria:

- Editors or chapter authors of internationally recognised textbooks on the use of simulation in nursing
- Keynote speakers at simulation conferences
- Authors of research papers on simulation use in nursing, published in peer reviewed nursing journals
- Executive members of the Australian Simulation Society
- Executive members of INACSL
- Australian and international nurse academics chosen for their experience in the use of simulation, following presentations at simulation conferences or their detailed responses to a previously conducted study on the use of simulation in Australian undergraduate nurse education (Arthur et al, 2011).

All participants were English speaking. They were provided with an information statement outlining the purpose and structure of the Delphi, and completion of the questionnaire was taken as implied consent. Seventeen experts from Australia, North America, Europe and Hong Kong completed the first round questionnaire. Of these 11 completed the second round and 12 completed the third round.

5.4.3 Round 1: Data

The first round results were analysed using mean and median scores of items as well as content analysis of comments. Simulation practices that were recommended or not recommended by the expert participants were synthesised based on scores obtained and additional comments.

- The importance of learning objectives (median 5, mean 4.8) and students' year of enrolment in relation to choice of simulation technology and design (median 5, mean 4.6) was mentioned repeatedly in participants' comments.
- Adequate staffing was viewed by the majority of participants as a critical element, with emphasis on selected academic staff (median 5 mean 4.4) and adequate support staff (median 5, mean 4.6). Adequate staff training was also a critical element (median 5, mean 4.8).
- Structured orientation and debriefing immediately following the simulation were identified by most participants as critical (median 5, mean 4.7).
- Curriculum integration and scaffolding of content, ensuring appropriate knowledge base, and adequate clinical and ICT skills prior to simulation activities was a highly recommended teaching approach (median 4, mean 4.4), as was increasing complexity and level of simulation immersion throughout the curriculum (median 5, mean 4.6)
- Using simulation to teach non-technical skills was also critical (median 5, mean 4.7).

There was a lack of clarity in the responses about ICT use in simulation activities, with no specific ICT equipment consistently viewed as a critical element.

All participants in the first round were sent a detailed report of the results in order to identify points of agreement and disagreement of the expert group. This technique facilitates convergence of expert opinion (Wiersma and Jurg, 2005, Skulmoski et al, 2007).

5.4.4 Round 2: Questionnaire development and analysis of results.

The round 2 questionnaire was constructed from the synthesis of round 1 results (Wiersma and Jurg, 2005). Questionnaire items included strongly worded statements designed to force participants to confirm previously identified critical elements, achieve greater consensus where not yet apparent (Skulmoski et al, 2007). The number of items was reduced to 69 and the rating scale was modified to:

1. Strongly disagree
2. Disagree
3. Undecided
4. Agree
5. Strongly agree
0. Don't know

The last category was included to allow participants who did not feel they had sufficient expertise related to any given question to provide a response to the item.

A section for additional comments and suggestions was also provided. Statistical means as well as content analysis of qualitative data were used for analysis of round 2. As a result of this analysis there were 17 high ranking quality indicator statements (mean above 4.45 out of 5). Of these, the four highest ranking statements (4.91/5) were: use of a range of simulation approaches, ability of staff to assist students to integrate theory to practice during debriefing, adequate training for staff, and student preparation and orientation prior to simulation activities. The 17 statements were further modified based on qualitative data and refined into 15 key quality indicator statements

5.4.5 Round 3: Verification of quality indicator statements

The list of 15 quality indicator statements derived from round 2 was then sent to all participants for comment. The statements were then further refined and developed based

on the last round of feedback, then categorised into five key areas for presentation: pedagogical principles, fidelity, student preparation and orientation, staff preparation and training and debriefing. These are presented below.

5.5 Delphi results: Quality Indicator Statements

5.5.1 Pedagogical principles:

1. **Simulation experiences are aligned with curriculum goals and course objectives.** Simulation experiences should be developed as part of a coherent curriculum structure with the ultimate goal of preparing graduates who are fit for practice.
2. **The curriculum matrix illustrates how simulation experiences are integrated throughout program.** A curriculum matrix provides a way of ensuring alignment between program, course and simulation objectives.
3. **There is scaffolding of learning experiences throughout the curriculum; and the required knowledge, psychomotor skills, clinical reasoning and reflective thinking skills, and use of health care technologies are taught prior to their implementation into simulation experiences.** The term scaffolding refers to the provision of adequate support to promote learning. It implies purposefully constructed activities that build towards student mastery, with gradual reduction in staff involvement.
4. **Simulation experiences, in some form, are integrated into every clinical course and progress in complexity throughout the program.** The introduction of simulation from the first year of the students' program provides early experiential learning opportunities within a safe practice environment, as well as familiarising students with simulation activities and building confidence for subsequent more complex activities.
5. **Learning objectives guide all aspects of simulation design including: student preparation activities, clinical scenario, group size, inclusion of observers or students from other disciplines, selection of manikin fidelity and other**

equipment, level of student support during the simulation, and method of debriefing. Clear learning objectives should be written prior to simulation design, and should be available to all staff and students prior to simulation activities.

5.5.2 Fidelity:

- 1. The range of simulation technologies and approaches used are consistent with learning objectives, resource availability and cost effectiveness. These include but are not limited to, low, medium or high fidelity human patient simulation or part-task trainers.** The advantage of more expensive manikin technologies for all levels of skill acquisition has not been demonstrated. Cost as well as suitability to meet required learning objectives should be considered when planning simulation activities and purchasing equipment.
- 2. Environmental fidelity is developed in line with the learning objectives of the simulation session.** The fidelity level of the manikin often overshadows consideration of other aspects of fidelity. Providing a realistic environment gives the scenario contextual richness and assists the students to become immersed in the situation.
- 3. Contextually appropriate clinical equipment and the availability of hardcopy or electronic patient information and charts support a realistic clinical environment.** Wherever possible equipment and charts should be the same as those used in local clinical venues to increase the transferability of skills.

5.5.3 Student preparation and orientation:

- 1. A structured orientation is provided for students prior to the simulation session and, depending on the students' prior exposure to simulation activities, includes: introduction to and an opportunity to become familiar with the learning objectives, structure, timing and process of the session; the simulation environment, equipment, manikin, monitoring devices, and ICT to be used.** Adequate briefing prior to simulation sessions alleviates students' anxiety and improves learning. Additional preparation before the

simulation activity in the form of lectures, learning packages or skill training provides the scaffold that assists students to perform in simulated situations.

5.5.4 Staff preparation and training:

- 1. Staff who design scenarios, conduct the simulation sessions, facilitate debriefing and manage the technology have each undertaken appropriate training.** Training of staff is an essential to the effective instigation and continuation of simulation within any curriculum, and needs to be considered as an important aspect of the simulation budget.
- 2. Staff who design simulation scenarios and program manikins are familiar with curriculum goals, have relevant clinical knowledge and understand the technological capabilities of manikins.** Academic staff who are responsible for simulation activities require a range of skills and may need additional training in new technologies.
- 3. Staff who facilitate simulation sessions have relevant clinical knowledge, understand course objectives, and possess expert clinical teaching skills to enable students to relate theory to practice during debriefing.** The quality of students' simulation experience is largely dependent on the skills and knowledge of those facilitating the simulation sessions. A supportive attitude and effective debriefing skills are at least as important as familiarity with the manikin technology.

5.5.5 Debriefing:

- 1. A structured debriefing is provided immediately following the simulation.** Debriefing sessions should be structured to explore key concepts from learning objectives and help consolidate students' learning. Debriefing is most effective when conducted immediately after the simulation while the events and emotions are fresh in students' minds.
- 2. The debriefing facilitates students' reflection on practice, self-evaluation and feedback on their perceptions of the experience.** It should encourage

students to identify areas for improvement and how to transfer learning into clinical practice.

3. **Depending on the simulation objectives, opportunities for discussion of students' non-technical skills such as clinical reasoning, situation awareness, communication, leadership and teamwork are included in debriefing.** Research continues to demonstrate the importance of these skills to patient health outcomes, and simulation provides a valuable teaching strategy for the acquisition of non-technical skills.

These quality indicator statements, along with rationales and useful resources, were published in a brochure format in November 2010 (Arthur et al, 2010) and via the ALTC project website, and have been distributed to attendees at the Simulation and Beyond Symposium, School of Nursing and Midwifery, The University of Newcastle, NSW, Australia, November, 2010, and the INACSL 10th Annual International Nursing Simulation/ Learning Resource Center Conference, Orlando, USA, June, 2011.

5.6 Discussion

The expert opinions of the participants were consistent with the literature review findings overall. In particular the need for clear objectives to guide all aspects of simulation design, the importance of adequately trained and skilled staff for simulation activities, student preparation and debriefing and curriculum integration were identified as critical from the ranked data.

As well as ranking highly in the quantitative data, clear and specific objectives were repeatedly mentioned in the additional comments as the essential guide for all aspects of simulation design. Educators should identify specific objectives for each simulation session and then select the appropriate scenario, design features and equipment to be used. Participant consensus was that high fidelity manikins are not a requirement for all simulation activities. This approach is supported by recent studies which have found that medium fidelity manikins are more cost effective than high fidelity in some learning situations (Levett-Jones et al, 2011).

The importance of adequate staffing and staff training in simulator technology and scenario design, and in particular in debriefing techniques were very highly ranked. This is consistent with the results of the cross sectional survey of the use of simulation in Australian university schools of nursing which found that lack of adequate staffing was the greatest impediment to the effective use of simulation in undergraduate nurse education (Arthur et al, 2011). Studies in other countries also point to the critical role of staff acceptance and staff training in integrating simulation into a nursing curriculum (Jones and Hegge, 2008).

Another focus was the integration of simulation throughout the undergraduate nursing curriculum. Delphi panel members recommended that simulation experiences should be introduced into all years of the program, with increasing levels of complexity and immersion. The pedagogical term scaffolding refers to the provision of sufficient support and coaching to promote learning when concepts and skills are first introduced, followed by a gradual withdrawal of support as the learner progresses and begins to assume an increasingly independent role (Doolittle, 1997). Scaffolding implies that learners are adequately supported by prior learning experiences prior to fully immersive simulation experiences.

The role of student preparation and orientation prior to the simulation experience was very highly rated and could be viewed as a key aspect of creating the scaffold to support the learning experience. This is an important finding as preparation and orientation of the student were not previously identified in Jeffries' Simulation Design Characteristics of objectives, fidelity, problem solving, student support and debriefing (Jeffries, 2005). Debriefing has been recognised as critical to student learning during simulation activities (Dreifuerst, 2009). This study has confirmed expert opinion on the importance of debriefing immediately following the simulation, and the use of techniques of reflection and self-evaluation of practice.

It is useful to also consider the aspects of simulation that were not ranked highly by the participants. The use of ICT during simulation sessions was not identified as critical component of simulation activities. No one type of ICT support or software ranked as critical to quality simulation activities. The provision of some form of medical record was seen as an important component of environmental fidelity, but this was not

identified as requiring an electronic format. The use of video streaming and the provision of a separate control room were other areas not ranked as essential for quality simulation. The importance of repetition of activities to reinforce learning was mentioned only by one participant, so was not included in the quality indicator statements, although this is a principle supported in the literature. The notion of using simulation for assessment was not strongly supported in this study.

The quality indicator statements are consistent in many ways with a set of simulation standards developed by the INACSL Board or Directors (Sando et al, 2011), in particular the standards requiring set objectives, use of various facilitation methods, well prepared facilitation staff and quality debriefing. Main areas of difference are the lack of a separate standard related to student preparation, and the inclusion of standards for the use of simulation as summative evaluation of students. At the time this Delphi process was completed, the use of simulation for assessment was not well supported, and is still has limited use in the Australian context.

5.6.1 Limitations

The most common limitation of the Delphi method cited in the literature is difficulty generalising the results based on sample size, limited spectrum of views and geographic location of participants (Skulmoski et al, 2007). The choice of an international panel for this study with a high level of credibility and experience in the field has minimised this concern to some extent. The final quality indicator statements are thus applicable internationally as well as across a range of simulation contexts and methods.

5.7 Conclusion

The quality indicator statements resulting from this Delphi study will be of benefit to academics with an interest in the design, implementation and integration of simulation. They provide synthesis of research findings and expert opinion about clinical simulation and factors that should be considered for curriculum integration. The quality indicator statements can be used to guide the implementation of simulation within nursing curricula, or to evaluate the extent to which quality implementation has been achieved. Further research is currently being undertaken to develop and test instruments that will facilitate the use of these indicators for evaluation of simulation experiences.

Chapter 6 Discussion and Conclusion

This chapter brings the thesis to a close by drawing together key issues from all the data collected in this mixed methods study, including the cross sectional survey and the Delphi study in relation to the use of human patient simulation manikins (HPSM) and associated information communication technology (ICT) in nursing education. The extent to which the study has achieved its aims is discussed as well as the strengths and limitations of the study process. Further opportunities for extension of this work by testing and implementation of the quality indicator statements are then outlined. The chapter concludes by discussing the implications of this research for nursing education, further research directions and policy development.

6.1 Achievement of the study aims

The research has been successful in achieving the aims of the study. The cross sectional survey, with its high response rate from Australian schools of nursing, has provided a snapshot at the time of the use of HPSM and ICT in clinical laboratories and simulation experiences, and has been the most extensive Australian study of its kind. The data obtained provided information on resource availability, staffing, utilisation of technology and pedagogical approaches. It also highlighted the use of HPSM for students' formative or summative assessment, and the lack of availability of tools to evaluate the quality of simulation experiences. The second phase of the research, the Delphi study, used expert opinion to identify the principles and practices that constitute quality use of HPSM and ICT and developed a set of Quality Indicators Statements that can be used evaluating the quality of clinical simulation learning experiences for a range of modalities (not restricted to HPSM). These statements have the capacity to guide simulation design and implementation, to evaluate the quality of simulation teaching and learning experiences, and to be utilised as a framework for further research and policy development.

At the time that the research was commenced, technology in HPSM was advancing rapidly. While there was a lack of clarity about what constituted quality in the use of simulation as a teaching and learning strategy, there was an assumption by many nurse

educators that the use of expensive high fidelity technology must result in better learning outcomes. This research forms part of a developing body of knowledge that highlights the importance of quality pedagogical approaches that are applicable to a range of simulation technologies, with learning objectives being critical to guide all aspects of simulation design.

6.2 Simulation staffing

The importance of adequately trained staff for the successful implementation of simulation has been frequently discussed in the literature (Nehring and Lashley, 2004; McKenna et al, 2007; Jansen et al, 2009; Adamson, 2010). Both the cross sectional survey and the Delphi study reiterated the need for staff with experience and expertise in simulation design, programming, curriculum integration, and implementation. Indeed the cross sectional survey identified inadequate staffing as the greatest impediment to the effective implementation of simulation in Australian nursing schools; with issues of casualization of simulation staff and lack of specialised IT staff considered to be key issues. These findings are similar to those of a survey conducted in 2010 by the National Council of State Boards of Nursing (NCSBN) into the implementation of simulation in undergraduate nursing curricula in the United States (Hayden, 2010; Kardong-Edgren, Willhaus, Bennett and Hayden, 2012). This cross sectional study invited faculty from 1,729 pre-licensure registered nurse programs to complete a questionnaire on the use of simulation in their program; and a 62 percent response rate was achieved. While 81 percent of respondents felt that more simulation activities should be available for students within their program, the adequacy of staff training, particularly in relation to scenario writing and the facilitation of simulation experiences, was most commonly identified as a major barrier (Hayden, 2010). The Delphi study also identified staffing and staff training as essential aspects of quality use of simulation. Training of staff in scenario design, management of technology, conducting simulation experiences, and debriefing were perceived to be crucial, as well as knowledge of curricula and related course objectives. These findings have implications for the types of training and support that are available to nursing educators, as initially most training was provided by the simulator vendors, and possibly lacked pedagogical expertise (Kardon-Edgren et al, 2012). Long range planning for the development of

simulation programs needs to include support strategies for implementation, growth and sustainability, including costing of time required for simulation activity development, development of faculty expertise, and formal evaluation processes (Pattillo, Hewett, McCarthy and Molinari, 2010).

Since conducting the cross sectional survey in 2009 there has been considerable investment in training of simulation staff in Australia. Health Workforce Australia (HWA) has engaged in a range of activities to improve the education of simulation staff. Under the National Partnership Agreement on Hospital and Health Workforce Reform a two stage educational strategy has been implemented. The first stage, termed the Australian Simulation Education Trainer Training (Aus-SETT) program, used a “train the trainer” approach to develop a cadre of staff trained in simulation education and technology to act as leaders in the field and implement simulation activities at their own institutions. The second stage, National Health Education and Training-Simulation (NHET-Sim) provides a number of e-learning training modules and face to face workshops for anyone involved in simulation education (Health Workforce Australia, 2013).

Another important initiative has been the establishment of the Council of Deans of Nursing and Midwifery (CDMN) of Australia and New Zealand simulation learning environments (SLE) advisory group. This group was established to pool expertise and share best practice. The Council of Australia Governments (COAG) has also made a significant amount of money available for the development of simulation resources, and the CDMN SLE advisory group has played a key role in making recommendations to COAG so that funds are appropriately used. In addition, the SLE CDMN group worked with Laerdal to modify the established National League for Nurses (NLN)/Laerdal simulation scenarios to reflect the Australian context and a series of simulation workshops have been developed to train staff in all aspects of simulation including pedagogy, modes of delivery, debriefing, and current research initiatives, as reported by CDMN members (Brown et al, 2012).

These and other programs have helped to improve the preparation of simulation educators in Australian schools of nursing. However, as simulation programs continue

to expand the importance of adequate preparation of staff remains an ongoing challenge and key to the implementation of quality simulation programs.

6.3 Student centric quality indicators and comparison to Jeffries' framework

In this study the Quality Indicator Statements that relate to the student's experience of the simulation activity are: pedagogical principles, fidelity, student preparation and orientation and debriefing. These may be compared with the Simulation Design Characteristics from Jeffries' (2007) Nursing Education Simulation Framework – objectives, fidelity, problem solving, student support, and reflective debriefing. In the area of pedagogical principles the Quality Indicator Statements emphasise the importance of learning objectives, not only as a guide to simulation design for a specific learning outcome, but also as a way of integrating simulation activities into broader course and program objectives, and mapping the use of simulation as a learning strategy throughout the curriculum. Jeffries design characteristic of problem solving did not emerge from the Delphi data as a separate quality indicator statement. Aspects of this relating to the level of complexity of simulation activities were encompassed in the statement that all aspects of the simulation, including scenario complexity and level of immersion and student support should be tailored to meet learning objectives. The importance of scaffolding of learning across the curriculum is another important indicator of a quality simulation experience not mentioned in the Jeffries model.

Aspects of fidelity of manikins, scenarios and environments are recognised in both the Jeffries model and the Quality Indicator Statements, and the importance of a structured debriefing is also emphasised. The Quality Indicator Statements have however introduced a separate category for student preparation and orientation, with an emphasis on linking the simulation activity to prior theoretical and skills based learning. There is also a recommendation for a structured orientation prior to each simulation session that includes a reiteration of learning objectives and a familiarisation with the expected timing of the session and with all aspects of the environment, including the functional level of the manikin in use and the availability and use of equipment, ICT and charts.

6.4 Impact of cost of HPSM and relationship to choice of teaching strategies and curriculum implications

When exciting new simulation technology in the form of high fidelity manikins became available and was being heavily promoted and marketed by the manufacturers, many Australian schools of nursing were quick to purchase this equipment, without giving adequate consideration to the pedagogical implications. Manikin availability is only one aspect required for the implementation of an effective simulation based teaching program, and costs associated with building infrastructure, other equipment, staff training and ongoing staffing, scenario design and curriculum integration all need consideration. The importance of staffing and staff training is discussed above.

The infrastructure and technology associated with HPSM and associated ICT is costly. The cross sectional survey identified that adequate simulation spaces were a factor for some universities and that not all nursing schools, at the time of the survey, had access to high fidelity manikins or adequate facilities to incorporate ICT into simulation activities. Consensus of expert opinion in the Delphi study emphasised the importance of selecting the most appropriate technologies and teaching strategies to meet the learning objectives of the simulation activity and of utilising a range of approaches to achieve the best learning outcomes.

Simulation involves a range of possible modalities. While the focus of the study was initially HPSM, the results clearly indicate that educators should consider the full range of simulation strategies and choose the most appropriate equipment to meet curriculum and course objectives in the most cost-effective and educationally sound manner. The NCSBN Simulation survey conducted in the United States (Hayden, 2010) identified that the most common learning objectives for high and medium fidelity simulation activities at that time were patient assessment and psychomotor skills. While some respondents indicated that critical thinking, clinical decision making, time management and teamwork were also targeted learning objectives, 31 percent of respondents felt that communication could only be learned in the real clinical environment (Kardon-Edgren et al, 2012).

In the Delphi stage of this current study, participants were clear that high fidelity manikins are not necessarily a requirement for effective simulation activities in every situation. A recent cost-benefit analysis of high fidelity versus medium fidelity simulation manikins identified that similar outcomes, in terms of clinical reasoning, students satisfaction and knowledge acquisition could be achieved with medium fidelity manikins when appropriate scenarios were implemented (Lapkin and Levett-Jones, 2011). The Quality Indicator statements clearly identified the importance of learning objectives to guide selection of level of fidelity, simulation modalities and scenarios and these indicators may be used for a wide range of clinical simulation modalities. Within the researcher's own school of nursing this study outcome has supported the development of a diverse range of simulation activities; including medium and high fidelity manikins, standardised patients (actors), role play and silicone mask technology (Mask-EdTM KRS Simulation) (Kable, Arthur, Levett-Jones and Reid-Searl, 2013; McAllister et al, 2013).

Crucial aspects of effective pedagogy are the cornerstone of effective use of simulation in all forms. A curriculum that provides for clear learning objectives and outcomes, with simulation activities specifically designed to target key learning areas, and scaffolded to build students' knowledge and competence throughout the program emerged in the Delphi study as essential components of quality simulation use. While the newly available high fidelity manikins may have initially been the primary focus of the study, expert opinion of the Delphi panel clearly identified underpinning pedagogy as more important than the availability of a particular technology. The wider implications of these findings for nursing education are apparent; no one technology or teaching strategy will provide for every aspect of nursing education. Nurse educators should choose wisely from the many technologies available, and base their program on sound pedagogical principles and rigorous evaluation.

6.5 Use of simulation as a means of assessment

At the time of the cross-sectional survey 70% of Australian schools of nursing were using simulation in some form for the assessment of students' performance. A range of forms of simulation were used for both formative and summative assessment.

Commonly identified methods of student assessment were the use of part task trainers and medium fidelity manikins for skill assessment and remediation, and role play for therapeutic communication and patient assessment. High fidelity scenarios and manikins were less frequently used as an assessment strategy. Skills checklists, algorithms, marking criteria, Lasater's rubric (Lasater, 2007b), OSCERs and video analysis were mentioned as assessment tools.

In the Delphi study, the use of simulation for student assessment was not strongly recommended by members of the expert panel, so was not included in the Quality Indicator Statements. In particular, the use of simulation for high stakes or capstone assessment was associated with some reservations such as the need to ensure that tools were specifically designed to target the competencies being assessed.

6.6 Integration of ICT into simulation activities

Expert consensus in the Delphi study emphasised the importance of maintaining environmental fidelity by using the same documentation system currently used in the real world clinical context. The concept of a fully integrated electronic medical record, available across both hospital and community health care settings, has been recognised as a desirable healthcare goal. However, at the time of the cross sectional survey in 2009 the use of point of care ICT in association with simulation activities within the Australian context was relatively low.

Australia continues to lag behind international standards for the implementation of an electronic medical record and point of care electronic documentation, with most Australian hospitals currently using paper based charting for most aspects of documentation. An Australian study (Bembridge, Levett-Jones and Jeong, 2011) which examined the use of ICT by new graduate registered nurses in the workforce identified that competence and confidence in the use of ICT is an important factor in the role of the registered nurse in the clinical environment, but that ICT is mainly used for accessing pathology results, searching for information on medications or medical diseases, and accessing hospital and government policy documents. Graduates who participated in this study indicated that while tertiary education activities assisted them to develop general and academic ICT skills, this was not well linked to the ICT related

activities that were required in the clinical environment, and that there were no opportunities to learn about and practice using the software systems used in the clinical environment.

In Australia most large hospitals are state government, publically funded institutions, and universities, as federally funded bodies, have limited access to hospital ICT systems. The importance of collaboration between health and education institutions to provide students with relevant learning opportunities in the use of ICT systems has been identified in international studies (Curran, Sheets, Kirkpatrick and Bauldoff, 2007). The incorporation of ICT into simulation activities within Australian universities presents a challenge to nursing educators to find ways to increase this collaboration as Australian health care moves towards a fully integrated electronic medical record (NSW Health, 2013).

6.7 Application of the quality indicator statements to guide design, implementation and evaluation of simulation activities.

The Quality Indicator Statements that resulted from the Delphi study have potential for use in designing, implementing and evaluating simulation activities for undergraduate nursing programs, as well as for ongoing research. One example of how the Quality Indicators have been used to date is work by Rochester et al (2012) at the University of Technology Sydney, where the statements were used to design and evaluate the integration of a high fidelity HPSM activity into a foundational course for a large cohort of 375 first year nursing students from a university in Sydney, Australia. The Quality Indicator categories of alignment with curriculum pedagogy and goals, preparation of students and staff, fidelity and debriefing were used to ensure that quality was maintained throughout the endeavour. The researchers concluded that it was possible to provide large cohorts of students with simulation experiences by applying these quality indicators.

At the researcher's own university an extension project has been conducted to test the Quality Indicator Statements and their usefulness in the evaluation of various modalities

of simulation activities. A number of evaluation tools, based on the quality indicator statements, were designed, including a student satisfaction survey, a simulation observation schedule, and a course and program document audit. These tools have been used to evaluate simulation activities for second year students at the University of Newcastle, NSW; and for first year students at the Central Queensland University (Kable, Arthur, Levett-Jones and Reid-Searl, 2013). Of particular note was the capacity of the Quality Indicator Statements to provide valuable evaluation data and compare the use of a range of simulation modalities such as manikins of various levels of fidelity, standardised patients (actors), role play and silicone mask technology (Mask-Ed™ KRS Simulation) used in these learning experiences; and to identify potential areas for improvement in the planning and delivery of these learning sessions.

At this stage the Quality Indicator Statements have only been tested in relation to undergraduate nursing students. However the potential exists for further research to examine their effectiveness in guiding post graduate and inter-professional simulation activities.

6.8 Significance of the research

The published studies that are contained in this thesis have contributed significantly to the body of nursing knowledge surrounding the use of simulation in nursing education. At the time of the publication of the cross sectional survey, this was the only study available that scoped the extent to which HPSM and ICT was being used in Australian nursing simulation units. The survey explored not only the uptake of simulation approaches, but also the ways in which simulation was being employed and underlying pedagogical approaches in use.

The Delphi study was the first international study that sought international expert consensus on what constituted quality in terms of HPSM and associated ICT use in undergraduate nursing programs. The Quality Indicator Statements first published via the Australian Teaching and Learning Council (ALTC) web site in 2010, further developed key concepts from Jeffries' Nursing Education Simulation Framework (2007) and other literature, with a particular emphasis on the integration of simulation activities across a nursing curriculum in order to support desired learning outcomes in

an economically and practically sustainable manner. They provided not only a set of useful guidelines for design, implementation and evaluation, but a basis for the development of further work, such as the development of the International Nursing Association for Clinical Simulation and Learning (INACSL) Simulation Standards (personal communication, Suzan Kardong-Edgren, 2010).

6.9 Comparison of quality indicator statements to INASCL standards of best practice

Since the publication of the Quality Indicator Statements as a pamphlet and on the University of Newcastle web site in 2010 (<http://www.newcastle.edu.au/project/clinical-reasoning>) INASCL has produced a set of Standards of Best Practice: Simulation (2011). While there are a number of differences in the content and way in which these indicators and standards are presented, there is also congruence with the overall recommendations for quality simulation learning experiences.

The first INASCL Standard provides a detailed glossary of simulation terminology which provides a clear nomenclature and common understanding of terms. This lexicon is of value, not only during simulation activities, but for planning, training and future research.

The second INASCL Standard refers Professional Integrity of Participants. This standard draws together a number of important behavioural aspects of both facilitators and students during simulation activities, and is a valuable guide to educators in monitoring the conduct of staff and students and providing a safe, effective and professional learning experience.

One of the key areas of the Quality Indicator statements which is not emphasised in the INASCL Standards is the aspect of curriculum integration. These INASCL Standards progress through aspects of an individual simulation activity in a logical sequence from setting objectives, choosing facilitation methods, facilitator techniques, debriefing and evaluating outcomes, but do not situate an individual simulation learning experience within a student's overall curriculum of learning. By contrast the Quality Indicators that resulted from consensus of the Delphi participants emphasised a number of key

Pedagogical Principles important to the development of a curriculum wide program of simulation activities. Alignment of activities within curriculum goals as well as individual course objectives, use of a matrix to plot the use of simulation throughout the curriculum, scaffolding of learning both within individual simulation activities, and from one activity to the next, and integration of simulation into every clinically based course, are all recommended to achieve a quality simulation program.

Aspects of student preparation and briefing for simulation activities, set learning objectives, appropriate simulation methods, and quality debriefing are covered in both the Quality Indicators and the INASCL Standards, with considerable congruence between recommendations. While Standard V: Simulation Facilitator, emphasises the behaviours required for effective facilitation, the Quality Indicators have highlighted the need for adequacy of knowledge and training for simulation staff, and identified the varying needs of those responsible for designing simulation activities, and those facilitating. Lack of training was identified in the cross sectional survey as a major limitation in the development of simulation within the Australian context at the time of the study. The emphasis of Delphi participants on training requirements to achieve quality simulation programs was appropriate, and serves to guide simulation educators regarding the importance of planning to meet staffing needs and thus ensure both quality and sustainability of simulation activities.

The final INASCL Standard VII: Evaluation of Expected Outcomes covers the use of simulation as a tool for student evaluation. This aspect of simulation was not included in the Quality Indicator statements, as the use of simulation to evaluate students' performance was not well supported by the Delphi panel, particularly for "high stakes" evaluation such as passing course and program requirements. Current methods of evaluating the effectiveness of students' learning during simulation activities often rely heavily on self-evaluation (Elfrink Cordi, Leighton, Ryan-Wenger, Doyle and Ravert, 2012). More research is required to develop valid and reliable ways to quantify students' performance during simulation activities (Kardong-Edgren, Adamson and Fitzgerald, 2010).

6.10 Trustworthiness of the study findings

In a mixed method study of this kind which includes both quantitative and qualitative data there are a number of aspects to consider in relation to the trustworthiness of the data collection and analysis, and thus the study findings. Methods for achieving validity in the development of the cross sectional survey and Delphi questionnaire instruments such as considering the study aims, reviewing the literature, reviewing the instruments with an expert panel and testing the instrument before commencing data collection have been discussed in detail in Chapter 3. Simple quantitative descriptive statistics formed the main method of data analysis in both phases of the study. This process included checking and cleaning the data prior to analysis, and confirming statistical results to ensure reliability of findings.

In the cross sectional survey of the status of HPSM and ICT usage in Australian schools of nursing the amount of qualitative data collected through open ended questions and comments in the cross sectional survey was not extensive, these data were content analysed and reflected in study findings. The inclusion of all Australian nursing schools in the invitation to participate, the high response rate of 75% and the fact that responses were obtained from all Australian states was important in relation to the credibility of the study. The information from the cross sectional survey is not transferable outside the Australian context, and reflects the state of HPSM and ICT usage only at the time of the data collection.

There was also an element of qualitative analysis of the Delphi results at each stage of the process. Content analysis of additional comments from the first questionnaire was used to frame additional questions for the second round questionnaire. Qualitative analysis of the content of the highest scoring quality statements from the second round was used to group the quality indicator statements into the final categories: pedagogical principles, fidelity, student preparation and orientation, staff preparation and training and debriefing. The trustworthiness of qualitative research findings are enhanced by addressing issues of credibility, transferability, dependability and confirmability (Shenton, 2004).

The credibility of the Delphi results is supported by the range of expert opinion, and inclusion of participants with a very high level of recognised expertise in the field. The inclusion of participants from Australia, Europe, America and Asia increases the transferability of the findings to a range of international settings. Dependability of the Delphi process was supported by sending all participants a detailed analysis of the previous round's findings between rounds for their review. The final quality indicator statements were confirmed in the last round of the Delphi process, and consensus achieved.

6.11 Strengths and limitations of the study

When reviewing this study, an important strength is its iterative building of knowledge in a way that is pragmatic and of use to nurse educators, both in Australia and internationally. Knowledge gained by reviewing the literature was used to design the cross sectional survey and issues identified as crucial concerns were further explored by means of the expert Delphi panel, and resulted in the Quality Indicator statements.

The cross sectional survey was the first Australia wide study of simulation activities in nursing education. Its main strengths were its high response rate, scope, and evaluation of pedagogical principles used during simulation sessions. While the author acknowledges that the number of participants in the study was small, all university schools of nursing in Australia were invited to participate and the response rate was 75 percent. Participant numbers are therefore reflective of the population studied. Questions covered a broad range of issues and responses provided a 'snap shot' of HPSM and associated ICT use in Australia at the time. Limitations and weaknesses of this study are those common to the survey methodology. Information gathered is limited to the questions asked and the accuracy of the information given. Only one person completed the survey for each institution, who may have had limited access to information, although every effort was made to direct the survey to the most suitable person. Not all participants answered all questions in the survey, and there were some inconsistencies in responses between questions. The researcher carefully cleaned the data to provide the most accurate statistical analysis possible. Since the collection of these data in 2009 there have been many advances in the use of HPSM in Australia.

Additional research is needed to further explore the extent of change in simulation since 2009.

The strength of the Delphi study lay in the quality of national and international expert participants who were recruited. The process attracted a wide range of international opinion from some of the most recognised experts in the field. The main limitations of the Delphi method cited in the literature are difficulty generalising the results based on sample size, limited spectrum of views, and geographic location of participants (Skulmoski et al, 2007). The choice of an international panel for this study with a high level of credibility and experience in the field has mitigated this concern to some extent. The final Quality Indicator Statements are thus applicable internationally as well as across a range of simulation contexts and methods (and are not restricted only for HPSM), and potentially for other health disciplines.

6.12 Recommendations for future implementation and research

The Quality Indicator Statements which were the outcome of this study are useful as a guide to the implementation of simulation across curricula, for designing individual simulation activities, preparing staff, and evaluating quality outcomes of the learning sessions. They have the potential to provide an important contribution to the provision of quality simulation based education. As discussed above, the indicators have already been utilised as a framework for course and activity design and evaluation. Further research is needed to validate the use of the Quality Indicators and to evaluate their usefulness in the implementation of simulation across undergraduate nursing and other health professional curricula. There is also potential to research their applicability in post-graduate or inter-professional simulation activities. The findings of the research, particularly the importance of staff training in relation to quality outcomes, and need to consider suitability for purpose and cost effectiveness in the choice of manikin technology, can be used to guide policy and decision making for the provision of the most effective resource allocation for quality learning outcomes for various simulation modalities. As simulation based nursing education and research has continued to develop, repetition of the cross-sectional survey, conducted in 2009, would be a useful

way to measure changes that have occurred in simulation based nursing education in Australia.

6.13 Conclusion

This study was designed and conducted using a pragmatic approach to the investigation of the study aims, which underpinned all aspects of the study design and conduct. Firstly a process of abductive reasoning was utilised. The literature review was used to gain a theoretical perspective and understanding of the current level of knowledge about the use of HPSM and related ICT in undergraduate nursing education. Subsequently this knowledge was used to determine current usage in the Australian context using a cross sectional survey, and international expert opinion on quality usage of HPSM and related ICT using a Delphi study. The resultant data were then utilised to produce a workable set of Quality Indicator Statements for the design and implementation of simulation activities. Throughout the research process thinking moved backward and forward between known theoretical knowledge and newly acquired understanding from both the qualitative and quantitative data collected. Also critical to this study was the use of language, communication and shared meaning. Opinion was sought from participants, both in the cross sectional survey and the Delphi study. Open as well as closed questions were utilised to gain understanding. The Delphi technique used for the generation of the quality indicator statements is based primarily on the concept of expert consensus (Delbecq, Van de Ven and Gustafson, 1975). Furthermore, the results of the study have been disseminated to the profession through pamphlets, publications, presentations and seminars.

Pragmatism or practicality and the research aims guided the choice of design for the sequential components of the study – the cross sectional survey and Delphi study. Pragmatism has also allowed for the collection of both qualitative and quantitative data, with data analysis using statistical and content analysis to produce a broader understanding of the topic. Lastly the aspect of practical knowledge and transferability of knowledge has been central in the design and conduct of the study. As part of a larger study funded by the former Australian Learning and Teaching Council, there was an emphasis on a research outcome that could be used to guide quality teaching and

learning. The resultant set of Quality Indicator Statements has been made available as a pamphlet and on the University of Newcastle website

(<http://www.newcastle.edu.au/project/clinical-reasoning>).

and has been published in a peer reviewed journal. These quality indicators have been of benefit for design of learning activities and conduct of other research projects (Rochester et al., 2012; Kable, Arthur and Levett-Jones, 2013). Furthermore the Quality Indicator Statements have potential to form the basis of further research studies and to guide policy in the implementation of simulation programs.

From a personal perspective the journey that I have taken during the conduct of this research project has produced great rewards. At the commencement of the study I had considerable experience in nursing education and clinical skills teaching, but no experience with the teaching strategies associated with the new technologies of HPSM. The work involved in this study has produced a set of quality indicators that are a practical guide to achieving quality, integrated simulation throughout an undergraduate nursing curriculum. By the application of these indicators within our own undergraduate nursing program my colleagues and I have been able to achieve an integrated and scaffolded simulation program across all years and all clinical courses within our Bachelor of Nursing program. The research journey towards knowledge and the practical application of that knowledge has thus progressed contemporaneously for the benefit of the nurses of the future.

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Appendices

Appendix I – Survey Letter of Invitation to Heads of School

School of Nursing and Midwifery
Faculty of Health
University of Newcastle, Australia



Name of person

Head of School

School of Nursing

Name of Institution

Your School of Nursing is invited to participate in a survey which is part of an Australian Learning and Teaching Council (ALTC) project being undertaken by the School of Nursing and Midwifery at The University of Newcastle. This survey is a component of Carol Arthur's Master project. The supervisors for this Masters project are Dr Ashley Kable and Dr Tracy Levett-Jones.

The purpose of the survey is to investigate how human patient simulation (HPS) and information communication technology (ICT) are currently being used in clinical laboratory settings throughout Australian schools of nursing. Results of this survey and other information relating to the ALTC project will be made available on the project web site.

We are asking Heads of School from each Australian school of nursing to either complete the survey, or direct this information to a member of staff who would be best positioned to do this. The person completing the survey should be familiar with the range and usage of HPS and ICT within the school, or in a position to access this information. The person completing the survey could be the Head of School, Director of

Clinical Education, educator or academic from a Simulation Centre or other person deemed most suitable to provide the information.

If you choose to direct this information to another member of staff, please note that it contains an invitation for individual participants' contributions to be identified and also an option for the institution to be identified.

To access the information statement, consent form and survey, please proceed to the project web site.

www.newcastle.edu.au/project/clinical-reasoning/

Thank you for considering this invitation

If you would like further information please contact:

Ms Carol Arthur carol.arthur@newcastle.edu.au

Dr Ashley Kable Ashley.Kable@newcastle.edu.au

Dr Tracy Levett-Jones Tracy.Levett-Jones@newcastle.edu.au

Appendix II – Survey Reminder Letter to Heads of School

School of Nursing and Midwifery
Faculty of Health
University of Newcastle, Australia



The name of the person

Head of School

The name of the institution

This email is a brief reminder about the survey being conducted as part of an Australian Teaching and Learning Council (ALTC) grant project at The University of Newcastle on human patient simulation (HPS) manikins and information communication technology (ICT).

If you have already either completed this survey personally or passed the details on to a member of your staff who you felt was able to complete the survey, we would like to thank you. If you have not yet had an opportunity to complete the survey or forward it to an alternate staff member would you consider responding to this invitation to participate in the study. A copy of the email previously sent is attached for you convenience.

Please note that once you have forwarded this information to another person to complete the survey, that person may choose whether they consent to participate. Participation in this study is completely voluntary.

If you would like further information please contact:

Ms Carol Arthur carol.arthur@newcastle.edu.au

Dr Ashley Kable Ashley.Kable@newcastle.edu.au

Dr Tracy Levett-Jones Tracy.Levett-Jones@newcastle.edu.au

Thank you for your time and for considering this invitation.

Dr Ashley Kable RN, Dip Teach Nurs ED, Grad Dip Health Serv MAN, PhD MRCNA

Ms Carol Arthur BN, Dip App Sc (Nursing) RN, ICU/CCU Cert, M.Phil (Nursing)
candidate

Dr Tracy Levett-Jones RN, PhD, MEd and Work, BN, DipAppSc (Nursing)

Appendix III – Survey Information Statement

Survey Information Statement for the Research Project:

Human patient simulation manikins and information and communication technology:

Use and quality indicators in Australian schools of nursing

Document Version 2; dated 26/2/09



Researchers:	
Dr Ashley Kable (Principal Supervisor) Deputy Head of School (Research) School of Nursing and Midwifery, The University of Newcastle Tel: (02) 4921 6599 Ashley.Kable@newcastle.edu.au	Carol Arthur (Master Philosophy [Nursing]candidate) School of Nursing and Midwifery, The University of Newcastle Tel: (02) 4921 6339 Carol.Arthur@newcastle.edu.au
Dr Tracy Levett-Jones (Co-Supervisor) Deputy Head of School (Teaching and Learning) School of Nursing and Midwifery, The University of Newcastle Tel: (02) 4921 6599 Tracy.Levett-Jones@newcastle.edu.au	

You are invited to participate in the research project identified above which is part of an Australian Learning and Teaching Council (ALTC) project being undertaken as a component of Carol Arthur's Masters project at the School of Nursing and Midwifery, University of Newcastle. The supervisors for this Masters project are Dr Ashley Kable and Dr Tracy Levett-Jones.

Why is the research being done?

The purpose of the survey is to investigate how human patient simulation (HPS) and information communication technology (ICT) are currently being used in clinical laboratory settings throughout Australian schools of nursing. The project will:

6. Explore the range and types of HPS and ICT currently used in Australian university undergraduate nursing programs and the pedagogical approaches that underpin their use in clinical laboratories.
7. Investigate how the educational outcomes of HPS and ICT are assessed and the manner and extent to which these technologies are used for formative and/or summative assessment of students' performance.
8. Identify current principles and practices in the use of HPS and ICT in Australian university undergraduate programs indicative of quality teaching and learning.

Who can participate in the research?

We are recruiting a designated person from each Australian School of Nursing to complete the survey. The person completing the survey should be familiar with the range and usage of HPS and ICT within their respective school, or able to access this information. The person completing the survey could be the Head of School, Director of Clinical Education, educator or academic from a simulation centre or other person deemed most suitable to provide the required information.

What choice do you have?

Participation in this research is entirely your choice. Only those people who consent to participate will be included in the project. Whether or not you decide to participate, your decision will not disadvantage you.

If you do decide to participate, you may withdraw from the project at any time without giving a reason and you have the option of withdrawing any data which identifies you.

What would you be asked to do?

If you agree to participate, you will be asked to complete a web based survey. As part of the survey participants will be asked to provide their name and the name of the institution. The inclusion of this information is optional, but would allow for more meaningful analysis and reporting of the results. The survey also asks you to indicate if you have consented for your responses to be quoted in the reporting of our results. Once again this is optional but if you agree to be quoted we will contact you to confirm this and acknowledge your responses if they will form part of the study's report. This will give acknowledgement to your own intellectual property, such as teaching strategies that you have developed.

Following the analysis of the survey results we will be conducting a Delphi study to examine quality indicators for the use of HPS and ICT. A Delphi study uses a panel of experts to reach consensus regarding the topic of study. We may contact a number of survey participants to invite them to be part of the Delphi. Participation in this additional phase of the study will also be voluntary.

How much time will it take?

The survey will take approximately 30 minutes to complete.

What are the risks and benefits of participating?

There are no direct benefits to individuals or schools from this research. However, the information from this study will be of interest to the nursing profession and higher education in Australia and internationally. Results of this project may be particularly useful in future curriculum development and decisions related to the implementation of HPS and ICT.

How will your privacy be protected?

If you have indicated in the survey that you do not want you or your school to be identified, a numerical code will be used when analysing your survey and reporting the results. All data will be stored on a password protected computer and hardcopy documents be kept in locked storage. Data will be accessible by the researchers only and will be destroyed after five years.

How will the information collected be used?

The results of the survey, and also the larger project within which it is embedded, will be published on the project web site. The results will also form the basis of papers submitted for publication in scholarly journals and at professional conferences. The survey will also form part of a thesis to be submitted for Carol Arthur's Master of Philosophy (Nursing) degree.

As well as statistical analysis of the survey data it is planned that exemplars of quality practice in the use of HPS and ICT will also form part of the reporting of results. These exemplars will be attributed to individual participants and schools only if you indicate in the survey that you are willing for this to occur.

Participants will be able to view the results of the survey and exemplars of quality practice on the project web site.

What do you need to do to participate?

Please read this Information Statement and be sure you understand its contents before you consent to participate. If there is anything you do not understand, or you have questions, contact one of the researchers.

If you would like to participate, please click on the link to the Consent Form, complete and submit this, then click on the Survey button and proceed to complete and submit the survey.

Further information

If you would like further information please contact:

Ms Carol Arthur carol.arthur@newcastle.edu.au

Dr Ashley Kable Ashley.Kable@newcastle.edu.au

Dr Tracy Levett-Jones Tracy.Levett-Jones@newcastle.edu.au

Thank you for considering this invitation.

Dr Ashley Kable

RN, Dip Teach Nurs ED, Grad Dip Health Serv MAN, PhD MRCNA

Ms Carol Arthur

BN, Dip App Sc (Nursing) RN, ICU/CCU Cert, Master Philosophy (Nursing) candidate

Dr Tracy Levett-Jones

RN, PhD, MEd and Work, BN, DipAppSc (Nursing)

Complaints about this research

This project has been approved by the University's Human Research Ethics Committee, Approval No. H-2009-0016. Should you have concerns about your rights as a participant in this research, or you have a complaint about the manner in which the research is conducted, it may be given to the researcher, or, if an independent person is preferred, to the Human Research Ethics Officer, Research Office, The Chancellery, The University of Newcastle, University Drive, Callaghan NSW 2308, Australia, telephone (02) 49216333, email Human-Ethics@newcastle.edu.au.

Researchers:	
Dr Ashley Kable (Principal Supervisor) Deputy Head of School (Research) School of Nursing and Midwifery, The University of Newcastle Tel: (02) 4921 6599 Ashley.Kable@newcastle.edu.au	Carol Arthur (Master Philosophy [Nursing]candidate) School of Nursing and Midwifery, The University of Newcastle Tel: (02) 4921 6339 Carol.Arthur@newcastle.edu.au
Dr Tracy Levett-Jones (Co-Supervisor) Deputy Head of School (Teaching and Learning) School of Nursing and Midwifery, The University of Newcastle Tel: (02) 4921 6599 Tracy.Levett-Jones@newcastle.edu.au	

I agree to participate in the above research project (Cross sectional survey component) and give my consent freely.

I understand that the project will be conducted as described in the Survey Information Statement, a copy of which I have retained.

I understand I can withdraw from the project at any time and do not have to give any reason for withdrawing.

I consent to:

1. Completing a survey

- Yes
- No

2. Being quoted individually in the project report, with identification by name,
following confirmation of the material to be quoted by the researchers

- Yes
- No

3. The researchers identifying the institution I represent in the report produced

- Yes
- No

4. Being contacted for further information

- Yes
- No

I understand that my personal information will remain confidential to the researchers, unless I have given and confirmed specific consent to be quoted in the report. I also understand that the name of the institution I represent will be confidential unless I have given permission for identification.

I have had the opportunity to have questions answered to my satisfaction.

Name: _____

Email address: _____

Date: _____

Please click the “Submit” button to return this electronic consent form to the researcher before proceeding to the survey.

Appendix IV – Survey Instrument Validation Process

Summary Notes taken from reference group meeting at which the cross sectional survey validation process was conducted, with addition of amendments made as a result of the process.

Aims of the survey:

- Explore the range of HPSM and ICT currently used in clinical laboratories
- Explore staffing and resources for HPS and ICT
- Explore integration into BN curriculums
- Explore associate pedagogical principles and practices utilised
- Explore current use of HPSM for assessment
- Explore evaluation of the effectiveness of HPSM and current research
- Determine factors influencing the effective use of HPSM and ICT

Definition of terms:

- Simulation – Replication of a clinical situation
- Fidelity – Degree of realism
- Low fidelity HPS manikin – part task trainer or non-interactive manikin
- Medium fidelity HPS manikin – some basic interactivity e.g. Nursing Anne with VitalSim
- High fidelity HPS manikin – real time interactivity and computer controlled cue response e.g. SimMan
- ICT – Information and communication technologies such as computers and PDAs

Survey design

- Web based
- Use of pop-up for instructions and definitions
- Tick boxes and free text
- To be distributed to most appropriate person in each School of Nursing and Simulation Centre throughout Australia
- Participants identified via Heads of School and Clinical Co-ordinators
- Data analysis – Descriptive statistics and content analysis of text

Critiquing and Validation

- Method of gaining participants
- Any ethical concerns
- Definitions
- Timing for survey completion
- Face validity
- Content validity

Group members were asked to complete a paper based draft of the survey, and to write comments or queries on the paper as they went. The reviewers were asked to consider the recruitment process, any ethical issues, the length of the survey, face and content validity. Time taken by group was measured and recorded at between 23 and 40 minutes

Discussion of the main issues arising was then facilitated, and points raised were taken as notes. The discussion was also audio taped. The results of this process were analysed through review of the annotated completed surveys, discussion notes and audio taped discussion. The main recommendations were synthesised and summarised. Additional micro comments have also been synthesised for review of individual question wording once the main layout and design issues have been revised.

Issues raised in discussion and annotated comments

1. The wide scope of the information sought would mean that several people may need to be consulted to complete the survey. Suggestions to overcome this problem included
 - a) Dividing the survey into sections (such as individual years of the curriculum) for completion by the relevant people.
 - b) Highlighting at the beginning of the survey the additional information that would need to be collected
 - c) Making the survey paper based instead of web based to allow for completion over time and place, or ensuring a capacity to save and return to the document.
 - d) Sending the survey to each campus, where multiple campuses exist.

Amendments:

The survey has been simplified in terms of detail required, while still meeting the aims of the project. Specific amounts of equipment are not asked for, and year of subject specific information is not required. This has been done to allow the survey to be completed by one person, and also to shorten the amount of time required to complete the survey.

2. Some felt the survey was too long, and the above suggestions also related to length of time needed to access all information.

Amendment – see above.

3. Definition of School related terms need to be more universally applicable of defined e.g. course, unit, program. Also we need to consider if midwifery undergraduate programs are included.

Amendment:

Much of this terminology has been removed due the simplification of content. Where needed universal terms such as “topic” have been utilised.

4. The definition of simulation and the focus of the study need to be more clearly defined.
 - a) the definition of simulation needs to encompass all forms of simulation, including actors
 - b) the possibility of high fidelity that is not manikin based may need to be explored
 - c) we need to consider whether our survey should cover in detail all forms of simulation, or just focus on HPS manikins

Amendments:

The definitions of simulation, fidelity, low, medium and high fidelity simulation have been reviewed and modified to reflect definitions most universally accepted in the literature and by Australian Simulation Society and the Society for Simulation in Health Care.

The introductory explanation to the survey has been amended to explain that while simulation takes many forms, the focus of the project is HPS manikin and ICT. While simulation has been broadly scoped in the survey questions have focused on HPS manikin and ICT use.

5. The definition of laboratory ICT should include use of audio visual technology (which may be used as part of high fidelity HPS manikin simulation or with other forms of simulation such as actors) and question on this need to be included in the ICT section.

Amendments:

For the purpose of this survey ICT has been defined as the transfer of information in electronic form such as computer and PDAs.

Questions on use of audio-visual technology in high fidelity manikin simulation sessions have been improved. Questions 95, 96 and 97 allow for discussion of the any form of ICT in conjunction with any simulation activities.

6. There is a need to explore more specifically how simulation varies throughout the curriculum, as many questions are difficult to answer globally. There was a general suggestion to the material sought needs to be further broken down into matrices allowing varying responses for 1st, 2nd and 3rd year courses/units, or individual subjects.

Amendment:

A decision was made that in the interest of making the survey manageable for one person to answer within a reasonable time frame, and without having to consult with year or course/unit co-ordinators, this degree of detail would not be sought. This detail is not core to the aims of the project.

7. Questions on pedagogical principles are still limited; there may need to be greater emphasis on the teaching of clinical reasoning to align with the overall aims of the project.

Amendment:

This section has been reviewed and some questions specific to clinical reasoning included.

8. The section on teaching processes needs to be broken up into questions on simulation practices in general and practices specific to high fidelity HPS manikins.

Amendment:

The survey has been extensively reviewed from this perspective to ensure the reliability of responses. The survey has been further divided into sections, with some sections specific to medium and high fidelity HPS manikin only.

9. The section on assessment need to have a clear definition of formative and summative assessment and needs a matrix to include years and possibly courses/units to align with the teaching matrix.

Amendments:

Following discussion the need for definitions of formative and summative assessment deemed unnecessary.

Individual year based information now not required.

Assessment matrix aligned with teaching matrix.

10. The section on number of hours of simulation in the curriculum is not clear and difficult to give a specific and meaningful answer.

Amendment:

This question deleted.

11. Need to include more “Select all applicable” statements throughout to make clear that more than one answer is acceptable.

Amendment:

Survey extensively reviewed and instructions clarified.

12. A number of micro wording adjustments also noted.

Amendment:

Survey extensively reviewed for clarity and correctness.

Appendix V – Survey Instrument

Aim of the survey:

This survey explores the range and types of human patient simulation (HPS) manikins and information and communication technology (ICT) currently used in clinical laboratories in Australian schools of nursing, and the pedagogical principles that underpin their use.

While it is acknowledged that simulation in clinical laboratories can take many forms, including the use of actors (standardised patients) and various forms of case studies and role plays, the focus of this survey is HPS and ICT. This survey is the first stage of a larger project, and will be followed by a Delphi study that will identify quality indicators for the use of HPS and ICT. It is anticipated that the results of these projects will be informative to those who use HPS and ICT in their nursing programs.

Definition of terms:

Simulation is an attempt to replicate, to varying degrees, a clinical situation, in order to teach or assess nursing skills and knowledge.

Fidelity refers to the degree of realism achieved by the simulation.

Various definitions of the fidelity of manikins exist. In this survey the following terms are used:

Low fidelity HPS manikins include simple task trainers such as IV arms and resuscitation torsos, and anatomically correct full body static manikins that replicate the external anatomy and joint movement of humans, but have no interactive capacity.

Medium fidelity HPS manikins are full body manikins that have embedded software that is controlled by an external, hand held device. They have the capacity to have set breath sounds, heart sounds, pulse and blood pressure, and are also capable of coughing, moaning or basic verbal communication. An example is Laerdal's Nursing AnneTM with VitalSim capability.

High fidelity HPS manikins are more realistic and have embedded software that can be remotely controlled by computer to allow for individualised, programmed scenarios, real-time interactions and cue response. They allow the operator to set physiological parameters and respond to students' interventions with changes in voice, heart rate, blood pressure and other physiological signs. Examples include Laerdal SimManTM and METITM manikins.

Information and Communication Technology (ICT) allows for the transfer and retrieval of information in electronic form. Examples include personal digital assistant (PDA), tablet PCs, and desk top and lap top computers.

Survey Instructions

The following survey contains both tick box and text box questions. For tick box questions please select as many boxes as are applicable for you to answer the question fully. The text boxes will allow you to write more detailed comments where applicable.

Section A- Information about you and your school

1. Name of the person completing the survey:

2. Designated role_____

3. Email contact_____

4. School/Faculty/Centre_____

5. Institution_____

6. Have you indicated on the consent form that you are willing to be quoted in our report?

- Yes
- No

If you have responded no, your de-identified responses will be aggregated and used in our report.

7. Have you indicated on the consent form that you are willing to be contacted for further information?

- Yes
- No

Details relating to your school of nursing:

8. How many students are enrolled in your Bachelor of Nursing (BN) program(s)?

9. Across how many campuses is your BN program delivered? _____

10. How many clinical skills laboratories do you have? _____

11. On average, across campuses, how many beds or trolleys do you have in a standard laboratory? _____

12. On average, how many students are there per laboratory session?

Section B - Clinical Laboratory Staffing

Information about staff responsible for teaching in, and managing clinical laboratories.

13. Are some nursing laboratory sessions in your school usually taught by permanent academic staff?

- No (proceed to question 15)
- Yes

14. If yes, which academic staff teach in laboratories? Please select all that are applicable.

- Level A academic
- Level B academic
- Level C academic
- Other, please specify_____

15. Are some laboratory sessions in your school usually taught by casually employed laboratory educators?

- No (proceed to question17)
- Yes

16. If yes, at which level are they employed? Please select all that are applicable

- Level A academic
- Level B academic
- Level C academic
- Other, please specify _____

17. Do you have an appointed clinical laboratory manager?

- No (proceed to question 19)
- Yes

18. If yes, is your laboratory manager employed as?

- An academic staff member
- An administrative staff member
- Other, please specify_____

19. How many full time equivalent (FTE) laboratory technical support staff do you have, across campuses, other than a clinical laboratory manager? _____

Section C-Use of simulation in clinical laboratories - Overview

Information about the types of simulation, HPS manikins and other related equipment.

HPS manikins:

20. Please specify the types of HPS manikin equipment available in your laboratories.

Type	Yes or No	Specify items
20.1 Low fidelity equipment, e.g. task trainers, please specify types used.		
20.2 Low fidelity manikins, e.g. Nursing Anne TM <i>without</i> Vital Sim capability. Please specify brand		
20.3 Medium fidelity manikins, e.g. Nursing Anne TM <i>with</i> Vital Sim capability. Please specify brand		
20.4 High fidelity computerised manikins, e.g. SimMan TM or METI TM Please specify brand		
20.5 Other, please specify:		

Comments _____

Other forms of simulation:

21. Do you use actors (standardised patients) or role plays as a form of simulation?

Please select all that are applicable.

- No
- Students acting as patients
- Staff acting as patients
- Paid actors
- Hybrid simulations using actors with skill trainer equipment attached
- Other, please specify _____

Comments _____

22. Do you use any form of computer based simulation? Please select all that are applicable

- No
- Computer based patient scenarios
- Clinical decision making computer games
- Virtual ward/hospital simulation
- Other, please specify _____

Comments _____

Adjuncts to simulation

23. Are the following used as part of your simulations? Please select all that are applicable.

- Makeup or wigs
- Masks

- Clothing/night attire/gowns
- Moulage (to create wounds or other signs of disease)
- Props (such as personal belongings, photos, flowers)
- Patient identification and allergy bands
- Patient notes
- Other, please specify _____

Comments _____

24. When attending clinical laboratories what do students wear?

- Street clothes
- Uniform

25. Have you purchased scenarios for use in any form of simulation?

- No (proceed to question 27)
- Yes

26. If yes please describe the type of simulation that these scenarios are used for.

27. Do you design your own scenarios for any form of simulation?

- No (proceed to question 31)
- Yes

28. If yes please specify the type of simulation these scenarios are designed for.

29. Have you marketed scenarios for any form of simulation?

- No (proceed to section D)
- Yes

30. If yes please specify the type of simulation these scenarios are designed for

Section D- Pedagogical principles and practices associated with the use of simulation

Information about the educational principles and practices that underpin clinical laboratory simulations, and the integration of simulation into curriculum design.

31. Do you use a specific theoretical framework or model as a basis for simulation teaching and learning?

- No (please proceed to question 33)
- Yes

32. Could you please briefly outline the framework/model that you use?

33. Do your simulation sessions become more complex and immersive (requiring more intensive student engagement) as students progress through their undergraduate program?

- No (please proceed to question 35)
- Yes

34. If yes, please give a brief example.

35. Do you have specific written objectives/ outcomes for each simulation?

- No (proceed question 38)
- Yes

36. If yes, are these objectives embedded within or linked to a specific course, subject or unit?

- No
- Yes

Comments _____

37. Do these objectives align with documented curriculum objectives?

- No
- Yes

Comments _____

38. Are clinical reasoning, clinical decision making or clinical judgement skills specifically addressed as a discrete topic in your undergraduate program?

- No
- Addressed as a discrete topic, but no particular model utilised
- Addressed as a discrete topic using a specific model. Please outline the model used.

39. The following table is for you to list the objectives of your simulation sessions. Tick all that are applicable:

Targeted learning objectives	Role plays	Actors	Computer based simulation	Part task trainers	Low fidelity manikins	Medium fidelity manikins	High fidelity manikins
39.1 Therapeutic communication skills							
39.2 Patient assessment							
39.3 Clinical psychomotor skills							
39.4 Knowledge acquisition							
39.5 Clinical reasoning/ decision making							
39.6 Teamwork/ organisation and prioritisation							
39.7 Other, please specify							

40. If you believe you have an innovative approach that illustrates the use of any form of simulation in clinical laboratories, would you please share this with us here?

41. Is your institution committed to development of simulation as a teaching and learning strategy?

- No
- Yes

Comments

42. Do you currently use simulation as an alternative or replacement to some clinical placement hours?

- No (proceed to question 44)
- Yes

43. If yes, please indicate the type and number of hours of simulation, and the number of clinical placement hours that it replaces

44. Have you considered the possibility of using simulation as an alternative or replacement/further replacement to some clinical placement hours in the future?

- No (proceed to question 46)
- Yes

45. If you have answered yes to question 42 or 44, what issues have you considered in relation to this? _____

Section E -Processes for medium and high fidelity manikin simulation sessions

This section explores in more detail the specific use of medium and high fidelity HPS manikins for simulation scenarios.

Please complete the following questions only in relation to medium and high fidelity manikin use. (Please refer to items 20.3 and 20.4 to check that you selected YES as your response to these items).

If medium or high fidelity manikins are not used in your school please proceed to section G.

46. What preparation do students undertake *prior* to simulations? Please select all that are applicable.

- Lectures and/or tutorials related to simulation content
- Directed readings
- Written self-directed learning packages related to simulation content
- Computer based or online learning packages related to simulation content
- Specific skill training laboratories
- Teaching of professional skills such as communication and teamwork
- Other, please specify_____

Comments _____

47. Do students receive briefing *prior* to the simulation? Please select all that are applicable.

- No
- A general orientation to the simulation facilities
- Provision of scenario information
- Provision of information on the simulated patient's health issues
- Provision of information on the simulation process, including debriefing and options for pausing or discontinuing the session.
- Provision of information on environment, equipment and use of the manikin
- Other, please specify_____

Comments _____

48. Do you have access to a laboratory or laboratories specifically set up for medium or high fidelity manikin simulation?

- No (proceed to question 51)
- Yes

49. If yes, how many of these laboratories do you have access to? _____

50. Are these laboratories

- Part of your school of nursing
- Shared with another school or discipline
- A separate Simulation Centre
- Other, please specify _____

51. To what extent do students have assistance from educators during the simulation?

- There is a facilitator in the room to assist the students throughout the session
- The simulation can be stopped to allow for questions and/or discussion
- The simulation is fully immersive, with no assistance from educators.
- Degree of educator assistance varies depending on experience level of the students.
- Degree of assistance varies depending on the particular scenario
- Ad hoc assistance only

Comments _____

52. How many students are actively involved in a simulation session at one time?

53. Are other students present in the room as observers?

- No (proceed to question 58)
- Yes

54. If yes, how many students are in the room as observers? _____

55. Do the observers have a particular role?

- No (proceed to question 58)
- Yes

56. If yes, what roles/activities are allocated to observers?

57. Do the roles of active participants and observers reverse during the simulation sessions?

- No
- Yes

58. Can the simulation session be viewed by students in another room through video link up or one way glass screens?

- No (proceed to question 62)
- Yes

59. If yes, how many students are able to view the simulation? _____

60. Do the external student viewers have an allocated role/activity?

- No (proceed to question 62)
- Yes

61. If yes, what roles/activities are allocated to external student viewers?

62. How long does a simulation session take? _____minutes. (Indicate range if applicable)

Comments_____

63. Do students engage in debriefing *following* the simulation session?

- No (if no proceed to question 72)
- Yes

64. If yes, how much time is allowed for debriefing? _____ minutes.
(Indicate range if applicable)

Comments_____

65. How many facilitators conduct the debriefing session? _____

66. Is video recording of the simulation used for debriefing purposes?

- No
- Yes

Comments_____

67. Is video recording of simulations used for further classroom teaching?

- No
- Yes

Comments_____

68. Do debriefing techniques make use of student reflection on practice and self-identification of strengths and weaknesses?

- No (if no proceed to question 70)
- Yes

69. If yes, please give an example of how reflection is facilitated.

70. Are any other structured debriefing activities used?

- No (proceed to question 72)
- Yes

71. If yes, please briefly describe the structured debriefing technique used.

72. Do students undertake any of the following learning activities *on completion* of the simulation? Please select all that are applicable.

- No further activities
- Written reflection
- Self-evaluation of performance using marking criteria
- Academic work directed towards improving identified weaknesses/remediation
- Other, please specify_____

Comments _____

73. Do you view medium and high fidelity manikin simulation as an effective strategy for the teaching of:

- Technical and psychomotor skills
- Non-technical skills such as communication and teamwork
- Clinical reasoning/decision making/judgement
- Other, please specify _____

Comments _____

74. If you consider that medium or high fidelity manikin simulation is used effectively in your undergraduate teaching program, would you please share with us an example of your approach?

Section F -Roles and responsibilities of staff involved in the use of medium of high fidelity manikins.

Information about staff responsibilities, workload and preparedness for using medium and high fidelity HPS manikins

Please complete this section only if you currently use medium or high fidelity manikins, if not please proceed to Section G

75. Please indicate staff roles and responsibilities related to the use of medium and high fidelity HPS manikins. Tick all that are applicable.

Responsibilities in relation to high fidelity HPS	Clinical laboratory technician	IT technician	Supplying company representative	Casual laboratory educator	Simulation specialist staff	Lecturer/ permanent academic
75.1 Preparing physical environment						
75.2 Maintenance of manikins						
75.3 Maintenance of computer and audio-visual equipment						
75.4 Writing simulation scenarios						
75.5 Programming computer software						
75.6 Controlling the computer during simulation						
75.7 Supporting students in simulation room						
75.8 Debriefing students after simulation						

76. Preparation and training of staff involved in medium and high fidelity HPS includes the following. Please select all that are applicable.

- Introductory training from manufacturer
- Advanced training from manufacturer
- Training by staff already trained (train-the-trainer)
- Education in principles and practices of teaching using simulation
- Specialised tertiary courses
- Not all staff have been trained
- Other, please specify _____

77. Please add your comments on issues surrounding staffing requirements for medium and/or high fidelity simulation _____

Section G –Simulation and Student Assessment:

This section explores the use of simulation in ALL its forms as a tool to assess student outcomes

78. In your undergraduate program is simulation used:

- For teaching purposes only (proceed to section H)
- For student assessment

79. If your school uses simulation for student assessment please indicate what types of simulations are used and the domains that are assessed. Please tick all that are applicable in the table below.

Targeted Assessment Items	Role plays	Actors	Computer based simulation	Part task trainers or low fidelity manikins	Medium fidelity manikins	High fidelity manikins
79.1 Formative assessment						
79.2 Summative assessment						
79.3 Remediation following identified problem						
79.4 Therapeutic communication skills						
79.5 Patient assessment skills						
79.6 Clinical psychomotor skills						
79.7 Knowledge acquisition						
79.8 Clinical reasoning/ decision making						
79.9 Teamwork/ organisation and prioritisation						
79.10 Other, please specify						

80. How are students graded in relation to simulation activities? Please select all appropriate responses.

- Skills checklist
- Predetermined marking criteria
- ANMC competency statements
- Peer evaluation post simulation
- Self-evaluation post simulation
- Knowledge test post simulation
- OSCEs (Objective Structured Clinical Examination)
- Other, please specify _____

81. If clinical reasoning/clinical decision making are assessed using simulation scenarios, could you please explain how this is done?

82. If you consider that your school uses simulation of any kind in an effective or innovative way for student assessment, would you please share an example with us?

Section H - Evaluation of the use of medium and high fidelity HPS manikins and the simulation process

This section explores the ways in which the effectiveness of medium and high fidelity HPS manikins as teaching tools are being evaluated

Please complete this section only if you are currently using medium or high fidelity HPS manikins for teaching. If not proceed to Section I.

83. Which of the following methods, if any, are used in your school for evaluating the effectiveness of the medium and high fidelity HPS manikin simulation sessions? (Note that this question refers to evaluating the overall effectiveness of the teaching strategy, not evaluation/assessment of individual students)

Please tick all that are applicable

- Student satisfaction surveys
- Subjective input from staff
- Outcomes measurements (knowledge test)
- Outcomes measurements (skills test)
- Outcomes measurements (clinical reasoning/decision making/judgement)
- Outcomes measurements (ANMC competency achievement)
- Outcomes measurement (performance on placement)
- Other, please specify_____

84. Is your school currently conducting, or have they previously conducted research related to the use of simulation?

- No (proceed to section I)
- Yes

85. Please outline the research you are conducting or have conducted?

Section I - Use of Information and Communication Technologies (ICT) in clinical laboratories

This section will explore the range of ICT used in clinical laboratories and the integration of ICT into simulation activities.

86. Is any form of ICT available for your students' use in clinical laboratories?

- No (proceed to section J)
- Yes

87. Which of the following are supplied for students' use in clinical laboratories? Please select all applicable responses

- Desktop computers
- Laptop computers
- Hand held personal digital assistants (PDA)
- Tablet PCs
- Notebook PCs
- Other, please specify_____

88. In relation to PDAs are they

- Not used
- Used and students are required to supply their own
- Used throughout the program and provided by the school of nursing
- Used but provided by the school during specific courses or activities only, please specify_____

89. Comments on the use of ICT in clinical laboratories, including technologies currently being trialled

90. What systems are available for student use with ICT hardware use? Please select all applicable responses.

- Downloadable software
- Nursing information data bases
- Computer based clinical decision support systems
- Internet access
- Wireless broadband
- Library services
- Other, please specify_____

91. Have laboratory teaching and technical staff received any training in the use of the ICT systems provided?

- No
- Training by the product manufacturer or sales company
- Training by institutional IT services
- Training by full time academic staff
- Formal IT course
- Other, please specify _____

Comments on the adequacy of training of staff in use of ICT

92. Is ICT technical support available to teachers and students during clinical laboratories?

- No (proceed to question 95)
- Yes

93. Who is this support provided by? Please select all appropriate responses.

- Lecturers/academic staff
- Institutional IT services
- Hardware manufacturer/supplier
- Software manufacturer/supplier
- Other, please specify _____

94. In what form is ICT technical support available? Please select all appropriate responses.

- During business hours
 - ☐ In person
 - ☐ By phone
 - ☐ Online
- After hours
 - ☐ In person
 - ☐ By phone
 - ☐ Online

Comments on the availability of ICT support for students and laboratory staff _____

95. Is ICT used in conjunction with simulation activities?

- No (proceed to question 97)
- Yes

96. Please briefly outline how ICT is incorporated into simulation sessions.

97. If you consider that you use ICT in an effective or innovative way in your undergraduate program would you please share an example with us?

Section J- Factors influencing the use of medium and high fidelity HPS manikins and ICT

This section seeks to identify facilitating factors and constraints to the use of medium and high fidelity HPS manikins and ICT in clinical laboratories. These factors may be significant to your current level of use or non-use of these technologies.

98. Please complete the following table. Please check all that are applicable.

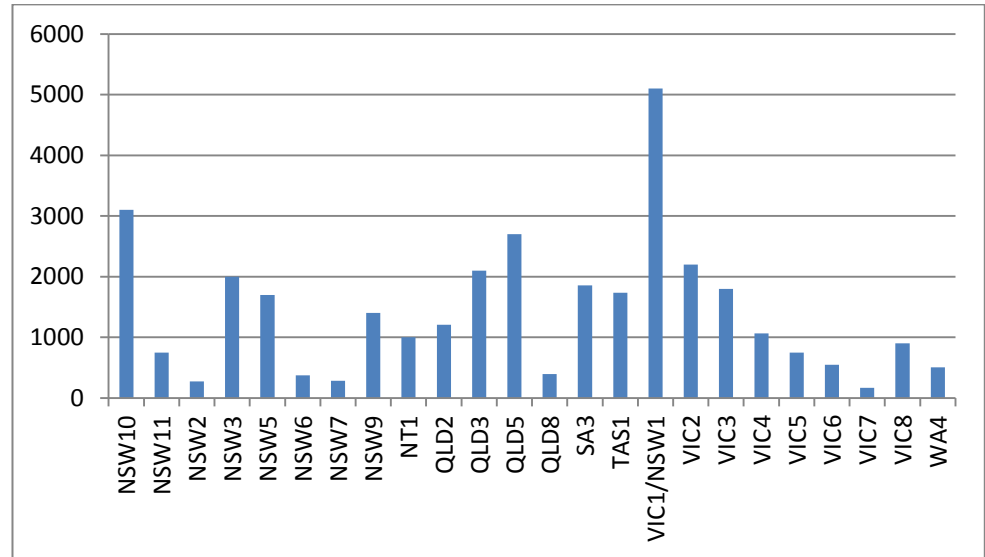
	Facilitators	Constraints	Not applicable
98.01 Large students numbers			
98.02 Multiple campus sites			
98.03 Level of staff enthusiasm			
98.04 Level of student enthusiasm			
98.05 Level of teaching staff training in simulation and ICT			
98.06 Adequate staff numbers for conducting simulation sessions			
98.07 Level of technical support			
98.08 Use of designated staff for simulation/ICT development and implementation			
98.09 Sufficient time for development and implementation in academic workload			
98.10 Availability of a model or framework for implementation			
98.11 Sufficient number of functional HPS manikins			
98.12 Sufficient functional high fidelity HPS manikins			
98.13 Sufficient functional audio-visual equipment			
98.14 Sufficient functional ICT equipment			
98.15 Adequacy of other equipment to support fidelity (realism)			
98.16 Adequacy of laboratory space			
98.17 Availability of pre-programmed scenarios			
98.18 Multidisciplinary collaboration			
98.19 Sharing resources with other institutions			

Thank you for taking the time to complete this survey.

Appendix VI – Survey Results Data

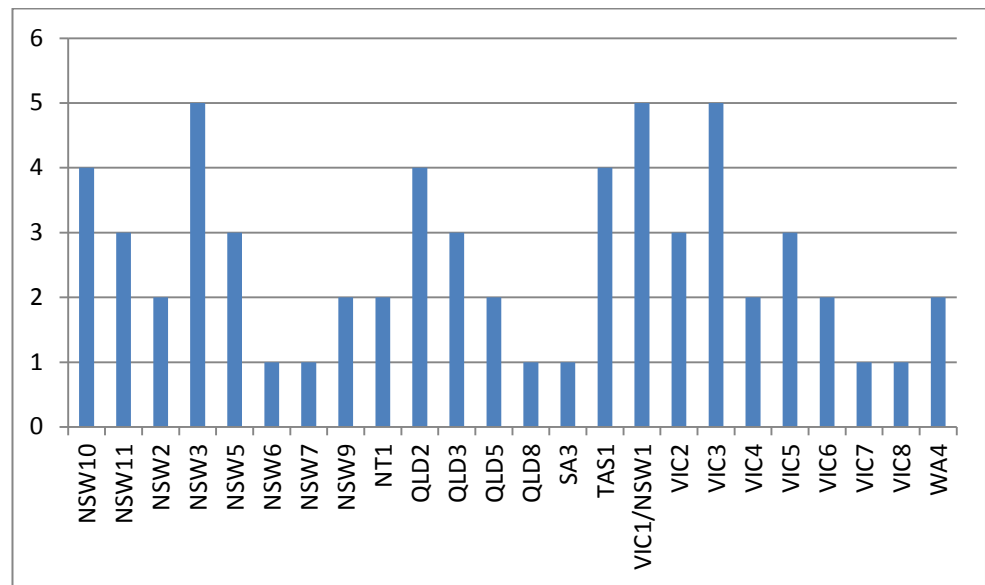
8. How many students are enrolled in your Bachelor of Nursing (BN) program(s)?

N=24



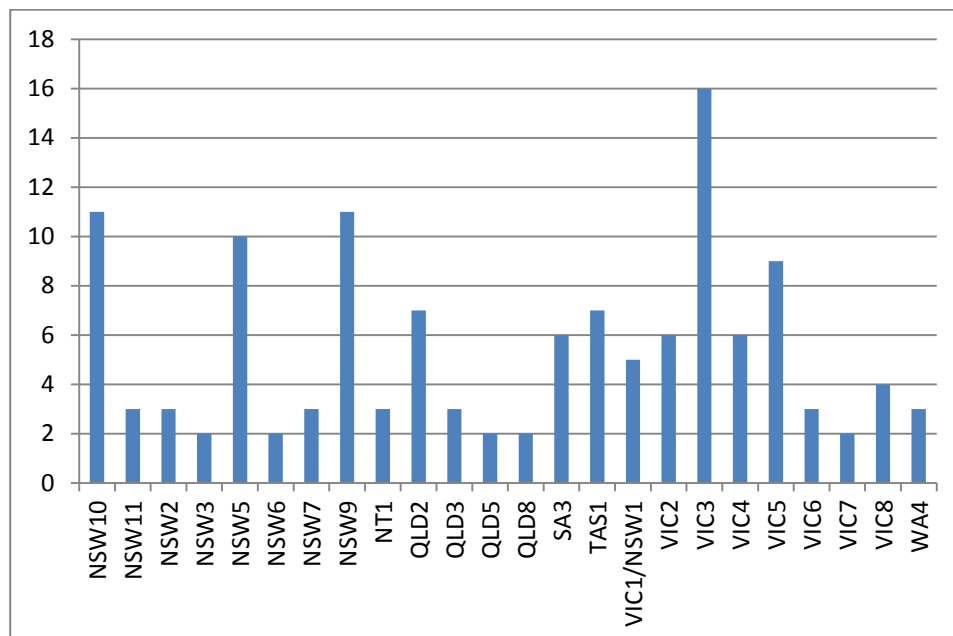
9. Across how many campuses is your BN program delivered?

N=24



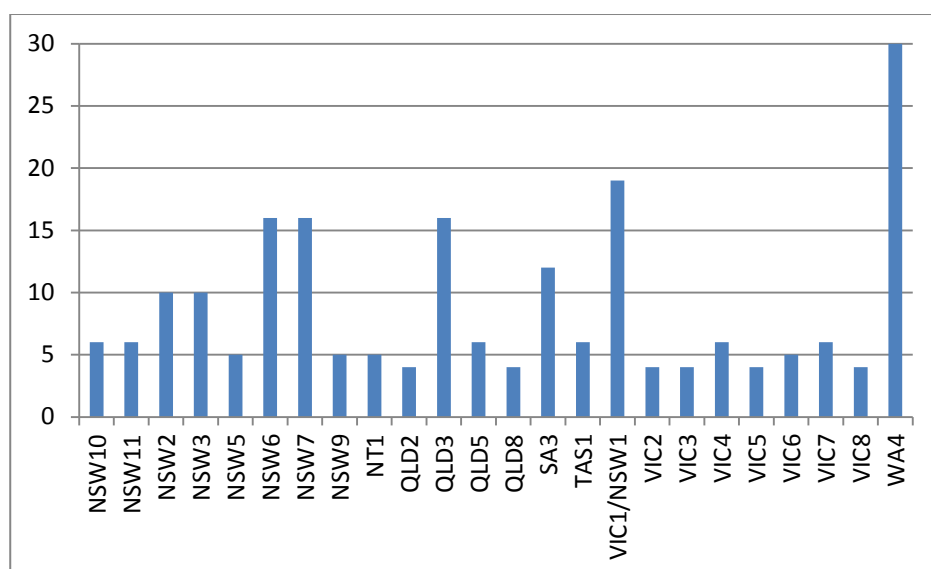
10. How many clinical skills laboratories do you have?

N=24



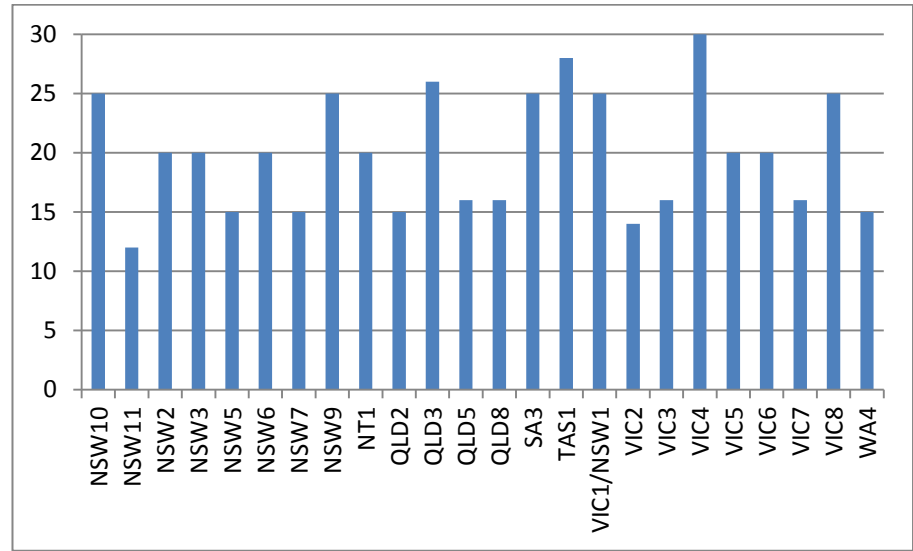
11. On average, across campuses, how many beds or trolleys do you have in a standard laboratory?

N=24



12. On average, how many students are there per laboratory session?

N=24

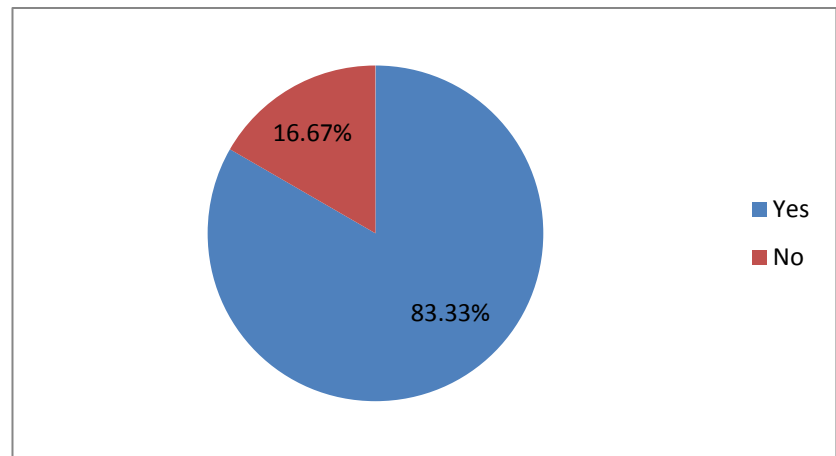


Section B - Clinical Laboratory Staffing

Information about staff responsible for teaching in, and managing clinical laboratories.

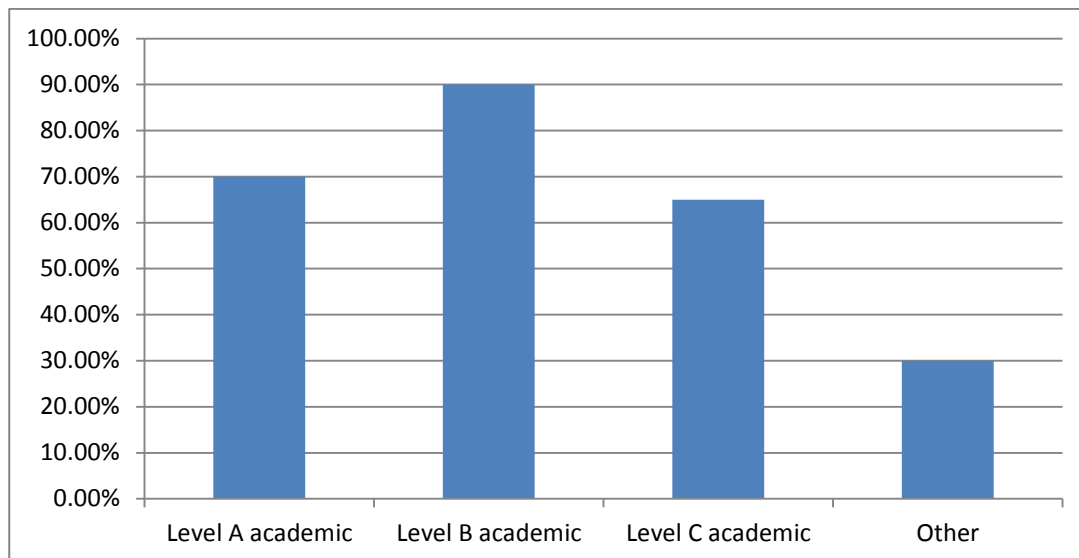
13. Are some nursing laboratory sessions in your school usually taught by permanent academic staff?

N=24



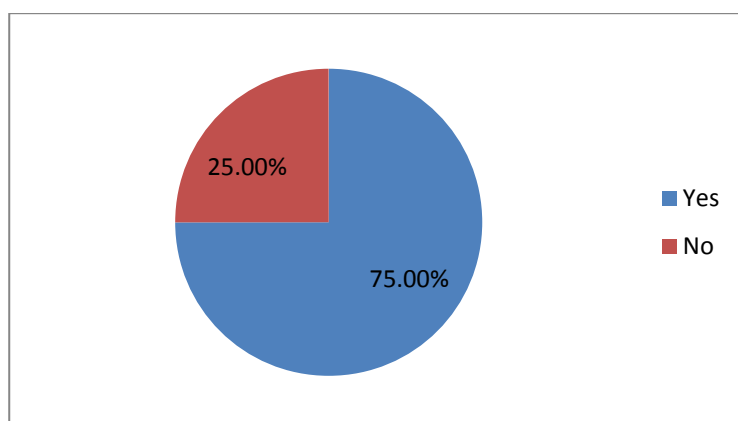
14. If yes, which academic staff teach in laboratories? Please select all that are applicable.

N=20



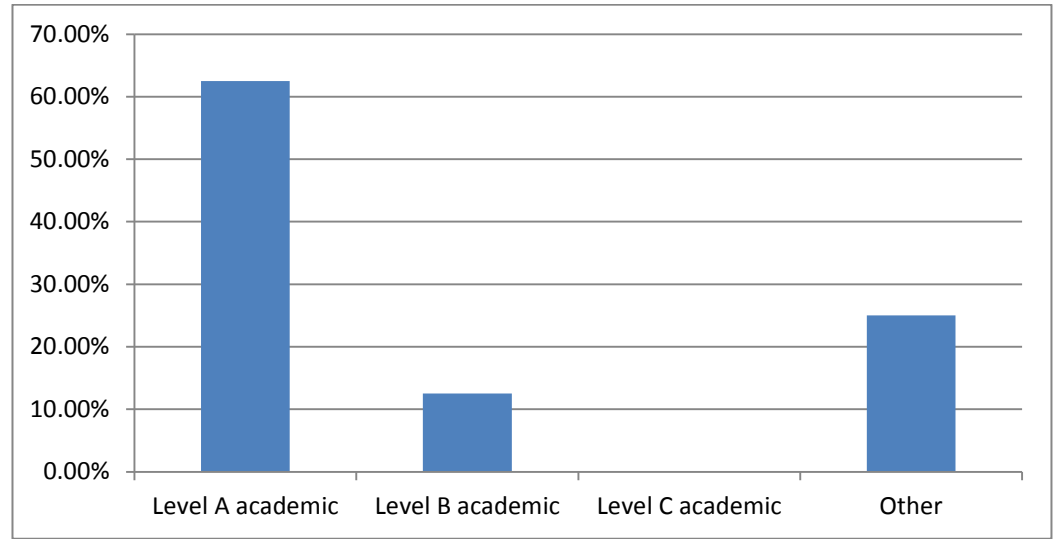
15. Are some laboratory sessions in your school usually taught by casually employed laboratory educators?

N=24



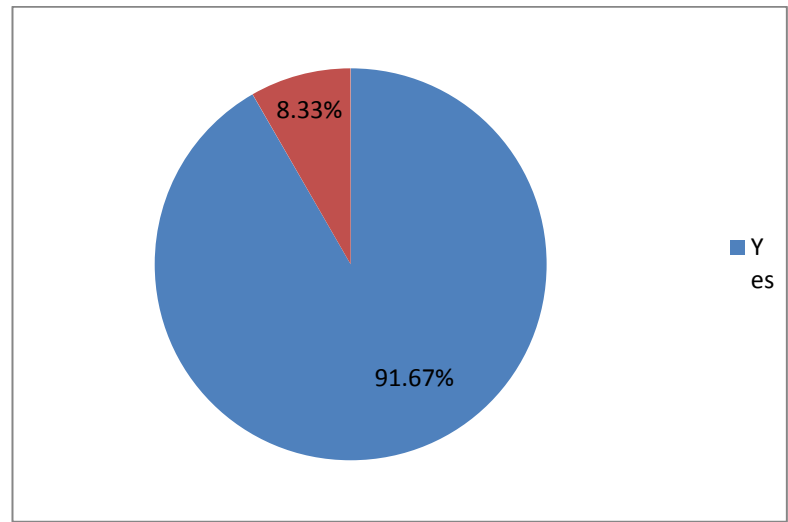
16. If yes, at which level are they employed? Please select all that are applicable

N=18



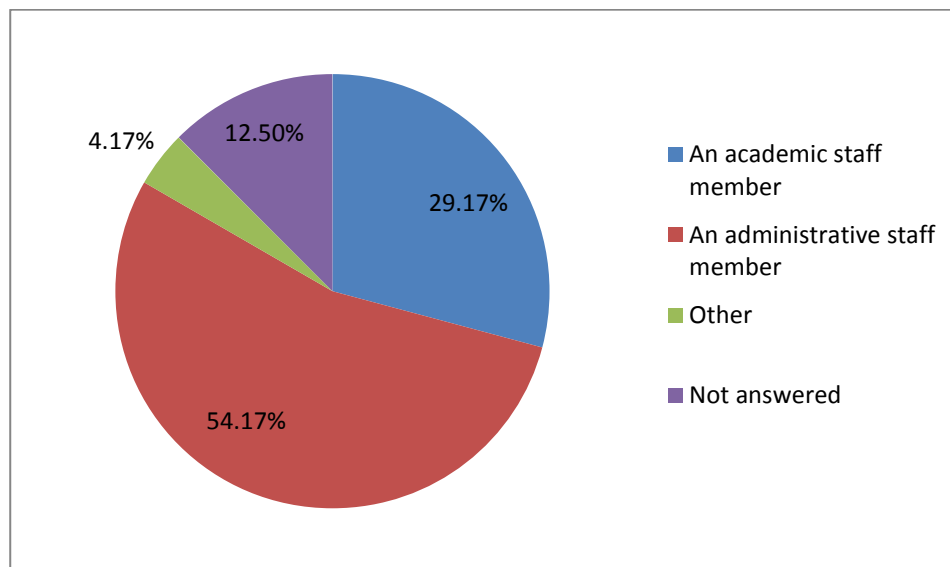
17. Do you have an appointed clinical laboratory manager?

N=24



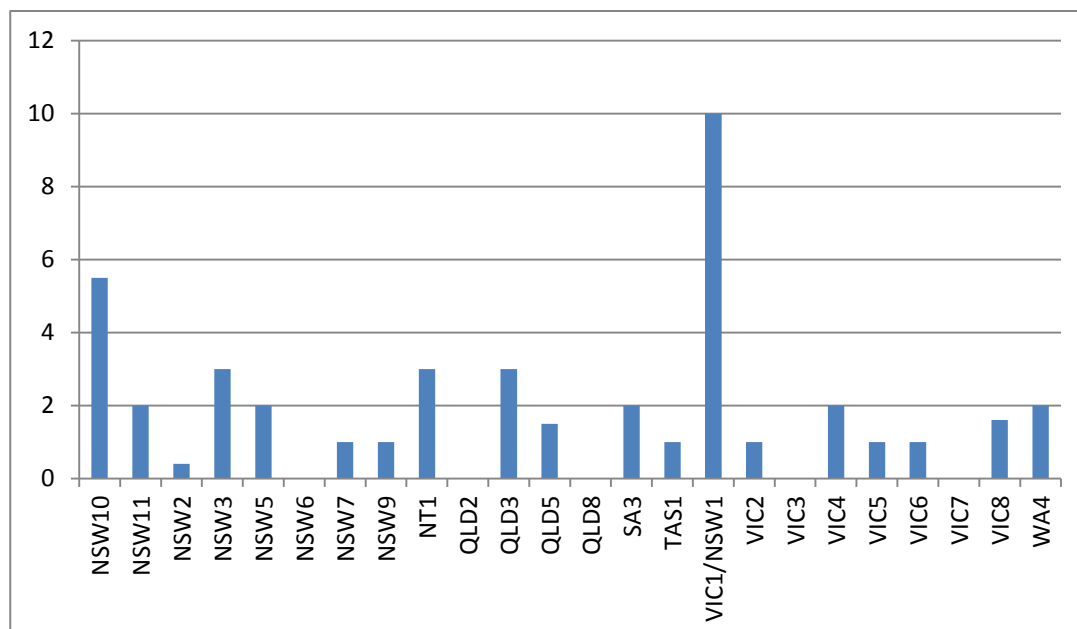
18. If yes, is your laboratory manager employed as?

N=24



19. How many full time equivalent (FTE) laboratory technical support staff do you have, across campuses, other than a clinical laboratory manager?

N=24



Section C-Use of simulation in clinical laboratories - Overview

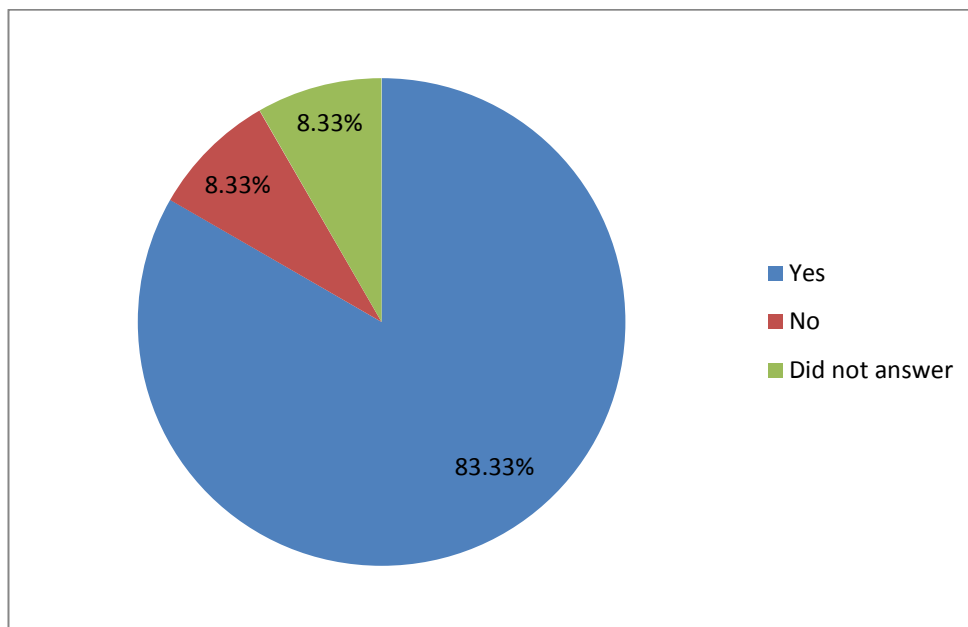
Information about the types of simulation, HPS manikins and other related equipment.

HPS manikins:

20. Please specify the types of HPS manikin equipment available in your laboratories.

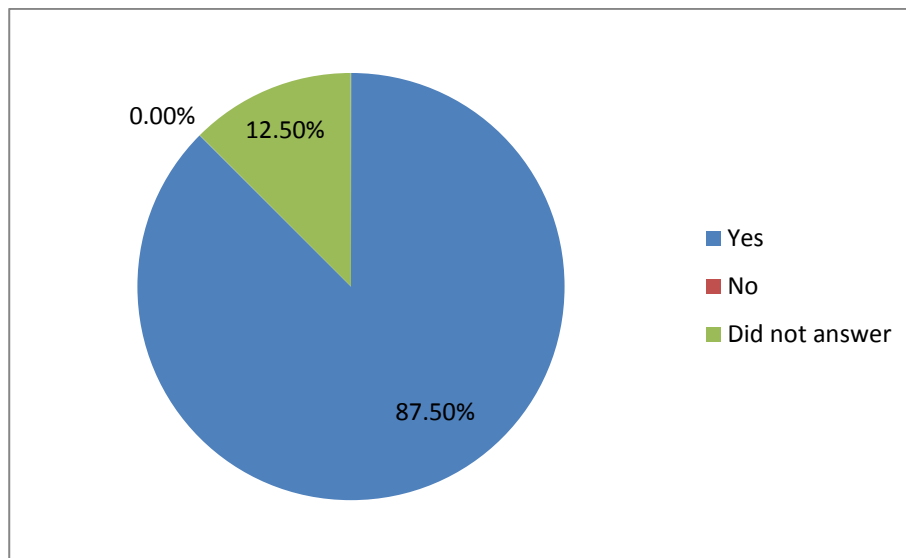
20.1 Low fidelity equipment, e.g. task trainers, please specify types used.

N=24



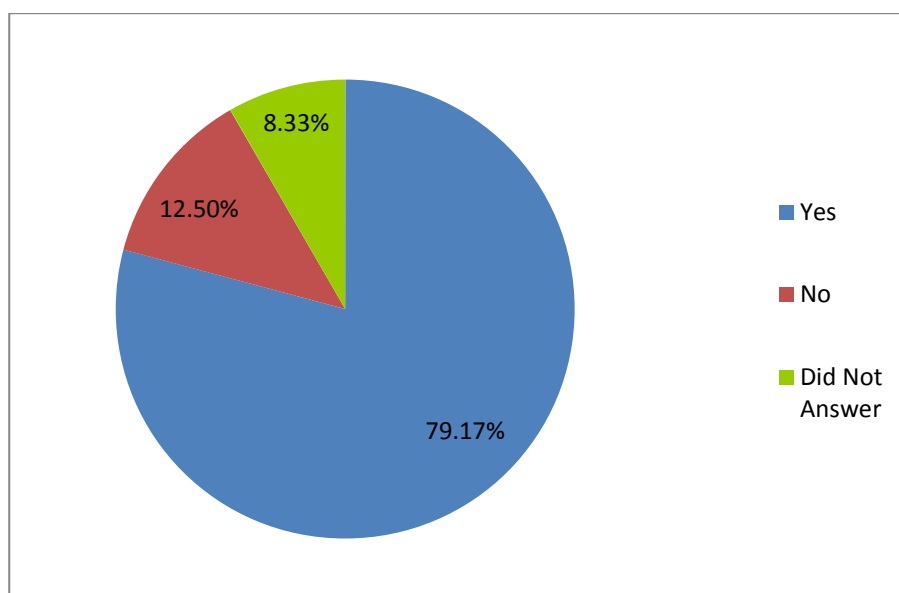
20.2 Low fidelity manikins, e.g. Nursing Anne™ *without* Vital Sim capability. Please specify brand

N=24



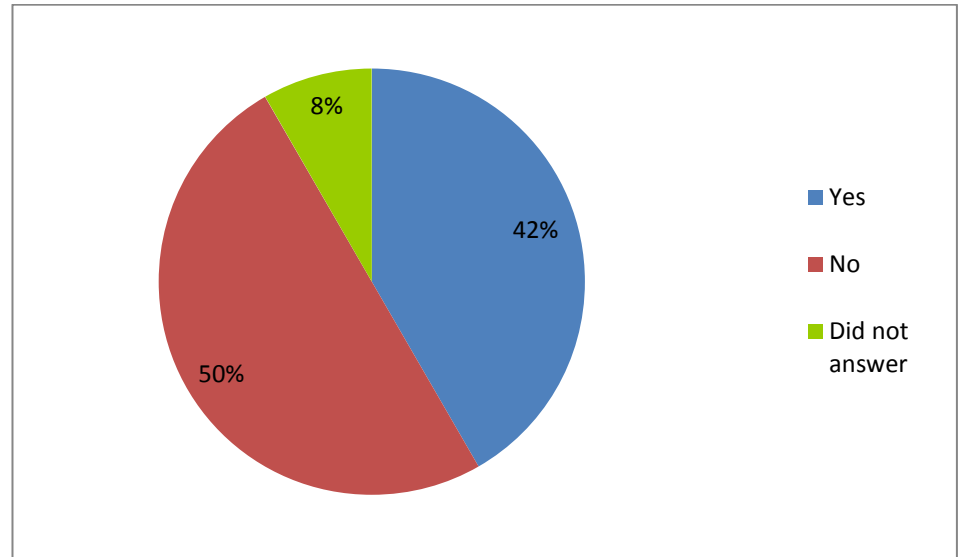
20.3 Medium fidelity manikins, e.g. Nursing Anne™ *with* Vital Sim capability. Please specify brand

N=24



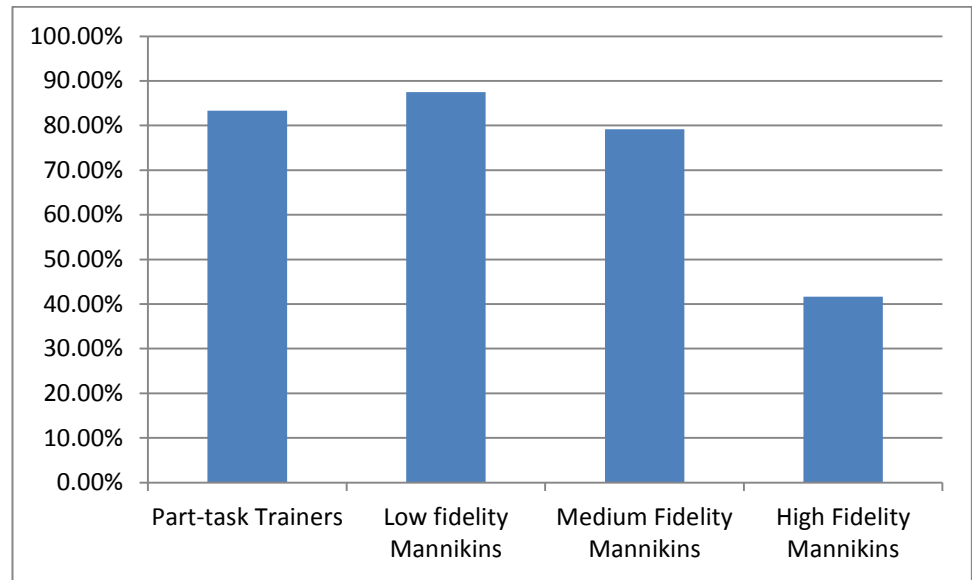
20.4 High fidelity computerised manikins, e.g. SimMan™ or METI™

N=24



Question 20 Summary

N=24

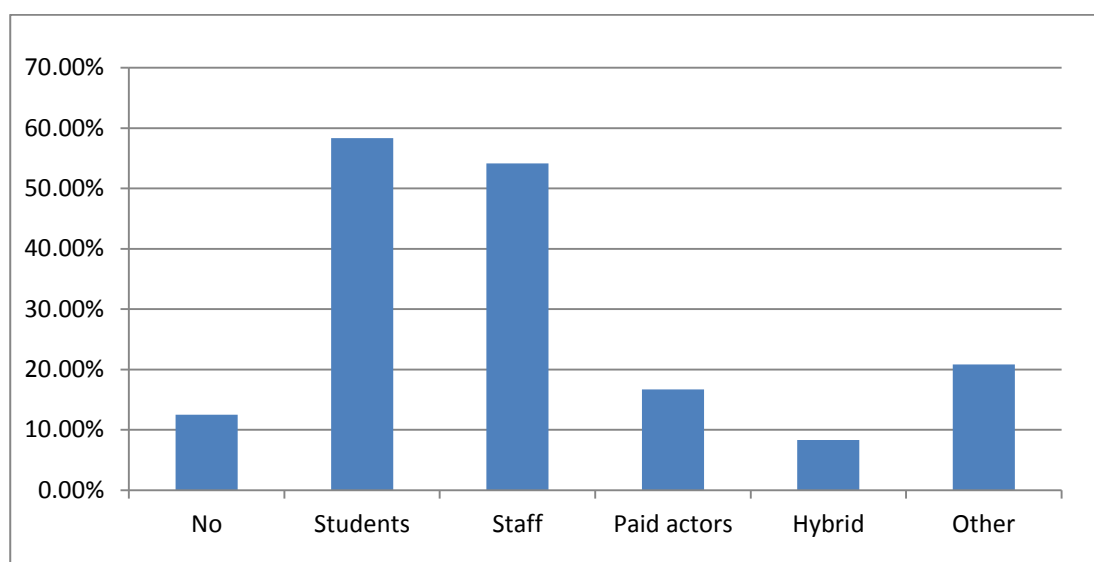


Other forms of simulation:

21. Do you use actors (standardised patients) or role plays as a form of simulation?

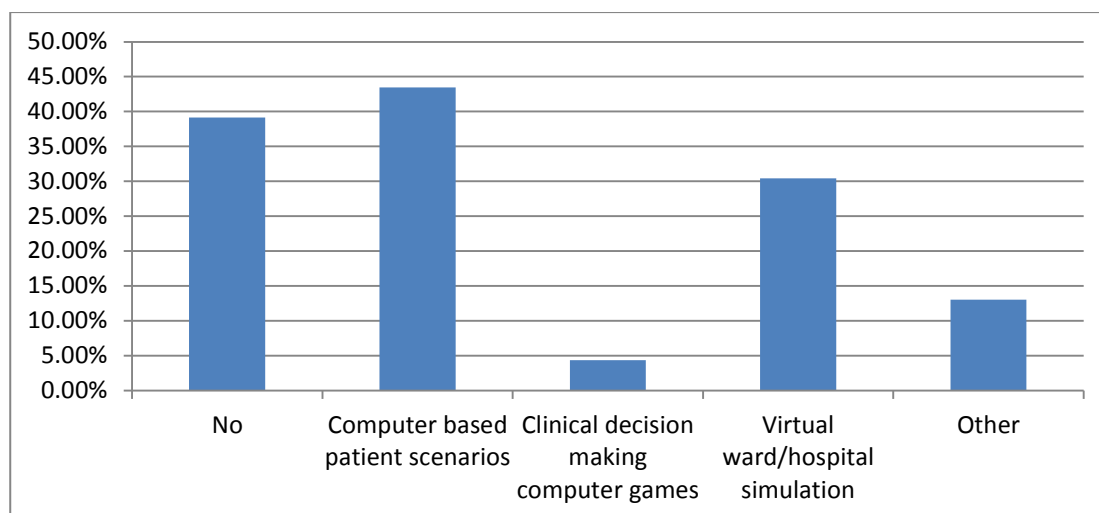
Please select all that are applicable.

N=23



22. Do you use any form of computer based simulation? Please select all that are applicable

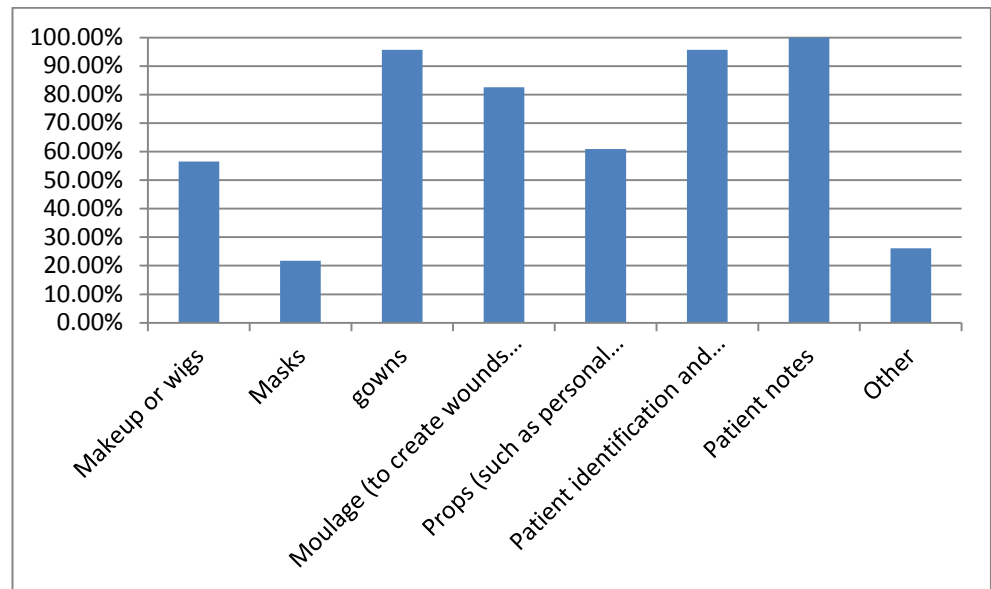
N=23



Adjuncts to simulation

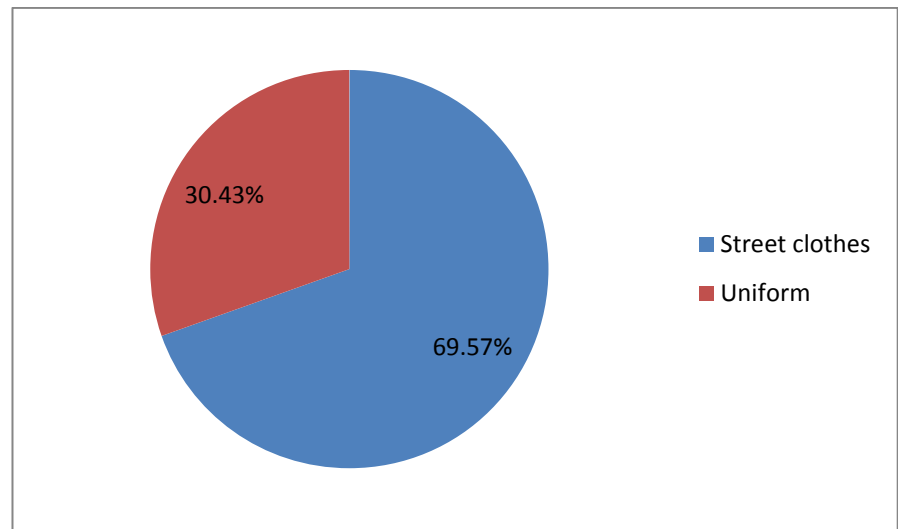
23. Are the following used as part of your simulations? Please select all that are applicable.

N=23



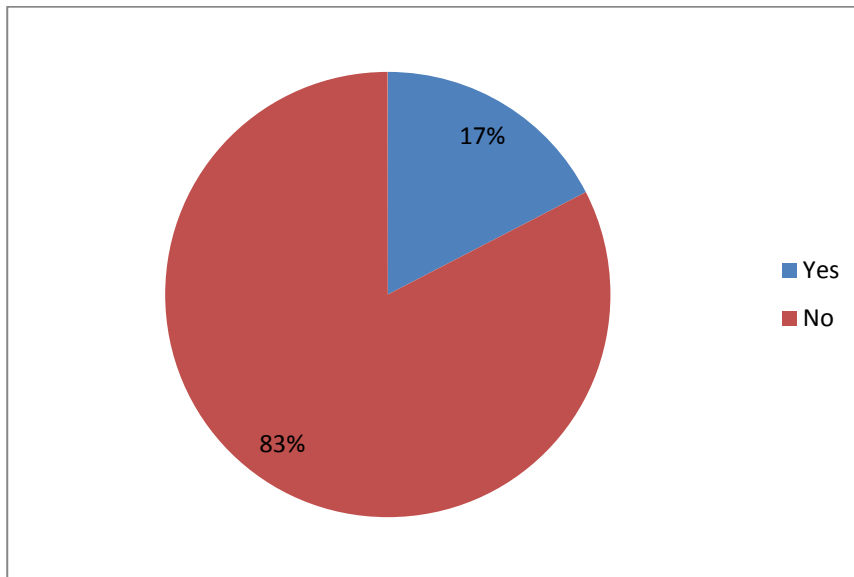
24. When attending clinical laboratories what do students wear?

N=23



25. Have you purchased scenarios for use in any form of simulation?

N=23

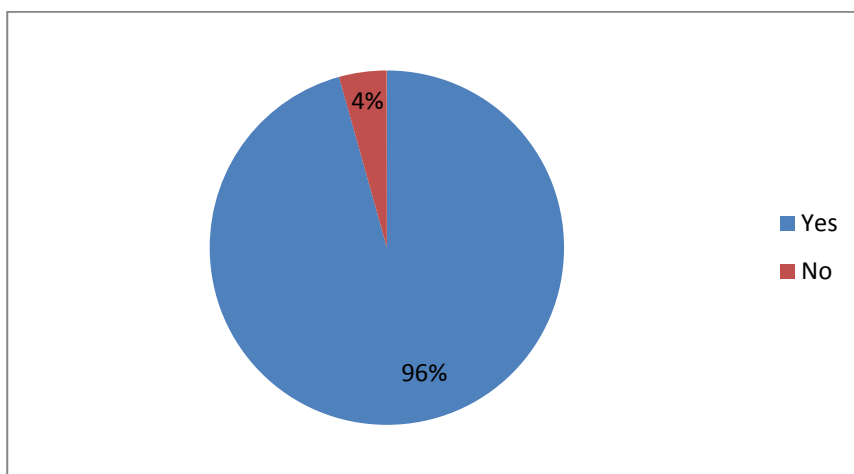


26. If yes please describe the type of simulation that these scenarios are used for.

Content analysis: Any scenarios purchased were mainly linked to manikin manufacturer.

27. Do you design your own scenarios for any form of simulation?

N=23

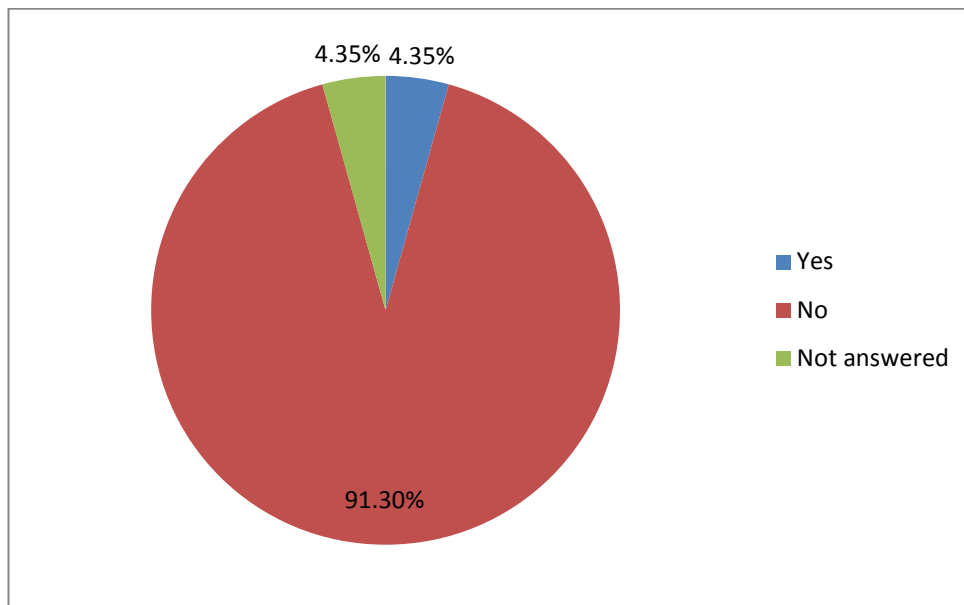


28. If yes please specify the type of simulation these scenarios are designed for.

Content analysis: Wide variety of scenarios used in clinical labs. Data did not link this clearly to the type of simulation involved

29. Have you marketed scenarios for any form of simulation?

N=23



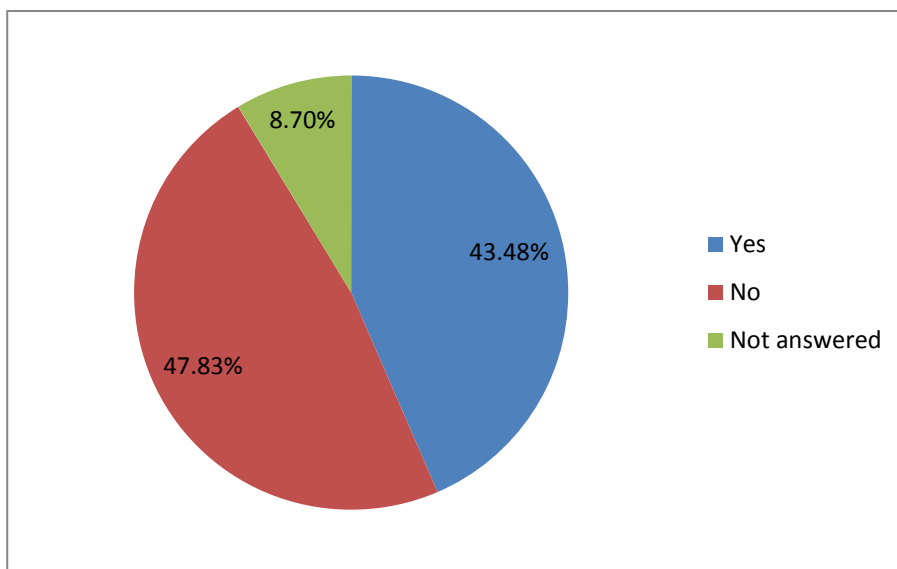
30. If yes please specify the type of simulation these scenarios are designed for

Content analysis: Only a single response, indicated development of scenarios for Laerdal.

Section D- Pedagogical principles and practices associated with the use of simulation

31. Do you use a specific theoretical framework or model as a basis for simulation teaching and learning?

N=23

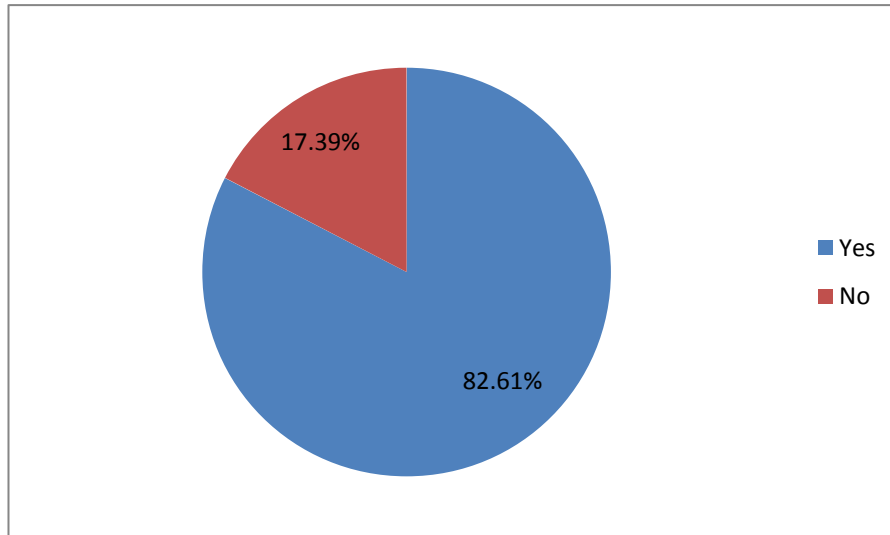


32. Could you please briefly outline the framework/model that you use?

Content analysis: Theoretical frameworks and models mentioned included curriculum based frameworks such as the nursing process or problem based learning, nursing theories such as Benner's (1984) novice to expert theory, models of clinical judgement such as Tanner (2005) and Lasater (2007b), experiential learning models and Jeffries' (2007) simulation framework.

33. Do your simulation sessions become more complex and immersive (requiring more intensive student engagement) as students progress through their undergraduate program?

N=23

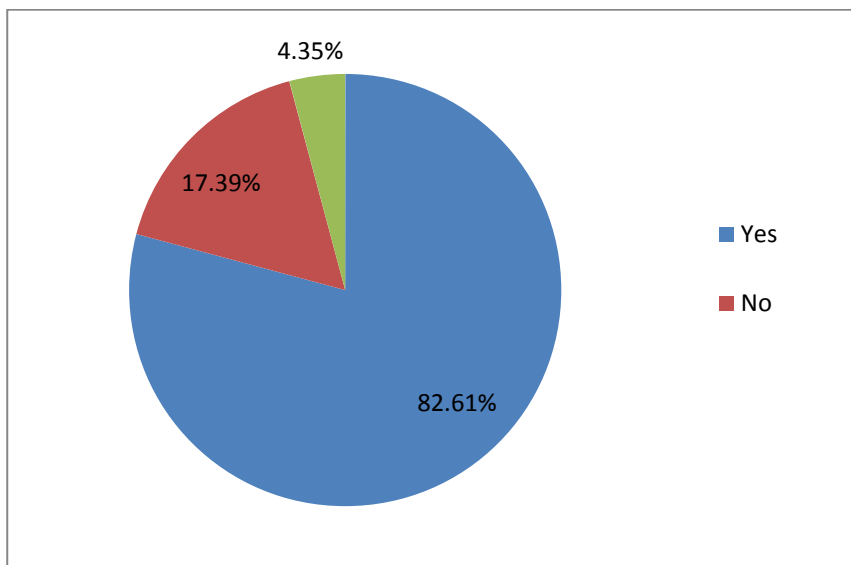


34. If yes, please give a brief example.

Content analysis: Some participants commented that they focused in first year on basic skill acquisition with static manikins, and patient assessment and communication and history taking. Most used role play for this, but immersive simulation for the development of communication skills was mentioned by one participant. In the second year students were introduced to more complex clinical skills and problem solving requirements, such as wound assessment and management. Simulation sessions for third year students often involved deteriorating patient scenarios requiring real time response and clinical reasoning, patient resuscitation and multi-disciplinary teamwork.

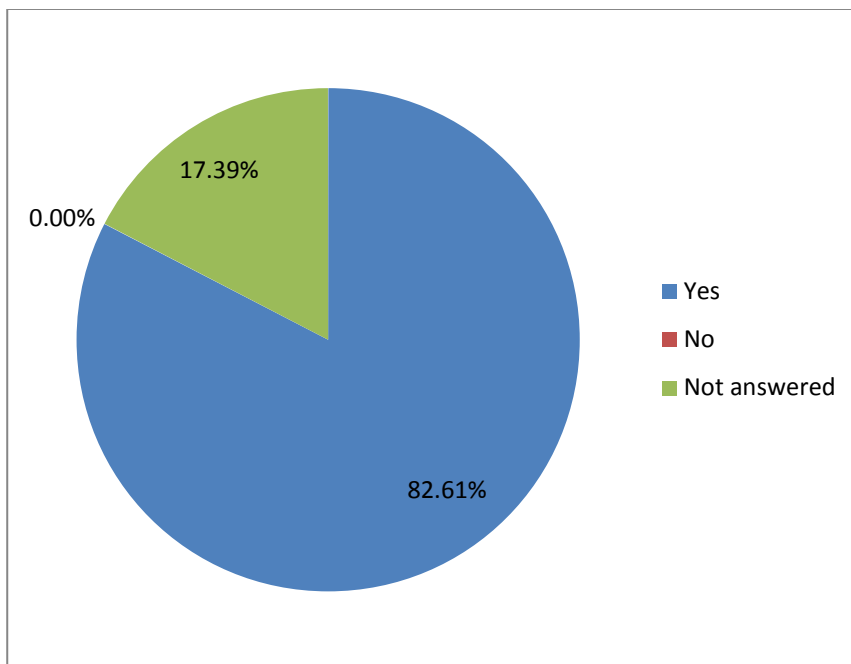
35. Do you have specific written objectives/ outcomes for each simulation?

N=23



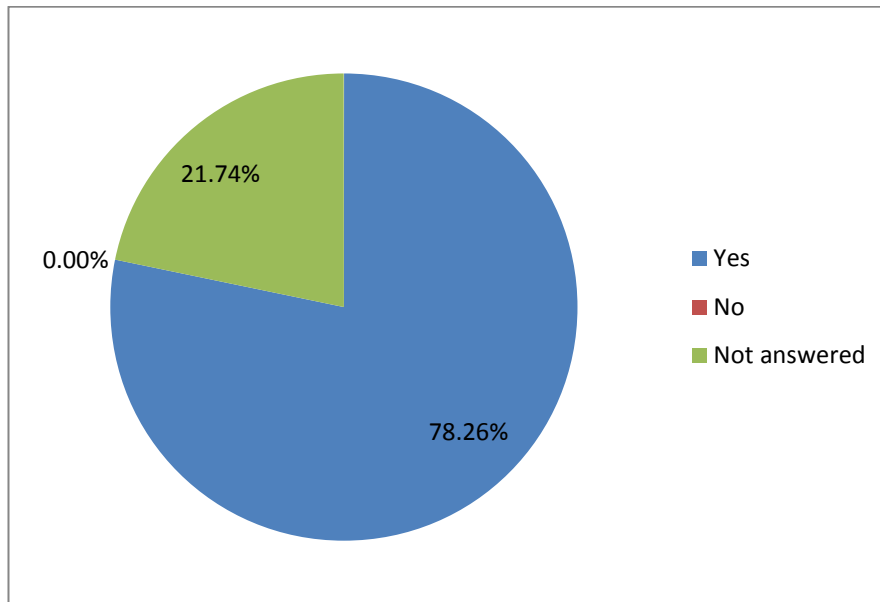
36. If yes, are these objectives embedded within or linked to a specific course, subject or unit?

N=23



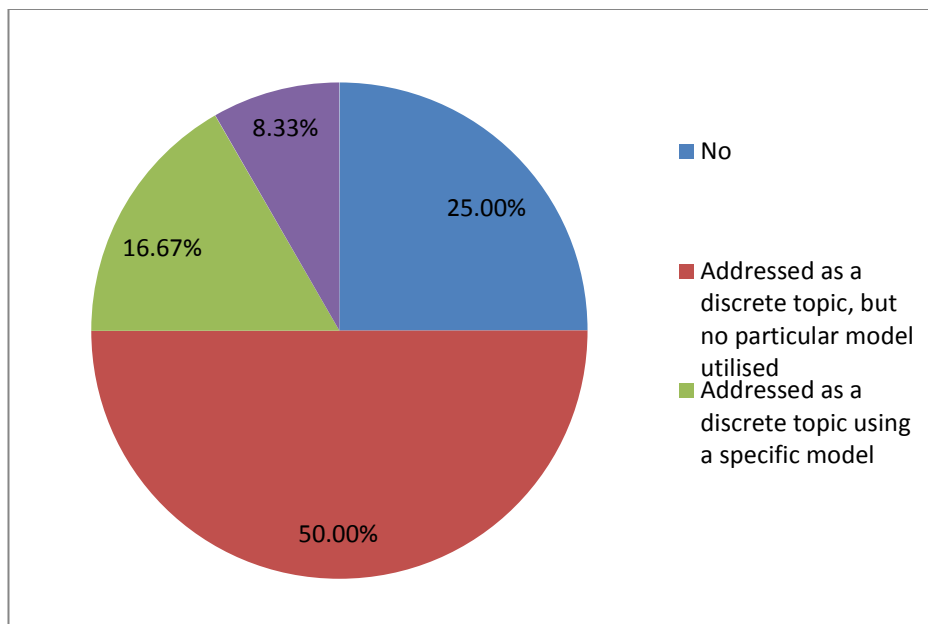
37. Do these objectives align with documented curriculum objectives?

N=23



38. Are clinical reasoning, clinical decision making or clinical judgement skills specifically addressed as a discrete topic in your undergraduate program?

N=24



39. The following table is for you to list the objectives of your simulation sessions. Tick all that are applicable:

N=15

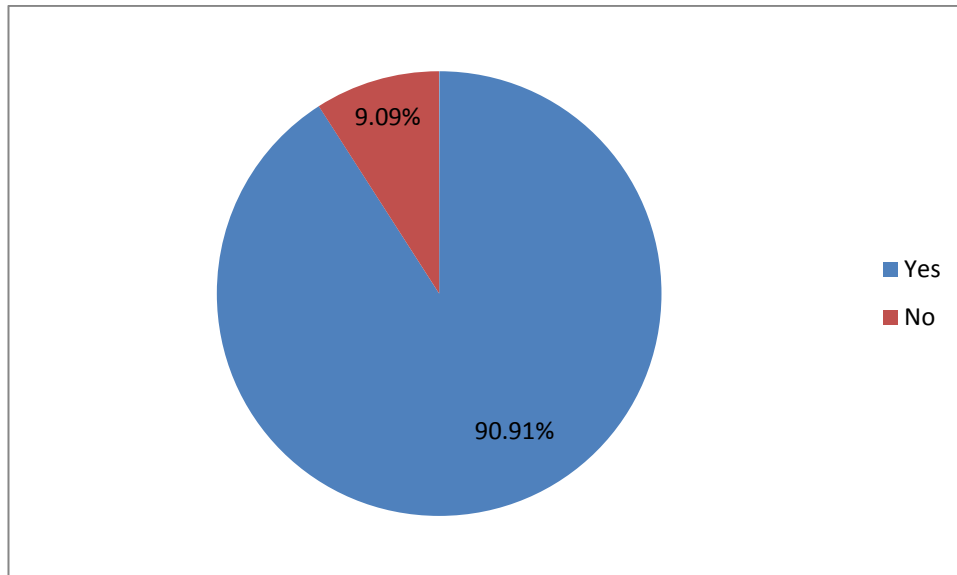
Targeted learning objectives	Role plays	Actors	Computer based simulation	Part task trainers	Low fidelity manikins	Medium fidelity manikins	High fidelity manikins
39.1 Therapeutic communication skills	80%	20%	13%	13%	53%	27%	27%
39.2 Patient assessment	73%	27%	20%	33%	73%	67%	33%
39.3 Clinical psychomotor skills	47%	13%	13%	60%	80%	67%	33%
39.4 Knowledge acquisition	60%	20%	27%	33%	53%	53%	27%
39.5 Clinical reasoning/ decision making	80%	20%	7%	53%	53%	60%	33%
39.6 Teamwork/ organisation and prioritisation	73%	20%	0%	20%	53%	53%	33%
39.7 Other, please specify	0%	7%	0%	0%	0%	0%	0%

40. If you believe you have an innovative approach that illustrates the use of any form of simulation in clinical laboratories, would you please share this with us here?

Content Analysis: Development of online virtual reality environments was mentioned by 4 respondents.

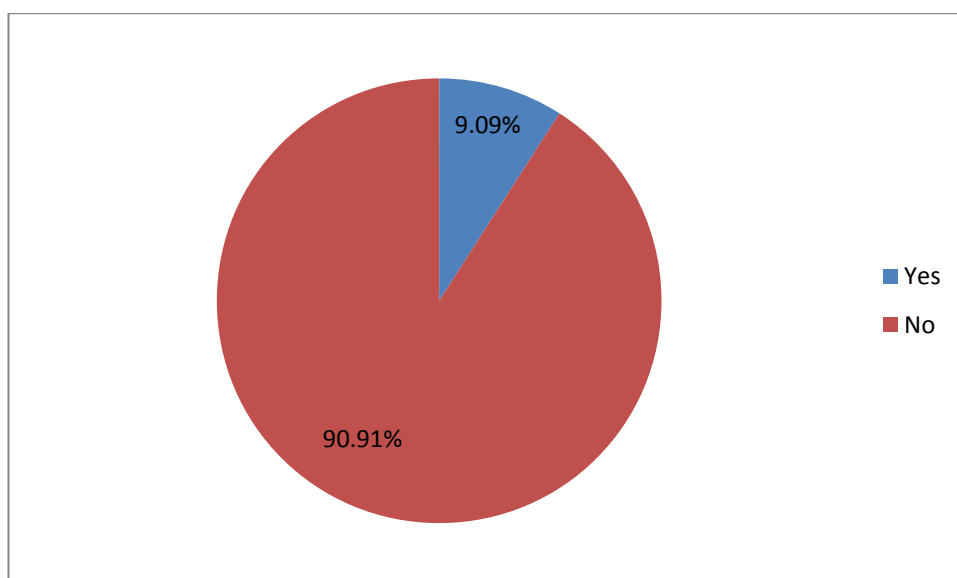
41. Is your institution committed to development of simulation as a teaching and learning strategy?

N=22



42. Do you currently use simulation as an alternative or replacement to some clinical placement hours?

N=22

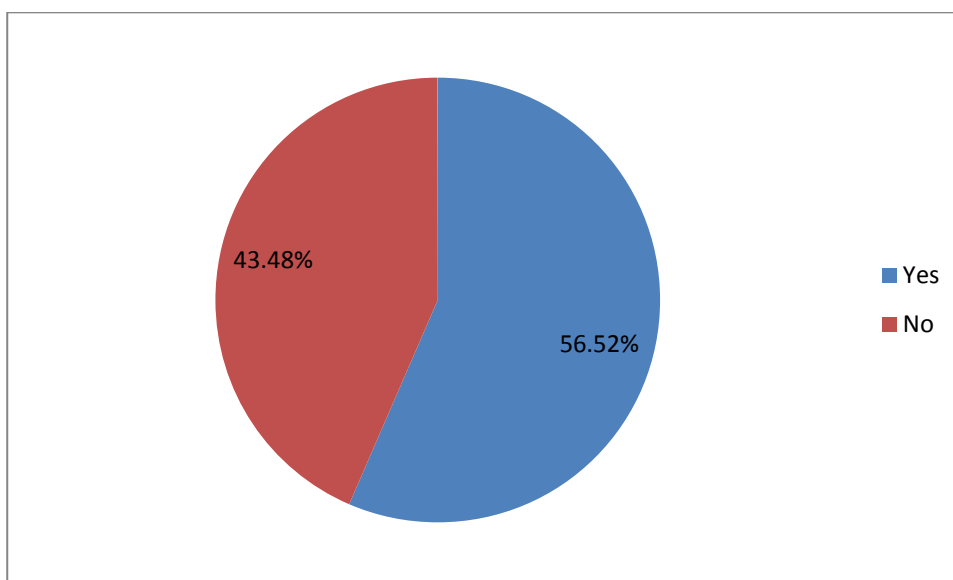


43. If yes, please indicate the type and number of hours of simulation, and the number of clinical placement hours that it replaces

Content Analysis: One respondent had replaced some third year hours with simulation. One respondent used simulation as a fallback in first year when required immunisation status for placement not reached.

44. Have you considered the possibility of using simulation as an alternative or replacement/further replacement to some clinical placement hours in the future?

N=23



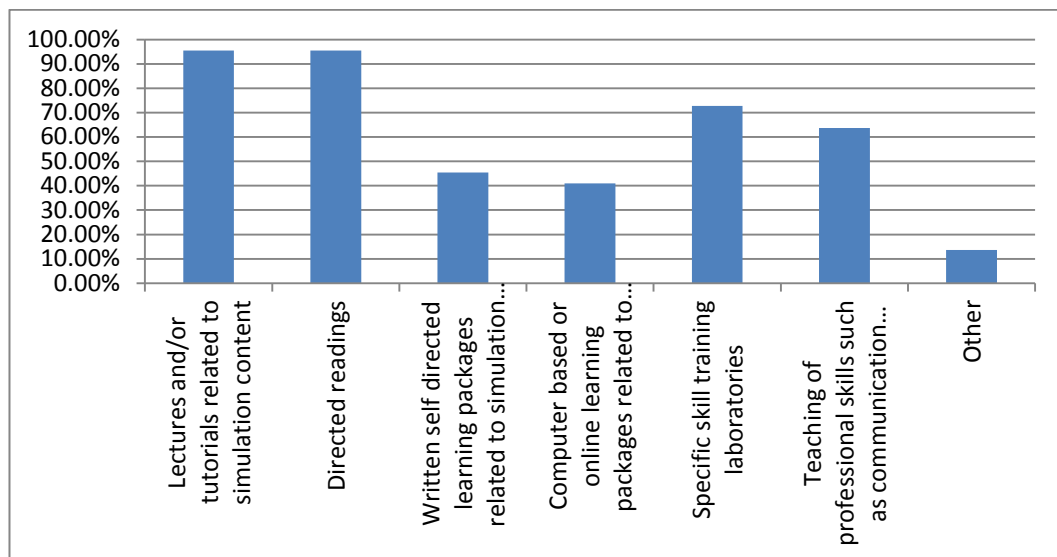
45. If you have answered yes to question 42 or 44, what issues have you considered in relation to this?

Content Analysis: Issues influencing this view included: difficulty finding enough suitable clinical placements, the quality of the learning environment in some clinical placements, adequacy of facilities and resources for simulation programs, philosophical stance as to whether simulation should replace or supplement clinical placement, and the requirements of the registration body, including potential changes due to 2010 nationalisation of nursing registration.

Section E -Processes for medium and high fidelity manikin simulation sessions

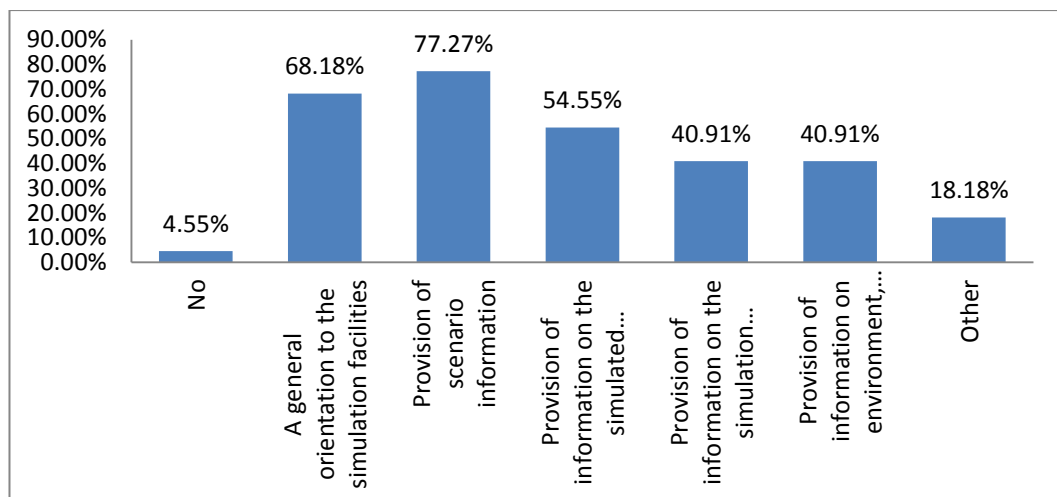
46. What preparation do students undertake *prior* to simulations? Please select all that are applicable.

N=22

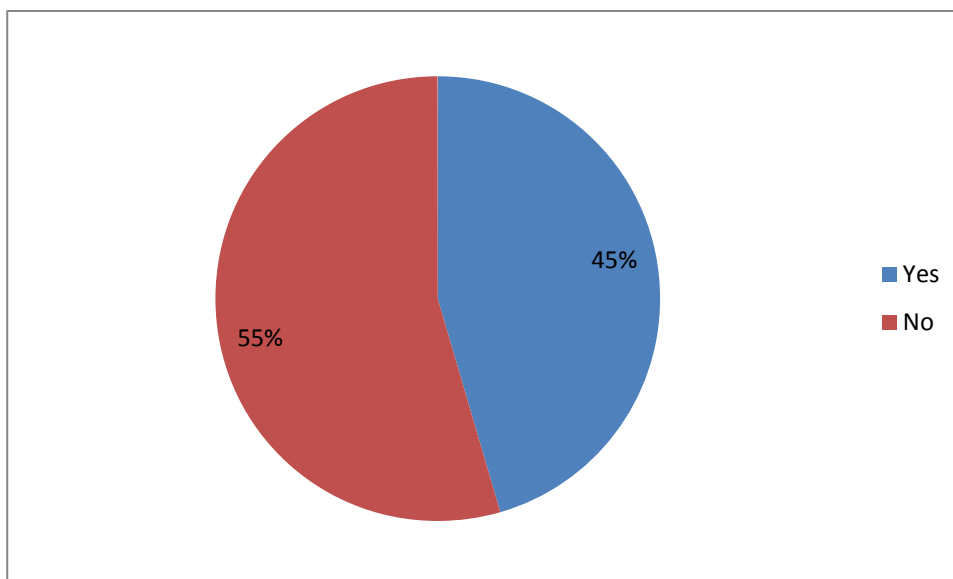


47. Do students receive briefing *prior* to the simulation? Please select all that are applicable.

N=22

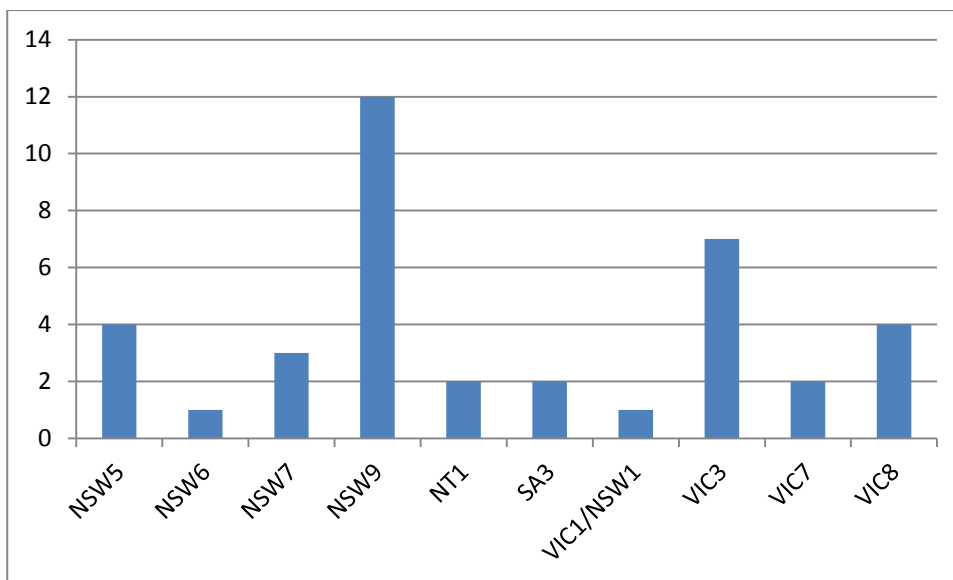


48. Do you have access to a laboratory or laboratories specifically set up for medium or high fidelity manikin simulation?



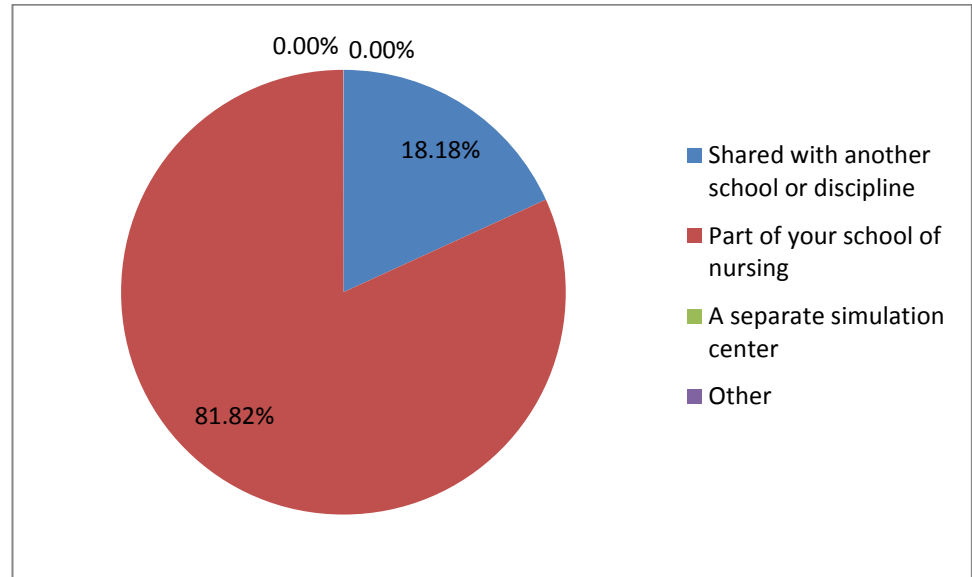
49. If yes, how many of these laboratories do you have access to?

N=10

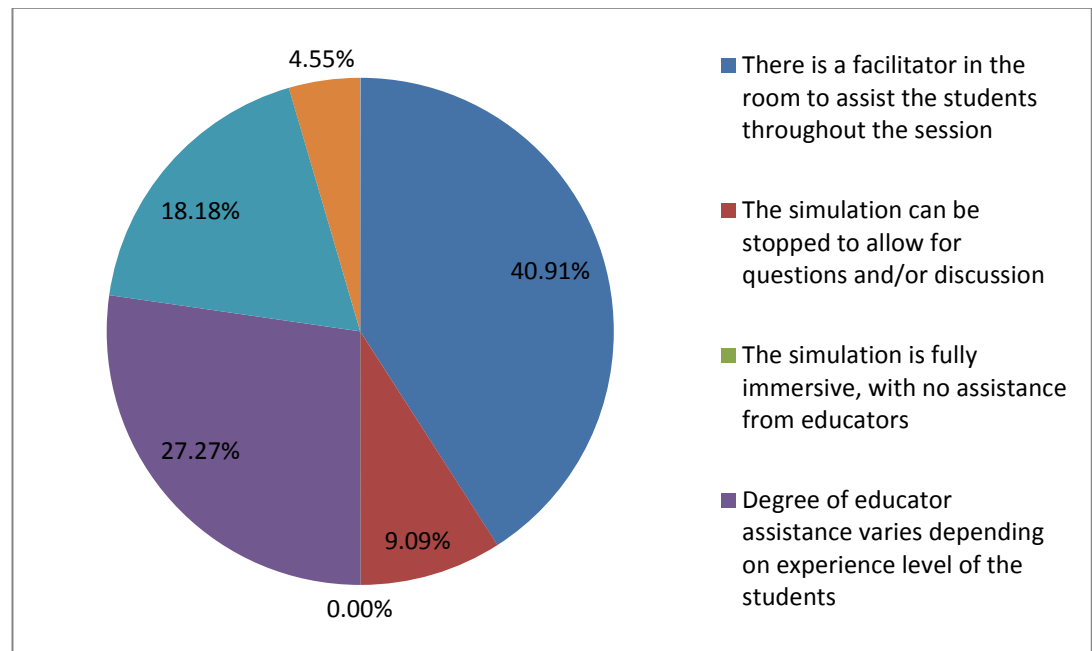


50. Are these laboratories

N=11

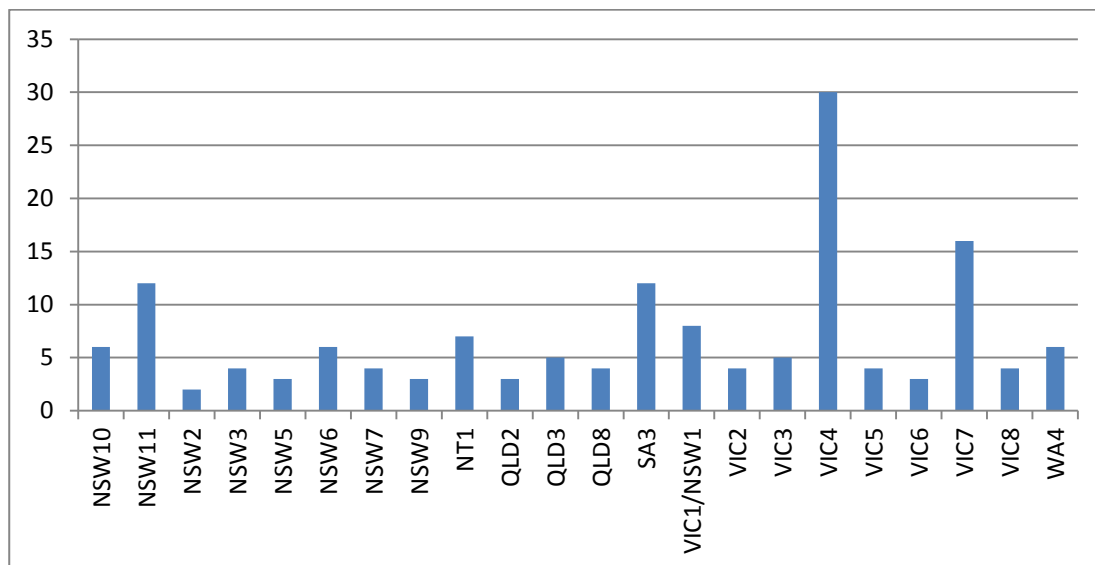


51. To what extent do students have assistance from educators during the simulation?



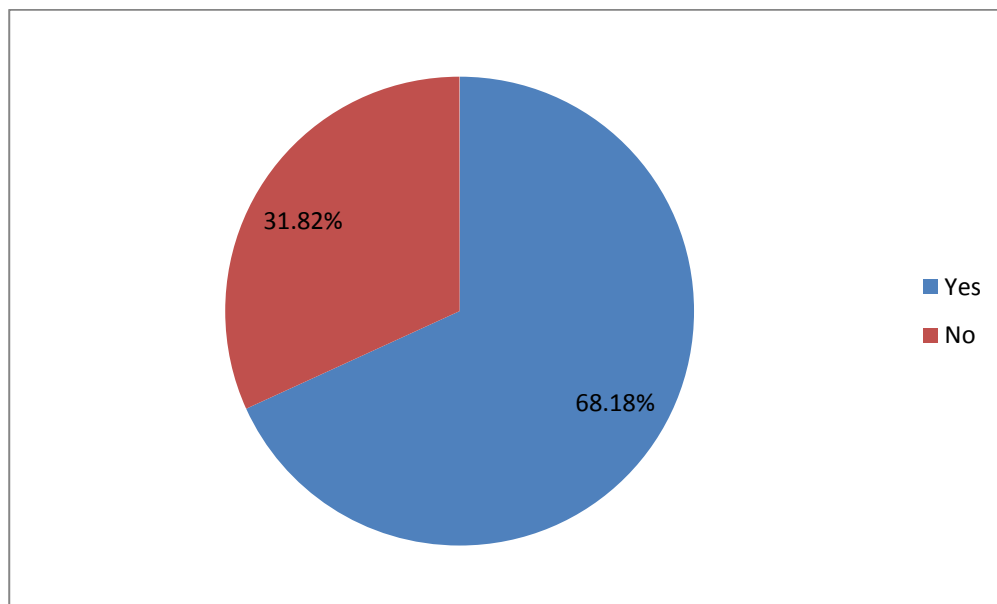
52. How many students are actively involved in a simulation session at one time?

N=22



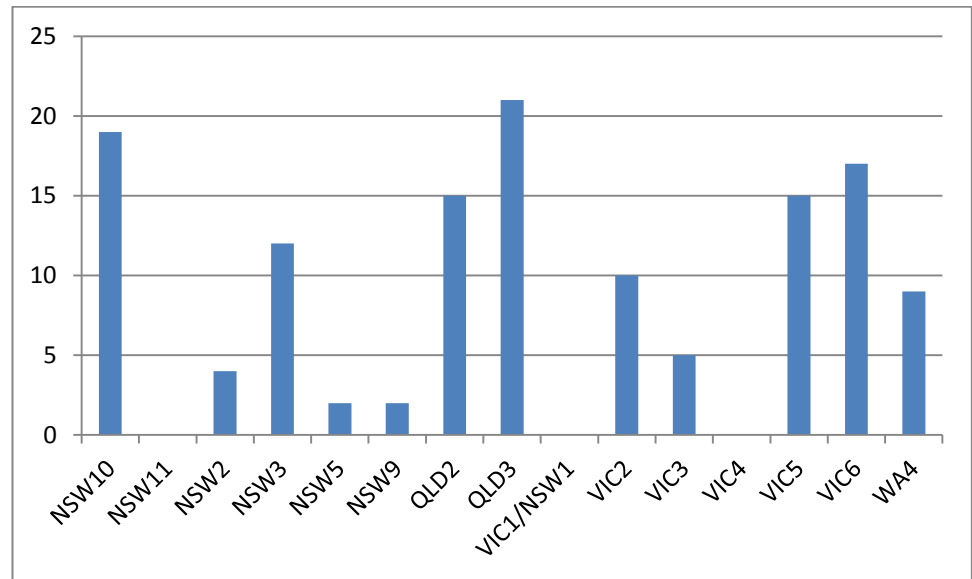
53. Are other students present in the room as observers?

N=22



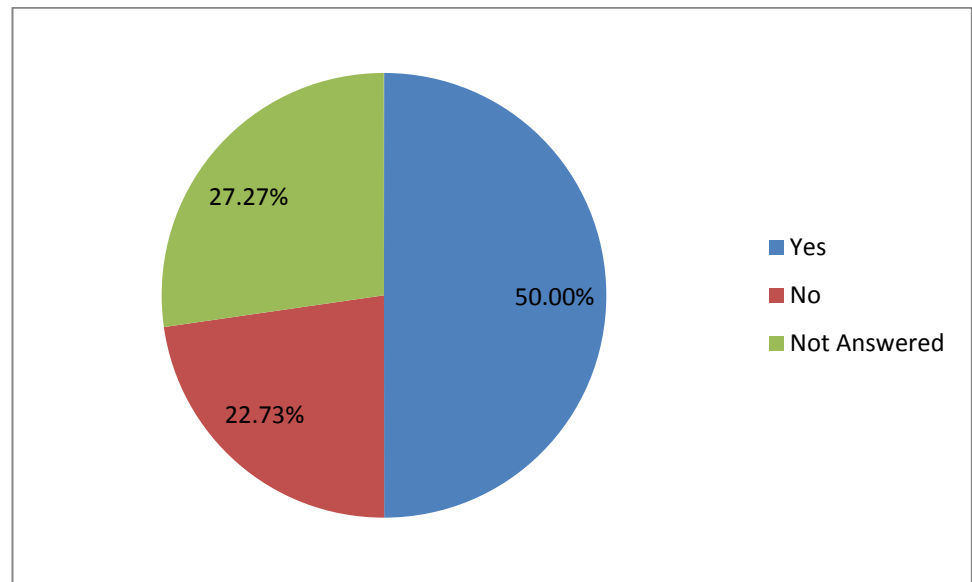
54. If yes, how many students are in the room as observers?

N=15



55. Do the observers have a particular role?

N=22

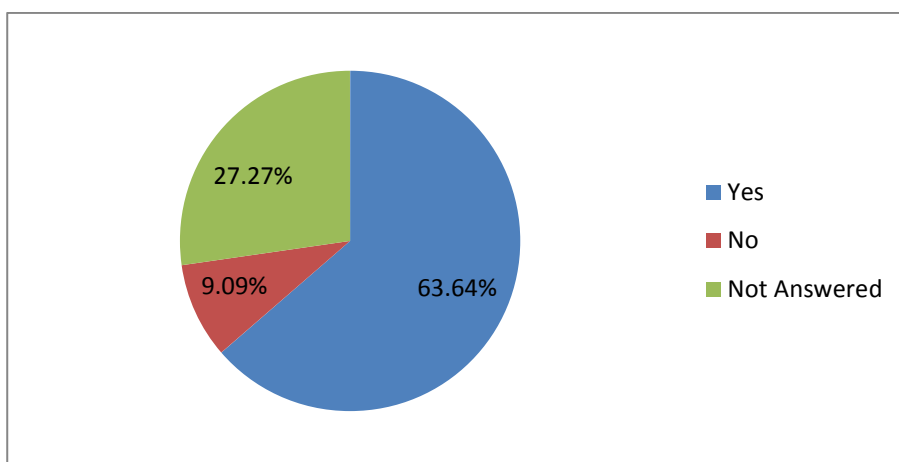


56. If yes, what roles/activities are allocated to observers?

Content Analysis: Roles allocated to observers included evaluation of the team performance and providing critical feedback during debriefing.

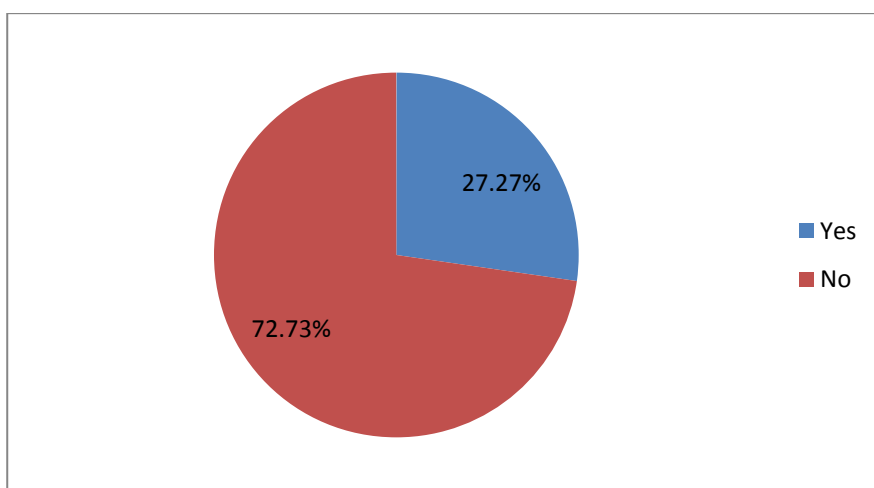
57. Do the roles of active participants and observers reverse during the simulation sessions?

N=22



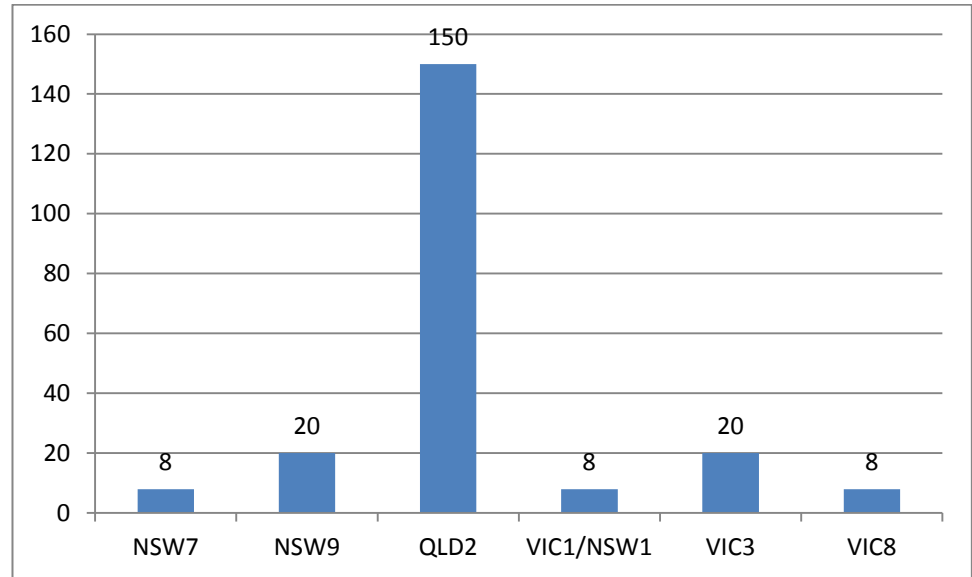
58. Can the simulation session be viewed by students in another room through video link up or one way glass screens?

N=22



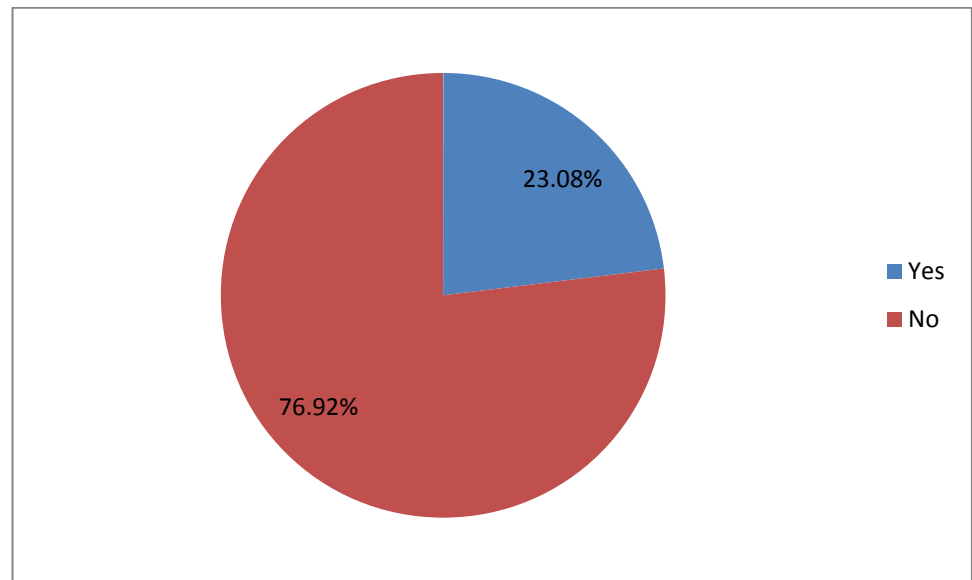
59. If yes, how many students are able to view the simulation?

N=6



60. Do the external student viewers have an allocated role/activity?

N=13



61. If yes, what roles/activities are allocated to external student viewers?

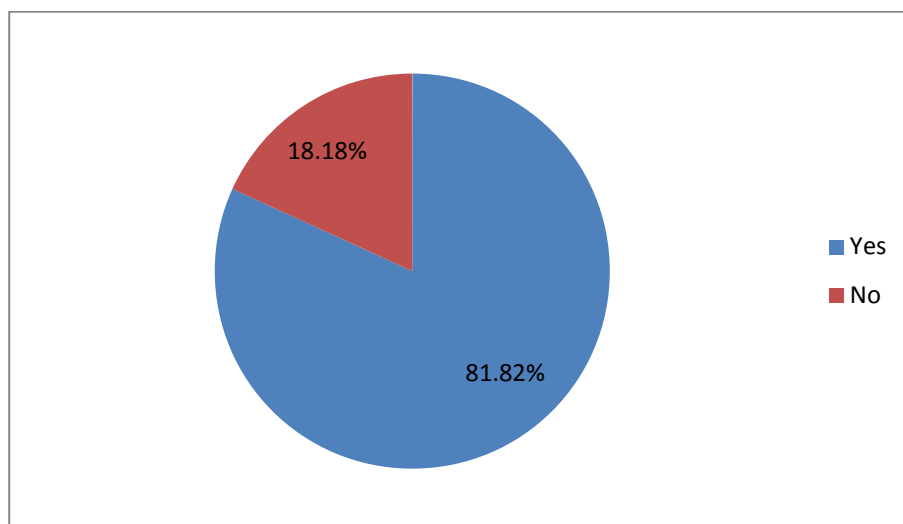
Content analysis: Involvement in face-to-face or online debriefing.

62. How long does a simulation session take? _____minutes. (Indicate range if applicable)

Content Analysis: Responses indicate that simulation session times range between 5 minutes and 3 hours, with an average session time of 46 minutes.

63. Do students engage in debriefing *following* the simulation session?

N=22

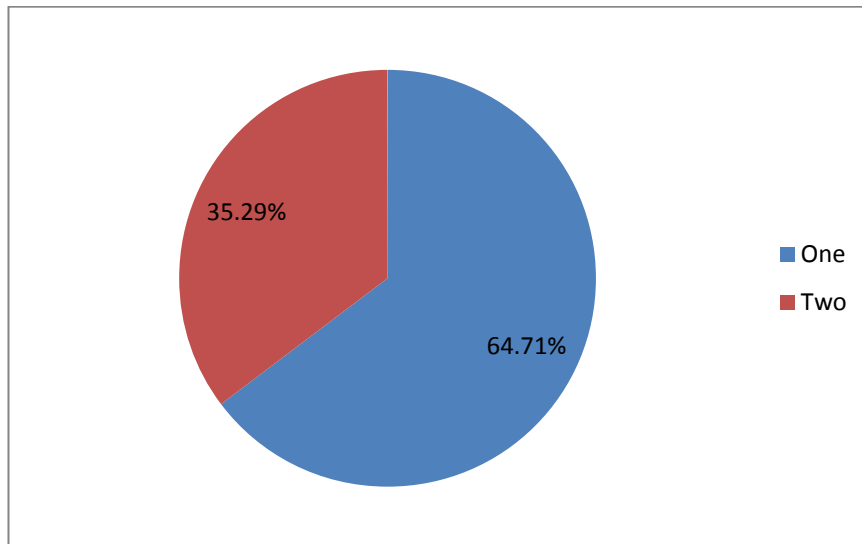


64. If yes, how much time is allowed for debriefing? _____ minutes.
(Indicate range if applicable)

Content Analysis: Responses indicate that simulation session times range between 5 minutes and 1 hour, with an average session time of 46 minutes.

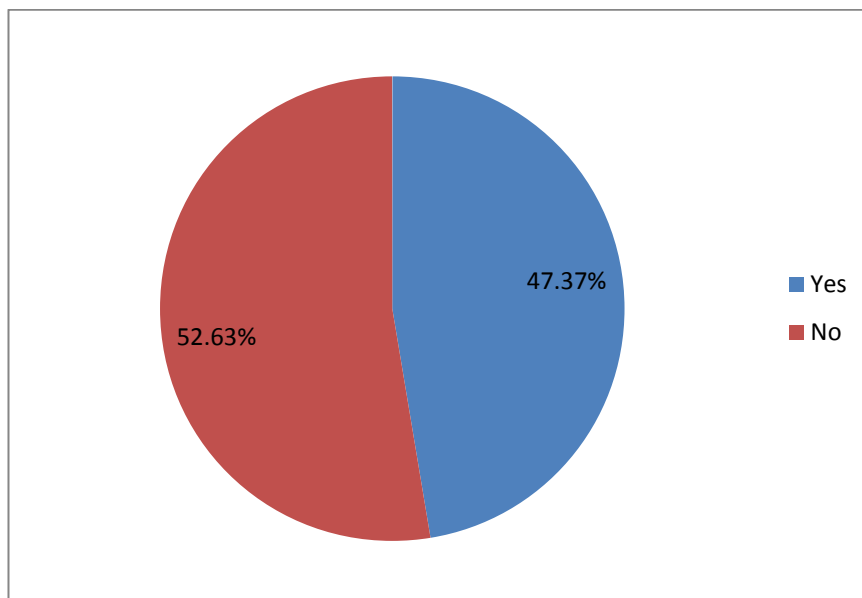
65. How many facilitators conduct the debriefing session?

N=17



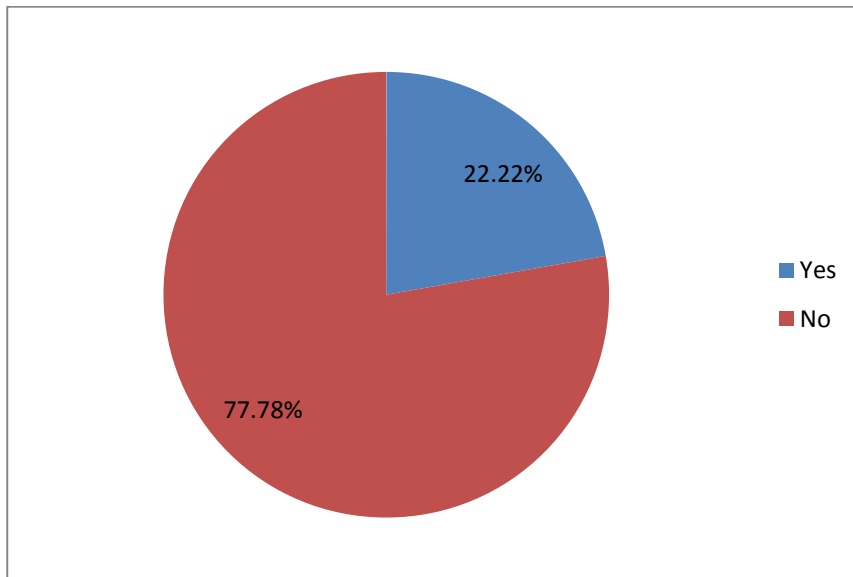
66. Is video recording of the simulation used for debriefing purposes?

N=19



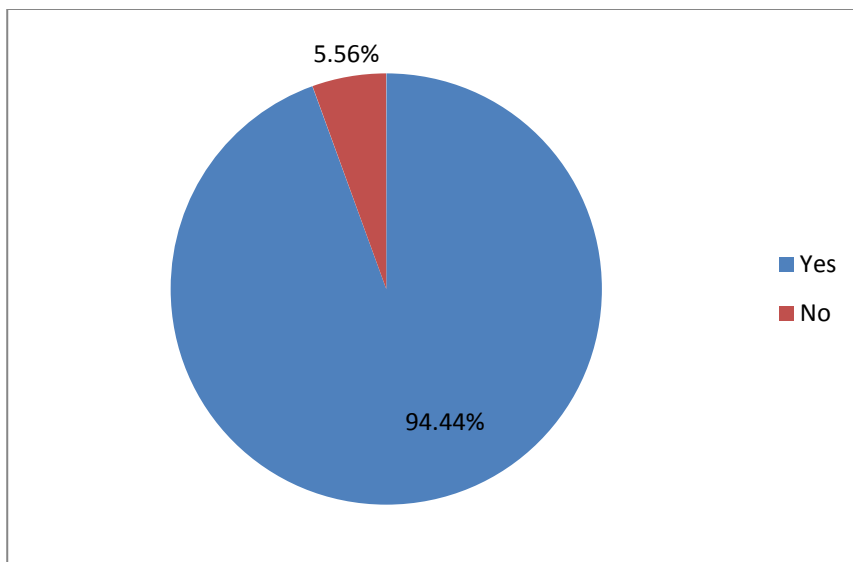
67. Is video recording of simulations used for further classroom teaching?

N=18



68. Do debriefing techniques make use of student reflection on practice and self-identification of strengths and weaknesses?

N=18

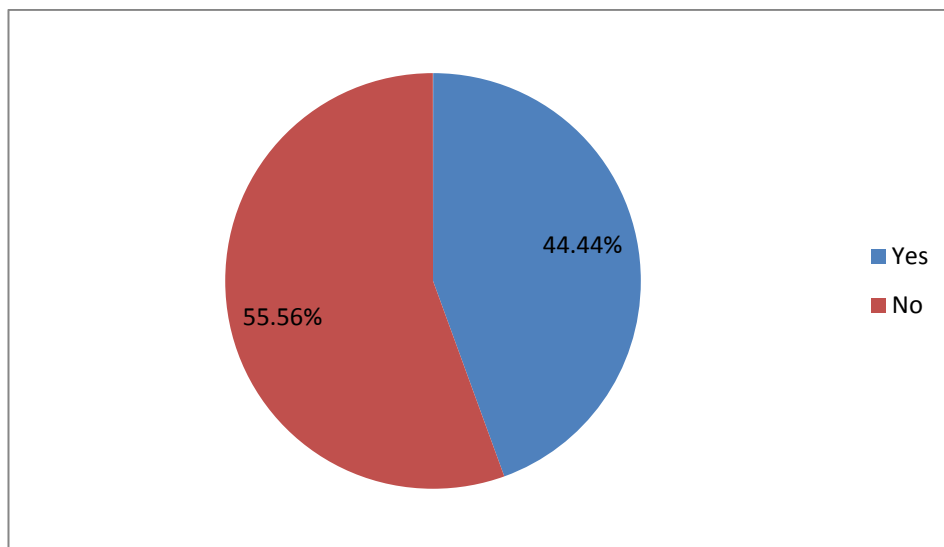


69. If yes, please give an example of how reflection is facilitated.

Content Analysis: Reflection facilitated through questioning by facilitators, group discussion, video review or written reflection aimed at self-identification of strengths and weaknesses, areas for improvement and implications for practice.

70. Are any other structured debriefing activities used?

N=18

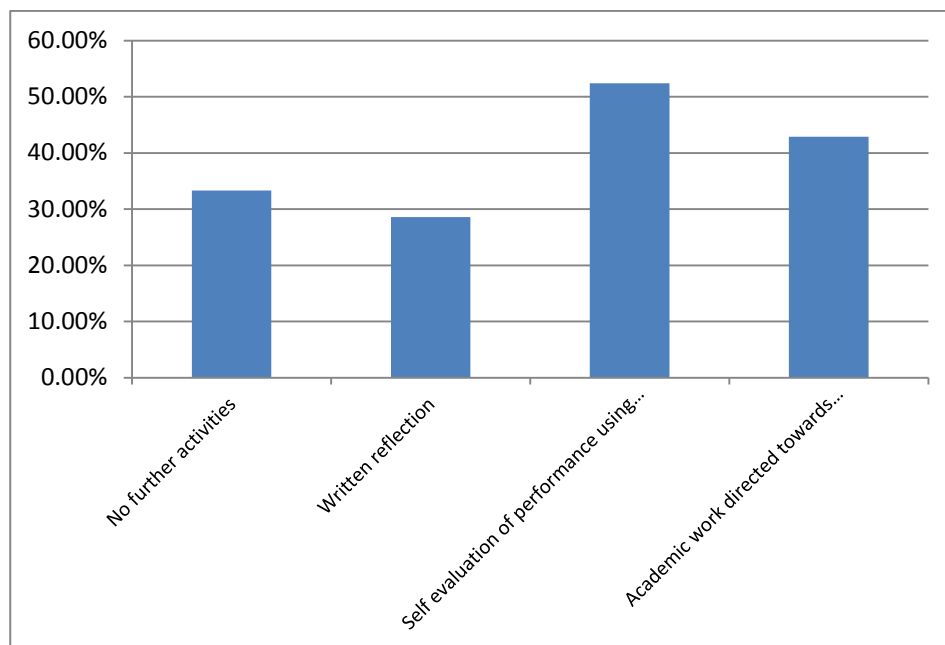


71. If yes, please briefly describe the structured debriefing technique used.

Content Analysis: Comparison with predetermined best practice criteria, structured questions and learning logs.

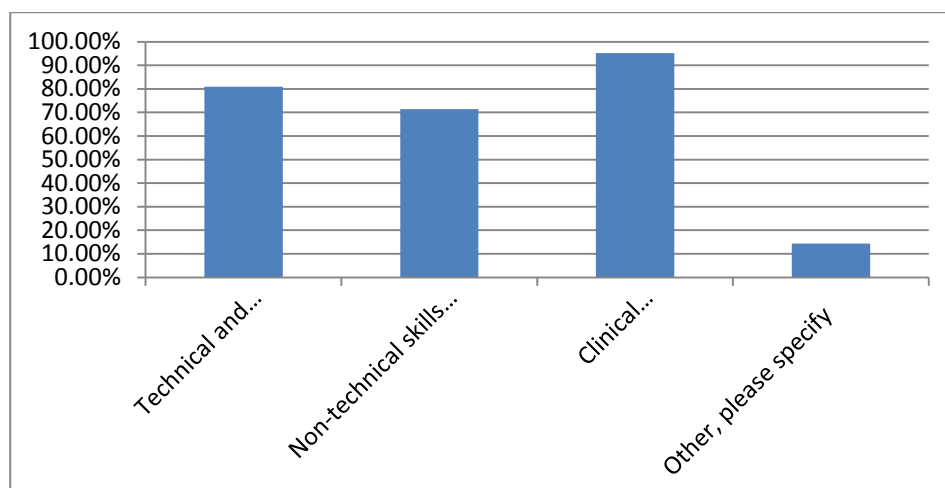
72. Do students undertake any of the following learning activities *on completion* of the simulation? Please select all that are applicable.

N=21



73. Do you view medium and high fidelity manikin simulation as an effective strategy for the teaching of:

N=21



74. If you consider that medium or high fidelity manikin simulation is used effectively in your undergraduate teaching program, would you please share with us an example of your approach?

Content Analysis: Answers to this question mainly focused on scaffolding of learning. Strategies included: pre-reading, lectures or tutorials, case studies, integration of skills previously taught in laboratory, group support, inclusion of nontechnical skills and increasing complexity throughout the curriculum. One participant discussed use of latex mask technology and roleplay.

Section F -Roles and responsibilities of staff involved in the use of medium of high fidelity manikins.

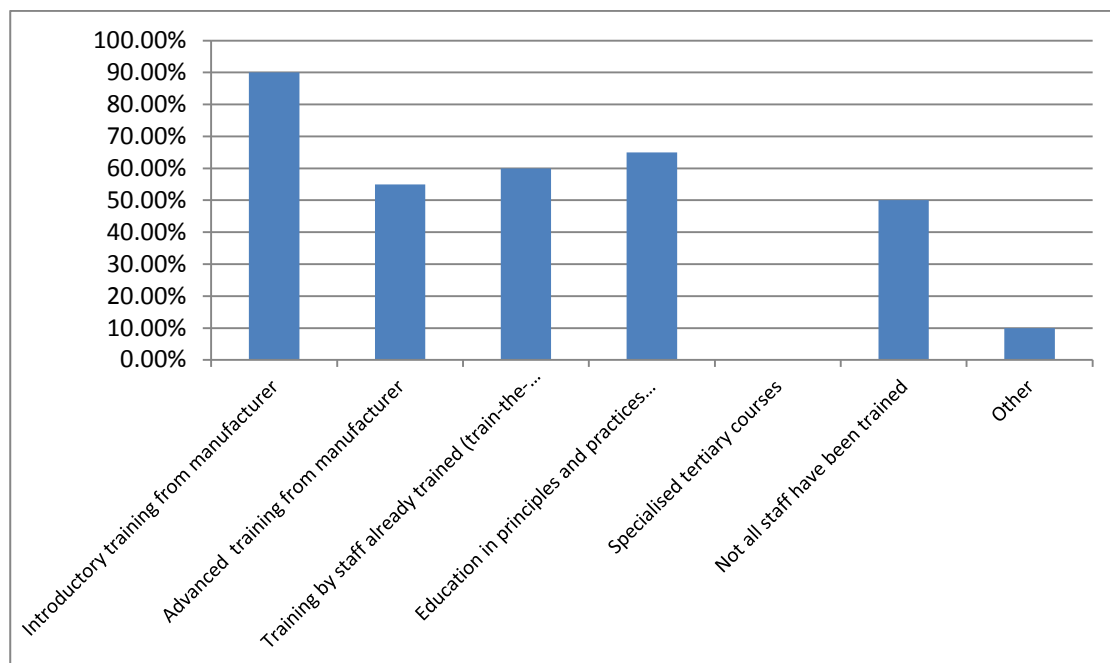
75. Please indicate staff roles and responsibilities related to the use of medium and high fidelity HPS manikins. Tick all that are applicable.

N=12

Responsibilities in relation to high fidelity HPS	Clinical laboratory technician	IT technician	Supplying company representative	Casual laboratory educator	Simulation specialist staff	Lecturer/ permanent academic
75.1 Preparing physical environment	83%	0%	8%	8%	8%	33%
75.2 Maintenance of manikins	75%	0%	25%	0%	17%	33%
75.3 Maintenance of computer and audiovisual equipment	42%	50%	17%	0%	8%	8%
75.4 Writing simulation scenarios	0%	0%	8%	8%	25%	100%
75.5 Programming computer software	25%	42%	8%	0%	25%	42%
75.6 Controlling the computer during simulation	17%	8%	0%	17%	25%	75%
75.7 Supporting students in simulation room	8%	0%	0%	33%	17%	83%
75.8 Debriefing students after simulation	0%	0%	0%	33%	8%	83%

76. Preparation and training of staff involved in medium and high fidelity HPS includes the following. Please select all that are applicable.

N=20



77. Please add your comments on issues surrounding staffing requirements for medium and/or high fidelity simulation

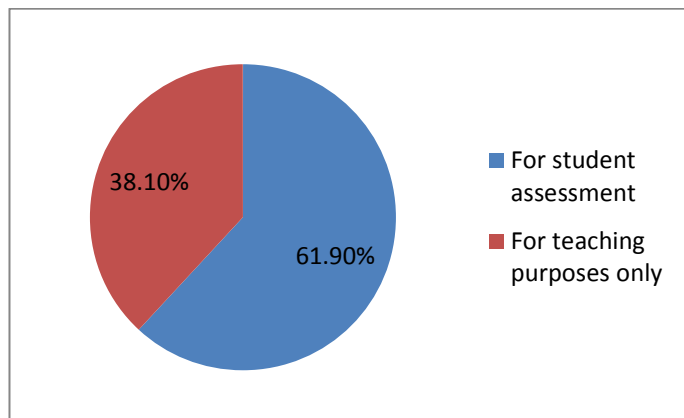
Content Analysis: Issues associated with training of new and casual staff in required skills and workload allocation for simulation development mentioned.

Section G –Simulation and Student Assessment:

This section explores the use of simulation in ALL its forms as a tool to assess student outcomes

78. In your undergraduate program is simulation used:

N=21



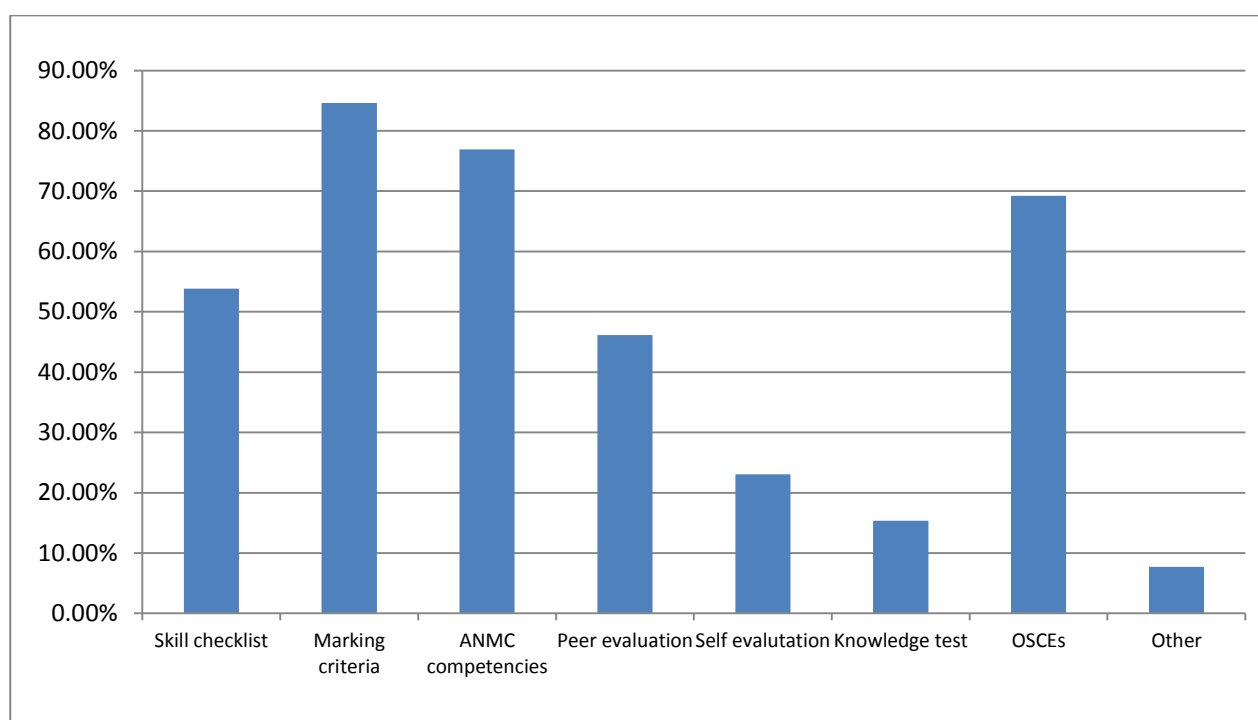
79. If your school uses simulation for student assessment please indicate what types of simulations are used and the domains that are assessed. Please tick all that are applicable in the table below.

Targeted Assessment Items	Role plays	Actors	Computer based simulation	Part task trainers or low fidelity manikins	Medium fidelity manikins	High fidelity manikins
79.1 Formative assessment	50.00%	7.14%	35.71%	64.29%	64.29%	21.43%
79.2 Summative assessment	35.71%	21.43%	14.29%	50.00%	57.14%	21.43%
79.3 Remediation following identified problem	42.86%	14.29%	0.00%	85.71%	71.43%	21.43%
79.4 Therapeutic communication skills	78.57%	35.71%	0.00%	57.14%	28.57%	21.43%
79.5 Patient assessment skills	71.43%	28.57%	35.71%	71.43%	57.14%	28.57%
79.6 Clinical psychomotor skills	64.29%	21.43%	21.43%	92.86%	57.14%	21.43%

79.7 Knowledge acquisition	64.29%	14.29%	50.00%	64.29%	57.14%	28.57%
79.8 Clinical reasoning/ decision making	57.14%	14.29%	42.86%	42.86%	50.00%	35.71%
79.9 Teamwork/ organisation and prioritisation	42.86%	21.43%	14.29%	28.57%	28.57%	14.29%
79.10 Other, please specify	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

80. How are students graded in relation to simulation activities? Please select all appropriate responses.

N=13



81. If clinical reasoning/clinical decision making are assessed using simulation scenarios, could you please explain how this is done?

Content Analysis: Use of an inquiry model, Lasater's rubrik, skill checklists, algorithms, OSCARS, video analysis, marking criteria based on verbal rationales.

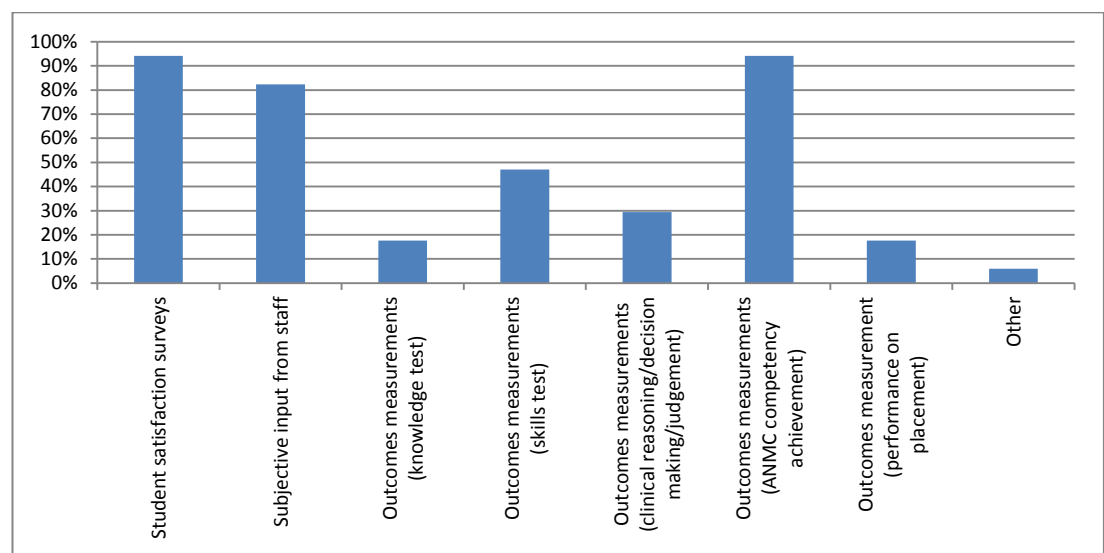
82. If you consider that your school uses simulation of any kind in an effective or innovative way for student assessment, would you please share an example with us?

Content Analysis: No useful data.

Section H - Evaluation of the use of medium and high fidelity HPS manikins and the simulation process

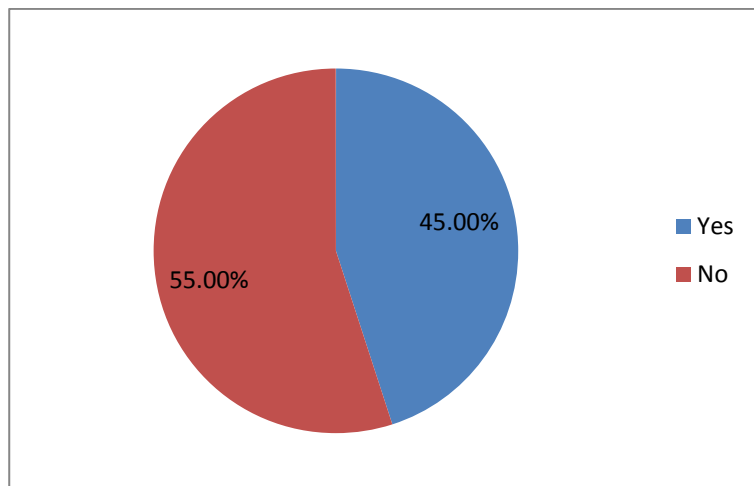
83. Which of the following methods, if any, are used in your school for evaluating the effectiveness of the medium and high fidelity HPS manikin simulation sessions? (Note that this question refers to evaluating the overall effectiveness of the teaching strategy, not evaluation/assessment of individual students)

N=17



84. Is your school currently conducting, or have they previously conducted research related to the use of simulation?

N=20



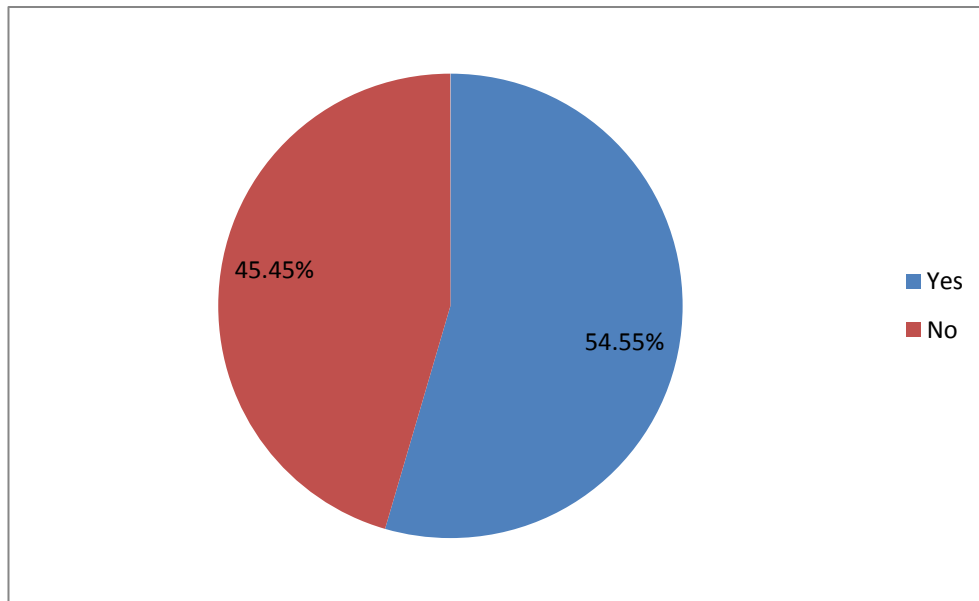
85. Please outline the research you are conducting or have conducted?

Content Analysis: Research areas being undertaken include: methods of evaluation, clinical reasoning, development of simulation for enrolled nurses and post-graduate acute care, large group simulations, transfer of learning to the clinical setting, impact of simulation on detection of deteriorating patient, video assessment use of Second Life as a virtual environment, staff development needs.

Section I - Use of Information and Communication Technologies (ICT) in clinical laboratories

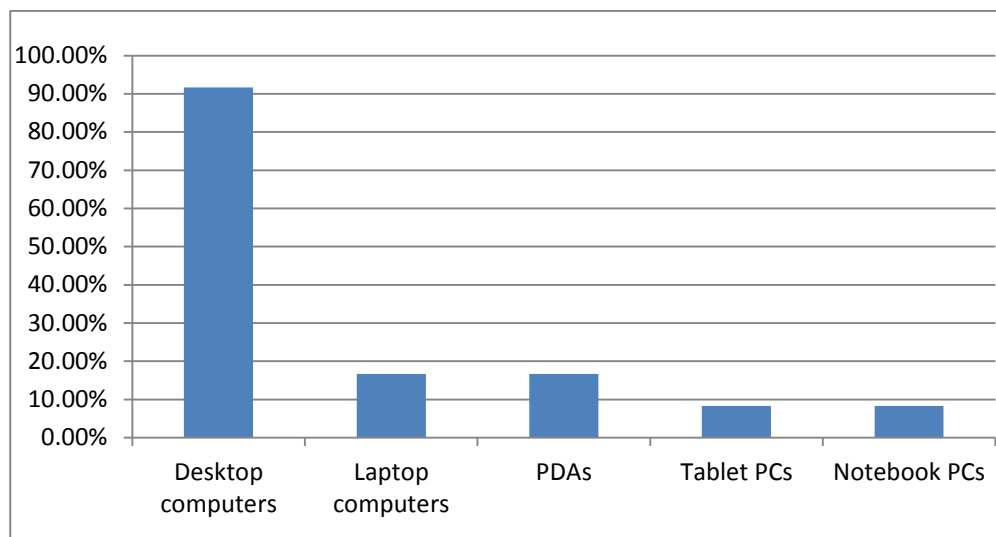
This section will explore the range of ICT used in clinical laboratories and the integration of ICT into simulation activities.

86. Is any form of ICT available for your students' use in clinical laboratories?



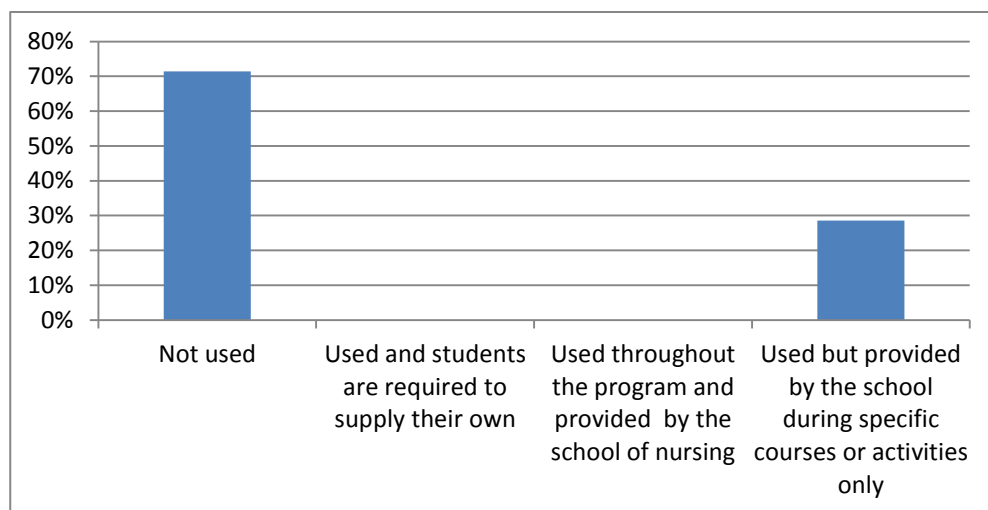
87. Which of the following are supplied for students' use in clinical laboratories? Please select all applicable responses

N=12



88. In relation to PDAs are they

N=7

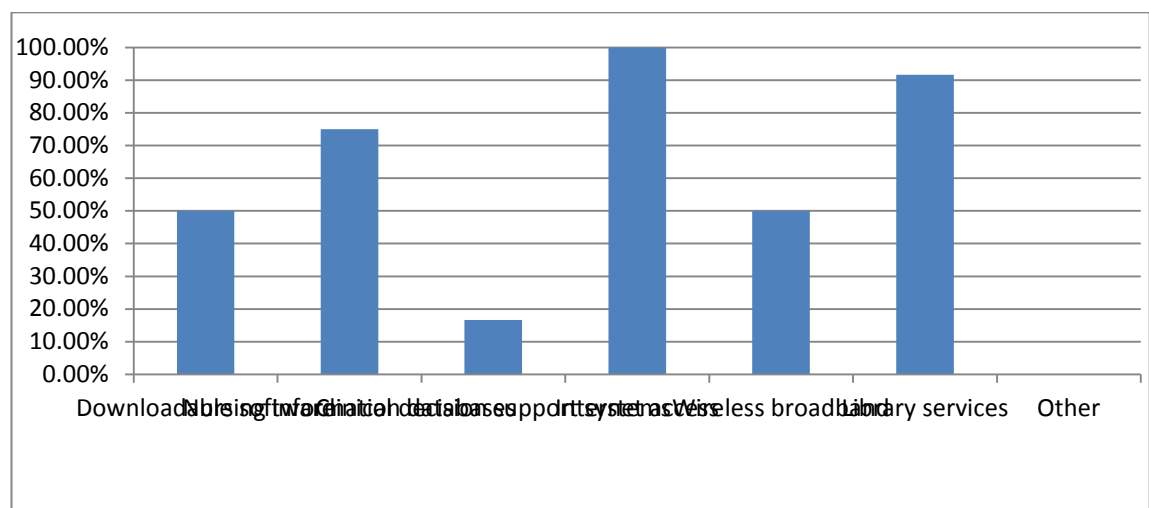


89. Comments on the use of ICT in clinical laboratories, including technologies currently being trialled

Content Analysis: Participants discussed the construction of new simulation laboratories, development of a clinical skills webpage, use of tablet devices and software packages such as Pharmacology and virtual hospital environments.

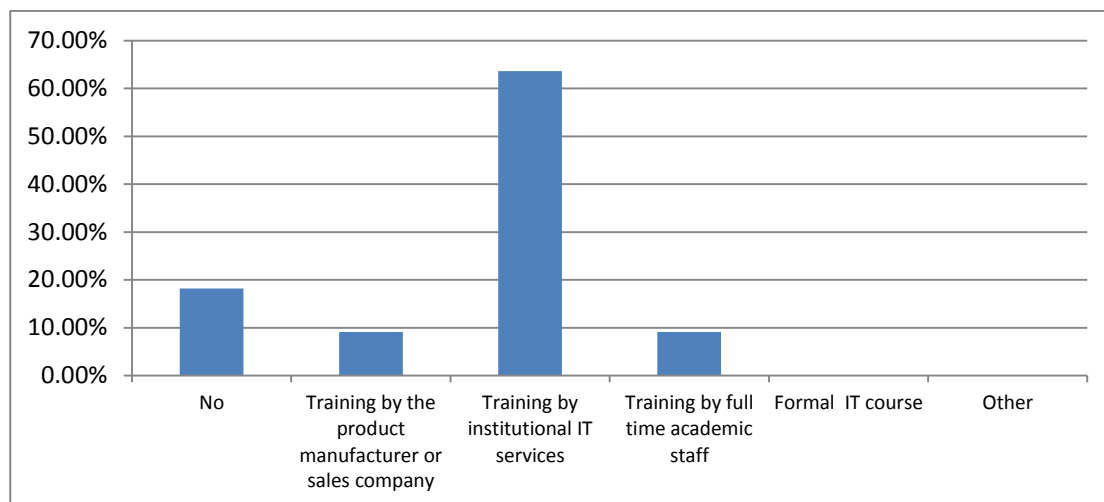
90. What systems are available for student use with ICT hardware use? Please select all applicable responses.

N=12



91. Have laboratory teaching and technical staff received any training in the use of the ICT systems provided?

N=11

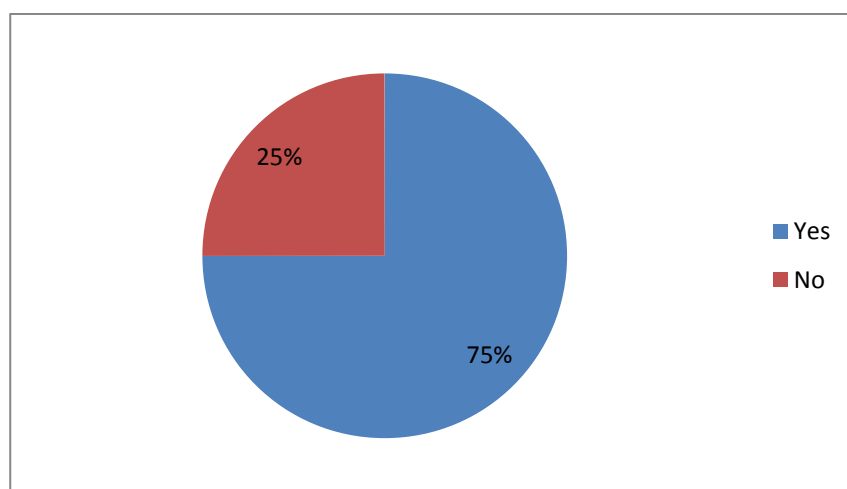


Comments on the adequacy of training of staff in use of ICT

Content Analysis: Some stated more development needed including computer literacy.

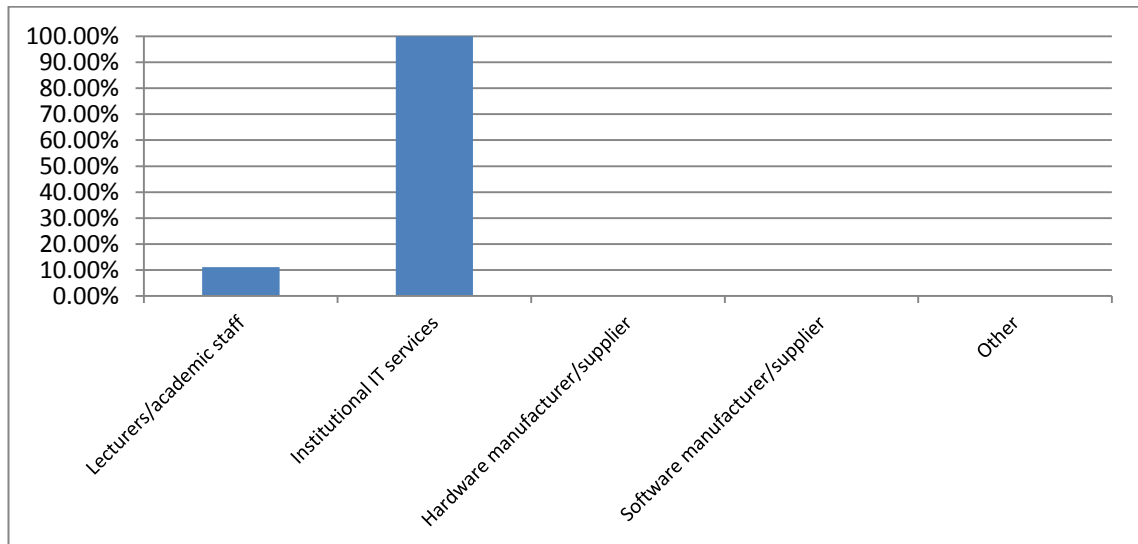
92. Is ICT technical support available to teachers and students during clinical laboratories?

N=12



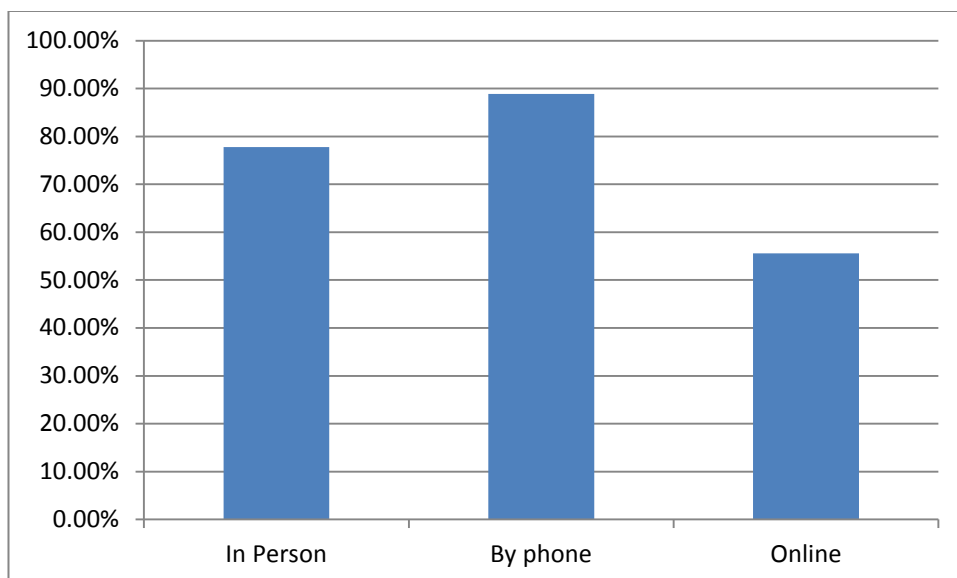
93. Who is this support provided by? Please select all appropriate responses.

N=9



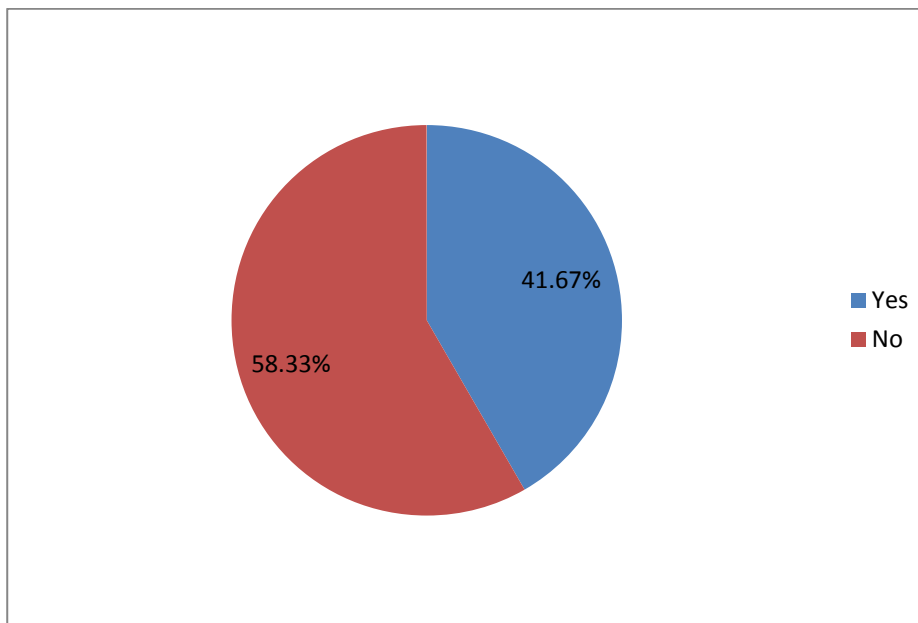
94. In what form is ICT technical support available? Please select all appropriate responses.

N=9



Due to an error in recording the response for this question we were unable to distinguish between business hours and after hours responses, so I have combined them.

95. Is ICT used in conjunction with simulation activities?



96. Please briefly outline how ICT is incorporated into simulation sessions.

Content Analysis: Access to laboratory results and other data, projected images of clinical setting, online scenarios and discussion board.

97. If you consider that you use ICT in an effective or innovative way in your undergraduate program would you please share an example with us?

Content Analysis: No useful data.

Section J- Factors influencing the use of medium and high fidelity HPS manikins and ICT

98. Please complete the following table. Please check all that are applicable.

	Facilitators	Constraints	Not applicable
98.01 Large students numbers	5%	80%	15%
98.02 Multiple campus sites	5%	55%	40%
98.03 Level of staff enthusiasm	60%	35%	5%
98.04 Level of student enthusiasm	85%	10%	5%
98.05 Level of teaching staff training in simulation and ICT	10%	90%	0%
98.06 Adequate staff numbers for conducting simulation sessions	15%	80%	5%
98.07 Level of technical support	30%	65%	5%
98.08 Use of designated staff for simulation/ICT development and implementation	20%	70%	10%
98.09 Sufficient time for development and implementation in academic workload	15%	85%	0%
98.10 Availability of a model or framework for implementation	35%	50%	15%
98.11 Sufficient number of functional HPS manikins	35%	60%	5%
98.12 Sufficient functional high fidelity HPS manikins	15%	60%	25%
98.13 Sufficient functional audiovisual equipment	40%	60%	0%
98.14 Sufficient functional ICT equipment	25%	65%	10%
98.15 Adequacy of other equipment to support fidelity (realism)	40%	50%	10%
98.16 Adequacy of laboratory space	60%	35%	5%
98.17 Availability of pre programmed scenarios	35%	45%	20%
98.18 Multidisciplinary collaboration	30%	45%	25%
98.19 Sharing resources with other institutions	15%	35%	50%

Appendix VII – Delphi Information Statement

Delphi Study Information Statement for the Research Project:

Human patient simulation manikins and information and communication technology:
Use and quality indicators in Australian schools of nursing

Document Version 3; dated 30/11/09



Researchers:	
Dr Ashley Kable (Principal Supervisor) Deputy Head of School (Research) School of Nursing and Midwifery, The University of Newcastle Tel: (02) 4921 6599 Ashley.Kable@newcastle.edu.au	Carol Arthur (Master Philosophy [Nursing] candidate) School of Nursing and Midwifery, The University of Newcastle Tel: (02) 4921 6339 Carol.Arthur@newcastle.edu.au
Associate Professor Tracy Levett-Jones (Co-Supervisor) Deputy Head of School (Teaching and Learning) School of Nursing and Midwifery, The University of Newcastle Tel: (02) 4921 6599 Tracy.Levett-Jones@newcastle.edu.au	

You are invited to participate in the second section of the research project identified above which is part of an Australian Learning and Teaching Council (ALTC) project led by Associate Professor Tracy Levett-Jones and Dr Kerry Hoffman. The component of the project referred to in this information statement is being undertaken by Carol

Arthur as part of her Masters project at the School of Nursing and Midwifery, University of Newcastle. The supervisors for this Masters project are Dr Ashley Kable and Associate Professor Tracy Levett-Jones.

Why is the research being done?

The aims of the Delphi study are:

9. To identify the principles and practices related to the use of HPS and ICT that are indicative of quality learning and teaching approaches, and
10. Through expert consensus develop a set of quality indicators of HPS and ICT use.

Who can participate in the research?

We are recruiting health professionals from Australia and internationally who have expertise in the use of HPS and/or ICT as an expert panel for the Delphi study

This expertise will have been demonstrated by professional standing and reputation, publications, professional presentations, or by detailed answers to the Australian survey which has been an initial stage of this research project.

Experts participating in the Delphi study may be academics or staff involved in the use of HPS and/or ICT within a school of nursing or affiliated simulation centre.

What choice do you have?

Participation in this research is entirely your choice. Only those people who consent to participate will be included in the project. Whether or not you decide to participate, your decision will not disadvantage you. Proceeding to complete the questionnaire will be regarded as consent.

If you do decide to participate, you may withdraw from the project at any time without giving a reason and you have the option of withdrawing any data which identifies you.

What would you be asked to do?

A Delphi study uses a panel of experts to reach consensus regarding the topic of study. The Delphi study will consist of three rounds of web based questionnaires. Participants

are asked to rank items on the questionnaire and to add further quality indicators or comments if they wish. Between each round of the Delphi participants will be given a summary of results from the previous round.

How much time will it take?

It is estimated that the questionnaires will take approximately 15-30 minutes to complete.

What are the risks and benefits of participating?

There are no direct benefits to individuals or schools from this research. However, the information from this study will be of interest to the nursing profession and higher education in Australia and internationally.

How will your privacy be protected?

Numerical codes will be assigned to all participants and used when analysing your responses. Participants will not be identified in data analysis or results. Data will be kept on a password protected computer, and hardcopy documents will be kept in locked storage. Data will be accessible by the researcher only and will be destroyed after five years.

How will the information collected be used?

The results of the Delphi study, and also the larger project within which it is embedded, will be published on the project web site. The results will also form the basis of papers submitted for publication in scholarly journals and at professional conferences. The Delphi study will also form part of a thesis to be submitted for Carol Arthur's Master of Philosophy (Nursing) degree.

It is planned that the final outcome of this project will be the development of a set of quality indicators for the use of HPS manikins and ICT with illustrative exemplars, which will be available on the project web site.

What do you need to do to participate?

Please read this Information Statement and be sure you understand its contents before commencing the questionnaire. If there is anything you do not understand, or you have questions, contact one of the researchers. Proceeding to the questionnaire will be regarded as consent to participate.

If you would like to participate, please follow the link provided to the initial and subsequent questionnaires via the “Delphi study” button.

Further information

If you would like further information please contact:

Ms Carol Arthur carol.arthur@newcastle.edu.au.

Dr Ashley Kable Ashley.Kable@newcastle.edu.au

Associate Professor Tracy Levett-Jones Tracy.Levett-Jones@newcastle.edu.au

Thank you for considering this invitation.

Associate Professor Tracy Levett-Jones

RN, PhD, MEd and Work, BN, DipAppSc (Nursing)

Dr Ashley Kable

RN, Dip Teach Nurs ED, Grad Dip Health Serv MAN, PhD MRCNA

Ms Carol Arthur

BN, Dip App Sc (Nursing) RN, ICU/CCU Cert, Master Philosophy (Nursing) candidate

Complaints about this research

This project has been approved by the University's Human Research Ethics Committee, Approval No. H-2009-0016. Should you have concerns about your rights as a participant in this research, or you have a complaint about the manner in which the research is conducted, it may be given to the researcher, or, if an independent person is preferred, to the Human Research Ethics Officer, Research Office, The Chancellery, The University of Newcastle, University Drive, Callaghan NSW 2308, Australia, telephone (02) 49216333, email Human-Ethics@newcastle.edu.au.

Researchers:	
Dr Ashley Kable (Principal Supervisor) Deputy Head of School (Research) School of Nursing and Midwifery, The University of Newcastle Tel: (02) 4921 6599 Ashley.Kable@newcastle.edu.au	Carol Arthur (Master Philosophy [Nursing]candidate) School of Nursing and Midwifery, The University of Newcastle Tel: (02) 4921 6339 Carol.Arthur@newcastle.edu.au
Associate Professor Tracy Levett-Jones (Co-Supervisor) Deputy Head of School (Teaching and Learning) School of Nursing and Midwifery, The University of Newcastle Tel: (02) 4921 6599 Tracy.Levett-Jones@newcastle.edu.au	

I agree to participate in the above research project (Delphi study component) and give my consent freely.

I understand that the project will be conducted as described in the Delphi Information Statement, a copy of which I have retained.

I understand I can withdraw from the project at any time and do not have to give any reason for withdrawing.

I consent to:

Completing three rounds of questionnaires, including reviewing feedback sent between the rounds

- Yes
- No

I understand that my personal information will remain confidential to the researchers. I also understand that the name of the institution I represent will be confidential. I have had the opportunity to have questions answered to my satisfaction.

Please click the “Return” button to return this electronic consent form to the researcher before proceeding to the first Delphi questionnaire.

Appendix VIII – Delphi Questionnaire – Round 1

The aim of the study:

The aim of this study is to identify quality indicators for the use of human patient simulation manikins (HPSM) and information communication technologies (ICT) in undergraduate nursing education.

Research question:

What are the quality indicators for the use of HPSM and ICT in undergraduate nursing education?

Definition of terms:

For the purpose of this study the following definitions have been used.

Simulation is an attempt to replicate, to varying degrees, a clinical situation, in order to teach or assess nursing skills and knowledge.

Fidelity refers to the degree of realism achieved by the simulation.

Various definitions of the fidelity of manikins exist. In this study the following terms are used:

Low fidelity HPS manikins include simple task trainers such as IV arms and resuscitation torsos, and anatomically correct full body static manikins that replicate the external anatomy and joint movement of humans, but have no interactive capacity.

Medium fidelity HPS manikins are full body manikins that have embedded software that is controlled by an external, hand held device. They have the capacity to have set breath sounds, heart sounds, pulse and blood pressure, and are also capable of coughing, moaning or basic verbal communication. An example is Laerdal's Nursing AnneTM with VitalSim capability.

High fidelity HPS manikins are more realistic and have embedded software that can be remotely controlled by computer to allow for individualised, programmed scenarios, real-time interactions and cue response. They allow the operator to set physiological parameters and respond to students' interventions with changes in voice, heart rate, blood pressure and other physiological signs. Examples include Laerdal SimMan™ and METI™ manikins.

Information and Communication Technology (ICT) allows for the transfer and retrieval of information in electronic form. Examples include personal digital assistant (PDA), tablet PCs, and desk top and lap top computers.

Study design:

A modified Delphi approach has been used for this study. Items in this first round questionnaire have been identified from the literature and from a survey of current use of HPSM and ICT in Australian schools of nursing. Data from the first round of the questionnaire will be analysed and form the basis of second and third rounds.

Questionnaire instructions:

Items are divided into sections. Please rate each item according to the scale below, to indicate its value for optimising quality use of HPS manikins and ICT in undergraduate nursing education.

- 1. Not recommended**
- 2. Limited value**
- 3. Undecided**
- 4. Recommended**
- 5. Critical element**
- 6. Don't know (Please select the "Don't know" category if you do not feel you have sufficient expertise in any area to answer particular questions.)**

Even if an item may seem similar to another item please answer all questions. It should not be necessary to spend a lot of on any one question.

At the end of each section there is space for you to add comments. Please add any other items not mentioned that you believe to be important indicators of quality HPSM and ICT use, also any comments you would like to make.

The questionnaires are anonymous, and you will not be identified in data analysis or results.

Comment

Comments

Section 3: Information and communication technology (ICT) resources	1	2	3	4	5	6
Laboratory internet connection points						
Wireless internet connection						
Desktop computers						
Laptop computers						
Notebook or tablet computers						
Any types of computers						
Personal digital assistants (PDAs)						
Pharmacology software (eg Australian Medicines Handbooks or MIMS online)						
Access to online pathology results						
Access to radiology results						
Nursing information software such as electronic books or CD ROMs						
Clinical decision support or algorithm software						
Library and data base access						
Comments						

Section 4: Staffing resources and training	1	2	3	4	5	6
A staff member specifically employed to design simulation activities						
A staff member specifically employed to implement simulation activities						
The capacity for all academic staff to design simulation activities						
The capacity for all academic staff to implement simulation activities						
Involvement of selected academic staff to design simulation activities						
Involvement of selected academic staff to implement simulation activities						
Availability of adequate training for all simulation staff						
A staff member with ICT expertise specifically employed to support simulation activities						
Availability of staff to set up, dismantle and maintain simulation equipment						
Comments						
Section 5: Teaching and learning approaches	1	2	3	4	5	6

Preparation:						
Ensuring that students are provided with opportunities to acquire the relevant theoretical knowledge prior to the simulation activities						
Ensuring that students are provided with opportunities to develop the relevant clinical skills prior to the simulation activities						
Structured orientation of the students to the simulation unit, features of the manikin and simulation procedures prior to the simulation						
Provision of written handover material and charts						
Provision of audio-taped handover						
Appropriate number of students per manikin = 1						
Appropriate number of students per manikin = 2						
Appropriate number of students per manikin = 3						
Appropriate number of students per manikin = 4						
Appropriate number of students per manikin > 4						
Comments						

Conducting simulation sessions	1	2	3	4	5	6
Having clear learning objectives to guide the design of the simulation						
Providing students with a list of learning objectives prior to the simulation						
Asking students to set their own learning objectives						
Keeping learning unstructured, depending on how the scenario unfolds						
Having observers as well as active participants in the simulation unit						
Having observers viewing and critiquing the simulation from another room or via video linkage						
Having specific roles for observers such as critiquing a particular participant, or marking off a list of actions taken						
Having staff members in the room with the students during the simulation to provide support and advice						
Having a "fully immersive" simulation in which the participants have to react to the scenario in real time without staff support						
Having the option for students to call "time out" if they need support						
Staff to use "pause and discuss" technique to stop the scenario when they judge guidance is needed						

	1	2	3	4	5	6
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Varying the level of immersion depending on students' level of experience						
Manikin parameters linked and pre programmed explicitly to scenarios requiring students to engage in clinical reasoning, clinical decision making or clinical judgement						
Additional cues or changes to parameters added into the scenario by the facilitators ("on the fly" technique) in response to student's actions						
Encouraging students to verbalise their thinking processes during the simulation						
Encouraging students to use ICT to access information during simulations						
Comments						

Debriefing	1	2	3	4	5	6
Having debriefing immediately following the simulation						
Having debriefing at a later time						
Using video of the simulation during the debriefing for students to review their performance						
Involving observers as well as participants in the debriefing						
Using the list of objectives to evaluate the student's performance during debriefing						
Using reflection on practice as the main debriefing strategy						
Using best practice guidelines to critique participant performance						
Using a clinical reasoning, clinical decision making or clinical judgement framework to critique participant performance						
Using a structured debriefing process such as the GAS (gather, analyse, summarise) process						
Encouraging students to retrospectively and consciously 'talk aloud' as they reflect on their thinking processes during the simulation						
Staff explaining to students where they made errors during the simulation						
Staff providing constructive feedback and suggestions for future practice						
Encouraging students to identify their own strengths and weaknesses during the simulation						
Encouraging student participants to give feedback on the simulation experience						
Requiring the completion of follow up activities such as written reflection on practice.						
Comments						

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Assessment using simulation	1	2	3	4	5	6
Using simulation as a formative assessment strategy						
Using simulation as a summative assessment strategy						
Using simulation as a remediation strategy						
Using simulation as a high stakes assessment strategy						
Using simulation as a capstone (final) assessment strategy						
Using competency statements such as the Australian Nurses and Midwives Council (ANMC) competency statements as assessment criteria						
Using a structured observation technique such as SOAP to assess performance						
Using skill checklists to assess performance						
Testing related knowledge on completion of the simulation						
Evaluating the effectiveness of the simulation using specific evaluation instruments such as student satisfaction or confidence scores.						
Comments						

Section 6: Curriculum integration and pedagogical principles	1	2	3	4	5	6
The use of appropriate educational theories, or models as a theoretical basis for simulation activities						
Use of a behaviourist pedagogical approach for the simulation						
Use of a constructivist pedagogical approach for the simulation						
Use of both behaviourist and constructivist approaches as indicated by learning objectives						
Use of a specific model or framework to structure simulation activities						
The use of a clear matrix mapping objectives of courses/subjects with appropriate learning strategies						
The use of a clear matrix mapping objectives of courses/subjects with the use of appropriate simulation activities						
Involvement of students in simulation planning within the curriculum						
	1	2	3	4	5	6

Appendix IX – Analysis of round 1 Delphi results

Section 1 and 2 - Physical resources	Median	Mean
Critical requirements		
Manikins chosen on the basis of learning objectives.	5	4.6
Up to date hospital equipment for providing fidelity	5	4.6
Use of audio equipment to allow the manikin to talk and respond to questions.	5	4.2
Recommended resources		
Purpose built simulation laboratory with video and audio equipment.	4	4.1
Equipment, props, moulage, additional actors and a telephone.	4	4-4.2
Medium or high fidelity simulation manikins for the development of clinical reasoning.	4	4.1
Additional recommendations and comments		
Video review capacity is important for debriefing.		
Equipment and charts should be matched to the local hospital environment to provide further realism.		
Realism of the environment is key to fidelity of the simulation experience – “Can have realism without technology”.		
High fidelity manikins are beneficial for the development of clinical reasoning.		
High fidelity manikins are often not needed for beginning level students.		
Resources not recommended		
The use of a voice modulator	3	3.1
Use of high fidelity manikins for all simulation activities.	3	2.5
Section 3. ICT equipment		
Critical requirement - no critical requirements identified		
Recommended resources		
There should be some type of computer available in laboratories, and wireless internet connection.	4	4.1
The use of software such as pharmacology resources, and to a lesser extent textbook CD ROMs, library data bases and clinical decision support systems were all recommended.	4	4.1-3.6
Additional recommendations and comments		
Portability, buying only software with demonstrated effectiveness, and use of equipment and software that is used in the local clinical environment were recommendations.		
Whatever ICT equipment is chosen, its use needs to relate to curriculum objectives and be integrated into courses throughout the program.		
Resources not recommended		

Use of PDAs as a hardware choice.	3	3.2
Section 4. Staffing		
Critical staffing requirements		
Staffing with designated academic staff selected to implement simulation activities.	5	4.4
Availability of staff to set up, dismantle and maintain equipment.	5	4.6
Adequate staff training.	5	4.8
Recommended staffing		
Involvement of selected academic staff in simulation design.	4	4.3
A staff member with ICT expertise specifically employed to support simulation.	4	4.3
A staff member employed specifically to implement simulation activities.	4	4
Staffing policies not recommended		
Creating the capacity for all academic staff to design simulation activities..	2	2.7
Creating the capacity of all academic to implement simulation activities.	3	2.9
Section 5. Teaching and learning approaches		
Critical approaches		
Having clear learning objectives to guide the design of simulation activities.	5	4.8
Having a structured orientation to the simulation unit and manikin.	5	4.7
Debriefing immediately following the simulation.	5	4.7
Encouraging students to give feedback on their perception of the simulation experience.	5	4.4
Recommended approaches		
Students should be prepared for simulation by: being familiar with the learning objectives, having requisite and relevant theoretical knowledge and clinical skills, and being provided with written handover material and charts.	4	4.2-4.4
If observers included they should view via video link.	4	3.4
The level of immersion should vary depending on the students' level of experience.	4	4.2
Having fully immersive simulations in which students have to react in real time.	4	3.6
Adjusting cues to meet the changes throughout the scenario ("on the fly" technique).	4	4.1
Debriefing techniques including: measuring performance against objectives, encouraging student reflection and self identification of strengths and weaknesses, using a clinical decision making framework to critique performance, and staff providing constructive feedback.	4	4.1
Debriefing techniques including: use of video replay, involving observers in the debriefing, using best practice guidelines to critique students' performance, using a structured debriefing method such as GAS (gather, analyse, summarise) using "talk aloud" techniques, and requiring written reflection following simulation.	4	3.6-3.9
Use of simulation for formative assessment.	4	4
Additional recommendations and comments		

Size of the group of students participating in the simulation should be influenced by the complexity of the activity and the learning objectives.		
The level of immersion should vary depending on the learning objectives of the simulation.		
Having a staff member in the room during simulation impairs fidelity.		
Interrupting the scenario (as in 'pause and discuss') also reduces fidelity.		
Debriefing should include: the use of video replay or file log of actions taken, inclusion of observers' comments, and discussion of the effectiveness of non-technical skills such as communication and teamwork.		
For any high stakes assessment using simulation it is important to ensure student familiarity with the manikin, well constructed scenarios, skilful simulation staff and a validated assessment tool.		
Teaching approaches not recommended		
Having one student alone or more than four in a simulation group.	1-2	1.7-1.9
Having a staff member in the room to support students during the simulation.	3	3.1
Having student observers in the room.	3.5	3.2
Asking students to set their own objectives.	2.5	2.8
Keeping learning unstructured depending on how the scenario unfolds.	2.5	2.5
Using "time out" or "pause and discuss" techniques	3.5	3-3.3
Having debriefing at a later time following the simulation.	1	1.6
Encouraging students to access information using ICT during simulations.	3	3.5
Using simulation for summative or capstone assessment.	3	3.1
The use of simulation for high stakes assessment.	3	2.7
Section 6. Curriculum integration and pedagogical principles		
Critical principles		
Structuring of the curriculum to increase the level of simulation immersion and complexity throughout the program.	5	4.6
Using simulation to teach non- technical skills such as clinical reasoning, communication and teamwork.	5	4.7
Recommended principles		
The use of an appropriate educational theory or model as a basis of simulation activities.	4	4.5
Use of a specific model or framework to structure activities.	4	4.1
Using both behavioural and constructivist approaches to simulation design based on the learning objectives.	4	4.1
Using a constructivist approach to simulation design	4	3.7
Matrix mapping of objectives and simulation activities within the curriculum.	4	4.4
Using simulation for a wide range of learning objectives.	4	4.2
Using simulation to teach and assess technical skills.	4	3.7
Simulation integration throughout all years of the program, across all clinically based courses.	4	4.4
Including non-nursing members of the multidisciplinary team in simulations.	4	4.4
Training students in point of care ICT technology from the first year of the program.	4	4.1

Integrating ICT into clinical laboratories and simulation activities.	4	3.9
Include point of care technology in all simulation activities.	4	3.8
Comments on recommended principles		
Curriculum development as the starting point for the integration of simulation activities, with other aspects such as selection of equipment and staffing based on curriculum needs.		
The need to include holistic care principles, therapeutic communication with the patient, intra and interdisciplinary communication and patient and family education in all simulation activities.		
The importance of "scaffolding" the curriculum to teach cognitive skills and clinical reasoning early in the program as a basis for simulation activities.		
The use of HPSM to teach basic technical and psychomotor skills has limited value		
Application of principles not recommended		
Using a behaviourist approach to simulation design.	3	3.5
Involving students in curriculum and simulation planning.	3	3
Only conducting simulations in the final year of the undergraduate program	1	1.4
Using simulation in some courses only.	1	1.8

Appendix X – Feedback to Participants following Round 1

Summary of the key issues from the Delphi survey – Round 1

Thank you very much to all those who participated in the first round of the Delphi study on Quality Indicators for the use of human patient simulation manikins (HPSM) and information and communication technology (ICT) in undergraduate nursing education. Below is a summary of the results from the first round of the Delphi study.

We are sending these results to you so that you will have an opportunity to consider the diversity of opinions expressed and reflect on your own responses prior to undertaking the second round questionnaire.

I have identified below a number of recurring issues and summary points from the statistical analysis of the various sections.

I will be sending the second round questionnaire soon, which will aim to clarify some of the identified quality indicators.

Research question:

What are the quality indicators for the use of HPSM and ICT in undergraduate nursing education?

Summary of findings

1. The importance of considering the **learning objectives** and **students' year of enrolment** as a guide to simulation design and process were key considerations in relation to choice of
 - manikin fidelity,
 - group sizes,
 - inclusion of observers,

- level of immersion.

Learning objectives were considered by many participants to be the main factor in choice of both simulation technology and simulation process.

2. **Staffing** was viewed by most participants as a critical element in the effectiveness of simulation. There was strong support for the involvement of selected academic staff to implement simulation activities, the employment of support staff for the care of equipment, and adequate staff training.
3. Having a **structured orientation prior to and debriefing immediately following** the simulation session was identified as critical by most participants.
4. **Integration of simulation and ICT throughout the curriculum** by “scaffolding” was a key issue identified. Ensuring an appropriate knowledge base, adequate clinical and ICT skills and clinical reasoning ability were seen as important aspects of effective simulation design.
5. **Increasing complexity and level of immersion** throughout the curriculum were also seen as critical elements.
6. The use of simulation to teach **non-technical skills** such as clinical reasoning, communication and teamwork was viewed as a critical component. The fact that simulations should take a **holistic approach** was raised in participants’ comments, including psychosocial aspects of patient care, and the teaching of non-technical skills such as communication with patient, family and the multidisciplinary team, and patient education.
7. There was a lack of clarity in the findings in relation to the use of **ICT** in clinical laboratories, and in conjunction with simulation activities

Findings related to each section of the survey

Note that both mean and median scores have been considered in this analysis of participants’ responses to best reflect the overall spread of opinion.

Section 1 and 2 - Physical resources

Critical requirements

- There was a strong recommendation that the manikins should be chosen on the basis of learning objectives, and some felt that high fidelity manikins were often not needed for beginning level students.
- Up to date hospital equipment was rated highly for providing fidelity
- Use of audio equipment to allow the manikin to talk and respond to questions was identified as the most important technical aspect of high fidelity simulation.

Recommended resources

- Purpose built simulation laboratory with video and audio equipment recommended for high fidelity simulations.
- Equipment, props, moulage, additional actors and a telephone were recommended for achieving fidelity.
- Medium fidelity simulation manikins may be adequate for some scenarios, and were viewed by many as suitable for the development of clinical reasoning.

Additional recommendations and comments

- Some participants commented that video review capacity is an important aspect of debriefing.
- It was suggested that ideally equipment and charts should be matched to the local hospital environment to provide further realism.
- Realism of the environment was stated as key to fidelity of the simulation experience – “Can have realism without technology”
- Some participants felt that high fidelity manikins are beneficial for the development of clinical reasoning.

Resources not recommended

- The use of a voice modulator was considered to be less important
- Use of high fidelity manikins for all simulation activities was not recommended by most participants.

Section 3. ICT equipment

Critical requirement

- Participants were less clear about recommendations for ICT equipment in clinical laboratories.
- There were no ICT resources identified as a critical requirement for clinical nursing laboratories/simulation laboratories

Recommended resources

- There was a recommendation that there should be some type of computer available in laboratories, and wireless internet connection.
- The use of software such as pharmacology resources, and to a lesser extent textbook CD ROMs, library data bases and clinical decision support systems were all recommended.

Additional recommendations and comments

- Participants' additional comments recommended portability, buying only software with demonstrated effectiveness, and use of equipment and software that matches that found in the local clinical environment.
- It was also suggested that whatever ICT equipment was chosen, its use needed to relate to curriculum objectives and be integrated into courses throughout the program.

Resources not recommended

- Use of PDAs as a hardware choice was not strongly supported.

Section 4. Staffing

Critical staffing requirements

- Staffing was identified as critical with designated academic staff selected to implement simulation activities.
- Availability of staff to set up, dismantle and maintain equipment was viewed as critical.
- Adequate staff training was viewed as critical.

Recommended staffing

- A staff member with ICT expertise specifically employed to support simulation was recommended by many participants.
- A staff member employed specifically to design and implement simulation activities was recommended by some participants

Staffing policies not recommended

- The involvement of all academic staff in simulation activities and design was not recommended by participants.
- Creating the capacity of all academic staff to implement, and more particularly to design simulation activities was not recommended.

Section 5. Teaching and learning approaches

Critical approaches

- Having clear learning objectives to guide the design of simulation activities was viewed as a critical element.
- Having a structured orientation to the simulation unit and manikin was also viewed as a critical element by many.
- Debriefing immediately following the simulation was seen as crucial.

- Encouraging students to give feedback on their perception of the simulation experience was also seen as crucial by many.

Recommended approaches

- It was recommended that students should be prepared for simulation by: being familiar with the learning objectives, having requisite and relevant theoretical knowledge and clinical skills, and being provided with written handover material and charts.
- No clear consensus was found for the value of having observers or their roles. If observers included there was a preference for observers to view via video link rather than be in the room at the time of the simulation and to have specific roles or activities to perform.
- Most participants recommended varying the level of immersion depending on the year of the students' enrolment.
- There was no clear consensus regarding using fully immersive simulation, pause and discuss or time out strategies, but there was a slight preference for fully immersive simulation.
- Most recommended adjusting cues to meet the changes throughout the scenario ("on the fly" technique).
- Debriefing techniques most recommended included measuring performance against objectives, encouraging student reflection and self-identification of strengths and weaknesses, using a clinical decision making framework to critique performance, and staff providing constructive feedback.
- Use of video replay, involving observers in the debriefing, using best practice guidelines to critique students' performance, using a structured debriefing method such as GAS (gather, analyse, summarise) using "talk aloud" techniques, and requiring written reflection following simulation were less strongly recommended.
- Participants overall preferred simulation for formative rather than summative assessment.

Additional recommendations and comments

- Comments indicated that the size of the group of students participating in the simulation should be influenced by the complexity of activity to be carried out and the learning objectives.
- Many participants commented that the level of immersion should also vary depending on the learning objectives of the simulation
- Some participants felt that having a staff member in the room during simulation impaired fidelity.
- Some felt that interrupting the scenario (as in 'pause and discuss') also reduced fidelity.
- Additional comments regarding debriefing included the use of video replay or file log of actions taken, inclusion of observers' comments, and discussion of the effectiveness of non-technical skills such as communication and teamwork.
- For any high stakes assessment using simulation the importance of student familiarity with the manikin, well-constructed scenarios, skilful simulation staff and validated assessment tool were mentioned in participants' comments.

Teaching approaches not recommended

- No clear consensus was found for ideal group numbers, but one student alone or more than four was not recommended.
- There was no consensus regarding having a staff member in the room to support students
- Asking students to set their own objectives was not recommended
- Keeping learning unstructured depending on how the scenario unfolded was not recommended.
- Having debriefing at a later time following the simulation was not recommended.

- Encouraging students to access information using ICT during simulations was not strongly supported.
- There was no consensus regarding simulation for remediation or capstone assessment, and its use as a high stakes assessment was not recommended.

Section 6. Curriculum integration and pedagogical principles

Critical principles

- Structuring of the curriculum to increase the level of simulation immersion and complexity throughout the program was seen as critical by many.
- Using simulation to teach non- technical skills such as clinical reasoning, communication, teamwork, and holistic care was also identified as a critical element by many.

Recommended principles

- The use of an appropriate educational theory or model as a basis of simulation activities was recommended.
- Use of a specific model or framework to structure activities was also recommended
- Both behavioural and constructivist approaches were recommended based on the learning objectives; there was a preference for a constructivist approach.
- Matrix mapping of objectives and simulation activities within the curriculum was recommended.
- Using simulation to teach and assess technical skills was supported, but not as strongly as for non-technical skills.
- Simulation integration was recommended for use throughout all years of the program, across all clinically based courses, and to address a wide range of learning objectives
- Including non-nursing members of the multidisciplinary team in simulations was recommended.

- Training students in point of care ICT technology from first year was recommended
- Integrating ICT into clinical laboratories and simulation activities was supported, but not strongly.
- Consensus was not reached on the need to include point of care technology in all simulation activities although it was recommended by many participants.

Comments on recommended principles

- Comments recommended curriculum development as a starting point for the integration of simulation activities, with other aspects such as selection of equipment and staffing based on curriculum needs.
- Comments recommended the need to include holistic care principles, therapeutic communication with the patient, intra and interdisciplinary communication and patient and family education in all simulation activities.
- The importance of “scaffolding” the curriculum to teach cognitive skills and clinical reasoning early in the program was recommended as a basis for simulation activities.
- The use of HPSM to teach basic technical and psychomotor skills was commented to have limited value

Application of principles not recommended

- It was not recommended to involve students in curriculum and simulation planning.
- It was not recommended to only conduct simulations in the final year of the undergraduate program
- It was not recommended to use simulation in some courses only.

Appendix XI – Delphi Questionnaire Round 2

Delphi Questionnaire - Round 2

The aim of the study:

The aim of this study is to identify quality indicators for the use of human patient simulation manikins (HPSM) and information communication technologies (ICT) in undergraduate nursing education.

Definition of terms:

For the purpose of this study the following definitions have been used.

Simulation is an attempt to replicate, to varying degrees, a clinical situation, in order to teach or assess nursing skills and knowledge.

Fidelity refers to the degree of realism achieved by the simulation.

Various definitions of the fidelity of manikins exist. In this study the following terms are used:

Low fidelity HPS manikins include simple task trainers such as IV arms and resuscitation torsos, and anatomically correct full body static manikins that replicate the external anatomy and joint movement of humans, but have no interactive capacity.

Medium fidelity HPS manikins are full body manikins that have embedded software that is controlled by an external, hand held device. They have the capacity to have set breath sounds, heart sounds, pulse and blood pressure, and are also capable of coughing, moaning or basic verbal communication. An example is Laerdal's Nursing AnneTM with VitalSimTM capability.

High fidelity HPS manikins are more realistic and have embedded software that can be remotely controlled by computer to allow for individualised, programmed scenarios, real-time interactions and cue response. They allow the operator to set physiological parameters and respond to students' interventions with changes in voice, heart rate,

blood pressure and other physiological signs. Examples include Laerdal SimMan™ and METI™ manikins.

Information and Communication Technology (ICT) allows for the transfer and retrieval of information in electronic form. Examples include personal digital assistant (PDA), tablet PCs, and desk top and lap top computers.

Study design:

A modified Delphi approach has been used for this study. Items in the first round questionnaire were identified from the literature and from a cross sectional survey of Australian schools of nursing. Data from the first round of the questionnaire were analysed and forms the basis of the second round. Questions in this round aim to confirm or eliminate quality indicators from the first round, and further clarify points raised.

Questionnaire instructions:

Items are divided into sections. Please rate each item according to the scale below, to indicate whether you agree or disagree with the statement.

1. Strongly disagree

2. Disagree

3. Undecided

4. Agree

5. Strongly agree

0. Don't know (Please select the "Don't know" category if you do not feel you have sufficient expertise to answer particular questions.)

Even if an item may seem similar to another item please answer all questions. It should not be necessary to spend a lot of time on any one question.

At the end of each section there is space for you to add comments and any other items not mentioned that you believe are important indicators of quality HPSM and ICT use.

The questionnaires are anonymous, and you will not be identified in data analysis or results unless specific permission has been sought.

	1	2	3	4	5	6
Section 1: Physical resources of simulation units						
The choice of equipment and manikin should be governed by the learning objectives for the simulation.						
Video recording capacity is important for review during debriefing.						
Video streaming is important to allow additional students to observe from another area.						
Use of audio equipment to allow the manikin to talk and respond to questions is critical to fidelity						
Paper based logs are as effective as video logs for debriefing purposes						
Up to date, locally used hospital equipment such as intravenous infusion pumps, resuscitation equipment and patient charts are important for achieving fidelity						
A control room that makes staff invisible to students is an important part of "suspending disbelief" for high fidelity simulation.						
Comments						

	1	2	3	4	5	6
Section 2: Manikin fidelity level						
The selection of high, medium, or low fidelity manikins or part task trainers should be based on learning objectives.						
Medium fidelity manikins are as effective as high fidelity manikins for all learning outcomes.						
High fidelity manikins that allow the simulation of physiological signs such as breathing and blood pressure are critical in allowing students to respond to deteriorating patient situations.						
Additional features of high fidelity manikins such as blinking, sweating, bleeding and cyanosis contribute significantly to realism.						
High fidelity manikins are not needed for beginning level students						

High fidelity manikins are valuable at all levels for teaching communication skills and holistic care.						
The fidelity of the scenario itself and the created environment are more important than the fidelity level of the manikin						
Comments						

	1	2	3	4	5	6
Section 3: Information and communication technology (ICT) resources and use						
All clinical laboratories should have some form of computer access						
Computer hardware for clinical laboratories should be mobile						
Computer hardware in laboratories should be the same as that used in local hospitals						
Students should be taught how to use software applications in laboratories throughout their program.						
Software used in laboratories should be similar to that used in hospitals						
Software used in laboratories should be chosen to support students' learning needs						
Pharmacology software is the most important material for students to have access to in clinical laboratories.						
Students should have electronic access to pathology and radiology results during high fidelity simulations.						
Students have limited or no time during a simulation to consult data bases and other ICT materials						
Students often lack the ICT skills necessary for effective use of the technology.						
Comments						

	1	2	3	4	5	6
Section 4: Staffing resources and training						
Academic staff with interest and ability in simulation activities should be selected to design and implement simulation.						
The ability of the staff member to adjust the physiological parameters of the manikin in response to students' interventions is crucial when teaching the management of the deteriorating patient						

The ability of the staff member implementing the simulation to take on the voice role of the patient is crucial when teaching communication						
The ability of staff to assist students to integrate theory and practice during debriefing is critical to achieving student learning.						
Advanced ICT skills are crucial for staff involved in simulation						
Availability of adequate training for all simulation staff is critically important						
Technical staff should be available to support academic staff in setting up, dismantling and maintaining simulation equipment						
Comments						
	1	2	3	4	5	6
Section 5: Teaching and learning approaches						
Preparation:						
The curriculum matrix should ensure that appropriate theoretical knowledge and practical skills have been taught prior to the simulation activity.						
Structured orientation of the students to the simulation unit, features of the manikin and simulation procedures should be given prior to the simulation						
Students need to be aware of the learning objectives prior to the simulation activity						
Students should be presented with a scenario situation but not specific objectives prior to simulation to encourage real time critical thinking and problem solving						
The number of students per manikin should vary depending on the complexity and objectives of the simulation						
Comments						

Conducting simulation sessions	1	2	3	4	5	6
Observers benefit from simulations as much as active participants.						
Having observers as well as participants for simulation activities is mainly employed due to student numbers and time constraints.						
Observers should view the simulation from another room through one way glass or via video streaming.						
Having specific roles for observers such as critiquing a particular participant, or marking off a list of actions taken improves observer involvement.						
Fully immersive simulation in which the participants have to react to the scenario in real time without staff support should be used for all simulations and all student levels.						
The level of immersion should vary depending on students' level of experience and the objectives of the simulation activity.						
Use of staff or students, in addition to manikins, to role play family members or doctors is needed to teach communication skills and teamwork.						
Simulations are most effective when there are inter-professional learning opportunities provided.						
Comments						

Debriefing	1	2	3	4	5	6
Debriefing immediately following the simulation is critical to quality teaching and learning.						
Reviewing the video or log recording of the simulation during the debriefing is an important tool for students to critique their own practice.						
Encouraging student reflection and self-evaluation is the most important element of the debriefing process.						
Evaluation of non-technical skills such as communication with the patient and teamwork should be part of every debriefing.						
Student feedback on their experience should be part of every debriefing.						
A structured method of some type should be used to ensure effective debriefing.						
Comments						

Assessment using simulation	1	2	3	4	5	6
Simulation should be used as a formative assessment strategy only.						
Student performance during simulation is indicative of their level of performance on clinical placement.						
Simulation should not be used as a high stakes assessment strategy.						
Simulation can be used for high stakes assessment providing student familiarity with the manikin and process, a well- constructed scenario, skilful staff implementation and the use of a validated assessment tool can be guaranteed.						
When using simulation for assessment the assessment tool used must specifically target the domains and competencies being assessed.						
Comments						

Section 6: Curriculum integration and pedagogical principles	1	2	3	4	5	6
Having clear learning objectives to guide the design of the simulation is a critical element of quality use of simulation.						
The development of a curriculum matrix with integrated simulation activities provides the foundation for choices related to provision of resources and staffing.						
A clinical reasoning/clinical decision making model should be taught throughout the curriculum to support simulation activities.						
Use of ICT should be taught and integrated throughout the curriculum.						
Use of ICT should be integrated into simulation activities.						
Simulation activities should occur across all years of the undergraduate program, across all clinically based courses, and addressing a wide range of learning objectives.						
The use of an appropriate educational theory, or model as a theoretical basis for simulation activities is crucial.						
Both behaviourist and constructivist approaches are appropriate as indicated by learning objectives.						
Student feedback should be used to evaluate and refine simulation activities.						
Simulation scenarios should increase in complexity as students progress through the program.						
High fidelity HPSM should be used to teach technical skills.						
High fidelity HPSM should be used to teach non-technical skills such as holistic care, patient communication, patient education and teamwork.						

High fidelity HPSM should be used to teach clinical reasoning and clinical decision making.						
A range of simulation technologies including low, medium and high fidelity HPSM should be utilised based on learning objectives, technological capacity and cost effectiveness.						
Comments						

Appendix XII – Mean Score Results of Rankings for Round 2 Delphi Questionnaire

	1	2	3	4	5	6
Section 1: Physical resources of simulation units						
The choice of equipment and manikin should be governed by the learning objectives for the simulation.	4.55					
Video recording capacity is important for review during debriefing.	3.73					
Video streaming is important to allow additional students to observe from another area.	3.73					
Use of audio equipment to allow the manikin to talk and respond to questions is critical to fidelity	4.18					
Paper based logs are as effective as video logs for debriefing purposes	4					
Up to date, locally used hospital equipment such as intravenous infusion pumps, resuscitation equipment and patient charts are important for achieving fidelity	4.64					
A control room that makes staff invisible to students is an important part of “suspending disbelief” for high fidelity simulation.	4.09					

	1	2	3	4	5	6
Section 2: Manikin fidelity level						
The selection of high, medium, or low fidelity manikins or part task trainers should be based on learning objectives.	4.55					
Medium fidelity manikins are as effective as high fidelity manikins for all learning outcomes.	2.82					
High fidelity manikins that allow the simulation of physiological signs such as breathing and blood pressure are critical in allowing students to respond to deteriorating patient situations.	4.18					
Additional features of high fidelity manikins such as blinking, sweating, bleeding and cyanosis contribute significantly to realism.	4.09					
High fidelity manikins are not needed for beginning level students	3.09					
High fidelity manikins are valuable at all levels for teaching communication skills and holistic care.	3.55					
The fidelity of the scenario itself and the created environment are more important than the fidelity level of the manikin	4.36					

Section 3: Information and communication technology (ICT) resources and use	1	2	3	4	5	6
All clinical laboratories should have some form of computer access	4.27					
Computer hardware for clinical laboratories should be mobile	3.55					
Computer hardware in laboratories should be the same as that used in local hospitals	3.91					
Students should be taught how to use software applications in laboratories throughout their program.	3.82					
Software used in laboratories should be similar to that used in hospitals	4.0					
Software used in laboratories should be chosen to support students' learning needs	4.36					
Pharmacology software is the most important material for students to have access to in clinical laboratories.	2.36					
Students should have electronic access to pathology and radiology results during high fidelity simulations.	3.55					
Students have limited or no time during a simulation to consult data bases and other ICT materials	2.18					
Students often lack the ICT skills necessary for effective use of the technology.	3.73					

Section 4: Staffing resources and training	1	2	3	4	5	6
Academic staff with interest and ability in simulation activities should be selected to design and implement simulation.	4.0					
The ability of the staff member to adjust the physiological parameters of the manikin in response to students' interventions is crucial when teaching the management of the deteriorating patient	4.27					
The ability of the staff member implementing the simulation to take on the voice role of the patient is crucial when teaching communication	3.73					
The ability of staff to assist students to integrate theory and practice during debriefing is critical to achieving student learning.	4.91					
Advanced ICT skills are crucial for staff involved in simulation	3.82					
Availability of adequate training for all simulation staff is critically important	4.91					
Technical staff should be available to support academic staff in setting up, dismantling and maintaining simulation equipment	4.27					

Section 5: Teaching and learning approaches	1	2	3	4	5	6
<i>Preparation:</i>						
The curriculum matrix should ensure that appropriate theoretical knowledge and practical skills have been taught prior to the simulation activity.	4.3					
Structured orientation of the students to the simulation unit, features of the manikin and simulation procedures should be given prior to the simulation	4.91					
Students need to be aware of the learning objectives prior to the simulation activity	3.91					
Students should be presented with a scenario situation but not specific objectives prior to simulation to encourage real time critical thinking and problem solving	3.27					
The number of students per manikin should vary depending on the complexity and objectives of the simulation	4.10					

Conducting simulation sessions	1	2	3	4	5	6
Observers benefit from simulations as much as active participants.	3.73					
Having observers as well as participants for simulation activities is mainly employed due to student numbers and time constraints.	3.40					
Observers should view the simulation from another room through one way glass or via video streaming.	3.45					
Having specific roles for observers such as critiquing a particular participant, or marking off a list of actions taken improves observer involvement.	4.18					
Fully immersive simulation in which the participants have to react to the scenario in real time without staff support should be used for all simulations and all student levels.	2.6					
The level of immersion should vary depending on students' level of experience and the objectives of the simulation activity.	4.33					
Use of staff or students, in addition to manikins, to role play family members or doctors is needed to teach communication skills and teamwork.	4.36					
Simulations are most effective when there are inter-professional learning opportunities provided.	3.27					

Debriefing	1	2	3	4	5	6
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Debriefing immediately following the simulation is critical to quality teaching and learning.	4.82					
Reviewing the video or log recording of the simulation during the debriefing is an important tool for students to critique their own practice.	3.82					
Encouraging student reflection and self-evaluation is the most important element of the debriefing process.	4.64					
Evaluation of non-technical skills such as communication with the patient and teamwork should be part of every debriefing.	4.73					
Student feedback on their experience should be part of every debriefing.	4.60					
A structured method of some type should be used to ensure effective debriefing.	4.55					

Assessment using simulation	1	2	3	4	5	6
Simulation should be used as a formative assessment strategy only.	2.73					
Student performance during simulation is indicative of their level of performance on clinical placement.	3.20					
Simulation should not be used as a high stakes assessment strategy.	2.82					
Simulation can be used for high stakes assessment providing student familiarity with the manikin and process, a well-constructed scenario, skilful staff implementation and the use of a validated assessment tool can be guaranteed.	3.82					
When using simulation for assessment the assessment tool used must specifically target the domains and competencies being assessed.	4.27					

Section 6: Curriculum integration and pedagogical principles	1	2	3	4	5	6
Having clear learning objectives to guide the design of the simulation is a critical element of quality use of simulation.	4.55					
The development of a curriculum matrix with integrated simulation activities provides the foundation for choices related to provision of resources and staffing.	4.45					
A clinical reasoning/clinical decision making model should be taught throughout the curriculum to support simulation activities.	4.36					
Use of ICT should be taught and integrated throughout the curriculum.	4.27					
Use of ICT should be integrated into simulation activities.	4.09					
Simulation activities should occur across all years of the undergraduate program, across all clinically based courses, and addressing a wide range of learning objectives.	4.55					
The use of an appropriate educational theory, or model as a theoretical basis for simulation activities is crucial.	4.45					
Both behaviourist and constructivist approaches are appropriate as indicated by learning objectives.	4.36					
Student feedback should be used to evaluate and refine simulation activities.	4.36					
Simulation scenarios should increase in complexity as students progress through the program.	4.73					
High fidelity HPSM should be used to teach technical skills.	2.73					
High fidelity HPSM should be used to teach non-technical skills such as holistic care, patient communication, patient education and teamwork.	4.0					
High fidelity HPSM should be used to teach clinical reasoning and clinical decision making.	4.18					
A range of simulation technologies including low, medium and high fidelity HPSM should be utilised based on learning objectives, technological capacity and cost effectiveness.	4.91					

Appendix XIII – Top Quality Indicators

The following statements were highest ranked statement derived from the Delphi round 2, based on mean scores from rankings given.

Statements ranked 4.91 average

Staffing

The ability of staff to assist students to integrate theory and practice during debriefing is critical to achieving student learning.

Availability of adequate training for all simulation staff is critically important.

Simulation process

Structured orientation of the students to the simulation unit, features of the manikin and simulation procedures should be given prior to the simulation

Curriculum integration

A range of simulation technologies including low, medium and high fidelity HPSM should be utilised based on learning objectives, technological capacity and cost effectiveness.

Statements ranked 4.82 average

Process/debriefing

Debriefing immediately following the simulation is critical to quality teaching and learning.

Statements ranked 4.73 average

Process/debriefing

Evaluation of non-technical skills such as communication with the patient and teamwork should be part of every debriefing.

Curriculum integration

Simulation scenarios should increase in complexity as students progress through the program.

Statements ranked 4.64 average

Equipment

Up to date, locally used hospital equipment such as intravenous infusion pumps, resuscitation equipment and patient charts are important for achieving fidelity

Process/Debriefing

Encouraging student reflection and self evaluation is the most important element of the debriefing process.

Statements ranked 4.6 average

Process/Debriefing

Student feedback on their experience should be part of every debriefing.

Statements ranked 4.55 average

Equipment

The choice of equipment and manikin should be governed by the learning objectives for the simulation.

The selection of high, medium, or low fidelity manikins or part task trainers should be based on learning objectives.

Process/Debriefing

A structured method of some type should be used to ensure effective debriefing.

Curriculum integration

Having clear learning objectives to guide the design of the simulation is a critical element of quality use of simulation.

Simulation activities should occur across all years of the undergraduate program, across all clinically based courses, and addressing a wide range of learning objectives.

Statements ranked 4.45 average

Curriculum integration and pedagogical principles

The development of a curriculum matrix with integrated simulation activities provides the foundation for choices related to provision of resources and staff.

The use of an appropriate educational theory or model as a theoretical basis for simulation activities is critical.

Appendix XIV – Quality Indicator Statements

Below are the Quality Indicator Statements as sent to Delphi participants in round 3 for confirmation and comments. These statements were constructed based on the highest ranking scores for round 2, with modifications based on content analysis of participants' comments from round 2.

Quality Indicator Statements for Simulated Learning Experiences Using Human Simulation Manikins

1. Each simulation experience is based on clear learning outcomes that are aligned with curriculum and course objectives.
2. The curriculum matrix clearly illustrates how simulation experiences are integrated throughout program.
3. Simulation experiences are integrated into every clinical course.
4. Simulation experiences progress in complexity throughout the program.
5. There is adequate scaffolding of learning experiences throughout the curriculum to ensure that the required theoretical knowledge, psychomotor skills, ICT skills, clinical reasoning processes and use of health care technologies have been taught prior to their implementation in simulated clinical situations.
6. Learning outcomes are used to guide all aspects of simulation design including: student preparation activities, group size, inclusion of observers or students from other disciplines, selection of manikin and other equipment, level of student support during the simulation, and method of debriefing.
7. A range of simulation technologies and methods are used based on learning outcomes, available resources and cost effectiveness. These may include low, medium or high fidelity human patient manikins, part-task trainers, hybrid simulations, actors or standardised patients.
8. Staff members engaged in designing scenarios, conducting the simulation session and managing the technology have undergone appropriate training; and where possible are credentialed for their defined roles.

9. Staff members designing simulation activities have relevant clinical knowledge as well as an understanding of curriculum structure and manikin technological capabilities.
10. A structured orientation is provided for students prior to the simulation session and includes: introduction to and an opportunity to become familiar with the structure, timing and process of the session; the simulation environment, equipment, manikin, monitoring devices, and information and communication technology to be used.
11. Environmental fidelity is maintained using up to date hospital equipment and hard copies or electronic patient information and charts.
12. A structured debriefing is provided immediately following the simulation.
13. Staff facilitating simulation sessions having the relevant clinical knowledge and understanding of course objectives in order to assist students to relate theory to practice during debriefing.
14. The debriefing facilitates students' reflection on practice, self-evaluation and feedback on their perceptions of the experience.
15. Opportunities for discussion and reflection on students' non-technical skills such as clinical decision making, communication, patient's psycho-social care, leadership and teamwork are included in each debriefing.

Appendix XV – Definitions

The following are definitions of key terminology used throughout this document and as part of the instruction to study participants.

Simulation is “an attempt to mimic essential aspects of a clinical situation” (National League for Nursing, 2010)

Human patient simulation manikins (HPSM) are any part or complete human body shaped manikin used to simulate a real person. This distinguishes HPSM from other forms of simulation such as role play, standardised patients (actors) or online virtual reality programs.

Fidelity is used to describe the degree to which a simulation approaches reality.

Simulation fidelity refers to the “physical, contextual and emotional realism” (National League for Nursing, 2010). HPSM technology is usually described as low, medium or high fidelity.

Low fidelity manikins have a basic anatomical structure, either full or part body, are static, and have no capacity to display physiological signs or respond to nursing interventions.

Medium (or moderate) fidelity manikins are more realistic, and have breath sounds (but no chest movement), heart sound and pulses. Physiological signs can be controlled by a manually operated remote control, but can also have computerised scenario building capabilities. An example is Laerdal’s Nursing AnneTM or Nursing KellyTM with VitalSimTM.

High fidelity manikins or simulators outwardly appear more realistic, but perhaps more importantly have a greater capacity to display physiological signs and respond to students’ interventions. Latest models have chest and eye movement, can sweat, bleed and pass urine, have computer programmable complex physiological parameters that respond to interventions including medications, bedside screen physiological monitoring, and an in-built audio system to allow the operator to communicate in the

role of the patient, as well as a range of programmable vocalisations. An example is Laerdal's SimMan 3GTM (Seropian, 2004a; Laerdal, 2010).

Information communication technology (ICT) refers to any form of computer hardware or software being used as part of nursing education in clinical laboratories. This could include desktop or laptop computers, notebooks, or personal digital assistants (PDAs).